(19) DANMARK

(10) **DK/EP 3084277 T3**

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***F 16 K 31/122 (2006.01)*** ***F 16 K 11/07 (2006.01)*** ***F 16 K 31/143 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2020-04-06**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2020-01-08**

(86) Europæisk ansøgning nr.: **14799343.0**

(86) Europæisk indleveringsdag: **2014-11-12**

(87) Den europæiske ansøgnings publiceringsdag: **2016-10-26**

(86) International ansøgning nr.: **EP2014003032**

(87) Internationalt publikationsnr.: **WO2015090493**

(30) Prioritet: **2013-12-16 DE 102013021317**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **Hydraulisk ventilindretning**

(56) Fremdragne publikationer:
**WO-A1-98/05870**
**WO-A1-2010/063515**
**DE-A1- 3 135 109**
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Description

The invention relates to a hydraulic valve device, preferably an LS directional control valve with the features described in the preamble of claim 1.

Valve devices of this type are in widespread use to control hydraulic actuators. In this case, adjustable travel stops are used for the purpose of restricting the maximum volume flow in a valve section and thus the maximum speed of an operating function, for example the travel motion of a piston for an operating cylinder or the operating speed of a different actuator. According to the prior art, a respective adjustable end stop may be provided at each of two axial end regions in relation to the axis of travel movements of the control device to restrict stroke length accordingly, said end stop working together with the control device or parts that are in operative connection with the control device. For example, document WO 98/05870 describes such a solution in which each end stop on a measurement piston acts on one or the other end of a control valve. Such solutions are disadvantageous in that both sides of the housing arrangement of the valve devices must be accessible to carry out adjustment measures on the end stops. In many installation situations, free and unobstructed access is only possible on one side. In the case of valve devices that can be actuated by hand levers, this is generally only possible on the same side as the hand lever. In valve devices that can be actuated by hand levers, prior art offers an additional solution for the adjustment problem by making it possible to carry out the adjustment for both end stops from the hand lever side. When this solution is applied, one end stop acts directly on the control valve of the control device. The second end stop acts on the hand lever device so as to restrict said device to a lever end position. As the adjustment thus only acts indirectly on the control valve, i.e. via the mechanism of the hand lever device, the stop device operates very inaccurately due to the play, friction and deformation of the adjustment mechanism. Due to the disadvantageously transmitted actuating forces, this may also result in the mechanism being deformed and a further impairment of adjustment accuracy.

US 2013/0168580 A1 describes a hydraulic valve device with fluid connections provided on a housing arrangement, such as at least one pressure supply connection and at least one service connection, and with a control device, which can be moved in one or the other directions of motion to at least partially control fluid connections in the housing arrangement, an adjustable stop device being provided to restrict the stroke length of the travel movements of the control device or parts thereof in the one direction and in the other direction, the stop device comprising a stop face facing the one direction of motion and a second stop face facing the other direction of motion on the same axial end region of a sliding piston of the control device, a counterstop being provided for each stop face, both of these being arranged on the respective same end region of the housing arrangement, and a stop face being formed on the end face of the respective axial end of the sliding piston.

The object of the invention is to resolve this problem by providing a valve device of the generic type described at the outset, which makes it possible to adjust the stop device conveniently, safely and accurately.

This object is achieved according to the invention by a hydraulic valve device that has the features described in claim 1 in its entirety.

According to the characterising part of claim 1, a particular feature of the invention is that the position of the counterstops can be adjusted and the counterstop for the stop face located on the end face of the sliding piston is formed on an adjustment screw, which extends parallel with the axis of travel in the associated end portion of the housing arrangement and is accessible from the outer side of the housing.

It is intended that the stop device should comprise a stop face facing the one direction of motion and a second stop face facing the other direction of motion on the same axial end region of a sliding piston of the control device, a counterstop being provided for each stop face, both of these being arranged on the respective same end region of the housing arrangement such that their position can be adjusted. This means not

only that both counterstops can be accessed from one side of the housing, but they also work directly on the control valve, i.e. without any mechanical intermediate parts. The counterstops are therefore not subject to tension or pressure, with the result that there are no perceptible deformation or strength issues. The stop device can therefore not only be installed easily and conveniently, but also guarantees a high level of adjustment accuracy.

