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None

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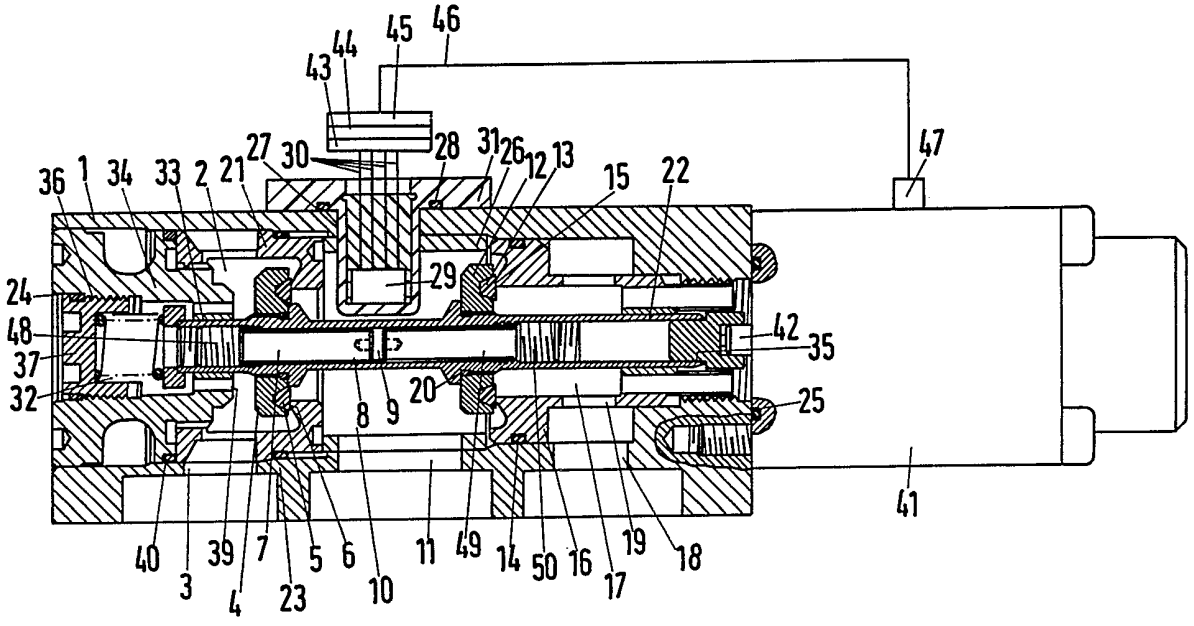
(54) Electromagnetic valve device

(57) A proportionally acting electromagnetic valve device has a valve housing (1) defining a plurality of pressure medium chambers (2, 10, 17) with connections (3, 11, 18) for the passage of pressure medium. Two valves are located within the valve housing on either side of the chamber (10), and provided with movable valve members (4, 12) connected to a valve tappet (20) for simultaneous actuation thereof. The two valve members (4, 12) of both valves are arranged coaxially and are connected jointly to the valve tappet (20). A permanent magnet (9) for detecting the position of the valve tappet (20) is arranged on or in the valve tappet (20) such that the displacement path of the magnet produced by actuating the valve tappet lies within the pressure medium chamber (10). A field sensor (29) is arranged extending through the valve housing wall and into the corresponding pressure medium chamber (10).



