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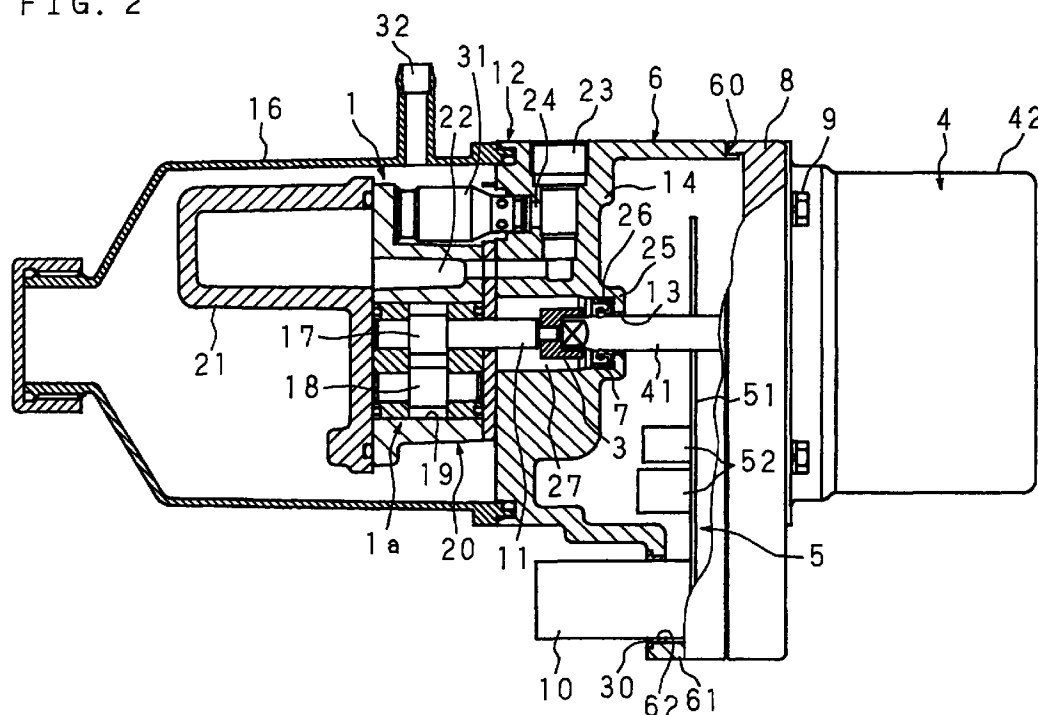
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(54) Electric pump apparatus

(57) The present invention provides an electric pump apparatus having a pump, an electric motor whose motor shaft is connected with a drive shaft supported rotatably to a housing of the pump via a shaft coupling, and a sealing member for sealing a circumference of the drive shaft, is arranged so that a motor con-

trol device for controlling the electric motor is provided in an area between the electric motor and the shaft coupling, and thus it can be easily installed and can be reduced in size.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an electric pump apparatus having a pump driven by an electric motor.

[0002] FIG. 1 is a longitudinal sectional drawing showing a conventional electric pump apparatus.

[0003] For example, as shown in FIG. 1, an electric pump apparatus for supplying hydraulic oil to a hydraulic operating device such as a hydraulic actuator provided in a steering mechanism of an automobile includes a pump C provided with a drive shaft A and a pump housing B supporting the drive shaft A rotatably, an electric motor F provided with a motor shaft E interlocked and coupled to the drive shaft A via a shaft coupling D, and a sealing member G for sealing a circumference of the drive shaft A so as to prevent oil from leaking from the pump C into the electric motor F.

[0004] A motor control device for controlling the electric motor F of the electric pump apparatus having the aforementioned arrangement is provided separately from the electric pump apparatus.

[0005] However, in the electric pump apparatus having the arrangement such that the motor control device is provided separately, it is necessary to provide electric wiring for connecting the motor control device and the electric motor F, and further it is necessary to secure separate spaces where they are provided, so the provision is complicated.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention has been made with the aim of solving the above problems, and it is one object of the present invention to provide an electric pump apparatus having a motor control device for controlling an electric motor for driving a pump, which can be provided easily and can reduce the entire apparatus in size by providing the motor control device between the pump and the electric motor.

