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(54) **Hydraulic intake/exhaust valve drive unit with damper**

Hydraulische Antriebseinheit mit Dämpfer für Ein- oder Auslassventil

Unité de commande hydraulique avec amortisseur pour soupape d'admission ou d'échappement

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Description

The invention relates to a hydraulic intake/exhaust valve drive unit according to the preamble of claim 1.

Such a hydraulic intake/exhaust valve drive unit is known from JP-A-60 085 208, wherein a damper chamber is formed in a piston which drives a valve, and a damping element projects into this chamber. A passage and a check valve are provided in the damping element and, when opening the valve, the oil being introduced into a cylinder is also introduced into the damper chamber through the passage and the check valve, causing smooth valve opening movement to take place. When closing the valve, the check valve closes the passage, causing the damper chamber to produce a damping effect.

In the technical field of an internal combustion engine, various types of mechanisms for opening/closing an intake or exhaust valve using oil pressure have been proposed. For example, Fig. 3 is a sectional view showing a prior art hydraulic intake/exhaust valve drive unit provided with a damper for use in an internal combustion engine.

An intake or exhaust valve (not shown) is driven by a working cylinder 100. A piston 101 is provided in the working cylinder 100 in such a manner as to be freely reciprocated. The upper end of a valve rod 102 for the intake or exhaust valve is connected to the lower end of the piston 101. A working oil is supplied from an oil passage 103 provided on the upper portion of the working cylinder 100. The working oil, which is supplied at a high pressure by an oil pressure generating pump in synchronization with the drive of the internal combustion engine, pushes down the piston 101, to thus open the intake or exhaust valve. On closing of the intake or exhaust valve, the flow of the working oil is reversed to that on opening of the valve, that is, the working oil is discharged from the oil passage 103 to the exterior of the working cylinder 100, and the intake or exhaust valve is returned to a specified upper position by a biasing means such as an air spring (not shown).

A damper 104 for controlling the speed of the intake or exhaust valve is provided in the working cylinder 100. A first damper member 106 having a projecting portion 105 is provided on the inner surface of the top portion of the working cylinder 100. On the other hand, a second damper member 108 having a recessed portion 107 corresponding to the projecting portion 105 is provided on the upper surface of the piston 101. On closing the intake or exhaust valve, both the damper members 106 and 108 are fitted to each other, so that an oil chamber 109 is formed between the projecting portion 105 and the recessed portion 107. In this case, the working oil trapped in the oil chamber 109 acts as a damper material, and controls the abrupt ascending of the valve, thus controlling the speed of the valve. In addition, a valve 110 for venting an air contained in the working oil is provided at the top portion of the working cylinder 100.

The prior art hydraulic intake/exhaust valve drive unit provided with a damper is capable of controlling the speed of the valve on closing the valve; however, it cannot control the speed of the valve on opening the valve.

In the state of closing the valve, the projecting portion 105 of the damper member 106 and the recessed portion 107 of the second damper member 108 are fitted to each other, and accordingly, when the working oil is supplied for opening the valve, it does not act over the whole sectional area of the working cylinder 100, that is, the oil pressure is not applied to the sectional area of the oil chamber 109. As a result, the build-up of the movement of the intake or exhaust valve is difficult to conform to the designed value. Moreover, when the piston 101 is descended and the projecting portion 105 of the first damper member 106 is separated from the recessed portion 107 of the second damper member 108, the oil chamber 109 is abruptly released and thereby a large sound is generated, which leads to the generation of an abnormal pulsating sound at the head portion on the valve side.

Fig. 4 is a graph showing the operational timing of an intake valve or the like in the conventional four cycle diesel engine having the above construction. As is apparent from this graph, there is generated an abnormal pulsating sound due to the abrupt variation in oil pressure near a crank angle of -45° , and the actual value of the lift amount of the valve is less than the designed value.

An object of the present invention is to provide a hydraulic intake/exhaust valve drive unit provided with a damper capable of effectively controlling an intake or exhaust valve not only on closing the valve but also on opening the valve.

This object is achieved by the features in the characterizing part of claim 1.

