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(54) Title: A MOTOR PUMP AND CONTROL MANIFOLD ASSEMBLY

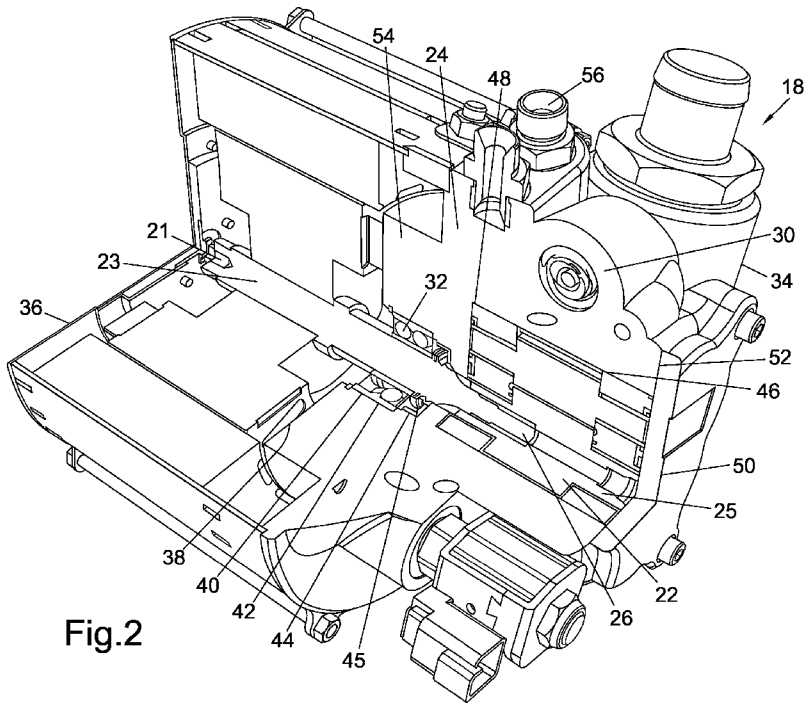

Fig.2

(57) Abstract: A motor pump assembly is provided that comprises a motor, a drive shaft connected to the motor, a pump and control manifold including means for controlling fluid flow to and/or from the pump. The motor, drive shaft, pump and manifold are contained within a single common housing. The manifold forms an integral part of the housing and includes a pump chamber that contains the pump.

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A Motor Pump and Control Manifold Assembly

The present invention relates to a motor pump and control manifold assembly, and in particular a motor pump assembly for use in controlling a hydraulic actuator.

A hydraulic system comprising a hydraulic actuator such as a hydraulic cylinder requires a pump for driving fluid to the actuator, and drive means such as a motor for driving the pump. A control manifold is also required to control and direct the pressurised hydraulic fluid from the pump and the depressurised fluid flowing to tank. Figure 1 shows an example of a hydraulic drive system. The system comprises an electric motor 1 contained within a motor housing 2. A pump 4 is contained within a pump housing 6. The pump housing 6 is connected to the motor housing 2 and the drive shaft of the motor (not shown) connects to the shaft of the pump via a coupling and drives the pump 4. A fluid outlet line 8 connects the outlet of the pump 4 to a control manifold 10 containing a series of control valves. The control manifold in turn includes a fluid outlet that may be connected to the supply port of a hydraulic actuator. A return line 12 connects the control manifold 10 to the inlet port of the pump 4. The control manifold 10 also connects to the outlet port of the hydraulic actuator and to tank. A support frame 14 connects the motor 1, pump 4 and control manifold 10. The size and/or cost of such an arrangement may be prohibitive for certain applications.

It is therefore desirable to provide an improved motor pump and control manifold assembly which addresses the above described problems and/or which offers improvements generally.

According to the present invention there is provided a motor pump assembly as described in the accompanying claims.

In an embodiment of the invention there is provided a motor pump and control manifold assembly assembly comprising a motor, a drive shaft connected to the motor, a pump and control manifold including means for controlling fluid flow to and/or from the pump.

The motor, drive shaft, pump and manifold are contained within a single common housing. The term 'single common housing' is a term which contrasts with the prior art in which each of the motor, pump and manifold are contained in independent, separately formed housings that are operatively connected, but at least one or more of which is independent of and physically separated from the others. Locating the motor, drive shaft, pump and manifold within an integrated housing advantageously obviates the requirement for a network of pipework interconnecting a number of separate components and enables the size of the assembly to be minimised. The manifold may comprise an integral part of the housing, and the term 'contained within' does not therefore require the manifold to be an independent component located within a separate housing; rather that at least the working elements of the manifold, namely the fluid channels and valves, are at least partially contained within the housing.