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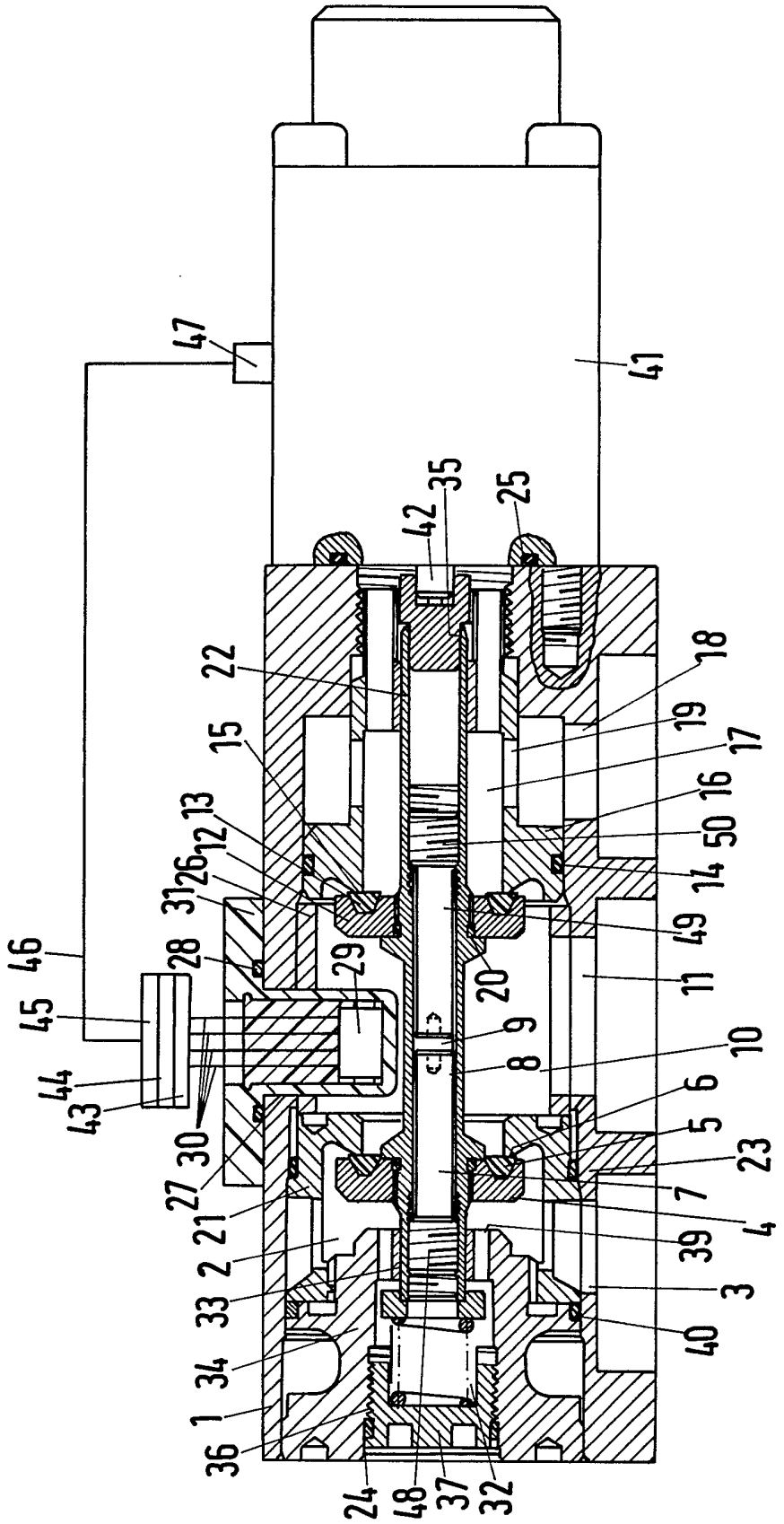
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Valve device

The invention relates to a valve device, in particular a proportionally acting electromagnetic valve in which a plurality of chambers within a housing and having external connections, are internally connected by two valves.

A valve device of the above type is known from US Patent No. 4,452,267. This valve device is controlled by an electromagnet. The armature of the electromagnet actuates a first valve, which is coupled to a second valve via a valve tappet. The control of the throughflow of pressure medium takes place exclusively via the electromagnet. As a consequence, the opening cross-section of the valve cannot be set reliably and reproducibly because of temperature fluctuations and possibly also due to flow forces of the pressure medium, since there is no provision for monitoring the opening cross-section of the valve.

A valve device is known from German Patent Specification No. OS 29 42 900 in which the position of the valve tappet is detected via a sensor means. In this case, the valve tappet is connected to a position transmitter, which together with the valve tappet is displaced when the valve tappet is actuated, and can be detected position-wise via a position indicator. The position indicator is located within a housing which is inserted into the entire valve arrangement. This additional housing increases the axial extent of the valve device. Thus such an arrangement cannot be used for valves of compact construction.

The present invention addresses the drawbacks of the prior art and seeks to provide a device which permits reliable and reproducible determination and influencing of the opening cross-section of the valve while having a simple and compact construction. To this end, a valve device according to the invention comprises a housing defining a plurality of chambers with connections for the

passage of pressure medium thereto; two valves located within the valve housing on either side of one of the chambers, and provided with respective movable valve members arranged coaxially and connected jointly to a valve tappet for simultaneous actuation thereby; a permanent magnet associated with the valve tappet such that the displacement of the valve tappet is monitorable within the one chamber; and a field sensor arranged in the one chamber for monitoring the position of the permanent magnet and thereby the valve tappet.

