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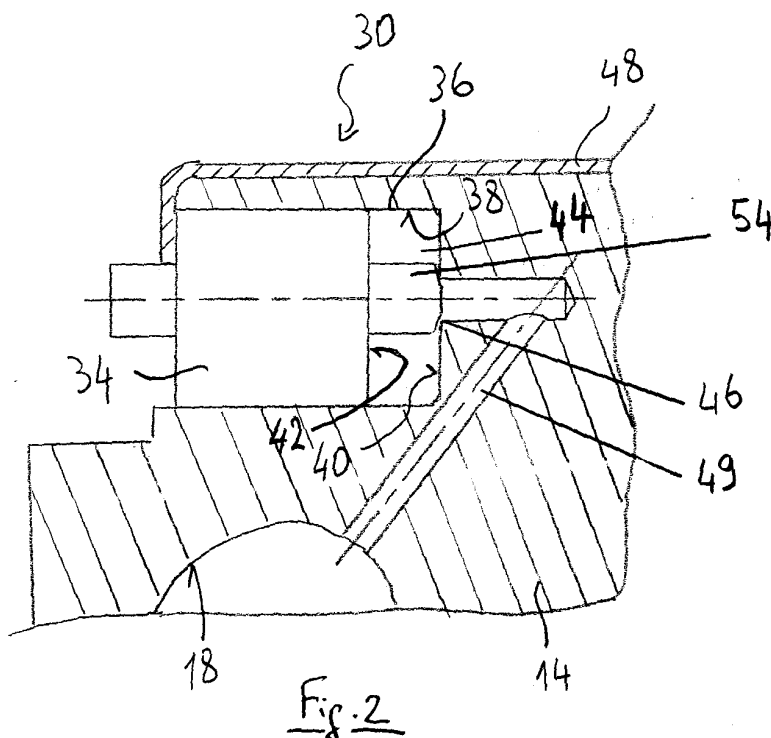
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(54) **Rocker arm assembly for a valve train**

(57) A rocker arm assembly comprises a latch member (48) moveable between a first position to provide a first rocker arm assembly configuration and a second position to provide a second rocker arm assembly configuration. The assembly further includes latch actuating means (30) comprising a piston (34) reciprocally arranged in a piston bore (36) and coupled to the latch member (48) for moving the latch member (48) from the first position to the second position. The piston (34) has a pressure surface (42) defining with the piston bore (36) a hydraulic chamber (44), the hydraulic chamber (44)

comprising an inlet for a pressurized hydraulic medium so as to move the piston 34() under the action of hydraulic pressure. According to an important aspect of the invention, the hydraulic chamber (44) and piston pressure surface (42) are designed in such a way that, in a first position of the piston (34), only a first area of the pressure surface (42) is exposed to pressurized hydraulic medium and, as from a second position of said piston (34), a second area of the pressure surface (42), larger than the first area, is exposed to pressurized hydraulic medium.



Description**FIELD OF THE INVENTION**

[0001] The present invention generally relates to a rocker arm assembly for a valve train, which has variable valve lift capability.

BACKGROUND OF THE INVENTION

[0002] Variable valve activation mechanisms for internal combustion engines are well known. For example, it is known to be desirable to lower the lift, or even provide no lift at all, of one or more valves of a multiple-cylinder engine, especially intake valves, during periods of high engine load.

[0003] A conventional two-step finger follower type rocker arm assembly includes an elongate, rigid main rocker arm body. This main rocker arm body has a first end for engaging a conventional hydraulic lash adjuster as a pivot means, and has an interface means at a second, opposite end for engaging a valve stem of a valve to be actuated. The assembly further includes two lateral rocker arms that can be selectively coupled to the main rocker arm to provide switching between two assembly configurations so as to obtain two different valve lift capabilities. This coupling is typically achieved by means of a latch member mounted on the main rocker arm. The latch member is moveable between a first, rest position, in which the lateral rocker arms are uncoupled, and a second position coupling the main rocker arm to the lateral rocker arms. In the first latch member position, the valve lift is only due to the action of a central cam on the main rocker arm, whereas in the second latch position, the valve lift is due to the action of associated lateral cams on the lateral rocker arms.