The housing preferably comprises a main housing body containing each of the motor, drive shaft, pump and manifold. The housing may comprise a first section housing the motor, and a second section comprising the pump housing and manifold, the first and second sections being secured to each other and the shaft extending through both the first and second sections. The term 'single piece', with reference to the entire housing, or the first and second sections, means that the body of the relevant housing section is formed as a single piece, and does not exclude the housing or housing sections from including additional components or 'parts' such as end plate covers, port connections or closure members.

Preferably the manifold is integrally formed as part of the housing, in that the valve chambers and associated fluid channels and ports are formed within a body which defines the housing. The manifold therefore forms one of the housing sections, within which the pump is contained. Forming the manifold such that it is comprises part of the housing removes the requirement for external pipes and connectors to connect a separate manifold to the pump. As well as reducing part numbers, this also simplifies assembly and reduces leak paths.

Preferably the housing includes an integrally formed pump chamber configured to house the pump, which may be a vane pump or gear pump or any other suitable pump arrangement. The pump chamber is fluidly connected to the manifold within the housing body. The pump chamber is preferably formed within the manifold.

The housing preferably further includes an integrally formed chamber for housing the motor. The motor and pump are both connected within the housing to the single common drive shaft. The term 'single common drive shaft' means that the shaft is continuous and unbroken along its length. A single bearing is preferably provided along the drive shaft between the motor and the pump, which is enabled by the use of a single piece shaft contained within a common housing. In contrast, in arrangements of the prior art an independent pump and motor are provided, each having separate drive shaft elements that must be connected when the independent are assembled together.

The pump chamber of the housing preferably includes an inner side wall which locates axially inwards of the pump. A closure member is provided at the opposing axial side of the pump, the closure member forming the outer side wall of the pump chamber. The pump preferably comprises a gear pump cartridge or a vane pump cartridge consisting of a cam ring and a plurality of vanes mounted to the drive shaft. The pump cartridge is clamped and secured directly between the inner and outer walls. In an embodiment where a vane pump is used, this arrangement removes the requirement for separate cheek plates or other additional components to secure and port the pump, thereby enabling the size of the assembly to be reduced, and in particular a reduction in the axial length.

Preferably the fluid channels of the control manifold are axially located between the pump chamber and the motor chamber. This arrangement enables the pump to be located at the end of the assembly for ease of assembly. The housing may include one or more integrally formed heat exchange fluid channels having a pathway extending proximate a wall of the motor chamber. Preferably a matrix or network of channels are formed to flow through the housing proximate the inner wall of the motor chamber. The

manifold may be configured to channel and control fluid flow through the heat exchange fluid channels to assist in cooling the motor. Locating the manifold adjacent the motor chamber advantageously facilities this arrangement and limits the length of the cooling channels.

The motor pump assembly may comprise at least one control manifold module including one or more valves. The control manifold module is provided in addition to the control manifold and optionally connectable to the control manifold. The control manifold module is configured to secure to and fluidly connect with the control manifold. The control manifold module comprises a manifold body and one or more control valves and additional ports configured to provide additional control functionality to the motor pump assembly. For example, the control manifold may include a port and valve arranged to control fluid supply to a primary hydraulic cylinder and an auxiliary cylinder, and the control manifold module may include valves arranged to control fluid supply to one or more additional auxiliary cylinders.

The control manifold preferably includes one or more fluid ports arranged for connection to the at least one control manifold module. These may be the inlet and outlet ports of the control manifold that in the basic configuration i.e. without additional manifold modules connected, connect directly to the primary and/or auxiliary cylinders. Alternatively additional ports may be included in the control manifold that may be accessed by the control manifold module when connected to the main control module. The main control manifold and the control manifold module include corresponding connections means that enable the control manifold module to be bolted or otherwise secured to the control manifold.

The control manifold module preferably includes connector elements arranged to enable a further control manifold module to be secured thereto in a similar manner to which it is secured to the main control manifold. As such, the functionality of the motor pump assembly may be selectively increased and modified in a modular manner through the addition of further control manifold modules. This enables a universal motor pump unit

to be manufactured which is able to be selectively modified through the addition of control manifold modules depending on the required functionality, rather than multiple different units, with a fixed configuration and functionality.

