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

(57) A rocker arm assembly (10) for variably activating a gas valve in an internal combustion engine has at least two configurations to vary its valve lift capability. The rocker arm assembly (10) comprises a main rocker arm body (12) having a socket (16) for engaging a pivot (18) at a first end (14) and having an interface means (24) for engaging a valve stem (26) at a second end (22). The assembly (10) further comprises a latch member (66) having latch actuating means (40) comprising a reciprocally arranged piston (44), wherein the piston (44) has a pressure surface. According to an important aspect of the invention, the assembly (10) comprises a first feed channel (56) that is arranged so as to fluidly connect a supply port (64) to a first area (52) of the pressure

surface and a second feed channel (58) that is arranged so as to fluidly connect a supply port (64) to a second area (54) of the pressure surface, the second area (54) being larger than the first area (52). The second feed channel (58) is in fluid communication with a supply port (64) only in a switching position of the main rocker arm body (10). The pressurized hydraulic medium is at a first pressure or at a second pressure, wherein the first pressure is insufficient to displace the piston (44) when acting on the first area (52) and/or the second area (54); and the second pressure is insufficient to displace the piston (44) when acting only on the first area (52), but sufficient to displace the piston (44) when acting on the second area (54).

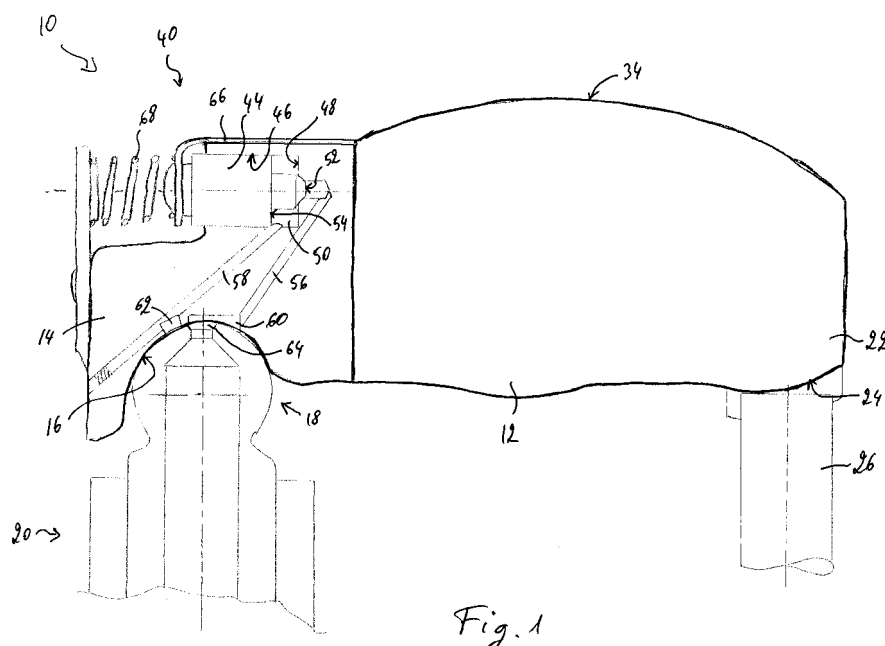


Fig. 1

Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to a rocker arm assembly for a valve train, in particular to a two-step finger follower type rocker arm assembly of a valve train.

BACKGROUND OF THE INVENTION

[0002] Variable valve activation mechanisms for internal combustion engines are well known. 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 (HLA) as a pivot means, and has an interface means at an opposite, second end for engaging a valve stem of a valve to be actuated.

[0004] 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, in which the main rocker arm is coupled to the lateral rocker arms. In the first latch position, the valve lift is only due to the action of a main cam on the main rocker arm, whereas in the second position, the valve lift is due to the action of associated lateral cams on the lateral rocker arms.

[0005] In order to actuate the latch member, a piston coupled to the latter is arranged in the main body on the socket side. 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.

[0006] Generally, known rocker arm assemblies have a random trigger mechanism for actuation. That is, at a random point of the cam revolution, the command to change the valve lift is received from an ECM. The latch member is then urged into its second position regardless of the position of the lateral rocker arms with respect to the main rocker arm. Often, the latch member is prevented from reaching the second position because the latch member hits another part of the assembly. The switch to another valve lift is delayed, causing slight drivability and emission problems. More critically, partial

switches are also possible, wherein the latch member only partially locks the lateral rocker arms to the main rocker arm such that, during the lift, the lateral rocker arms can free themselves from engagement with the main rocker arm, leading to high stress at the switching mechanism. This causes wear and tear at the switching mechanism. Worse still, the valve is let loose and either slams into its seat driven by the valve spring or slams back to the low lift profile. The valve, valve seat, cam surfaces and cam contacting surfaces of the assembly can thereby be damaged.

OBJECT OF THE INVENTION

[0007] 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 assembly as claimed in claim 1.

SUMMARY OF THE INVENTION

[0008] A rocker arm assembly for variably activating a gas valve in an internal combustion engine has at least two configurations to vary its valve lift capability. The rocker arm assembly comprises a main rocker arm body having a socket for engaging a pivot at a first end and having an interface means for engaging a valve stem at a second end. The assembly further comprises a latch member associated with the main rocker arm body, the latch member being 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 also has 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, wherein the piston has a pressure surface defining with the piston bore a hydraulic chamber, the hydraulic chamber comprising at least one inlet for a pressurized hydraulic medium so as to move the piston under the action of hydraulic pressure.