On closing the intake or exhaust valve, both of the damper members are fitted to each other, so that the oil chamber is formed between the projecting portion and the recessed portion. Thus, the working oil trapped in the oil chamber acts as a damper and controls the abrupt ascending of the valve. On opening the intake or exhaust valve, the working oil is supplied to the oil chamber by way of the valve unit provided in the first damper member, so that the pressure in the oil chamber is made positive thus making smooth the movement of the piston.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of the present invention; Fig. 2 is diagram showing the drive timing of the present invention; Fig. 3 is a sectional view of a prior art hydraulic intake/exhaust valve drive unit with a damper; and Fig. 4 is a diagram showing the drive timing of the prior art hydraulic intake/exhaust valve drive unit with a damper.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a sectional view of a hydraulic intake/exhaust valve drive unit 1 with a damper according to the present invention. A working cylinder 2 for opening/closing an intake or exhaust valve (not shown) is formed in a cylinder head of an internal combustion engine. The internal space of the working cylinder 2 is composed of a cylindrical space formed in the cylinder head. A cylindrical bush 3 is provided around the inner surface of the working cylinder 2, and a piston 4 is provided inside the bush 3 so as to be vertically slidable. The upper end of a valve rod for the intake or exhaust valve is connected to the lower end of the piston 4.

A plurality of oil holes 5 are formed, spaced at specified intervals, along the circumference of the upper portion of the bush 3. An annular supply groove 6 is formed in the cylinder head so as to surround a plurality of the oil holes 5. A supply/discharge hole 7 is communicated to the supply groove 6, and a working oil is supplied to the supply/discharge hole 7.

The working oil at a high pressure is supplied from an oil pressure generating pump (not shown) into the working cylinder 2 in synchronization with the drive of the internal combustion engine, to push down the piston 4, thus opening the intake or exhaust valve. On closing the intake or exhaust valve, the flow of the working oil is reversed to that on opening the valve, that is, the working oil is discharged from the oil holes 5 to the supply/discharge hole 7, and the intake or exhaust valve is returned to the upper specified position by means of a biasing means such as an air spring (not shown).

A damper 10 for controlling the speed of the intake or exhaust valve is provided in the working cylinder 2. A first damper member 11 is provided in the top portion of the working cylinder 2. The first damper member 11 has a disk-like flange portion 12, and a cylindrical projecting portion 13 formed at the central portion of the flange portion 12. The flange portion 12 is fixedly held between the upper end surface of the bush 3 and the top surface of the space of the working cylinder 2. The projecting portion 13 is directed downward in the working cylinder 2.

A valve unit 14 for controlling the flow passage of the working oil is formed in the projecting portion 13. A through-hole 15, which is opened at both the upper and lower end surfaces, is formed in the projecting portion 13. A fixing member 16 having a hole 16a is mounted in the lower end of the through-hole 15. A valve body 17 is mounted on the fixing member 16 in the through-hole 15 of the projecting portion 13. A seat surface 18 for closing the through-hole 15 when the valve body 17 abuts thereon, is formed in the through-hole 15. A coil spring 19 as a biasing means is provided between the upper surface of the valve body 17 and a stepped portion 15a provided at the upper end of the through-hole 15. The coil spring 19 pushes down the valve body 17

from the seat surface 18 such that the valve body 17 abuts on the upper surface of the fixing means 16.

Oil communication holes 20 are formed in the flange portion 12. On opening the intake or exhaust valve, as shown by the arrow in the figure, the working oil flowing from the oil holes 5 into the working cylinder 2 passes through the oil communication holes 20, and turns to the upper surface side of the first damper member 11. It enters the through-hole 15, and pushes down the valve body 17. The valve body 17 is thus separated from the seat surface 18. The working oil is then supplied from a gap 18a formed between the valve body 17 and the seat surface 18 to the oil chamber 23 by way of oil holes 17a of the valve body 17.

A second damper member 22 including a recessed portion 21 corresponding to the projecting portion 13 is provided on the upper surface of the piston 4. On closing the intake or exhaust valve, both the damper members 11 and 22 are fitted to each other, so that an oil chamber 23 is formed between the projecting portion 13 and the recessed portion 21. The working oil trapped in the oil chamber 23 acts as a damper, which controls the abrupt ascending of the valve, thus controlling the speed of the valve. In addition, a valve 9 for venting an air contained in the working oil is provided in the top portion of the working cylinder 2.