The invention provides the possibility of controlling the throughflow rates or valve opening cross-section in a simple manner. A sensor which detects the size of the magnetic field which is generated by the permanent magnet and acts at the corresponding point of the magnetic field acting in the region of the field sensor is used as the field sensor. Typically, the permanent magnet is located in a cavity or in a longitudinal bore of the tappet. It is preferred that the field sensor is located within the housing, in order to achieve the most effective utilisation of magnetic field possible. In another preferred feature in order to establish the opening cross-section of the valve, the distance between the field sensor and the permanent magnet is adjustable in that the permanent magnet is arranged to be movable in the valve tappet by means of a threaded bolt.

Since the device according to the invention operates without contact, it is substantially wear-free. Due to its arrangement in the valve housing, the valve can also be used in aggressive media with minimal risk of consequential damage.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawing which shows the valve device in partial cross-section.

As shown in the drawing a valve housing 1, has one end face into which a first housing insert 34 designed as a sealing member is screwed. At the other end face, which is located opposite the first housing insert 34, a proportional magnet 41 is attached. A second housing insert 21 is screwed to the first housing insert 34 and extends into the interior of the valve housing 1. The first housing insert 34 and the second housing insert 21 may also be made of a structural unit constructed in one piece.

A first valve seat 6 is provided in the valve housing 1, which seat forms a first valve 4, 5, 6 with a first valve member 4, 5. The valve member 4, 5 consists of a valve disc 4 and a valve seal 5. A second valve seat 15, which is located on a third housing insert 16 of the valve housing 1, forms a second valve 12, 13, 15 with a second valve member 12, 13. Here the valve member 12, 13 likewise consists of a valve disc 12 and a valve seal 13. The first valve 4, 5, 6 and the second valve 12, 13, 15 are arranged coaxially and adjacent in the housing 1. The first valve member 4, 5 and the second valve member 12, 13 are attached to a valve tappet 20 which serves for joint actuation of the two valves 4, 5, 6 and 12, 13, 15.

A first pressure medium inlet chamber 2 can be connected to a pressure medium outlet chamber 10 via the first valve 4, 5, 6. Likewise, a second pressure medium inlet chamber 17 can be connected to the pressure medium outlet chamber 10 via the second valve 12, 13, 15. Since both valve members 4, 5 and 12, 13 are attached to the valve tappet 20 which is common for actuating both valves, the first pressure medium inlet chamber 2 and the second pressure medium inlet chamber 17 can be connected simultaneously to the pressure medium outlet chamber 10 or blocked off therefrom. The first pressure medium inlet chamber 2 is connected via a first pressure medium inlet 3, and the second pressure medium inlet chamber 17 via a second pressure medium inlet 18, to a pressure medium source. The pressure medium outlet chamber 10 is

connected to a consumer via a pressure medium outlet 11. In an alternative arrangement, the two pressure medium inlet chambers 2 and 17 may also be used as pressure medium outlet chambers, in which case the pressure medium outlet chamber 10 is then used as a pressure medium inlet chamber.

The housing insert 16 which bears the second valve seat 15 is sealed off from the inner wall of the valve housing 1 by means of a sealing ring 14. The sealing ring 14 is located on the housing insert 16 in such a manner that it seals off the pressure medium inlet 18 of the second pressure medium inlet chamber 17 and also openings 19 of the housing insert 16, via which the second pressure medium inlet chamber 17 is connected to its associated pressure medium inlet 18, from the pressure medium outlet chamber 10.

The third housing insert 16 has centrally a guide bore 22 for one end of the valve tappet 20 running in the direction of its longitudinal axis. The other end of the valve tappet 20 is guided in a guide bore 33, which is provided in the first housing insert 34. The first housing insert 34 is sealed off by means of a sealing ring 40, and the second housing insert 21 by means of a sealing ring 23, from the inner wall of the valve housing 1. The two housing inserts 34 and 21 define the first pressure medium inlet chamber 2.