[0004] In order to actuate the latch member, a piston coupled to the latter is arranged in the main body. This piston is reciprocally arranged in a piston bore and defines therewith a hydraulic chamber, which is in communication with the socket via an oil feed channel. Actuation of the piston is achieved by increasing the oil pressure delivered by the HLA so as to move the piston against a return spring that biases the latch member in the uncoupled position.

[0005] It is desirable that the switching be carried out as rapidly as possible, which requires a relatively high force on the piston to move it rapidly. Unfortunately, the maximal oil pressure level is limited, especially under hot idle conditions. This makes the actuation of such a rocker arm assembly slow, insecure, with lots of variations.

OBJECT OF THE INVENTION

[0006] The object of the present invention is to provide a rocker arm assembly having an improved switching capability. This object is achieved by a rocker arm as-

sembly as claimed in claim 1.

SUMMARY OF THE INVENTION

[0007] A rocker arm assembly according to the present invention comprises a latch member moveable between a first position to provide a first rocker arm assembly configuration and a second position to provide a second rocker arm assembly configuration. The assembly further includes latch actuating means comprising a piston reciprocally arranged in a piston bore and coupled to the latch member for moving the latch member from the first position to the second position. The piston has a pressure surface defining with the piston bore a hydraulic chamber, the hydraulic chamber comprising an inlet for a pressurized hydraulic medium so as to move the piston under the action of hydraulic pressure.

[0008] According to an important aspect of the invention, the hydraulic chamber and piston pressure surface are designed in such a way that, in a first position of the piston, only a first area of the pressure surface is exposed to pressurized hydraulic medium and, as from a second position of said piston, a second area of the pressure surface, larger than the first area, is exposed to pressurized hydraulic medium.

[0009] This design of the actuating means provides a kind of "boost" effect in the displacement of the piston, due to a sudden increase in the actuating force. When the piston is in the first position, the initially low oil pressure (typical hydraulic medium) only acts on the first area of the piston. As the oil pressure increases and the piston is moved to the second position, the oil pressure suddenly acts on the second, larger area, causing a sudden and substantial increase in the pressure acting on the piston, and thereby rapidly moving the piston and thus the latch member. Such a rapid displacement of the latch member is advantageous in that it permits a rapid and precise switching from the first to the second rocker arm assembly configuration.

[0010] Advantageously, to provide a large variation in actuating force, the first area represents a minor portion of the piston pressure surface and the second area represents a comparatively predominant portion of the piston pressure surface. Preferably, the second area corresponds to the total area of the pressure surface, including the first area.

[0011] In a preferred embodiment, the hydraulic chamber is defined by a lateral side wall and an end wall of the piston bore, and the inlet for the pressurized hydraulic medium is arranged in the end wall. The piston head comprises a protruding pin extending towards the end wall so as to form a stepped pressure surface. In the first position of the piston, this protruding pin obstructs the inlet of the hydraulic chamber. In the first position, the piston surface that is exposed to the pressure (i.e. first area) is the pin area that coincides with the cross-sectional area of the inlet. When the piston reach-

es the second position, typically as soon as the pin will not any more obstruct the inlet, the full piston surface (i. e. area of the pin plus of the remaining piston head surface) will be exposed to the pressurised hydraulic medium. Of course, varying the dimensions of first and second area allows to play on the boost effect.

[0012] Although such a design is preferred for its efficiency and ease of implementation, a variety of designs can be envisaged to provide a first, reduced area and a second, large pressure area.

[0013] The rocker arm assembly preferably has a main rocker arm having a body, which comprises a socket for engaging a pivot at a first end and an interface means for engaging a valve stem at a second end of the body.