The one stop face is formed directly on the end face of the respective axial end of the sliding piston.

In particularly advantageous embodiments of the invention, a depression is provided on the respective axial end region on the sliding piston to form the second stop face, said second stop face being formed by a wall face of the depression running between the base of the depression and the outer circumference of the sliding piston such that a stop face is available for each direction of the travel movements on the same axial end region of the sliding piston.

With regard to the adjustable counterstop for the second stop face, the arrangement can advantageously be designed such that this counterstop is formed by a step face between the shaft of a second adjustment screw and its radially extended top portion which is provided to engage in the depression.

In particularly advantageous embodiments of the invention, the second adjustment screw is arranged parallel with the axis of travel in the associated end region of the housing arrangement next to the first adjustment screw and is similarly accessible from the outer side of the housing. When the second adjustment screw is positioned in this manner, the depression in the sliding piston, which forms the second stop face with one wall face, may be formed by a longitudinal groove, which extends along the axis of travel in the sliding piston.

When the stop device is designed in this manner, the top portion of the second adjustment screw is located inside the longitudinal groove of the sliding piston in the operating state, causing the shaft to overlap the closed end of the longitudinal groove. In this configuration, assembly and dismantling are possible by rotating the sliding piston. The arrangement can be advantageously designed for this purpose by forming a transverse groove in the sliding piston, said groove leading into the longitudinal groove in such a way that, when the sliding piston is rotated, the transverse groove forms an outlet from the longitudinal groove for the top portion of the second adjustment screw, and in that a break in the wall of the transverse groove forms another outlet, leading to the end face of the sliding piston for the top portion of the second adjustment screw. The transverse groove can be positioned such that the top portion can be aligned with the longitudinal groove for insertion into or retraction from said longitudinal groove if the sliding piston is rotated in an axial position located outside the operational working stroke region. The break in the wall of the transverse groove is located in such a position, displaced in the circumferential direction of the sliding piston, that the top portion is able to leave the transverse groove in an axial direction when the sliding piston is in this assembly rotation position.

The break in the wall of the transverse groove can be formed such that a flat bevel running along a chord on the circumference of the sliding piston is provided on the sliding piston.

In embodiments of the valve device in which hand actuation is intended, the arrangement can be particularly advantageously designed such that a recess extending radially inwards from the base of the transverse groove is provided in the sliding piston to engage with a carrier element of a device to manually produce travel movements.

In addition, in particularly advantageous embodiments, a guide device for the sliding piston is arranged on the housing arrangement such that said guide device only

prevents said sliding piston from rotating in axial positions corresponding to the operational working stroke region, but releases the sliding piston to rotate into the assembly rotation positions outside this working stroke region.

The invention is explained in detail below with the aid of an embodiment shown in the attached drawings, in which:

Fig. 1 shows a truncated longitudinal section of an embodiment of the valve device according to the invention showing only part of the housing arrangement;

Fig. 2 is a sectional view corresponding to line II-II in Fig. 1;

Fig. 3 is a partial longitudinal section through an axial end region of the housing arrangement of the embodiment; and

Fig. 4 shows a perspective oblique view, drawn on a larger scale, of part of the end region of the housing arrangement comprising the stop device in the embodiment.