A closure plug 37, which is provided with an external thread 36 and on which is supported a pressure spring 32 which acts on the first valve member 4, 5 in the direction of closure of the first valve 4, 5, 6, is screwed into a bore running in the direction of the longitudinal axis of the first housing insert 34, which bore is arranged coaxially to the guide bore 33. The initial tension of the pressure spring 32 can be set by turning the closure plug 37 about its longitudinal axis. The closure plug is sealed off from the wall of the bore receiving it by means of a sealing ring 24. The first housing insert 34 has a ventilation bore 39 which leads

from the first pressure medium inlet chamber 2 to the space receiving the pressure spring 32 and which prevents the formation of a pressure head upon movement of the valve tappet 20.

A sealing ring 25 is arranged between the side of the valve housing 1 close to the proportional magnet 41. The valve tappet 20 has a cavity which is designed as a bore 8 running in the direction of the longitudinal axis of the valve tappet 20. The bore 8 is closed on its side close to the proportional magnet 41 by a thrust member 35 which is operatively connected to the armature 42 of the proportional magnet. A threaded bolt 48, which is screwed into the side of the valve tappet 20 opposite the thrust member 35, serves as a support for a first holding element 7, located in the bore 8 of the valve tappet 20, for a permanent magnet 9 which is likewise located in the bore 8 of the valve tappet 20. A second holding element 49 is located in the bore of the valve tappet 20 on the side of the permanent magnet 9 which is remote from the first holding element 7. The second holding element 49 is supported on another threaded bolt 50, which is screwed into the bore 8 of the valve tappet opposite the first threaded bolt 48. The permanent magnet 9 is thus fixed in an accurate position by the facing end faces of the two holding elements 7 and 49.

The permanent magnet 9 and the holding elements 7 and 49 are guided by the inner wall of the bore 8. The permanent magnet can be adjusted in the direction of the longitudinal axis of the bore 8 by turning the threaded bolts 48 and 50 about their longitudinal axes. The two holding elements 7 and 49 are designed as rod-shaped members. They are made, as are the valve tappet 20, the housing inserts 34, 21, 16 and the valve housing 1, of a non-magnetisable material. It is also possible to provide only one threaded bolt, which at the same time has the function of a holding element and to which the permanent magnet is fixed.

A field sensor 29 is arranged transversely to the

valve tappet 20 in the region of the permanent magnet 9 or in the region of the section over which the permanent magnet 9 can be moved by the valve tappet. A Hall generator, a coil or alternatively a magneto-resistive element may for instance serve as a field sensor. The field sensor 29 is secured in an adapter-like housing 31 which extends into the valve housing 1 through a recess 27 provided in the wall of the valve housing 1. The adapter-like housing 31 for the field sensor is made of a magnetically non-conductive material, such as a plastics material, and is sealed off from the wall of the valve housing 1 by means of a sealing ring 28. A shielding means 26 adjoining the adapter-like housing 31 or the field sensor 29 is located on the inner wall of the valve housing 1 in the region through which the permanent magnet 9 together with the valve tappet 20 can pass, which shielding means is made of a magnetically conductive material.

From the field sensor 29, electric lines 30 pass to an electronic circuit 43 for detecting and evaluating the field sensor signals. The position of the valve tappet 20 and hence also the opening cross-section of the two valves 4, 5, 6 and 12, 13, 15 is indicated by means of this circuit. An additional electronic circuit 44 likewise connected to the field sensor by the lines 30 serves to compensate for temperature effects on the field sensor 29.

The electronic circuit 43 for detecting and evaluating the field sensor signals is connected to an electronic circuit 45 which compares the actual position of the valve tappet 20 with its predetermined intended position, and if the actual position deviates from the intended position of the valve tappet 20 sends a correction signal to an input 47 of the proportional magnet 41 via an electric line 46. This produces a closed control circuit.

The function of the valve device described above will be explained in greater detail below.

In the illustration, the two valves 4, 5, 6 and 12, 13, 15 are in the closed position. If a pressure medium is to be controlled by the valve device, an electric signal is sent to the proportional magnet 41. Due to the proportional magnet 41, the valve tappet 20 is displaced to the left in the direction of opening of the two valves 4, 5, 6 and 12, 13, 15, counter to the force of the spring 32, by means of the force of the proportional magnet. The armature 42 of the proportional magnet 41 then bears with its end face on the valve tappet 20 without a fixed connection. However, it would also be conceivable for the valve tappet 20 to have a fixed connection to the armature 42.