[0007] An electric pump apparatus of the present invention includes a pump, an electric motor whose motor shaft is connected with a drive shaft supported rotatably to a housing of the pump via a shaft coupling, and a sealing member for sealing a circumference of the drive shaft, characterized in that a motor control device is provided between the electric motor and the shaft coupling.

[0008] According to the present invention, since the motor control device is provided integrally to the pump and electric motor, the installation is easy, and the whole apparatus can be reduced in size.

[0009] Another electric pump apparatus of the present invention is arranged so that in the aforementioned electric pump apparatus, the shaft coupling for coupling the drive shaft of the pump and the motor shaft of the

electric motor is positioned on the side of the drive shaft with respect to the sealing member.

[0010] According to the present invention, since the shaft coupling is positioned on the side of the drive shaft with respect to the sealing member for sealing the circumference of the shaft, in the case where the motor control device is placed between the pump and the electric motor, even if a wet-type shaft coupling with low cost is used, the motor control device is not likely to soak into liquid.

[0011] In addition, in the electric pump apparatus, since oil leakage from the pump into the electric motor causes a malfunction of the electric motor, an inspection is made as to whether or not the leakage occurs from the sealing member. Then, leakage from the connected portion between the housing of the motor control device and the housing of the pump can be detected with the sealing member being detached, and the leakage from the sealing member can be detected with the sealing member being mounted. Therefore, for example, leakage from the hole for mounting a connector in the housing of the motor control device and leakage on the circumference of the shaft can be individually detected easily, and measures against leakage can be taken easily.

[0012] Another electric pump apparatus of the present invention is arranged so that the housing of the pump includes accession means for the sealing member provided to a shaft hole penetrated by the drive shaft on the side of the drive shaft, and has a diameter larger than that of the shaft hole.

[0013] Still another electric pump apparatus of the present invention is arranged so that the housing of the pump includes accession means for the shaft coupling provided to the shaft hole penetrated by the drive shaft on the side of the drive shaft, and has a diameter larger than that of the shaft hole.

[0014] According to these inventions, since the accession means for the sealing member and shaft coupling are provided to the shaft hole on the side of the drive shaft, the sealing member is pressed against its accession means and can be received by the accession means by hydraulic which is transmitted from the pump via the shaft hole and acts upon the sealing member. Therefore, it is not necessary to additionally provide a fastener for the sealing member, and thus the cost can be further reduced.

[0015] The above and further objects and features of the invention will more fully be apparent from the following detailed description with accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0016]

FIG. 1 is a longitudinal sectional drawing showing a conventional electric pump apparatus;

FIG. 2 is a longitudinal front view of an electric pump apparatus according to the present invention; and

FIG. 3 is an explanatory drawing in the case where leakage from a shaft hole portion of the electric pump apparatus according to the present invention is inspected.

DETAILED DESCRIPTION OF THE INVENTION

[0017] The present invention will now be described in detail referring to the accompanying drawings illustrating the embodiment thereof. FIG. 2 is a longitudinal front view of an electric pump apparatus according to the present invention and FIG. 3 is an explanatory drawing in the case where leakage from a shaft hole portion of the electric pump apparatus according to the present invention is inspected.

[0018] The electric pump apparatus shown in FIG. 2 includes a pump 1 in which a drive shaft 11 is supported rotatably to a pump housing 12, an electric motor 4 provided with a motor shaft 41 to be interlocked and coupled to the drive shaft 11 via a shaft coupling 3, and a sealing member 7 for sealing a circumference of the drive shaft 11. Moreover, a motor control device housing 6 containing a motor control device 5 for controlling the electric motor 4, is provided between the electric motor 4 and the shaft coupling 3 as this is a characteristic of the present invention, so that oil leakage from the pump 1 into the motor control device housing 6 is prevented by the sealing member 7.

[0019] The pump housing 12 includes a housing base 14 provided with a shaft hole 13 bored through in the longitudinal direction of the drive shaft 11 and the motor shaft 41, a bottomed cylindrical cover 16 coupled to one side of the housing base 14 so as to be detachable by a plurality of screws.

[0020] A pump portion 1a is mounted to the housing base 14. The pump portion 1a includes a drive gear 17 provided to the drive shaft 11, a driven gear 18 to be meshed with the drive gear 17, and a gear housing 20 having a gear chamber 19 containing the drive gear 17 and driven gear 18.