The valve device according to the invention is described with reference to the drawings using an LS directional control valve by way of an example. Of the housing arrangement 1, only the main portions of the housing that interact functionally with the hydraulic control device are shown in Fig. 1, namely a control housing 3, in which a control piston 5 of the control device can be moved along an axis 7, and housing end regions 9 and 11, which close off the control housing 3 at both axial ends. The usual housing connections in this kind of valve device, such as a pressure supply connection P and two service connections A and B, are located on the control housing 3. Additional connections, such as tank return connections or connections for a pressure balance, for example, are not shown with reference numerals in Fig. 1. The control piston 5 of the control device as such can be controlled in a known manner, which is not therefore described here in more detail, by standard pilot valves 13 and 15, which can be actuated electromagnetically. A spring arrangement 17 located in the housing end region 9 provides a neutral or central position for the control piston 5 in the standard manner for such directional control valves. As the valve function

corresponds to the prior art in this respect, the description below merely refers to the axial end region 11 positioned on the right-hand side in Fig. 1, said region including the stop device for restricting the stroke length of the control piston 5 and its axial end portion 19.

This housing end region 11 is connected in a sealed manner to the control housing 3 of the multi-part housing arrangement 1 and comprises an inner cylindrical pressure chamber 21 that extends along the axis of travel 7, into which the end portion 19 of the sliding piston 5 extends. The inner diameter of the pressure chamber 21 is larger than the outer diameter of the end portion 19 of the control piston 5 and its axial length is such that the closed end 23 lies outside the operational working stroke region of the control piston 5, and this is therefore out of contact with the end 23 of the pressure chamber 21 when it comes closest to the end 23 with its axial end face 25. A connection 27 from the pilot valve 15 leads into the pressure chamber 21 in the vicinity of the end 23.

Fig. 2 to 4, which illustrate the housing end region 11 separately, clearly show more details of the adjustable stop device. The stop faces, which restrict the stroke lengths of the travel movements of the control piston 5 in one or the other direction of motion in interaction with the associated counterstops of the adjustable stop device, are both formed on the end portion 19 of the sliding piston 5. The first stop face, which restricts the stroke motion of the sliding piston 5 in the direction of the end of the chamber 21, is formed by the end face 25 of the sliding piston 5, which is in the form of a radial plane. An adjustment screw 29 in the form of a threaded bolt is provided as an adjustable counterstop for the end face 25, one end 31 of the shaft 30 of said bolt forming the counterstop for the end face 25 as a stop face of the control piston 5. The other outer end of the shaft 30 is furnished with an internal hexagon socket. The adjustment screw 29 passes through a threaded hole 35, which extends parallel with and is closely adjacent to the axis of travel 7 in the housing end region 11. The adjustment screw 29, which can be rotated by inserting an adjustment rotation tool in the internal hexagon socket 33 to adjust the position, i.e. to restrict

the stroke length, can be secured in the respective adjustment position by means of a collar nut 37 with a sealing function, said nut being supported on the outer side of the housing end region 11 with its flange-like extended collar 39, said collar 39 sitting in a shallow depression 41.

The second stop face opposite the end face 25 as the first stop face is configured a small axial distance from the end face 25 on the end portion 19 of the sliding piston 5. To this end, the end portion 19 has a special shape, which can be seen particularly clearly in Fig. 2 to 4. To this end, a depression in the form of a longitudinal groove 43 incorporated into the circumference of the end portion 19 of the control piston 5 is formed in the end portion 19, said depression extending parallel with the axis approximately over the entire axial length of the end portion 19 in the direction of the end face 25, but ending at a distance from said end face, so that there is still an unrecessed region 45 between the end face 25 and the longitudinal groove 43, which forms a wall face 47 on the inside as an axial restriction of the longitudinal groove 43. This wall face 47 acts as a second stop face for the adjustable stop device.

A second adjustment screw 49 is provided as a counterstop with an adjustable position for the wall face 47 of the longitudinal groove 43 as the second stop face, the threaded portion 53 of the shaft 51 of said screw passing through a threaded hole 55 in the housing end region 11, said hole extending parallel with the axis of motion 7 at a distance such that the shaft 51 extends over the unrecessed region 45 of the end portion 19, but the radially extended top 57 engages with the recessed longitudinal groove 43. In this position arrangement, the head 57 forms the second counterstop with the step face 59 located between said top and the shaft 51 to ensure interaction with the wall face 47 at the end of the longitudinal groove 43 as the second stop face. As in the case of the first adjustment screw 29, the second adjustment screw 49 is also furnished with an internal hexagon socket 61 at the end for ease of adjustment rotation. In the same way as for the first adjustment screw 29, a collar nut 63 is provided to establish the adjustment position, the radially extended

collar 65 of said nut sitting in a depression 41 in the housing end region 11 in the same way as the collar 39 of the other nut 37.