[0014] Preferably, the latch actuating means are provided in the main rocker arm body. A feed channel thus advantageously connects the socket to the inlet in the end wall of the hydraulic chamber and the pivot is a hydraulic lash adjuster having a nose portion engaging said socket and provided with a bore for said hydraulic medium. The use of such a HLA permits to control the valve lift switching by varying the oil pressure delivered to the rocker arm assembly by the HLA.

[0015] The assembly preferably further includes spring means for biasing the latch member in a direction opposite to the direction in which the piston is moved due to action of the hydraulic medium on said piston pressure surface, the piston and latch member being coupled by a rigid coupling element. This allows to bring the piston back in its first position by simply diminishing the hydraulic medium pressure in the feed channel, thereby also switching from the second to the first assembly configuration.

[0016] The present rocker arm assembly is preferably designed as a two-step finger follower rocker arm assembly, which includes two lateral rocker arms, one on each side of the main rocker arm. In such a case, the latch member, in its second position, shall engage co-operating latch surfaces of the lateral rocker arms.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG.1: is a longitudinal section view of a preferred embodiment of a rocker arm assembly according to the invention:

FIG.2: is a detailed view of the latch actuating means in a first, rest position;

FIG.3: is a detailed view of the latch actuating means in its end position; and

FIG.4: is a graph showing the hydraulic force on the

piston, the spring force on the piston and the total force on the piston as well as the piston travel in function of oil pressure.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0018] Fig.1 shows a preferred embodiment of a rocker arm assembly 10 for variably activating a gas valve in an internal combustion engine. This rocker arm assembly 10 is of the so-called two-step finger follower type, so that the rocker arm assembly 10 configuration can be varied to provide two different valve lift capabilities. The assembly 10 includes a main rocker arm 12 having a rocker arm body 14 and a lateral rocker arm 16. The main rocker arm 12 has at a first end a spherical socket 18 for receiving the head of a hydraulic lash adjuster (HLA, 19) so as to provide a pivotal mounting of the assembly 10 in the engine. At a second, opposite end, the main rocker arm 12 is provided with an arcuate pad 20 for interfacing with and actuating a valve stem 21. Preferably, for symmetry reasons, a second lateral rocker arm (not shown) is usually provided on the other side of the main rocker arm 12. Such a rocker arm assembly 10 cooperates with the camshaft, which has one main cam for engaging an outer surface 24 of the main rocker arm 12, as well as two lateral cams for engaging respective outer surfaces 26 on the lateral rocker arms 16.

[0019] The assembly 10 further includes a latch member 48 that can be actuated by a latch actuating means, generally indicated 30, in order to couple or uncouple the lateral rocker arms to the main rocker arm 12 so as to vary the configuration of the assembly 10 and thus the valve lift capability. Only the part of the latch member 48, which is connected to the latch actuating means 30, is shown in the figures. The latch member 48 can be any sort of mechanism capable of coupling the lateral rocker arms 16 to the main rocker arm 12, resp. of uncoupling the lateral rocker arms 16 from the main rocker arm 12. When the latch member 48 is not engaged, the lateral and main rocker arms are uncoupled. Therefore, it is the action of the central cam on the main rocker arm outer surface 24 that determines the valve lift. In this configuration, the action of the lateral cams on the lateral rocker arms 16 has no incidence on the valve lift, as the lateral rocker arms rock in a lost motion.

[0020] When the latch member 48 is engaged, a rigid coupling of the lateral rocker arms 16 with the main rocker arm 12 is achieved. This provides a second assembly configuration, in which the valve activation is due to the action of the lateral cams on the outer surfaces 26 of the lateral rocker arms 16, and the valve lift is determined by the design of these elements.

[0021] It will be understood that, as is typically the case in rocker arm assemblies with variable lift capability, the actuation of the latch member is carried out at a certain relative position between main and lateral rocker

arms, to ensure a proper engagement of the latch member with latch surfaces of the lateral rocker arms. In this connection, it is desirable to be capable of performing a rapid switching, i.e. rapidly moving the latch member.