Preferably at least the part of the housing comprising the control manifold and the pump chamber is a single piece body, for example the part of the housing comprising the control manifold and the pump chamber may be a single piece casting.

In an aspect of the invention there is provided a motor pump assembly comprising a motor, a drive shaft connected to the motor, a pump and control manifold including means for controlling fluid flow to and/or from the pump. The manifold defines a housing which contains the pump. The motor is contained within the housing and/or is contained with a housing section that is directly connected to the manifold, the motor housing and manifold combining to define a housing assembly.

The present invention will now be described by way of example only with reference to the following illustrative figures in which:

Figure 1 shows a motor pump assembly according to the prior art; and

Figure 2 shows a motor pump assembly according to an embodiment of the present invention.

Referring to Figure 1 there is a provided a hydraulic drive system 18 comprising an electric motor 20, a gear pump 22 and control manifold 24. The motor 20 is preferably a permanent magnet motor. In the arrangement of Figure 2 two permanent magnets are arranged in series, but it will be appreciated that in other embodiments one of more than two motors may be provided. A drive shaft 23 is connected to the motor 20 at a first end 21 and extends axially from the motor 20. The gear pump 22 is packaged within a pump cartridge 25 that is mounted to the shaft 23 at the second end 26 which functions as the

pump rotor. Advantageously only a single common shaft is required within the assembly that directly couples to both the motor 20 and the pump 22.

A roller bearing 32 is located between the motor 20 and the pump cartridge 25 that rotationally supports the shaft 23. As the assembly utilises a common shaft, advantageously only a single bearing is required along the length of the shaft 23. In contrast, in arrangements such as that of Figure 1, where a pump unit is bolted to a separate motor unit, two bearings are required along the shaft in the pump unit as well as in the motor unit. The applicant has further identified that the hydraulic pressure at the tips of the pump vanes supports the shaft 23 at the second end such that no additional bearing is required at the second end. The lower inherent side-load generated by the gear pump 22 as compared to other pump types further allows the shaft support bearing design to be optimized.

A housing 34 contains all of the components of the assembly. The housing is preferably a two part housing, although could be manufactured as a single piece casting. A first section of the housing 34 defines motor chamber 36 located at a first axial end of the housing 34. The motor housing 36 has an inner end wall 38 which closes the motor chamber 36. The end wall 38 includes an axial bore 40 through which the shaft 23 extends. The inner wall 38 may be formed as part of the first motor chamber section 35 of the second housing section 37. The bore 40 extends axially towards the second end and includes a first diameter section 42 that houses the bearing 32. A second stepped down section 44 of reduced diameter houses a shaft seal 45 to prevent egress of hydraulic fluid to the motor 20 along the shaft 23. A third section 46 defines a pump chamber having a diameter sized to receive the vane cartridge 25. Between the second and third sections the bore 40 has a diameter substantially equal to the diameter of the shaft 23, sized to permit free rotation of the shaft 23 within the bore 40.

The pump chamber 46 has an inner wall 48. A closure plate or cap 50 closes the open outer end of the pump chamber 46. The inner surface 52 of the end plate 50 defines the outer wall of the valve chamber 46. The closure plate 50 is bolted in position to the end

wall of the housing 34, and acts to clamp the pump cartridge in position against the inner wall of the pump chamber 46. The inner wall 48 of the pump chamber 46 is preferably an integrally formed part of the housing 34, formed in the casting process. The ports for the pump22 are formed in the inner wall 48. By clamping the vane cartridge between the closure plate 50 and the inner wall 48, and by forming the ports of the pump22 in the end wall 48, the cheek plates that are conventionally provided to clamp and port and pump are no longer required, which reduces the number of parts, simplifies assembly and reduces cost.

The housing 34 further includes a control manifold section 54. The manifold section 54 is arranged between the pump 22 and the motor 20. The manifold section 54 is integrally formed as part of the single piece housing 34. The manifold section 54 includes a plurality of ports, such as port 56, arranged to receive control valves such as cartridge valve 58, to control fluid flow to and from the pump 22. The pump extends directly from the inner wall porting face 48 of the pump chamber 46 into the manifold section 54, with the outer face of the manifold 54 forming the porting face 48 of the pump 22. Integrating the control manifold directly in the assembly housing obviates the requirement for a system of pipework connecting the pump with a separate control manifold assembly, thereby enabling the overall size of the assembly to be drastically reduced. Integrating the manifold into the housing also significantly simplifies assembly and greatly reduces parts. The integrated manifold 54 also enables the flow to and from the pump 22 to be readily controlled such that either port of the pump may be pressurised. This enables the pump 22 to be operated in a first direction as a pump and in a second direction as a motor driving the electric motor 20 to function as a generator. The assembly is therefore ideally suited to applications in which energy recovery from a hydraulic system is required.