The function of the above construction will be described below. On closing the valve, the second damper member 22 is ascended together with the piston 4, and the recessed portion 21 of the second damper member 22 is fitted to the projecting portion 13 of the first damper member 11. The pressure in the oil chamber 23 is increased, and when it exceeds the set-up load of the coil spring 19, the valve body 17 is ascended and seated on the seat surface 18. The through-hole 15 is thus closed. The working oil is trapped in the oil chamber 23 formed by the projecting portion 13 and the recessed portion 21, and it acts as a damper and controls the abrupt ascending of the intake or exhaust valve. Accordingly, on closing the valve, the sufficient damping effect can be obtained, and the intake or exhaust valve is gently seated thus generating little shock sound.

On opening the valve, the working oil at a high pressure supplied in the working cylinder 2 passes through the oil communication holes 20 of the flange portion 12 of the first damper member 11 and turns to the upper surface side of the first damper member 11. It enters the through-hole 15, and pushes down the valve body 17. The valve body 17 is thus separated from the seat surface 18. The working oil is supplied from the gap 18a formed between the valve body 17 and the seat surface 18 to the oil chamber 23 by way of the oil holes 17a of the valve body 17, so that the pressure in the oil chamber 23 becomes positive, thus smoothly moving the piston 4. Namely, the oil pressure can be applied to the whole sectional area of the working cylinder 2, so that the build-up of the movement of the intake or exhaust valve conforms to the designed value. As a result, when

the piston 4 is descended and both the damper members 11 and 22 are separated from each other, there is not generated any abnormal pulsating sound.

Fig. 2 is a graph showing the operational timing of an intake or exhaust valve in this embodiment. As is apparent from this graph, near a crank angle of -45° at which an abnormal pulsating sound has been generated, there is not confirmed any abnormal pulsating sound. Moreover, from the waveform at a crank angle of 180° or more, it becomes apparent that the shock sound is not generated when the valve is seated. Additionally, the actual value of the lift amount of the valve is substantially equal to the designed value.

In this embodiment, the dimensions of the projecting portion and the recessed portion of the first and second damper members are determined on the basis of the experiments. The axial fitting length of both the members is set at 5 mm, and the gap at the circumferential surface is set to be in the range from 0.08 to 0.12 mm. In these dimensions, the shock sound on closing the valve is small and the valve is gently seated; however, when the gap is 0.20 mm, the damping effect is little obtained, and the shock sound is generated. The dimension of the gap between the projecting portion and the recessed portion exerts a large effect on the control for the speed of the valve, as described above; accordingly, it is important to determine the gap at a suitable value.

According to the present invention, in a hydraulic intake/exhaust valve drive unit with a damper having an oil chamber formed by a recessed portion and a projecting portion of damper members, there is provided a valve unit which is closed on closing an intake or exhaust valve and which introduces a working oil into the oil chamber on opening the intake or exhaust valve. Accordingly, on closing the intake or exhaust valve, the valve is gently seated by the damping action of the oil chamber containing the working oil; and on opening the intake or exhaust valve, since the working oil is supplied in the oil chamber and the pressure in the oil chamber is made positive, the movement of the piston 4 conforms to the theoretical value, thus preventing the generation of a pulsating sound.

Claims

1. A hydraulic intake/exhaust valve drive unit including a working cylinder (2) to which a working oil is supplied; a piston (4) for driving an intake or exhaust valve of an internal combustion engine by being reciprocated in said working cylinder; and a damper (10) provided in said working cylinder for controlling the speed of the intake or exhaust valve, wherein said damper comprises:

a first damper member (11,31) having a projecting portion (13,32) provided in the top portion

of said working cylinder (2) to which the working oil is supplied;

a second damper member (22) including a recessed portion (21), said second damper member being moved in said working cylinder (2) together with said piston (4) accompanied by the reciprocating motion of the intake or exhaust valve, said recessed portion (21) being fitted to said projecting portion (13,32) of said first damper member (11,31) on closing the intake or exhaust valve for forming an oil chamber (23) with said first damper member; and a valve unit (14,33) provided in said first damper member (11,31), which is opened on opening the intake or exhaust valve for introducing the working oil into said oil chamber (23),

characterized in that said valve unit (14,33) includes a valve body (17,36), and a biasing means (19,38) for biasing said valve body in the opening direction.