As, in this configuration, the second adjustment screw 49 is able to extend over the unrecessed region 45 of the end portion 19 with its shaft 51, but not with its radially extended head 57, an outlet can be provided for assembly/dismantling procedures for the screw head 57, via which the screw head 57 is able to both leave the region of the longitudinal groove 43 and be released from the end portion 19 of the sliding piston 5. To this end, a second depression in the form of a transverse groove 67 is provided, which is directly adjacent to the wall face 47 on the end face of the longitudinal groove 43 and leads into said longitudinal groove, the base of the transverse groove 67 having the same radial depth in the end portion 19 as the base of the longitudinal groove 43. The axial width of the transverse groove 67 is adapted to the axial length of the head 57 such that said head can pass into the transverse groove 67 when the sliding piston 5 is rotated correspondingly far in the rotating position illustrated on the figures. To ensure that the head 57 is released completely from the end portion 19, when rotated accordingly, during which it leaves the region of the longitudinal groove 43, the transverse groove 67 has a bevel 69 in the peripheral area offset from the wall face 47 of the longitudinal groove 43, said bevel forming a break in the wall of the transverse groove 67 through which the circumference of the end portion 19 is radially recessed compared with the unrecessed region 45 such that the head 57 is released from the end portion 19 when the end portion is displaced axially accordingly.

Whereas a rotation movement of the control piston 5 is proposed for assembly/dismantling purposes, the sliding piston 5 should not be able to move in rotation during operation. To this end, a protruding guide rib 71 running parallel with the axis in the pressure chamber 21 is provided in the housing end region 11, said rib being provided to engage in an associated axial guide groove 73 in the end portion 19. In this process, the axial length of the rib 41 is selected such that it merely engages in the guide groove 73 in the normal operational working stroke range, with the result

that the sliding piston 5 no longer engages with the guide rib 71 in axial positions designed for assembly/dismantling purposes and is therefore rotatable.

The present embodiment of the invention shows a device for actuating using a hand lever. An additional depression 75 extending radially is incorporated into the base of the transverse groove 67 for this purpose. A rounded carrier head 77 at the end of a swivelling lever 79 can be made to engage with the depression, this lever being able to swivel around a swivel axis 81 by means of a hand lever which is not shown in the drawing. In this case, the swivelling option is designed such that the carrier head 77 is able to enter the depression 75 when the swivelling lever 79 is swivelled completely anticlockwise and with the corresponding axial position of the end portion 19, but is unable to leave the depression 75 in the corresponding axial positions for the operational working stroke region. As shown in Fig. 2, the swivelling lever 79 is located at the end of a pin 83, which is located in a sealed penetration 85 screwed into the housing end region 11, which is sealed from the end region 11 on its outer side by means of a sealing element 87. A hand lever positioned on an external hexagon socket 89 of the pin 88 for manual actuation purposes has been omitted in Fig. 2.

While the present embodiment relates to an LS directional control valve, it is evident that the adjustable stop device according to the invention can advantageously be used in the same way for other types of valve devices in which restricting the stroke length of the hydraulic control device is desirable or necessary.