In a further advantage, fluid channels (not shown) may be formed in the manifold that are routed though the manifold 54 in a region immediately adjacent the inner wall 38 of the motor housing 36. The fluid flow through these channels may be arranged to provide cooling to the motor housing 36. This integrated cooling system of the motor housing 36

is enabled by the integration of the manifold 54 into the housing 34, and its axial location next to the motor housing 36, between the motor housing 36 and the pump housing 46.

The use of a pump 22 such as a gear pump or vane pump within the single housing integrated assembly of the embodiment of Figure 2 is preferable as the pump 22 provides the assembly with a flexible range of operation. As the pump 22 is integrated into the assembly, it is desirable that the assembly is able to be specified across a wide range of operation without having to vary the size or configuration of the single piece housing 34.

In the arrangements of the prior art, if a system specification requires greater displacement from the pump a designer may simply specify an alternative pump and substitute this pump into the assembly. In the present embodiment, if it is required to vary the displacement of the pump, this may achieved by replacing the valve cartridge 25 with an alternative configuration. As it is only the internal configuration of the cam ring that varies, the pump cartridge 25 still occupies the same space within the housing 34.

A single assembly which includes an integrated pump, motor and control manifold package therefore optimizes the packaging and performance while minimizing the component parts required. The present embodiment advantageously reduces the number of parts and therefore cost and space claim. Motor pumps of the prior art typically use two shafts a coupling and four bearings. The present embodiment uses only one bearing with the pump 22 functioning like an oil bearing helping to support the shaft.

Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

CLAIMS

1. A motor pump and control manifold assembly comprising:

a motor;

a drive shaft connected to the motor;

a pump; and

a control manifold including means for controlling fluid flow to and/or from the pump, wherein the motor, drive shaft, pump and manifold are contained within a single common housing.

2. A motor pump and control manifold assembly according to claim 1 wherein the housing comprises a main housing body containing each of the motor, drive shaft, pump and manifold.

3. A motor pump and control manifold assembly according to claim 2 wherein the manifold is integrally formed as part of the housing body.

4. A motor pump and control manifold assembly according to claim 3 wherein the manifold includes an integrally formed pump chamber within which the pump is housed.

5. A motor pump and control manifold assembly according to claim 4 wherein the pump chamber is fluidly connected to the manifold within the housing body.

6. A motor pump and control manifold assembly according to any preceding claim wherein the pump is a gear pump.

7. A motor pump and control manifold assembly according to any preceding claim wherein the pump is a vane pump.

8. A motor pump and control manifold assembly according to any one of claims 2 to 7 wherein the housing includes an integrally formed chamber for housing the motor.

9. A motor pump and control manifold assembly according to any preceding claim wherein the drive shaft is a single piece common shaft connected to both the motor and the pump.

10. A motor pump and control manifold assembly according to claim 9 wherein only a single bearing is preferably provided along the drive shaft between the motor and the pump.

11. A motor pump and control manifold assembly according to any one of claims 2 to 10 includes an inner wall located axially inwards of the pump that defines the porting face of the valve chamber and includes a plurality of ports formed therein arranged to port fluid to and from the pump.

12. A motor pump and control manifold assembly according to claim 11 where a closure member is provided at the axially opposing end of the pump chamber to the porting face to close the pump chamber and secure the pump therein.

13. A motor pump and control manifold assembly according to claim 12 wherein the closure member forms the axially outer side wall of the pump chamber.

14. A motor pump and control manifold assembly according to any one of claims 2 to 11 wherein the control manifold is axially located between the pump chamber and the motor chamber.

15. A motor pump and control manifold assembly according to claim 14 wherein the housing includes one or more integrally formed heat exchange fluid channels arranged proximate the motor chamber to effect cooling thereof.

16. A motor pump and control manifold assembly according to claim 15 wherein a network of heat exchange fluid channels are formed within the housing proximate the axially inner wall of the motor chamber.

17. A motor pump and control manifold assembly according to claim 15 or 16 wherein the manifold is configured to control fluid through the heat exchange fluid channels.