[0022] Referring more precisely to the latch actuating means 30 illustrated in Fig.2, it comprises a piston 34 reciprocally mounted in a piston bore 36 having a cylindrical lateral wall 38 and an end wall 40. The piston has a head with a pressure surface 42 defining with the lateral and end walls 38, 40 of the piston bore 36 a hydraulic chamber 44. The hydraulic chamber 44 comprises an inlet 46 for a pressurized hydraulic medium, normally engine oil, so as to move the piston 34 under the action of hydraulic pressure. The inlet 46 is in communication with the socket 18 via an oil feed channel 49.

[0023] The piston 34 is coupled to the latch member 48. As can be seen, the latch member 48 is preferably biased in its rest position by means of a spring 50, pushing the latch member 48 in a direction aligned with the axis of the piston bore 36.

[0024] In the present embodiment, the piston head comprises a protruding pin 54 extending towards the end wall 40, thereby forming a stepped pressure surface 42. In the first piston position, as illustrated in Fig.2, the pin 54 obstructs the oil inlet 46, thereby hydraulically sealing the chamber 44 from the oil feed channel 49. Advantageously, the end of the pin 54 resting on the inlet 46 preferably has an annular sealing surface that cooperates with an annular seat of the inlet 46. In this first piston position, which is the rest position, only the pin area coinciding with the feed channel 49 is exposed to the actuating oil pressure delivered from the HLA via the oil feed channel 49. Indeed, the oil pressure required to actuate the piston is delivered by the HLA which, in addition to its lash adjusting function, has in its nose engaging the socket 18 an oil bore for delivering oil to the feed channel 49 so as to achieve a "switching" function.

[0025] In order to switch to the other assembly configuration, the piston 34 must be moved towards the left for engaging the lateral rocker arms, and e.g. ultimately to the end position shown in Fig.3. When such a switching is desired, the engine control module (ECM) will increase the oil pressure delivered to the HLA, so as to increase the oil pressure in feed channel 49. As long as the force resulting from the oil pressure acting on the pin 54 does not overcome the spring force the piston 34 remains in the rest position.

[0026] As the oil pressure in feed channel 49 will be sufficient to lift the piston 34 from its seat on the inlet 46, the oil pressure will be instantaneously transferred to the whole piston pressure surface 42, which is thus much larger than the initially exposed pin area. This will cause a sudden and substantial increase in the force exerted on the piston head, which will accordingly make a sudden shift to the left. In other words, the present latch actuating means 30 provides a kind of "boost" effect as soon as the spring force is overcome by the oil pressure in feed channel 49. This permits the latch

member 48 to rapidly engage the lateral rocker arms 16 with the main rocker arm 14. It then suffices to further increase the oil pressure to bring the latch member into its end position as shown in Fig.3.

[0027] This "boost" effect will also clearly appear from Fig.4, which is a graph illustrating, as a function of oil pressure :

- the force acting on the piston due to oil pressure (indicated by line 60);
- the spring force acting on the piston (indicated by line 62);
- the total force acting on the piston (indicated by line 64); and
- the piston travel (indicated by line 66).

[0028] As can be seen, as long as the oil pressure in feed channel 49 is below 1 bar (arbitrary value), the piston 34 remains in the rest position (Fig.2), as the total force is globally negative. The force acting on the piston 34 due to the oil pressure is equal to the product of the oil pressure by the pin surface coinciding with the inlet 46. As soon as the oil pressure reaches 1 bar, the spring force is counterbalanced and the piston 34 is lifted off its seat on the inlet 46. The oil pressure from feed channel 49 is thus instantaneously transmitted to the hydraulic chamber 44, so that the whole piston surface 42 (annular area plus pin area) is exposed to that oil pressure. This causes a sudden increase in the force acting on the piston 34 due to the oil pressure, as it becomes equal to the product of the whole pressure surface area (including pin area) by the oil pressure. This leads to a sudden and substantial displacement of the piston, as indicated by line 66 at the oil pressure of about 1 bar. Further increasing the oil pressure will then cause a linear increase of the force acting on the piston 34 due to oil pressure, and thus induce a linear displacement of the piston 34 towards the left to ultimately reach the end position of Fig.3.