[0009] According to an important aspect of the invention, the assembly comprises a first feed channel arranged so as to fluidly connect a supply port to a first area of the pressure surface when the piston is in its first position and a second feed channel is arranged so as to fluidly connect a supply port to a second area of the pressure surface, the second area being larger than the first area. The second feed channel is in fluid communication with a supply port only in a switching position of the main rocker arm body. The pressurized hydraulic medium is at a first pressure or at a second pressure, wherein the first pressure is insufficient to displace the piston when acting on the first area and/or the second area; and the second pressure is insufficient to displace the piston when acting only on the first area, but sufficient to displace the piston when acting on the second area.

[0010] The rocker arm assembly can only be switched into its second rocker arm assembly configuration when the pressurized hydraulic medium is at the second pressure and the second feed channel is in fluid communication with a supply port. This means that, once the order has been given to switch to the second configuration and the pressure of the hydraulic medium has been increased to the second pressure, the latch member can only be moved into its second position when the main rocker arm body is in the switching position, i.e. when the main rocker arm is in a particular position with respect to a lateral rocker arm. Safe switching of the latch member is thereby guaranteed and all disadvantages of mistimed switching, such as drivability and emission problems, high stress at the switching mechanism, wear and tear at the switching mechanism, damages to valve, valve seat, cam surfaces and cam contacting surfaces, are avoided.

[0011] Preferably, 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.

[0012] Advantageously, the first and second feed channels comprise a first and second feed port arranged in the socket of the main rocker arm body; and the pivot comprises a supply port communicating with the first and second feed ports for supplying pressurized hydraulic medium to the first and second feed channels. Pressurized hydraulic medium is thereby fed to the first or second feed channel through the pivot.

[0013] According to one embodiment of the invention, the supply port communicates with a first feed port of the first feed channel when the main rocker arm body is not in the switching position; and the supply port communicates with a second feed port of the second feed channel only when the main rocker arm body is in the switching position. Pressurized hydraulic medium is thereby fed to the first or second feed channel depending on the rotational position of the socket on the pivot. This is an easy, yet effective, way of ensuring that the hydraulic medium is applied to the second area of the pressure surface only when the main rocker arm body is in the switching position.

[0014] According to another embodiment of the invention, the supply port communicates with a first feed port of the first feed channel; and the supply port communicates with a second feed port of the second feed channel. A control valve is arranged in the second feed channel for opening the second feed channel only when the main rocker arm body is in the switching position. This is an alternative way of ensuring that the hydraulic medium is applied to the second area of the pressure surface only when the main rocker arm body is in the switching position.

[0015] In this embodiment, the first and second feed ports can be fused together to form a common feed port.

[0016] The control valve preferably comprises a plunger transversely arranged in the second feed channel, and biasing means for maintaining the valve in a closed position when the main rocker arm body is not in the switching position.

[0017] The rocker arm assembly preferably further comprises a configuration switch element moveably connected to the main rocker arm body. In the first rocker arm assembly configuration, the configuration switch element is freely moveable with respect to the main rocker arm body and the valve lift is defined by a first cam surface contacting a first cam contacting surface of the rocker arm assembly. In the second rocker arm assembly configuration, the configuration switch element is locked in position with respect to the main rocker arm body and the valve lift is defined by a second cam surface contacting a second cam contacting surface of the rocker arm assembly.

[0018] The configuration switch element is preferably a pair of lateral auxiliary rocker arm bodies, the main rocker arm body being sandwiched therebetween. A main cam contacts the main rocker arm body and moves the valve according to a first valve lift configuration. When the lateral auxiliary rocker arm bodies are fixed in position with respect to the main rocker arm body, two lateral cams can enter into contact with the lateral auxiliary rocker arm bodies to move the valve according to a second valve lift configuration.

[0019] The pivot is preferably a hydraulic lash adjuster.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG.1: is a longitudinal cut-away view of a rocker arm assembly according to a first embodiment in a first position and in a first assembly mode;

FIG.2: is a longitudinal cut-away view of the rocker arm assembly according to the first preferred embodiment in a second position and in an intermediate assembly mode;

FIG.3: is a longitudinal cut-away view of the rocker arm assembly according to the first preferred embodiment in the first position and in a second assembly mode;

FIG.4: is a longitudinal cut-away view of the rocker arm assembly according to a second embodiment in the first position and in the first assembly mode;

FIG.5: is a transversal cut-away view of the control valve of Fig.4 in its first position; and

FIG.6: is a transversal cut-away view of the control valve of Fig.4 in its second position.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0021] Fig.1 shows a rocker arm assembly 10 of a valve train of an internal combustion engine. This rocker arm assembly 10 is of the so-called two-step finger follower type, so that the configuration of the rocker arm assembly 10 can be varied to provide two different valve lift capabilities. A main rocker arm body 12 has a first end 14 having a spherical socket 16 for receiving a head 18 of a hydraulic lash adjuster HLA 20. An opposite, second end 22 of the main rocker arm body 12 is provided with an actuate pad 24 for interfacing with and actuating a valve stem 26. A first lateral rocker arm body 32 is provided and pivotably mounted on the main rocker arm body 12. Preferably, a second lateral rocker arm body (not shown) is, for symmetry reasons, provided on the other lateral side of the main rocker arm body 12. Such a rocker arm assembly 10 cooperates with the camshaft (not shown), which has one main cam (not shown) for engaging a cam contacting surface 34 of the main rocker arm 12, as well as two lateral cams for engaging respective cam contacting surfaces 36 on the lateral rocker arm bodies 32.