2. A hydraulic intake/exhaust valve drive unit according to claim 1, wherein

the working oil is supplied and directed downward in said working cylinder (2), a through-hole (15,34) is vertically passing through said projecting portion (13,32) for introducing the working oil; and

said valve unit (14,33) is provided in said through-hole (15,34) of said first damper member (11,31), which is operated by the working oil supplied in said working cylinder (2) for opening said through-hole and introducing the working oil into said oil chamber (23) opening the intake or exhaust valve, and closes said through-hole on closing the intake or exhaust valve.

3. A hydraulic intake/exhaust valve drive unit according to claim 2, wherein

the working oil flows in and out of said working cylinder (2) by way of oil holes (5) provided around the peripheral wall near the top portion of said working cylinder;

said first damper member (11,31) includes a base portion (12) fixed in said working cylinder at the upper portion from said oil holes (5), and oil communication holes (20) provided on said base portion (12) for communicating said oil holes (5) and the upper end of said through-hole (15,34), and

said valve body (17,36) being provided to be movable in said through-hole (15,34), and which is operated by the working oil in said oil chamber (23) for closing said through-hole on closing the intake or exhaust valve, and is op-

erated by the working oil entering said through-hole by way of said oil holes (5) and said oil communication holes (20) for opening said through-hole (15,34).

Patentansprüche

1. Hydraulische Einlaß/Auslaßventil-Antriebseinheit, aufweisend einen Arbeitszylinder (2), dem Arbeitsöl zugeführt wird, einen Kolben (4) zum Antreiben eines Einlaß- oder Auslaßventils eines Verbrennungsmotors, indem dieser im Arbeitszylinder hin- und herbewegt wird, und einen Dämpfer (10), der in dem Arbeitszylinder zum Steuern der Geschwindigkeit des Einlaß- oder Auslaßventils vorgesehen ist, wobei der Dämpfer aufweist:

Ein erstes Dämpferelement (11, 31) mit einem vorspringenden Abschnitt (13, 32), der im oberen Abschnitt des Arbeitszylinders (2) vorgesehen ist, dem Arbeitsöl zugeführt wird, ein zweites Dämpferelement (22), das einen ausgenommenen Abschnitt (21) aufweist, wobei das zweite Dämpferelement in dem Arbeitszylinder (2) zusammen mit dem Kolben (4) begleitet von der hin- und hergehenden Bewegung des Einlaß- oder Auslaßventils bewegt wird, wobei der ausgenommene Abschnitt (21) an dem vorspringenden Abschnitt (13, 32) des ersten Dämpferelements (11, 31) beim Schließen des Einlaß- oder Auslaßventils zum Bilden einer Ölkammer (23) mit dem ersten Dämpferelement anliegt, und eine Ventileinheit (14, 33), die in dem ersten Dämpferelement (11, 31) vorgesehen ist, das beim Öffnen des Einlaß- oder Auslaßventils zum Einleiten des Arbeitsöls in die Ölkammer (23) geöffnet wird, dadurch gekennzeichnet, daß die Ventileinheit (14, 33) einen Ventilkörper (17, 36) und ein Vorspannmittel (19, 38) zum Vorspannen des Ventilkörpers in der Öffnungsrichtung aufweist.

2. Hydraulische Einlaß/Auslaßventil-Antriebseinheit nach Anspruch 1, wobei das Arbeitsöl dem Arbeitszylinder (2) zugeführt und abwärts gerichtet ist, und ein Durchgangsloch (15, 34) vertikal den vorspringenden Abschnitt (13, 32) zum Einleiten des Arbeitsöls durchsetzt, und die Ventileinheit (14, 33) in dem Durchgangsloch (15, 34) des ersten Dämpferelements (11, 31) vorgesehen ist, das durch das Arbeitsöl betätigt wird, das in den Arbeitszylinder (2) zugeführt wird, um das Durchgangsloch zu öffnen, und das Arbeitsöl in die Kammer (23) beim Öffnen des Einlaß- oder Auslaßventils einzuleiten, und das Durchgangsloch beim Schließen des Einlaß- oder Auslaßventils ver-

schließt.