LIST OF REFERENCE SIGNS

[0029]

- 10 rocker arm assembly
- 12 main rocker arm
- 14 rocker arm body
- 16 lateral rocker arm
- 18 spherical socket
- 19 hydraulic lash adjuster HLA
- 20 arcuate pad
- 21 valve stem
- 22 pivot shaft
- 24 outer surface of main rocker arm
- 26 outer surface of lateral rocker arm

30 latch actuating means
 34 piston
 36 piston bore
 38 cylindrical lateral wall
 40 end wall
 42 piston pressure surface
 44 hydraulic chamber
 46 pressurized oil inlet
 48 latch member
 50 spring
 54 piston pin
 60 hydraulic force on the piston
 62 spring force on the piston
 64 total force on piston
 66 piston travel

Claims

1. Rocker arm assembly for variably activating a gas valve in an internal combustion engine, said rocker arm assembly having at least two configurations to vary its valve lift capability, said rocker arm assembly comprising:

a latch member moveable between a first position to provide a first rocker arm assembly configuration and a second position to provide a second rocker arm assembly configuration;

latch actuating means comprising a piston reciprocally arranged in a piston bore and coupled to said latch member for moving said latch member from said first position to said second position, wherein said piston has a piston head with a pressure surface defining with said piston bore a hydraulic chamber, said hydraulic chamber comprising an inlet for a pressurized hydraulic medium so as to move said piston under the action of hydraulic pressure;

characterised in that

said hydraulic chamber and piston pressure surface are designed in such a way that, in a first position of said piston, only a first area of said pressure surface is exposed to pressurized hydraulic medium and, as from a second position of said piston, a second area of said pressure surface, larger than said first area, is exposed to pressurized hydraulic medium.

2. Rocker arm assembly according to claim 1, **characterised in that** said first area represents a minor portion of said pressure surface and said second area represents a predominant portion of said pressure surface.

3. Rocker arm assembly according to claim 1 or 2,

characterised in that said second area corresponds to the total area of said pressure surface, including said first area.

4. Rocker arm assembly according to claim 1 2 or 3, **characterised in that** said hydraulic chamber is defined by a lateral side wall and an end wall of said piston bore, said inlet for the pressurized hydraulic medium being arranged in said end wall; said piston head comprises a protruding pin extending towards said end wall so as to form a stepped pressure surface; and said protruding pin obstructs said inlet when said piston is in said first position.

5. Rocker arm assembly according to any one of the preceding claims, **characterised by** a main rocker arm having a body comprising a socket for engaging a pivot at a first end and having an interface means for engaging a valve stem at a second end of said body.

6. Rocker arm assembly according to any one of the preceding claims, **characterised in that** said latch actuating means are provided in said main rocker arm body.

7. Rocker arm assembly according to claim 5 and 6, **characterised in that** a feed channel connects said socket to said inlet in said end wall of said hydraulic chamber; and said pivot is a hydraulic lash adjuster having a nose portion engaging said socket and provided with a bore for said hydraulic medium.

8. Rocker arm assembly according to any one of the preceding claims, **characterised by** spring means for biasing said latch member in a direction opposite to the direction in which said piston is moved due to action of the hydraulic medium on said piston pressure surface.

9. Rocker arm assembly according to any one of the preceding claims, **characterised by** two lateral rocker arms, one on each side of said main rocker arm, wherein said latch member, in its second position, engages cooperating latch surfaces of said lateral rocker arms.