[0022] The assembly 10 further includes a latch actuating means, generally indicated 40, in order to couple or uncouple the lateral rocker arm bodies 32 to the main rocker arm 12 so as to vary the configuration of the assembly 10 and thus the valve lift capability. When the lateral and main rocker arms 32 and 12 respectively, are uncoupled, it is the action of the central cam on the cam contacting surface 34 of the main rocker arm body 12 that determines the valve lift. In this configuration, the action of the lateral cams on the lateral rocker arm bodies 32 has no incidence on the valve lift, as the lateral rocker arm bodies rock in a lost motion.

[0023] Conversely, when the lateral and main rocker arm bodies 32,12 are coupled, a rigid coupling of the lateral rocker arm bodies 32 with the main rocker arm body 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 cam contacting surfaces 36 of the lateral rocker arm bodies 32, and the valve lift is determined by the design of these elements.

[0024] Referring more precisely to the latch actuating means 40, the latter comprises a piston 44 reciprocally mounted in a piston bore having a cylindrical lateral wall 46 and an end wall 48. The piston 44 has a head with a pressure surface defining with the lateral and end walls 46, 48 of the piston bore a hydraulic chamber 50. The pressure surface of the head of the piston 44 has a first area 52 and a second area 54, wherein the second area 54 is larger than the first area 52. The first area 52 is in communication with a first feed channel 56 for feeding pressurized hydraulic medium, normally engine oil, to

the first area 52. The second area 54 is in communication with a second feed channel 58 for feeding pressurized hydraulic medium to the second area 54.

[0025] The first feed channel 56 leads to a first feed port 60 in the socket 16 and the second feed channel 58 leads to a second feed port 62 in the socket 16. When the socket 16 is mounted on the head 18 of a HLA 20, oil is fed from a supply port 64 arranged in the head 18 to one or both of the first and second feed ports 60,62 and hence to one or both of the first and second areas 52,54.

[0026] The piston 44 is coupled to a latch member 66 for coupling the lateral rocker arm bodies 32 to the main rocker arm body 12. The latch actuating means 40 preferably comprises a spring 68 for pushing the piston 44 into a rest position as shown in Fig.1. Only the part of the latch member 66, which is connected to the latch actuating means 40, is shown in the figures. The latch member 66 can be any sort of mechanism capable of coupling the lateral rocker arm bodies 32 to the main rocker arm body 12, resp. of uncoupling the lateral rocker arm bodies 32 from the main rocker arm body 12.

[0027] When operating the rocker arm assembly 10 in the first configuration, the pressure of the oil being fed to the lash actuating means 40 is insufficient to move the piston 44 against the force of the spring 68, whether the oil is being fed to the first area 52 via the first feed channel or to the second area 54 via the second feed channel 58. The piston 44 hence remains in its rest position as shown in Fig.1.

[0028] In order to switch to the other assembly configuration, the piston 44 must be moved towards the left for engaging the lateral rocker arm bodies, 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 the first and second feed channels 56,58. The pressure of the oil is increased to a level wherein it is still insufficient to move the piston 44 against the force of the spring 68 when the pressure is only applied to the first area 52 of the pressure surface of the piston 44. The pressure is however sufficiently high to move the piston 44 against the force of the spring 68 when the pressure is applied to the second area 54 of the pressure surface of the piston 44. In practice, when switching is desired, the oil pressure is increased to a switching pressure. The piston 44 however can only be moved if the switching pressure is applied to the second area 54, i.e. when the oil is fed through the second feed channel 58.

[0029] The second feed port 62 of the second feed channel 58 is arranged so that it is only in communication with the supply port 64 of the head 18 of the HLA 20, as shown in Fig.2. This ensures that movement of the latch member 66 can only occur when the main rocker arm body 12 is in a switching position, i.e. in a position wherein the engagement of the lateral rocker arm bodies 32 with the main rocker arm body 12 is guaranteed.

All problems associated with failed or partial engagements can thereby be avoided.

[0030] In Fig.2, the main rocker arm body 12 is shown in the switching position and the supply port 64 is in communication with the second feed port 62 of the second feed channel 58. As the oil at switching pressure is now pushing on a larger area of the head of the piston 44, the latter is moved towards the left (with respect to Fig. 2) against the force of the spring 68. It will be noted that, as shown in Fig.2, the supply port 64 is also still in communication with the first feed port 60 of the first feed channel 56. This is however not necessary for the functioning of the invention, but provides an advantage in that the oil pressure can remain slightly lower as the pressure surface is bigger due to the fact that the first area is also pressurised by the oil.