[0021] A suction opening (not shown) connected with the gear chamber 19 and cover 16, and a discharge opening (not shown) connected with the gear chamber 19 are provided into the gear housing 20. Moreover, a bottomed noise damper drum 21 provided with an open chamber connected with the discharge opening is mounted detachably to the gear housing 20.

[0022] In addition, the housing base 14 is provided with an substantially L-shaped discharge path 23 connected with the noise damper drum 21 via a connecting path 22, a relief path 24 opened to the discharge path 23, and the shaft hole 13.

[0023] As shown in FIG. 2, the shaft hole 13 is provided with a sealing member accession portion 26 having a larger diameter than that of the shaft hole 13 and

a coupling accession portion 27 connected to the sealing member accession portion 26 on the side of the pump portion 1a via a step portion 25. The sealing member 7 composed of an oil seal is positioned in the sealing member accession portion 26 and the coupling accession portion 27 on the side of the drive shaft 11 (on the side of the pip portion 1a) with respect to the shaft coupling 3. The shaft coupling 3 is lubricated by hydraulic oil penetrating the shaft hole 13 along the circumference of the drive shaft 11 from the pump portion 1a, and the sealing member 7 is pressed against the step portion 25 by a pressure of the penetrated hydraulic oil so that the sealing member 7 is prevented from moving towards the shaft coupling 3.

[0024] The shaft coupling 3 is formed into a cylindrical shape by a sintered material, and it is fitted so as not to be able to rotate relatively its inner surfaces of one end and the other to the ends of the drive shaft 11 and motor shaft 41, and so as to be detachable in the axial direction.

[0025] The motor control device housing 6 is formed integrally with the other side of the housing base 14, and a disk-shaped covering member 8 is mounted detachably by a plurality of screws 9 to the end of the motor control device housing 6 on the side of the electric motor 4 via a ring-shaped sealing board 60. Moreover, one end of the motor control device housing 6 is protruded outward to form a protruded portion 61, and a through hole 62 for mounting a connector 10 is provided to the protruded portion 61, and the connector 10 is fitted into the through hole 62, and the sealing member 30 is provided between an outer circumferential surface of the connector 10 and the through hole 62.

[0026] The sealing member 30 according to the embodiment, is formed to be poured a molten sealing agent between the outer circumferential surface of the connector 10 and the through hole 62, and hardened the sealing agent, but the arrangement of the sealing member 30 is not particularly limited as described above.

[0027] The motor control device 5 contained in the motor control device housing 6 includes a circuit substrate 51 positioned so as to surround the motor shaft 41 and a plurality of capacitors 52 mounted exposed to the circuit substrate 51.

[0028] In addition, as shown in FIG. 2, the electric motor 4 includes a motor housing 42, and the motor housing 42 as well as the covering member 8 is mounted detachably into the motor control device housing 6.

[0029] Here, in the drawing, 31 is a cartridge-type relief valve mounted detachably to the relief path 24, and 32 is a liquid return opening provided to the cover 16 of the pump housing 12.

[0030] In the electric pump apparatus having the above arrangement, by driving the electric motor 4, the motor shaft 41 is rotated, and then the shaft coupling 3 and drive shaft 11, then the drive gear 17 and driven

gear 18 meshed with the drive gear 17 are rotated successively. Hydraulic oil is supplied from the gear chamber 19 via the discharge opening, noise damper drum 21, connecting path 22, and to the discharge path 23, and therefrom supplied to one operating chamber of a hydraulic actuator so that the hydraulic liquid is returned from the other operating chamber of the hydraulic actuator to the liquid return opening 32.

[0031] In addition, in the electric pump apparatus having the above arrangement, prior to the assembly, an inspection is made as to whether or not leakage occurs from the sealing member 7 of the shaft hole 13, the sealing member 30 of the through hole 62 for mounting the connector 10, and the sealing board 60 on the end portion of the motor control device housing 6.

[0032] This inspection is made in such a manner that the connector 10 is fitted into the through hole 62 for mounting the connector 10 of the motor control device housing 6 with the pump portion 1a while the cover 16 and sealing member 7 are not mounted, the through hole 62 is sealed with the sealing member 30, and after the covering member 8 and electric motor 4 are mounted into the motor control device housing 6 via the sealing board 60, as shown in FIG. 3, an air leak jig 33 provided with a connecting path connected with the coupling accession portion 27 and discharge path 23 is mounted to the housing base 14, and then a compressed air at a predetermined pressure is charged in the coupling accession portion 27 from the discharge path 23 via the connecting path of the air leak jig 33.