The two valves pass into the open position and release opening cross-sections for the pressure medium which are dependent on the size of the electric signal sent to the proportional magnet 41. From the first pressure medium inlet chamber 2, pressure medium flows from the pressure medium source through the opened first valve 4, 5, 6 and into the pressure medium outlet chamber 10. At the same time, pressure medium passes from the second pressure medium inlet chamber 17 into the pressure medium outlet chamber 10 via the opened second valve 12, 13, 15.

Since due to the movement of the valve tappet 20 the position of the permanent magnet 9 connected to the valve tappet 20 relative to the field sensor 29 has also changed, which leads to a change in the recorded magnetic field intensity, the electronic circuit 43 displays the instantaneous position of the permanent magnet 9 relative to the field sensor 29 and hence also the position of the valve tappet 20 and the position of the valve members 4, 5 and 12, 13 relative to their associated valve seats 6 and 15. The electronic circuit 45 performs a comparison of the actual position of the valve tappet 20 with its intended position, and sends a corresponding correction signal to the proportional magnet 41 via the electric line 46 into the input 47 if

the actual position of the valve tappet 20 deviates from the intended position. The proportional magnet 41 is thereby caused to bring the valve tappet 20 and the valve members 4, 5 and 12, 13 connected thereto back into a position in which the first valve 4, 5, 6 and the second valve 12, 13, 15 regain their predetermined opening cross-sections.

Obviously it is possible to use only one valve device with only one valve seat and one valve member. The valve tappet 20 bearing the valve member or members may have a blind bore for receiving the permanent magnet 9, but it may also be designed as a hollow tappet, as shown in the illustration. The permanent magnet is preferably located in the valve tappet 20, but it may also surround the valve tappet 20 for instance in the form of an annulus. Likewise, it is possible to locate the field sensor 29 externally on the valve housing 1 of the valve device.

The housing insert 16 having the second valve seat 15 is connected to the inner wall of the valve housing 1 by means of threads, and can thus be adjusted in the direction of the longitudinal axis of the valve housing 1. The correction circuit 45 can be dispensed with if it is only the opening cross-section of a valve which is to be monitored. The device for determining the opening cross-section of a valve can be used in any valve device desired, such as a seat valve or sliding valve device, with or without proportional magnets.

In the case of the seat valve, a valve body serving as a movable valve member and a valve seat cooperate. The sliding valve consists of a valve slide serving as a movable valve member and at least one control opening which cooperates therewith.

Claims

1. A proportionally acting electromagnetic valve device comprising a housing defining a plurality of chambers with connections for the passage of pressure medium thereto; two valves located within the valve housing on either side of one of the chambers, and provided with respective movable valve members arranged coaxially and connected jointly to a valve tappet for simultaneous actuation thereby; a permanent magnet associated with the valve tappet such that the displacement of the valve tappet is monitorable within the one chamber; and a field sensor arranged in the one chamber for monitoring the position of the permanent magnet and thereby the valve tappet.

2. A valve device according to Claim 1 designed as a seat valve.

3. A valve device according to Claim 1 or Claim 2 wherein the field sensor is connected to an electronic circuit for detecting and evaluating the field sensor signals.

4. A valve device according to Claim 3 wherein the electronic circuit is selectively connectable to an electronic circuit for controlling the opening cross-section of the valve device.

5. A valve device according to any preceding Claim wherein the permanent magnet is mounted in a cavity within the valve tappet and coupled to a bolt having an external thread matching an internal thread in the cavity, which bolt is adjustable in the cavity to set the position of the permanent magnet.

6. A valve device according to any preceding Claim wherein a shielding means made of a magnetically conductive material is located on the inner wall of the valve housing adjacent the field sensor or a housing therefor, and extends parallel to the longitudinal axis of the valve tappet.

7. A valve device according to any preceding Claim wherein the field sensor extends through the wall of the housing and into the one chamber.

8. A proportionally acting electromagnetic valve device substantially as described herein with reference to the accompanying drawing.

Patents Act 1977

Examiner's report to the Comptroller under S tion 17 (The Search Report)

Application number

9203757.1

Relevant Technical fields

(i) UK Cl (Edition K) F2V (VW12)

(ii) Int CL (Edition 5) F16K

Search Examiner

PAM HYETT

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

8 MAY 1992

Documents considered relevant following a search in respect of claims 1-8

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

SF2(p)

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Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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