[0031] While the main rocker arm body 12 is in the switching position as shown in Fig.2, and the oil is at switching pressure, the latch member 66 can engage the lateral rocker arm bodies 32 with the main rocker arm body 12 as shown in Fig.3.

[0032] While the main and lateral rocker arm bodies 12,32 are being coupled to one another, the cam continues to rotate and move the main rocker arm body 12 out of the switching position. The lateral rocker arm bodies 32 now move in harmony with the main rocker arm body 12 and the second assembly configuration is achieved. In this second assembly configuration, the valve activation is due to the action of the main cam on the cam contacting surface 34 of the main rocker arm body 12 and of the lateral cams on the cam contacting surfaces 36 of the lateral rocker arm bodies 32 and the valve lift is determined by the design of these elements.

[0033] In Fig.3, the main rocker arm body 12 is again shown in the position as in Fig.1 and the supply port 64 is in communication with the first feed port 60 of the first feed channel 60 only. No more oil is fed through the second feed channel 58. However, as the oil is still maintained at switching pressure and is fed to the pressure surface via the first feed channel 56, oil at switching pressure still acts on the first and second areas 52,54 of the pressure surface of the head of the piston 44. The piston 44 is therefore maintained in its end position and the latch member 66 still maintains the main and lateral rocker arm bodies in coupled relationship. As long as the oil is maintained at the switching pressure, the force on the piston 44 is stronger than the force of the spring 68 and the main and lateral rocker arm bodies 12,32 remain in the coupled state.

[0034] An alternative embodiment for a rocker arm assembly according to the invention is shown in Fig.4, wherein the first and second feed ports 60,62 of the previous embodiment, have been fused to a single common feed port 70. Regardless of the position of the main rocker arm body 12 with respect to the head 18 of the HLA 20, the supply port 64 is in communication with the feed port 70 and oil is fed to the first and second feed channels 56,58. However, in order to ensure that oil in only

fed through the second feed channel 58, a control valve 72 is arranged in the second feed channel 58. The control valve 72 is normally in a closed position, preventing oil from flowing through the second feed channel 58. Only when the main rocker arm body 12 is in a particular switching position, the control valve is allowed to open the second feed channel 58.

[0035] The control valve 72 and its functioning can be more clearly described by referring to Fig.5 and Fig.6. The control valve 72 comprises a plunger 74 reciprocally arranged in a bore 76. The bore 76 is arranged perpendicularly to and through the second feed channel 58. The plunger 74 is dimensioned so as to prevent any flow of oil from the common feed port 70 to the piston 44 when the plunger 74 is in a first position as shown in Fig. 5. A spring 78 is associated with the plunger 78 and acts on one end of the plunger 74, so as to push the other end of the plunger 74 against a profiled surface 80 of the lateral rocker arm body 32.

[0036] When the main and lateral rocker arm bodies 12,32 are uncoupled a relative movement exists between them. It is assumed that when the lateral rocker arm body 32 is at a particular position with respect to the main rocker arm body 12, a switching position of the main rocker arm body 12 is achieved. The profiled surface 80 of the lateral rocker arm body 32 is designed such that, in this particular position, the plunger 74 is allowed to move due to the force of the spring 78 acting on the plunger 74. The plunger 74 is brought into a second position, as shown in Fig.6, wherein a through bore 82 arranged through the plunger 74 comes into alignment with the second feed channel 58.

LIST OF REFERENCE SIGNS

[0037]

- 10 rocker arm assembly
- 12 main rocker arm body
- 14 first end
- 16 socket
- 18 head
- 20 hydraulic lash adjuster
- 22 second end
- 24 actuate pad
- 26 valve stem
- 32 lateral rocker arm body
- 34 cam contacting surface

36 cam contacting surfaces

40 latch actuating means

44 piston

5

46 lateral wall

48 end wall

10

50 hydraulic chamber

52 first area

54 second area

15

56 first feed channel

58 second feed channel

20

60 first feed port

62 second feed port

66 latch member

25

70 common feed port

72 control valve

30

74 plunger

76 bore

78 spring

35

80 profiled surface

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 pressure surface defining with said piston bore a hydraulic chamber, said hydraulic chamber comprising at least one inlet for a pressurized hydraulic medium so as to move said piston under the action of hydraulic pressure;

characterised in that

a first feed channel is arranged so as to fluidly connect a supply port to a first area of said pressure surface when said piston is in its first position;

a second feed channel is arranged so as to fluidly connect a supply port to a second area of said pressure surface, said second area being larger than said first area; and

said second feed channel is in fluid communication with a supply port only in a switching position of said main rocker arm body;

said pressurized hydraulic medium is at a first pressure or at a second pressure,

said first pressure being insufficient to displace said piston when acting on said first area and/or said second area,

said second pressure being insufficient to displace said piston when acting only on said first area, but sufficient to displace said piston when acting on said second area.