[0033] Thereafter, differential pressure between a charged compressive air circuit N1 and a sealing circuit N2 is detected by a differential pressure sensor 0 placed between the charged compressive air circuit N1 and the sealing circuit N2, and a detection is made as to whether or not leakage occurs from the sealing member 30 of the through hole 62 for mounting the connector 10 and from the sealing board 60. Here, in FIG. 3, P1 and P2 are solenoid valves.

[0034] After the inspection was made as to whether or not leakage occurs from the sealing member 30 of the through hole 62 for mounting the connector 10 and from the sealing board 60, the air leak jig 33 is temporarily dismantled, and the sealing member 7 is inserted into the sealing member accession portion 26 from the coupling accession portion 27 of the housing base 14.

[0035] Next, similarly to the aforementioned case, the air leak jig 33 is mounted to the housing base 14, compressed air at a predetermined pressure is charged in the coupling accession portion 27 from the discharge path 23 via the connecting path of the air leak jig 33.

[0036] The differential pressure between the charged compressive air circuit N1 and the sealing circuit N2 is detected by the differential pressure sensor 0 placed between the charged compressive air circuit N1 and sealing circuit N2, and a detection is made as to whether or not leakage occurs from the sealing member 7 of the shaft hole 13.

[0037] As mentioned above, the inspections can be made individually as to the leakage from the sealing member 30 of the through hole 62 for mounting the connector 10 in the motor control device housing 6, the leakage from the sealing board 60, and the leakage from the sealing member 7 of the shaft hole 13, so the measures against the leakage can be taken easily.

[0038] In addition, the sealing member accession portion 26 and the coupling accession portion 27 are provided to the shaft hole 13 on the side of the drive shaft 11, and the sealing member 7 is pressed against the step portion 25 of the sealing member accession portion 26 by hydraulics, which is transmitted from the pump 1 via the shaft hole 13 and acts upon the sealing member 7, so as to be received by the sealing member accession portion 26. Therefore, it is not necessary to specially provide a fastener for the sealing member 7, and thus the cost can be reduced.

[0039] Further, the shaft coupling 3 is placed on the side of the drive shaft 11 with respect to the sealing member 7, and hydraulic oil leaked from the circumference of the drive shaft 11 lubricates the shaft coupling 3. Therefore, the shaft coupling 3 can be formed by a sintered material, and thus the cost of the shaft coupling 3 can be reduced more than that of one formed by high-strength synthetic resin containing glass conventionally. Moreover, since the shaft coupling 3 can be lubricated, wear and noise on the shaft coupling 3 can be reduced.

[0040] In addition, the electric pump apparatus of the present invention is driven by hydraulic and is used in order to generate hydraulic operating pressure of auxiliary machineries for assisting an operation of an automobile such as a power steering apparatus and automatic transmission, but applications in which the electric pump apparatus is used are not limited.

Claims

1. An electric pump apparatus, comprising:

a pump (1);
an electric motor (4) whose motor shaft (41) is connected with a drive shaft (11) supported rotatably to a housing (12) of said pump (1) via a shaft coupling (3); and
a sealing member (7) for sealing a circumference of said drive shaft (11),
characterized by including:
a motor control device (5) provided in an area between said electric motor (4) and said shaft coupling (3).

2. The electric pump apparatus according to claim 1, wherein said housing (12) includes:

accession means (26) for accepting said sealing member (7), which is provided to a shaft hole (13) penetrated by said drive shaft (11)

and which has a diameter larger than that of said shaft hole (13).

3. The electric pump apparatus according to claim 1, wherein said housing (12) includes: 5

accession means (27) for accepting said shaft coupling (3), which is provided to a shaft hole (13) penetrated by said drive shaft (11) and which has a diameter larger than that of said shaft hole (13). 10

4. An electric pump apparatus, comprising:

a pump (1); 15
 an electric motor (4) whose motor shaft (41) is connected with a drive shaft (11) supported rotatably to a housing (12) of said pump (1) via a shaft coupling (3); and
 a sealing member (7) for sealing a circumference of said drive shaft (11), 20
 characterized by including:
 a motor control device (5) provided in an area between said electric motor (4) and said shaft coupling (3), 25
 wherein said shaft coupling (3) is positioned on the side of said drive shaft (11) with respect to said sealing member (7).