3. Hydraulische Einlaß/Auslaßventil-Antriebseinheit nach Anspruch 2, wobei das Arbeitsöl in den Arbeitszylinder (2) hinein und aus diesem mittels Öllöchern (5) strömt, die um die Umfangswand in der Nähe des oberen Abschnitts des Arbeitszylinders herum vorgesehen sind, das erste Dämpferelement (11, 31) einen Basisabschnitt (12) aufweist, der in dem Arbeitszylinder am oberen Abschnitt ausgehend von den Öllöchern (5) befestigt ist, und Ölverbindungs Löcher (20), die am Basisabschnitt (12) zum Verbinden der Öllöcher (5) und des oberen Endes des Durchgangslochs (15, 34) vorgesehen sind, und der Ventilkörper (17, 36) dazu vorgesehen ist, in dem Durchgangsloch (15, 34) beweglich zu sein, und durch das Arbeitsöl in der Ölkammer (23) betätigt wird, um das Durchgangsloch beim Schließen des Einlaß- oder Auslaßventils zu verschließen, und durch das Arbeitsöl betätigt wird, das in das Durchgangsloch mittels der Öllöcher (5) und der Ölverbindungs Löcher (20) zum Öffnen des Durchgangslochs (15, 34) eintritt.

Revendications

1. Unité de commande hydraulique pour une soupape d'admission ou d'échappement, comprenant un vérin hydraulique (2) alimenté en huile hydraulique, un piston (4) qui commande une soupape d'admission ou d'échappement d'un moteur à combustion en étant entraîné dans un mouvement de va-et-vient à l'intérieur dudit vérin hydraulique, et un amortisseur (10) prévu à l'intérieur dudit vérin hydraulique pour contrôler la vitesse de la soupape d'admission ou d'échappement, ledit amortisseur comprenant:
 - un premier membre amortisseur (11, 31) présentant une portion en saillie (13, 32) prévue dans la partie supérieure dudit vérin hydraulique (2) alimenté en huile hydraulique,
 - un deuxième membre amortisseur (22) présentant une portion en retrait (21), ledit deuxième membre amortisseur étant entraîné à l'intérieur dudit vérin hydraulique (2), à l'unisson avec ledit piston (4), ce mouvement étant accompagné par le mouvement de va-et-vient de la soupape d'admission ou d'échappement, ladite portion en retrait (21) étant appliquée contre ladite portion en saillie (13, 32) dudit premier membre amortisseur (11, 31) en fermeture de la soupape d'admission ou d'échappement afin de former, en, coopération avec ledit premier membre amortisseur, une chambre à huile (23), et
 - une unité de soupape (14, 33) prévue dans ledit premier membre amortisseur (11, 31),

s'ouvrant au moment de l'ouverture de la soupape d'admission ou d'échappement pour permettre l'introduction de l'huile hydraulique à l'intérieur de ladite chambre à huile (23), **caractérisée en ce que** ladite unité de soupape (14, 33) comprend un corps de valve (17, 36) et un moyen de précontrainte (19, 38) pour précontraindre ledit corps de valve dans la direction d'ouverture.

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2. Unité de commande hydraulique pour une soupape d'admission ou d'échappement selon la revendication 1, dans laquelle l'huile hydraulique est alimentée et dirigée vers le bas, à l'intérieur dudit vérin hydraulique (2), un trou passant (15, 34) traverse verticalement ladite portion en saillie (13, 32), permettant l'introduction de l'huile hydraulique, et ladite unité de soupape (14, 33) est prévue dans ledit trou passant (15, 34) dudit premier membre amortisseur (11, 31), opérée par l'huile hydraulique fournie dans ledit vérin hydraulique (2) pour ouvrir ledit trou passant et introduire l'huile hydraulique dans ladite chambre à huile (23), en ouvrant la soupape d'admission ou d'échappement, et fermer ledit trou passant en fermant la soupape d'admission ou d'échappement.