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 main rocker arm body having a socket for engaging a pivot at a first end and having an interface means for engaging a valve stem at a second end;

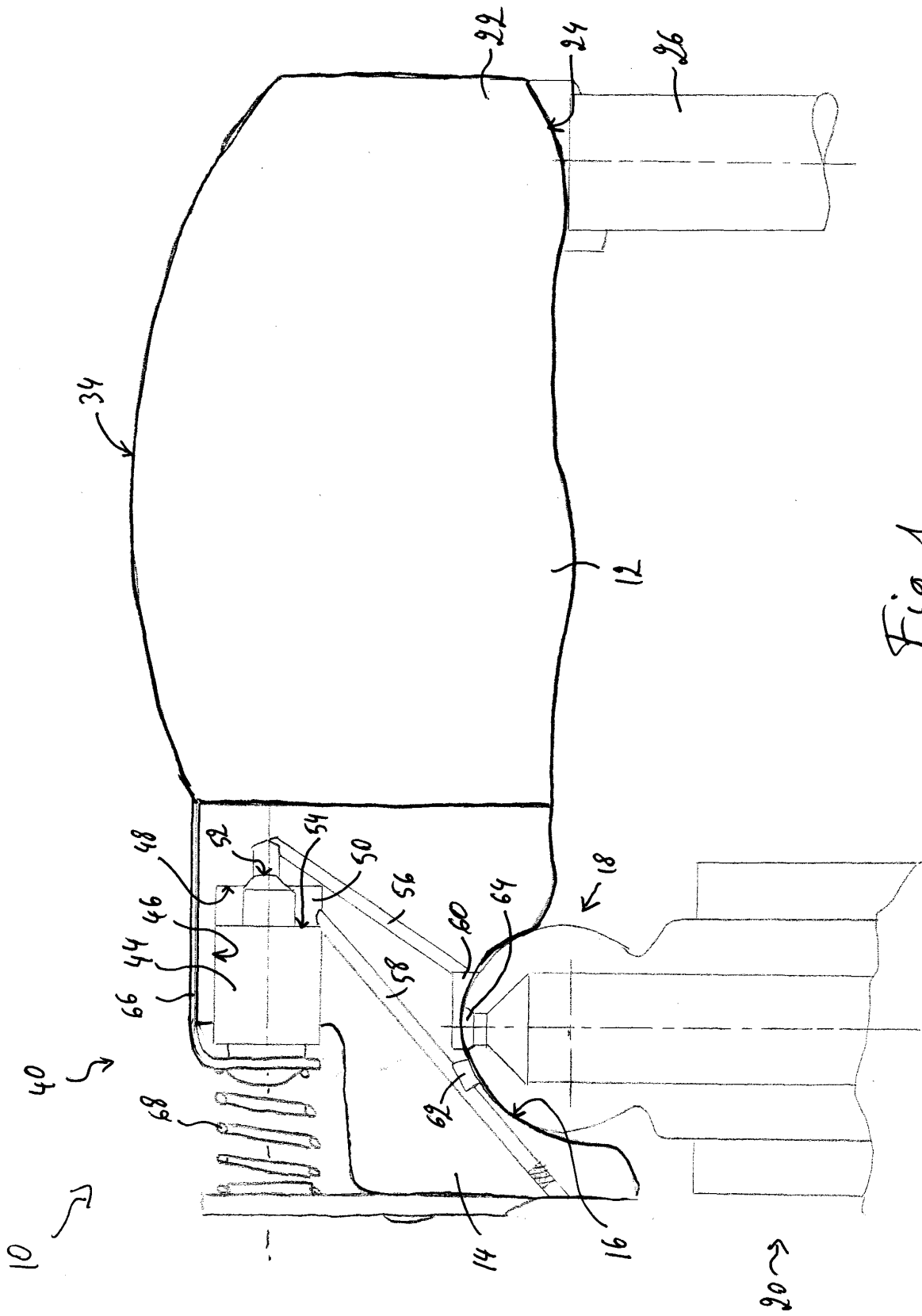
a latch member associated with said main rocker arm body, said latch member being moveable between a first position to provide a first rocker arm assembly configuration and a second position to provide a second rocker arm assembly configuration;

2. Rocker arm assembly according to claim 1, wherein 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, wherein said second area corresponds to the total area of said pressure surface, including said first area.

4. Rocker arm assembly according to any of the previous claims, wherein said first and second feed channels comprise a first and second feed port arranged in said socket of said main rocker arm body; and wherein said pivot comprises a supply port communicating with said first and second feed ports for supplying pressurized hydraulic medium to said first and second feed channels.

5. Rocker arm assembly according to any of claims 1 to 4,
wherein said supply port communicates with a first feed port of said first feed channel when said main rocker arm body is not in said switching position;
and
wherein said supply port communicates with a second feed port of said second feed channel only when said main rocker arm body is in said switching position. 5 10
6. Rocker arm assembly according to any of claims 1 to 4,
wherein said supply port communicates with a first feed port of said first feed channel; and
wherein said supply port communicates with a second feed port of said second feed channel,
wherein said second feed channel comprises a control valve for opening said second feed channel only when said main rocker arm body is in said switching position. 15 20
7. Rocker arm assembly according to claim 6, wherein said first and second feed ports are fused together to form a common feed port. 25
8. Rocker arm assembly according to claim 6 or 7, wherein said control valve comprises a plunger transversely arranged in said second feed channel, and biasing means for maintaining said control valve in a closed position when said main rocker arm body is not in said switching position. 30
9. Rocker arm assembly according to any of the previous claims, further comprising 35
- a configuration switch element moveably connected to said main rocker arm body, wherein:
- in said first rocker arm assembly configuration, said configuration switch element is freely moveable with respect to said main rocker arm body and said valve lift is defined by a first cam surface contacting a first cam contacting surface of said rocker arm assembly; 40 45
 - in said second rocker arm assembly configuration, said configuration switch element is locked in position with respect to said main rocker arm body and said valve lift is defined by a second cam surface contacting a second cam contacting surface of said rocker arm assembly. 50 55
10. Rocker arm assembly according to claim 9, wherein said configuration switch element is a pair of lateral auxiliary rocker arm bodies, said main rocker arm body being sandwiched therebetween.
11. Rocker arm assembly according to any of the previous claims, wherein said pivot is a hydraulic lash adjuster.