5. The electric pump apparatus according to claim 4, wherein said housing (12) includes: 30

accession means (26) for accepting said sealing member (7), which is provided to a shaft hole (13) penetrated by said drive shaft (11) and which has a diameter larger than that of said shaft hole (13). 35

6. The electric pump apparatus according to claim 4, wherein said housing (12) includes: 40

accession means (27) for accepting said shaft coupling (3), which is provided to a shaft hole (13) penetrated by said drive shaft (11) and which has a diameter larger than that of said shaft hole (13). 45

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FIG. 1
PRIOR ART

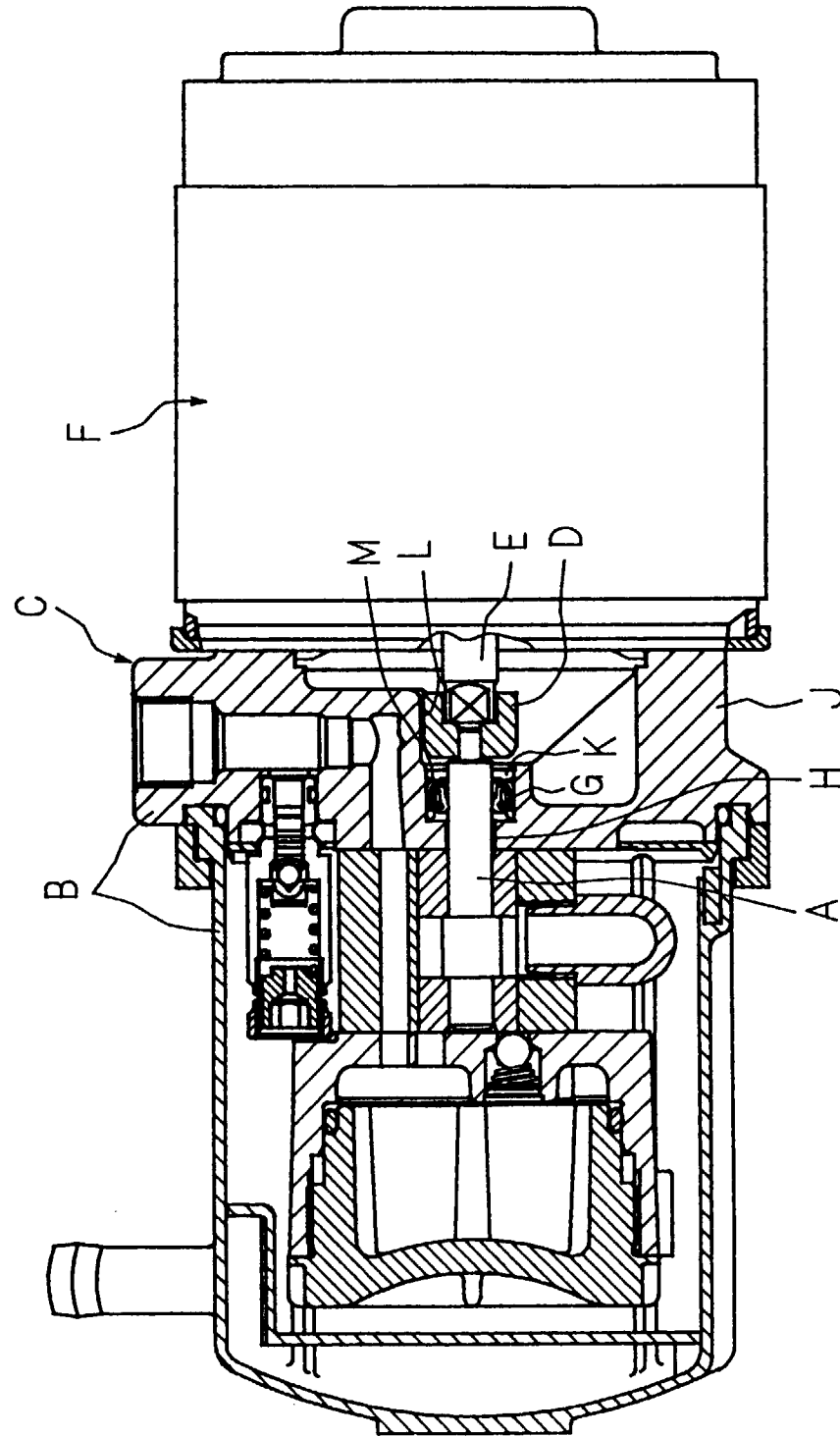


FIG. 2

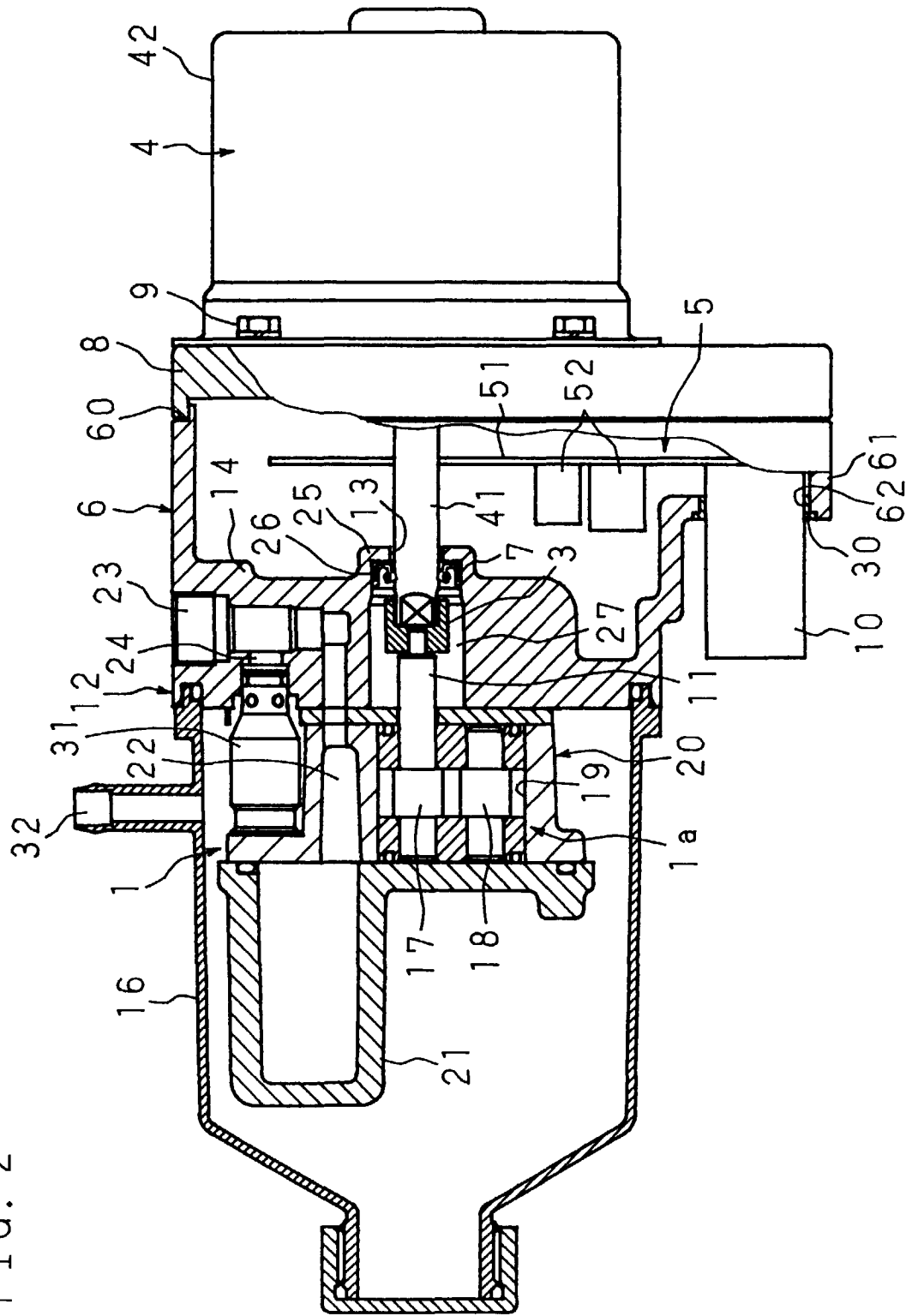
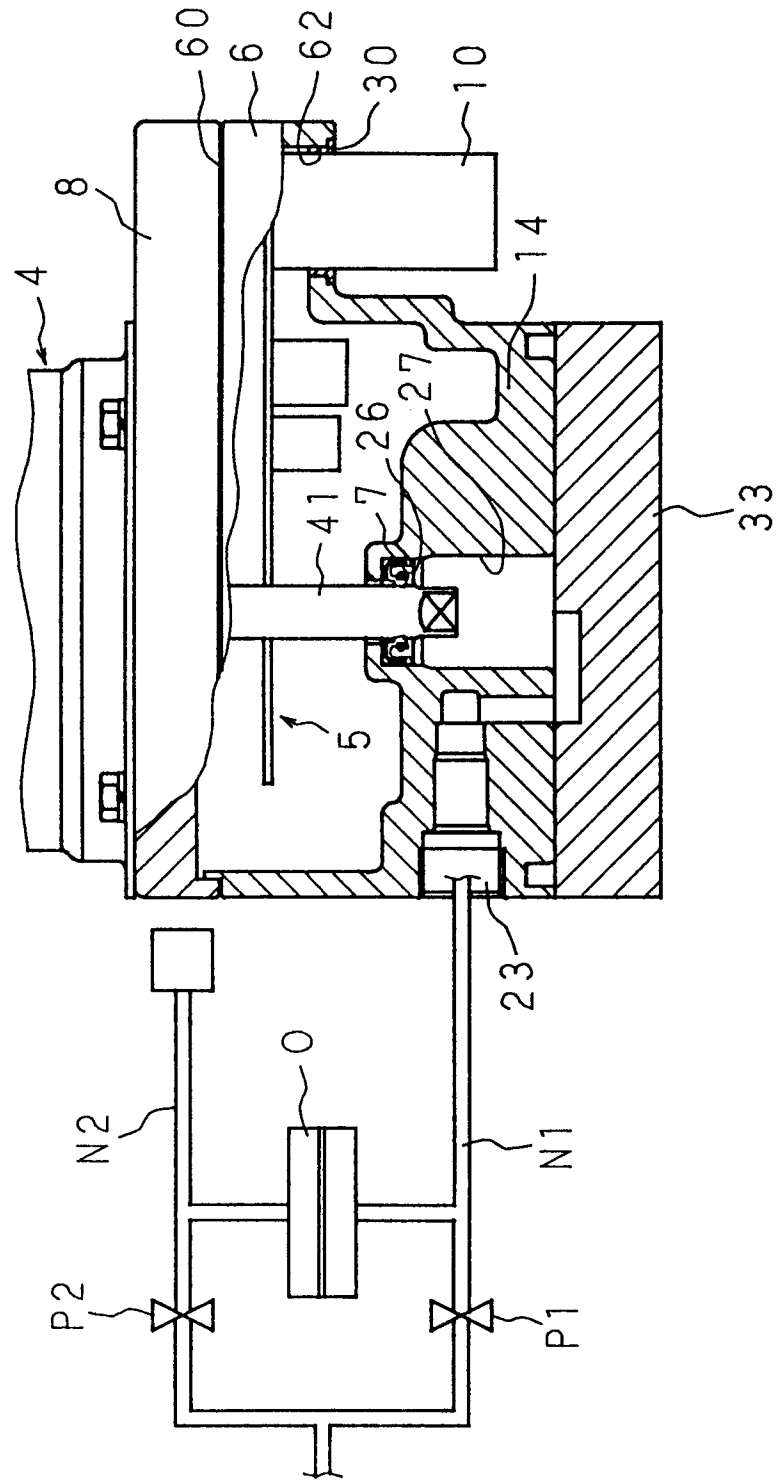


FIG. 3





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 98 11 7511

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.6)
X	EP 0 593 913 A (ITT AUTOMOTIVE EUROPE GMBH) 27 April 1994 * column 2, line 41 - column 3, line 43; figure 1 * -----	1-6	F04C11/00
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F04C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 5 January 1999	Examiner Dimitroulas, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P4/C01)

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

EP 98 11 7511

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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05-01-1999

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		DE 59306251 D	28-05-1997
		ES 2100412 T	16-06-1997

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82