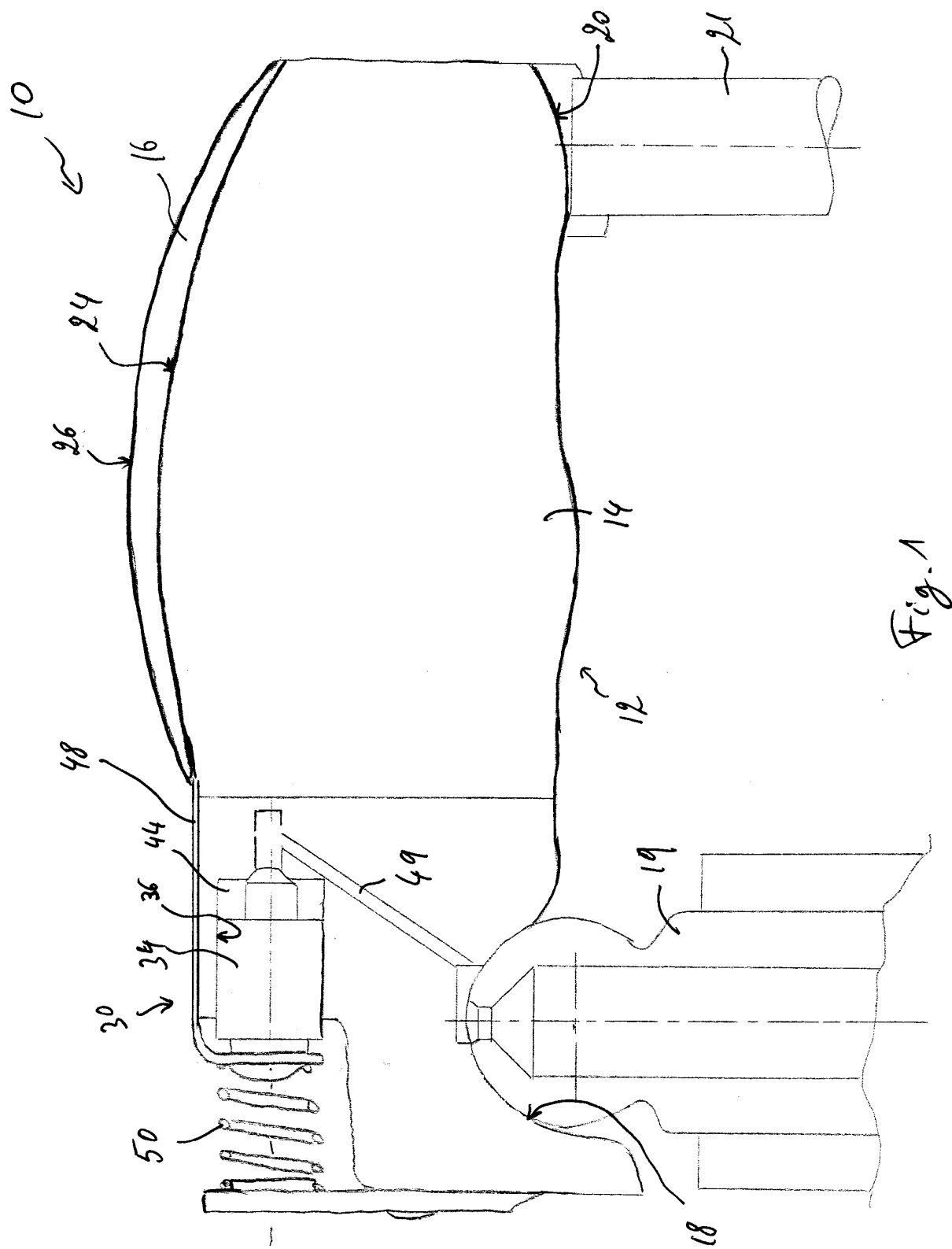
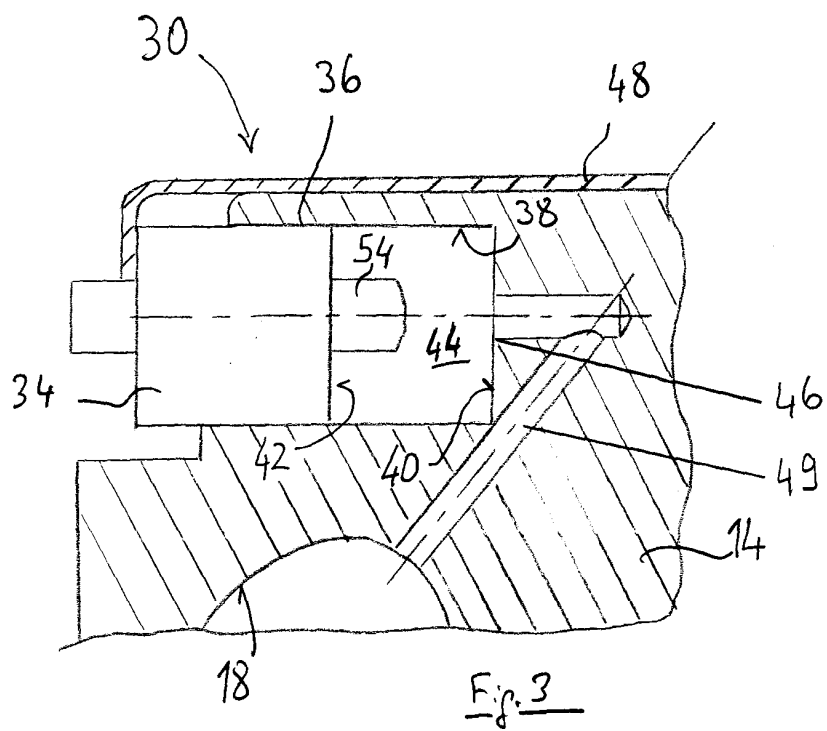