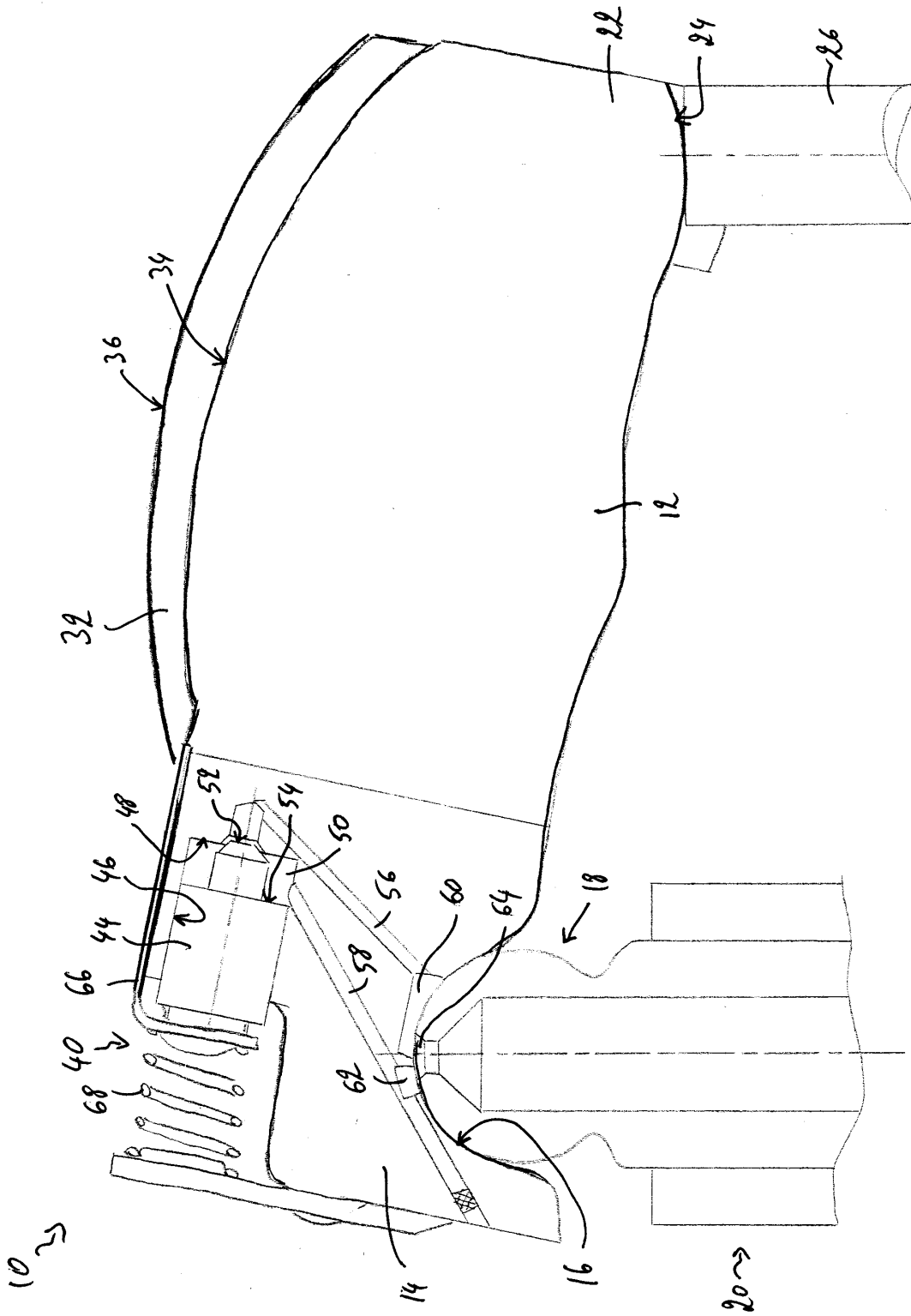


Fig. 2

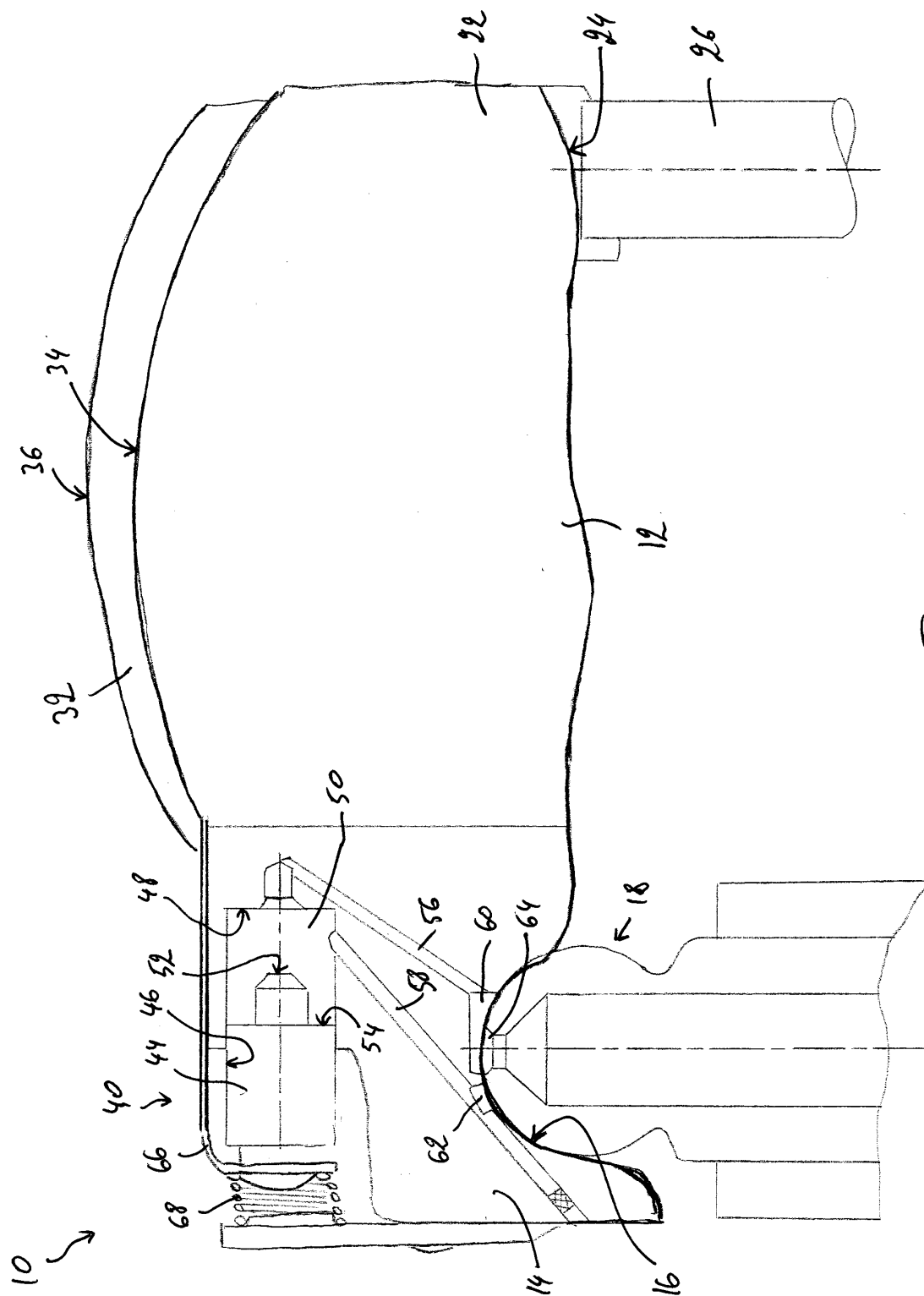
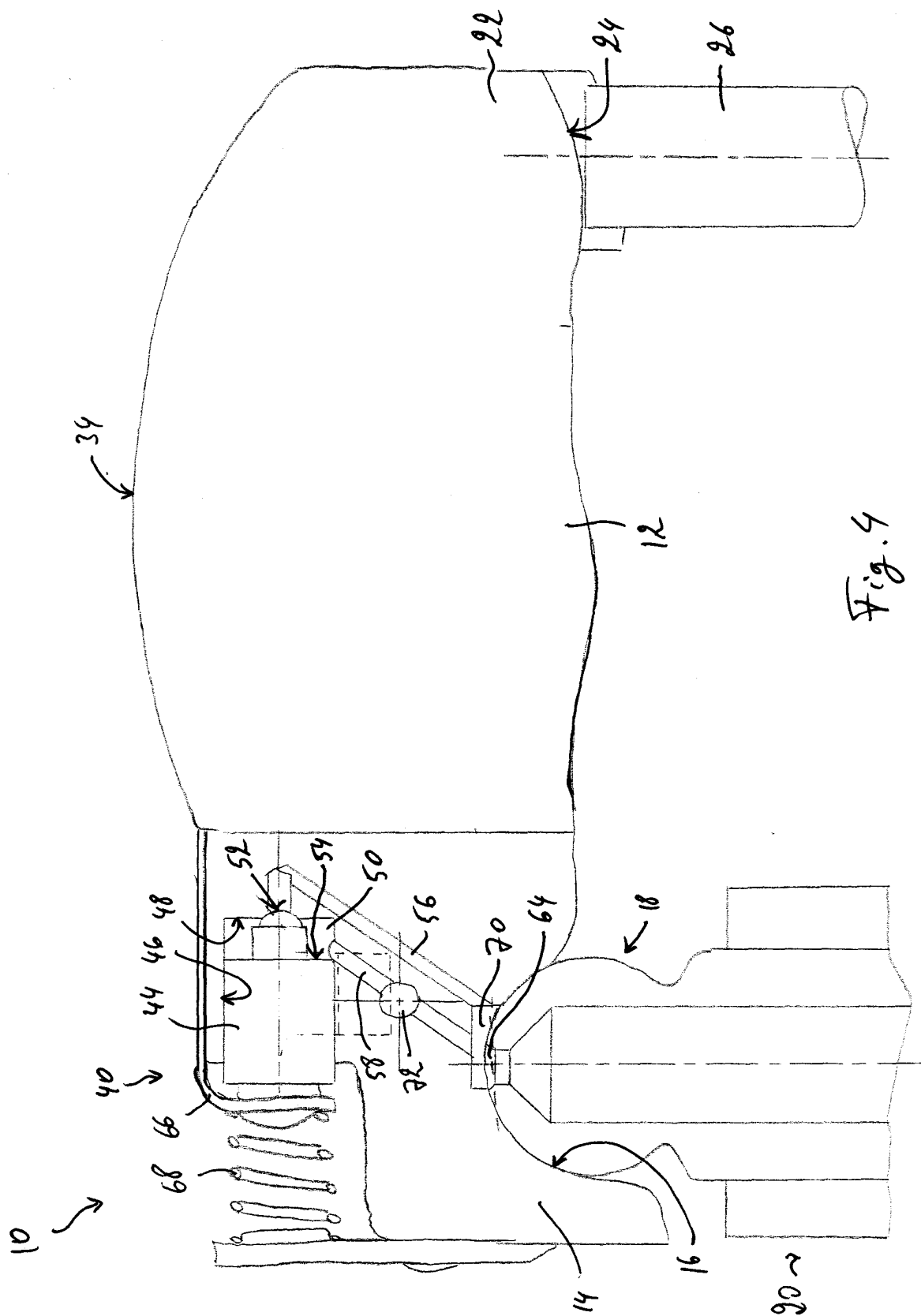
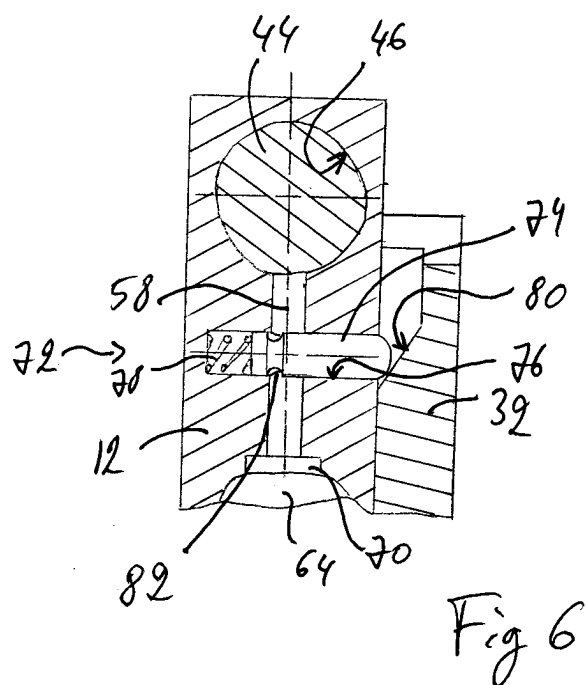
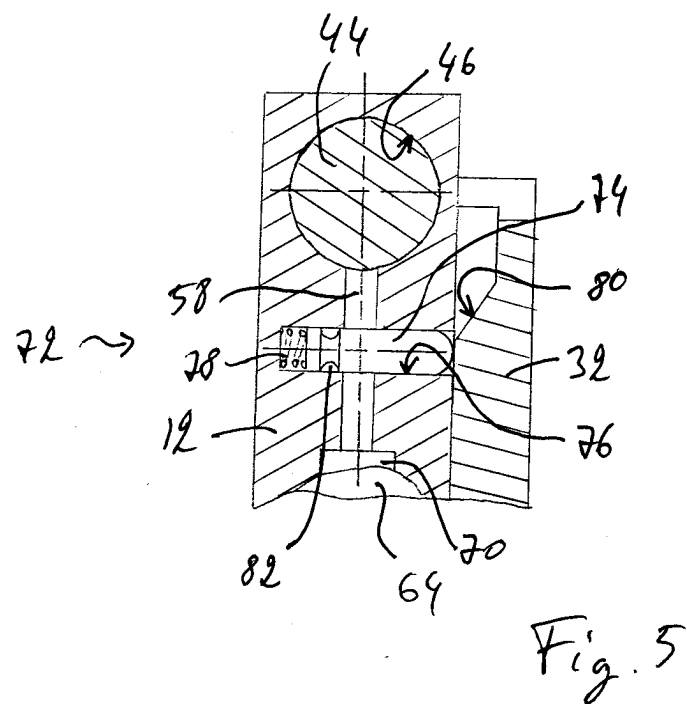


Fig. 3







European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 0732

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.7)
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			F01L
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 July 2004	Examiner Klinger, T
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 10 0732

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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15-07-2004

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