18. A motor pump and control manifold assembly according to any preceding claim comprising at least one control manifold module including one or more valves, the control manifold module being configured to connect to the control manifold to increase the control functionality of the motor pump assembly.

19. A motor pump and control manifold assembly according to claim 18, wherein the control manifold includes one or more fluid ports arranged for connection to the at least one control manifold module, the control manifold and control manifold module including corresponding connector elements to enable the control manifold module to be secured to the control manifold.

20. A motor pump and control manifold assembly according to claim 19 wherein the control manifold module includes connector elements arranged to enable a further control manifold module to be secured thereto.

21. A motor pump and control manifold assembly according to any preceding claim wherein at least the part of the housing comprising the control manifold and the pump chamber is a single piece body.

22. A motor pump and control manifold assembly according to claim 21 wherein at least the part of the housing comprising the control manifold and the pump chamber is a single piece casting.

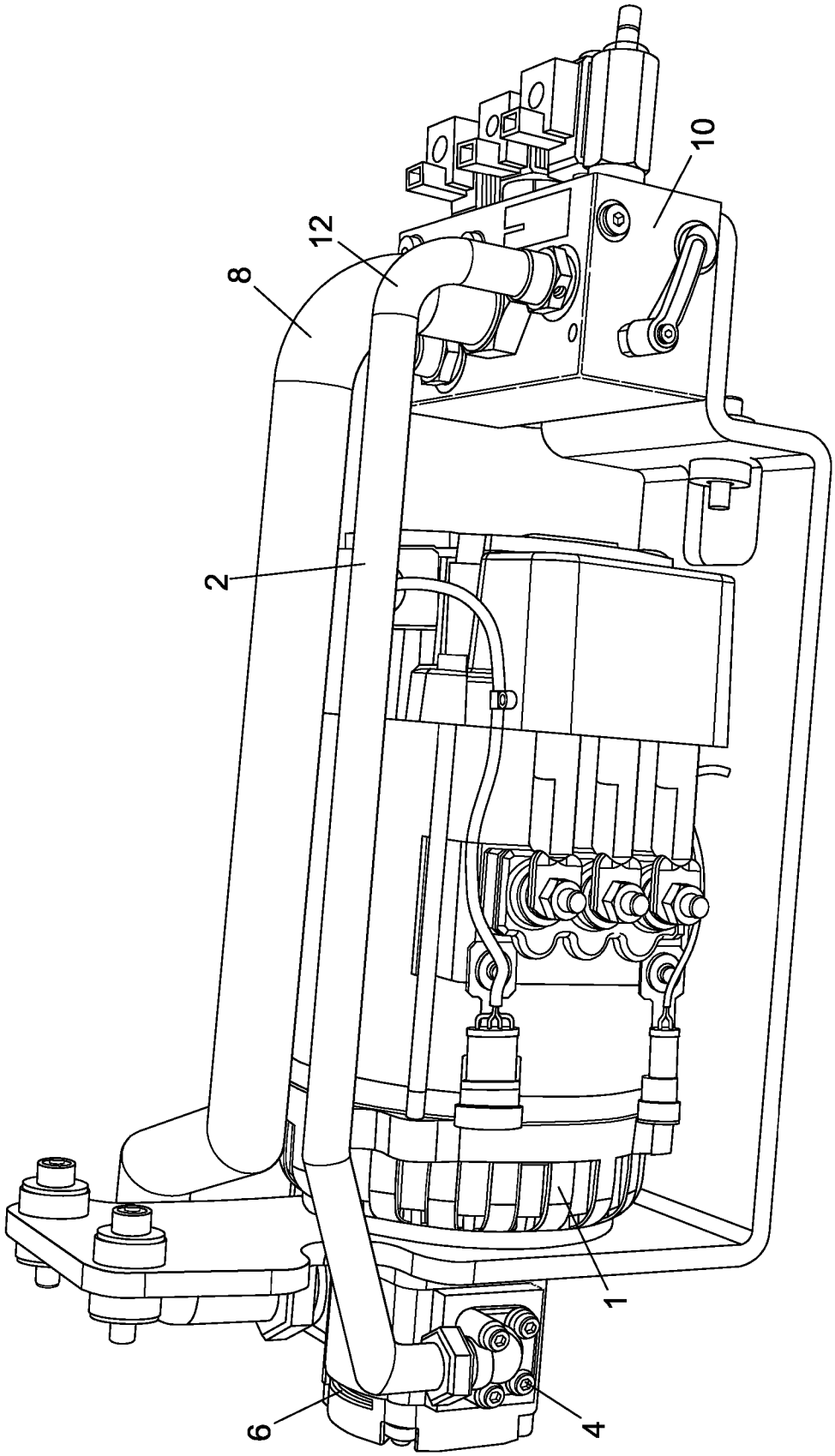

Fig.1

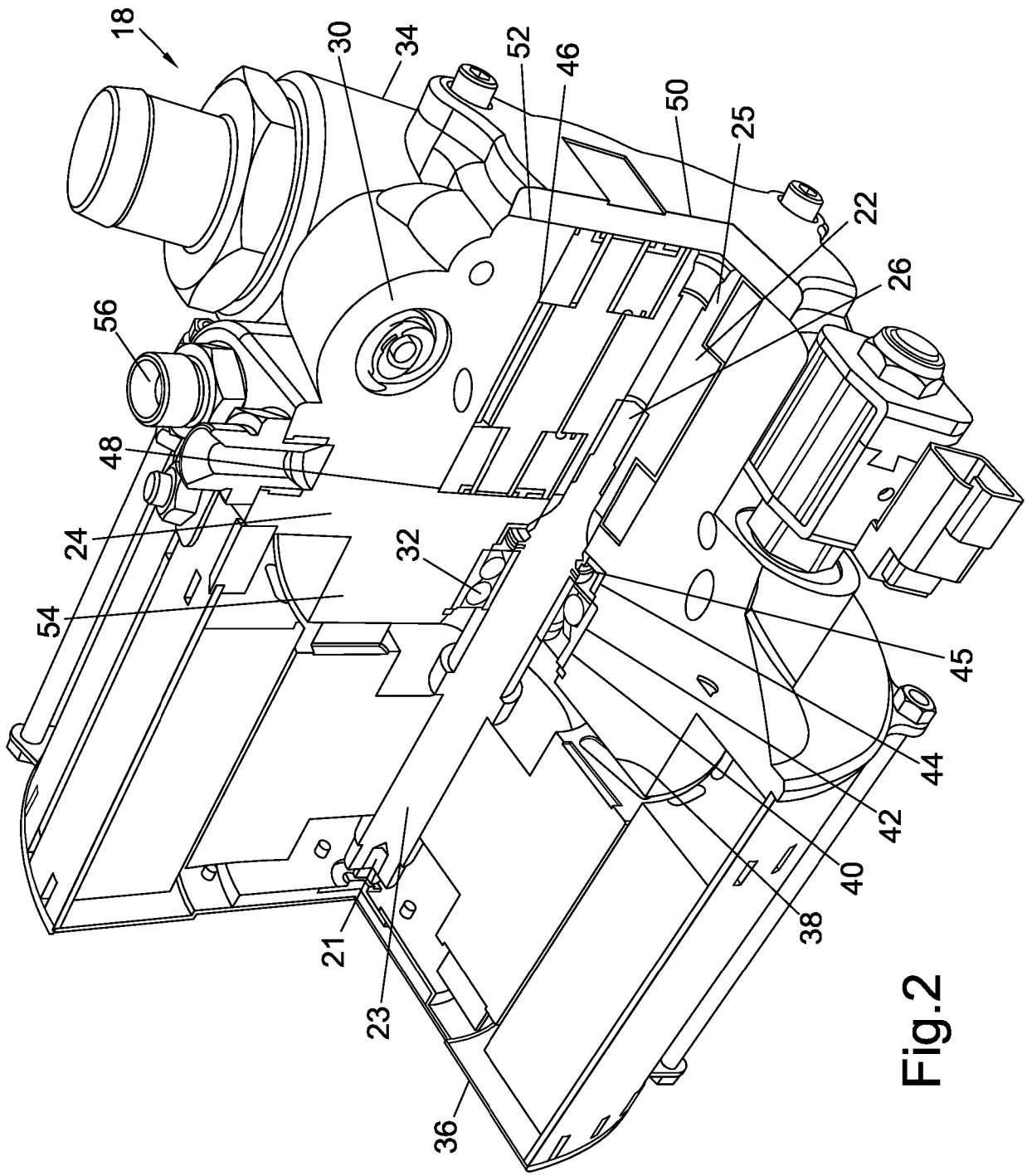

Fig.2