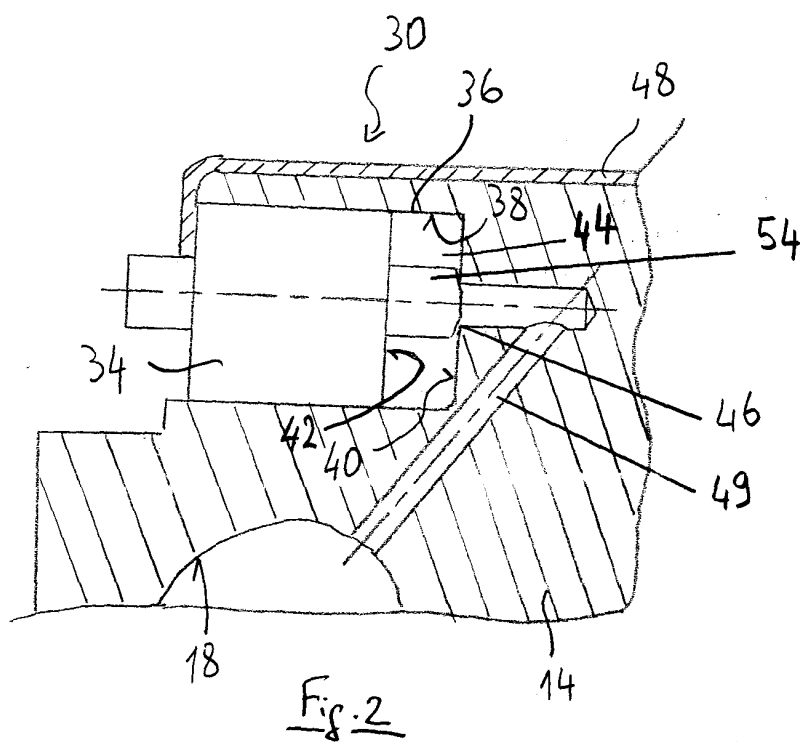