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3. Unité de commande hydraulique pour une soupape d'admission ou d'échappement selon la revendication 2, dans laquelle

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- l'huile hydraulique passe à l'intérieur et à l'extérieur dudit vérin hydraulique (2) en traversant des trous à huile (5) prévus dans la paroi périphérique, près de la portion supérieure dudit vérin hydraulique;

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- ledit premier membre amortisseur (11, 31) comprend une portion de base (12) fixée dans ledit vérin hydraulique (2), dans la portion située au-dessus desdits trous à huile (5), et des trous de communication d'huile (20) prévus dans ladite portion de base (12) et assurant la communication entre lesdits trous à huile (5) et l'extrémité supérieure dudit trou passant (15, 34), et

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- ledit corps de valve (17, 36) est prévu de façon mobile dans ledit trou passant (15, 34) et est opérée par l'huile hydraulique se trouvant dans ladite chambre à huile (23), pour fermer ledit trou passant en fermant la soupape d'admission ou d'échappement, et est opérée par l'huile hydraulique menée dans ledit trou passant en traversant lesdits trous à huile (5) et lesdits trous de communication d'huile (20), pour ouvrir ledit trou passant (15, 34).

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FIG. 1

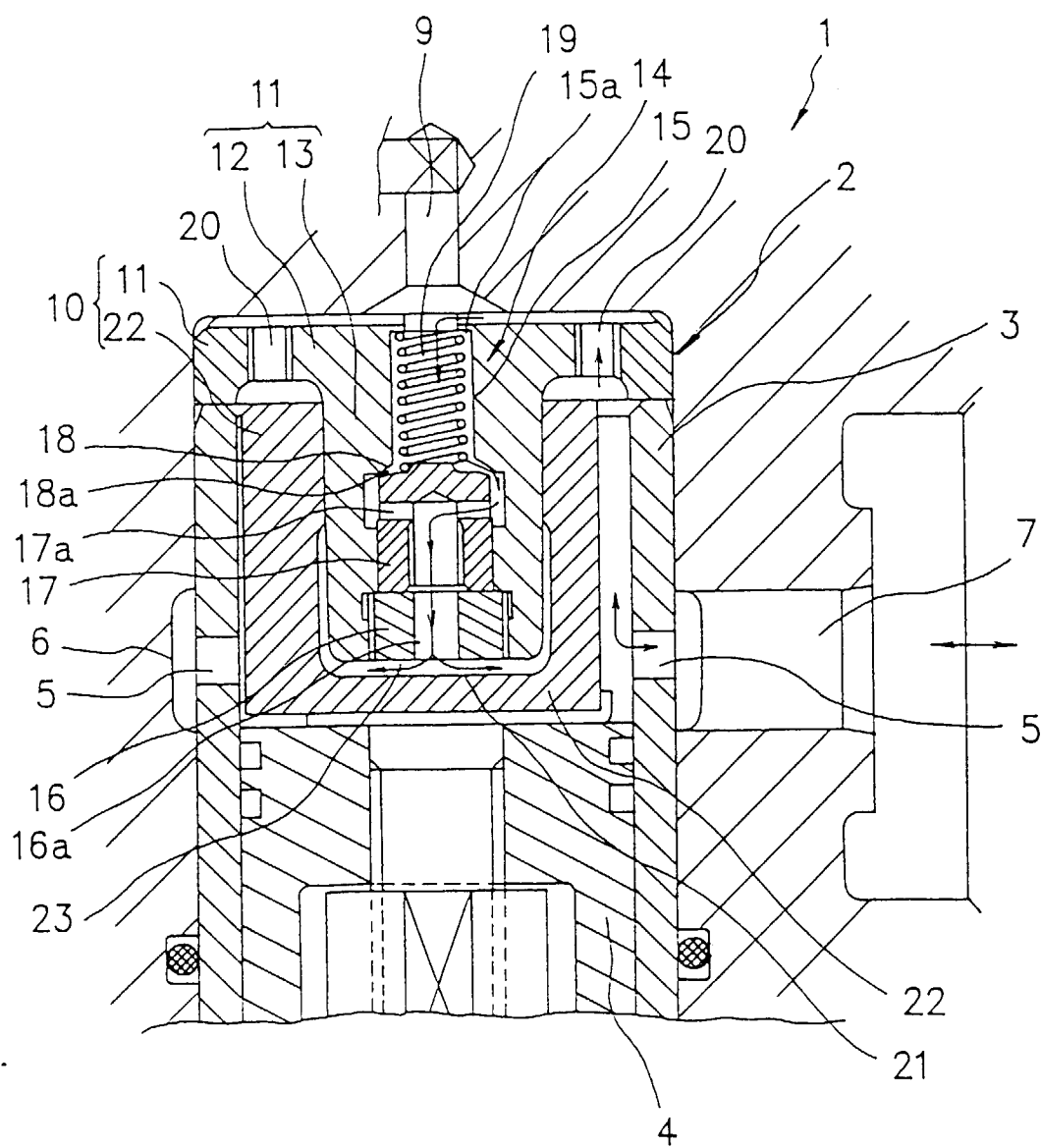


FIG. 2

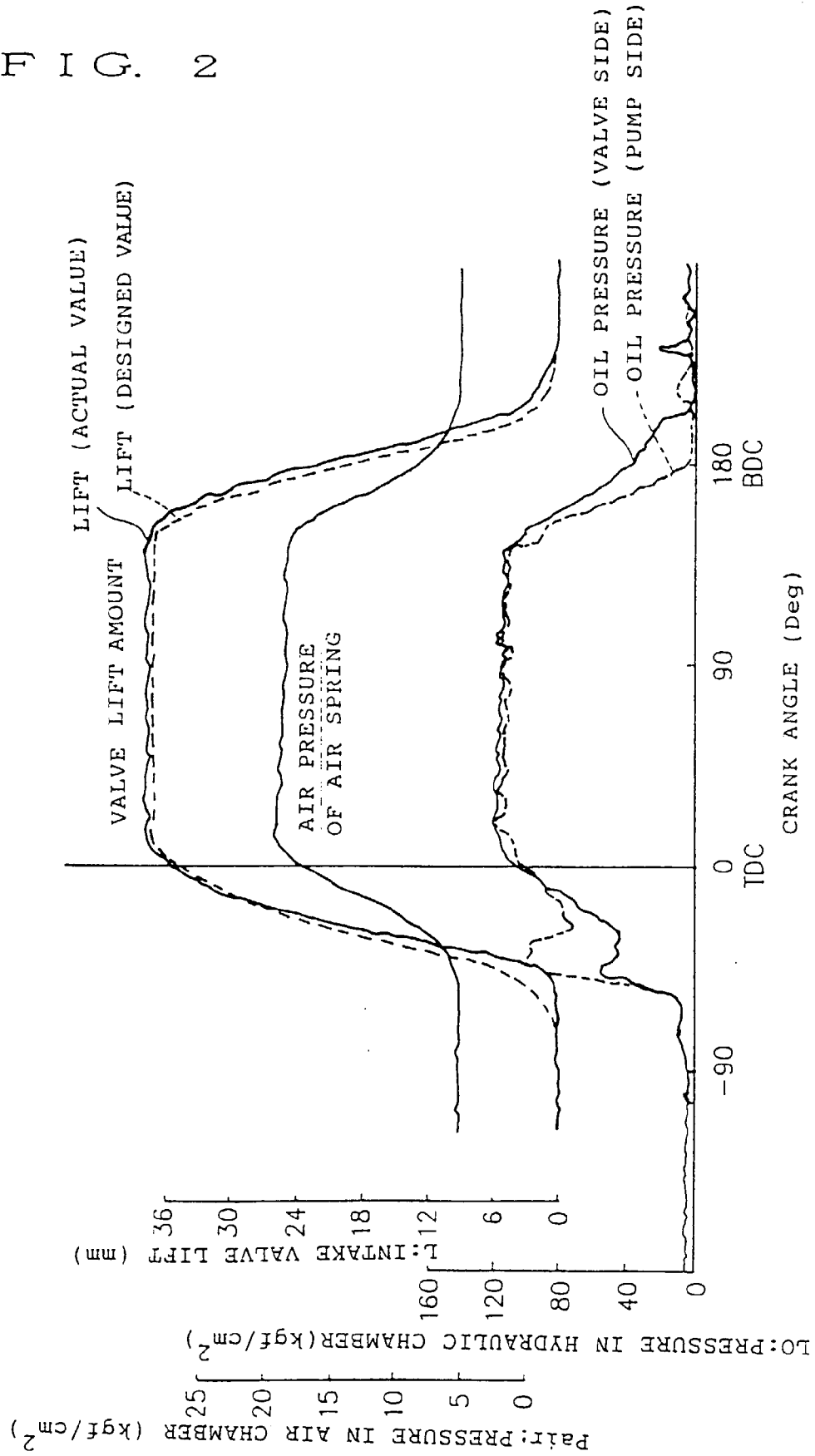


FIG. 3

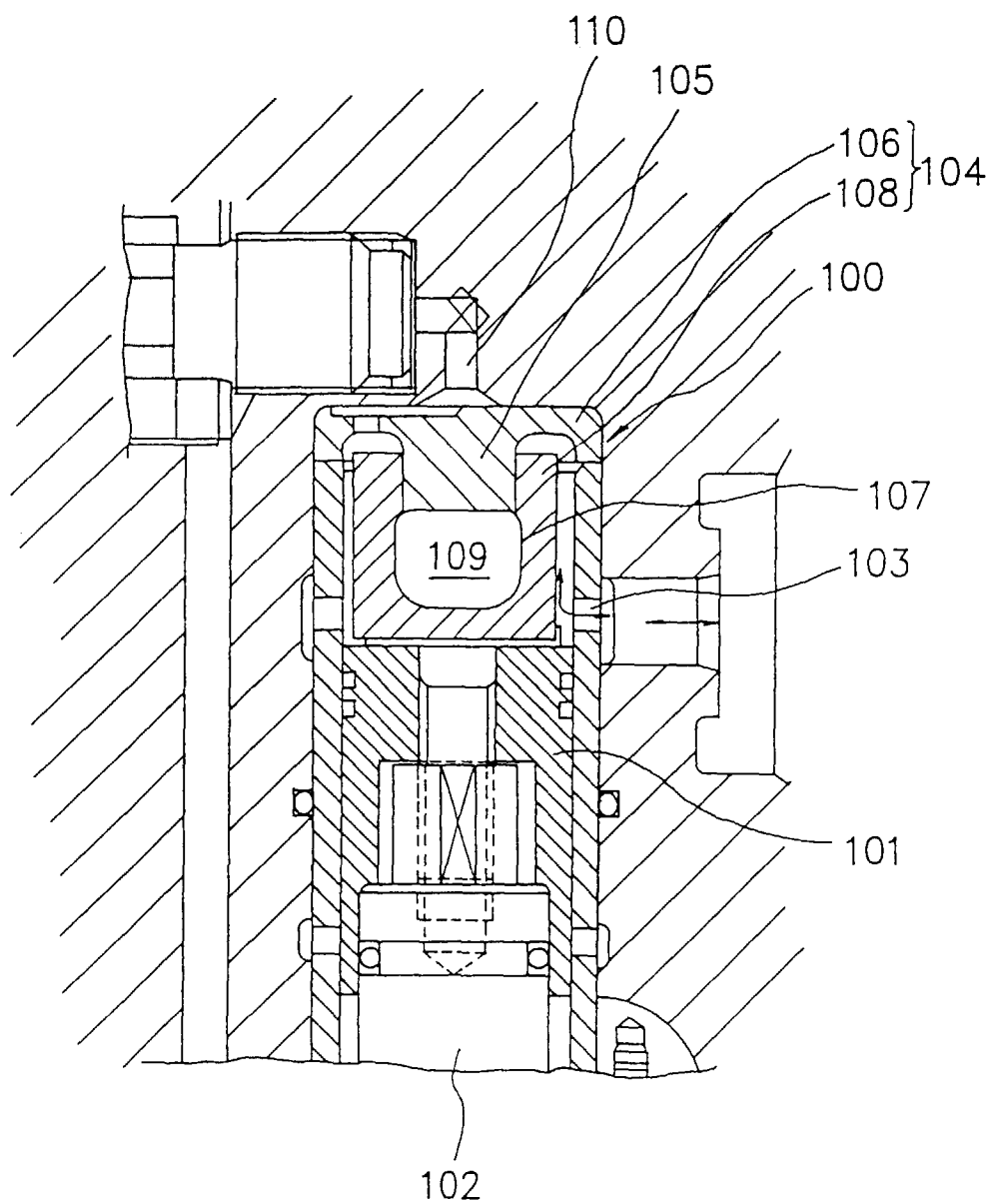


FIG. 4