Fig. 1



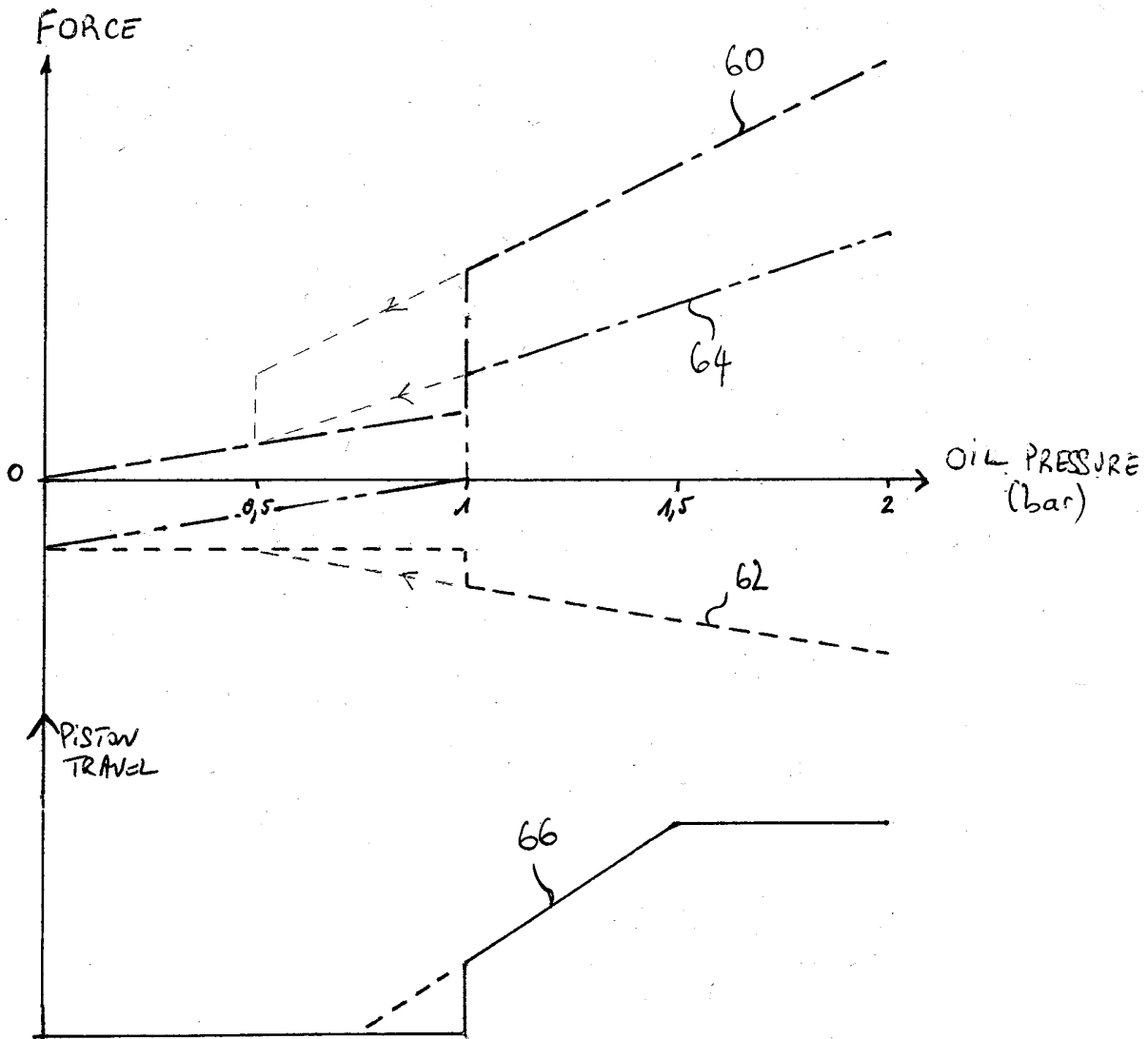


Fig. 4



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Application Number
EP 04 10 0729

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 04 10 0729

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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