## Patentkrav

**1.** Hydraulisk ventilindretning, især LS-retningsventil, med fluidtilslutninger, som er tilvejebragt på en husanordning (1), som i det mindste en trykforsyningstilslutning (P), i det mindste en nyttetilslutning (A, B) og fortrinsvis en lastmeldingstilslutning, og med en styreindretning (5), som er forskydelig for mindst en delvis styring af husanordningens (1) fluidtilslutninger i den ene eller anden bevægelsesretning, hvor der forefindes en indstillelig anslagsindretning (25, 31, 47, 59), som begrænser slaglængden af styreindretningens (5) forskydningsbevægelser eller af dele af samme i den ene retning og i den anden retning, hvor anslagsindretningen 25, 31, 47, 59) på samme aksiale endeområde (19) af et skyderstempel (5) af styreindretningen har en anslagsflade (25), som vender mod den ene bevægelsesretning, og en anden anslagsflade (47), som vender mod den anden bevægelsesretning, hvor der for hver anslagsflade (25, 47) er tilvejebragt et modanslag (31, 59), som begge er anbragt på det pågældende, samme endeområde (11) af husanordningen (1), og hvor en anslagsflade er udformet på endefladen (25) af den pågældende aksiale ende (19) af skyderstemplet (5), **kendetegnet ved, at** modanslagene (31, 59) er positionsindstillelige, og at modanslaget (31) for anslagsfladen, som befinder sig på endefladen (25) af skyderstemplet (5), er udformet på en indstillingsskrue (29), der strækker sig i den tilordnede endedel (11) af husanordningen (1) parallelt med forskydningsaksen (7) og er tilgængelig fra husydersiden.

**2.** Ventilindretning ifølge krav 1, **kendetegnet ved, at** skyderstemplet (5) på det pågældende aksiale endeområde (19) har en fordybning (43), og at den anden anslagsflade er dannet af en mellem fordybningens (43) grund og skyderstemplets (5) udvendige omkreds forløbende vægflade (47) af fordybningen (43).

**3.** Ventilindretning ifølge krav 1 eller 2, **kendetegnet ved, at** modanslaget for den anden anslagsflade (47) er dannet af en trinflade (59) mellem skaftet (51) af en anden indstillingsskrue (49) og dens radialt udvidede hoveddel (57), som er beregnet til indgrebet i fordybningen (43).

**4.** Ventilindretning ifølge et af de foregående krav, **kendetegnet ved, at** den anden indstillingsskrue (49) er anbragt parallelt med forskydningsaksen (7) i det tilordnede endeområde (11) af husanordningen (1) ved siden af den første indstillingsskrue (29)

og som denne er tilgængelig fra husydersiden.

**5.** Ventilindretning ifølge et af de foregående krav, **kendetegnet ved, at** skyderstemplets (5) fordybning er dannet af en langsgående not (43), som strækker sig langs forskydningsaksen (7).

**6.** Ventilindretning ifølge et af de foregående krav, **kendetegnet ved, at** der i skyderstemplet (5) er udformet en tværgående not (67), som munder ud i den langsgående not (43) på en sådan måde, at den tværgående not (67) ved drejning af skyderstemplet (5) for hoveddelen (57) af den anden indstillingsskrue (49) danner en udgang fra den langsgående not (43), og at en afbrydelse af væggen af den tværgående not (67) danner en yderligere udgang for hoveddelen (57) af den anden indstillingsskrue (49), hvilken udgang fører til endefladen (25) af skyderstemplet (5).

**7.** Ventilindretning ifølge et af de foregående krav, **kendetegnet ved, at** der med henblik på at danne afbrydelsen af væggen af den tværgående not (67) på skyderstemplet (5) er tilvejebragt en plan affasning (69), som forløber langs en korde på skyderstemplets (5) omkreds.

**8.** Ventilindretning ifølge et af de foregående krav, **kendetegnet ved, at** der i skyderstemplet (5) er tilvejebragt en udsparing (75) for indgrebet af et medtagerelement (77) af en indretning (79, 81), hvilken udsparing strækker sig radialt indad fra bunden af den tværgående not (67), til manuel frembringelse af forskydningsbevægelser.

**9.** Ventilindretning ifølge et af de foregående krav, **kendetegnet ved, at** der på husanordningen (1) er anbragt en føringsindretning (71, 73) for skyderstemplet (5) på en sådan måde, at den kun ved aksialpositioner, som svarer til det driftsmæssige arbejdsslagområde, sikrer dette mod rotation.

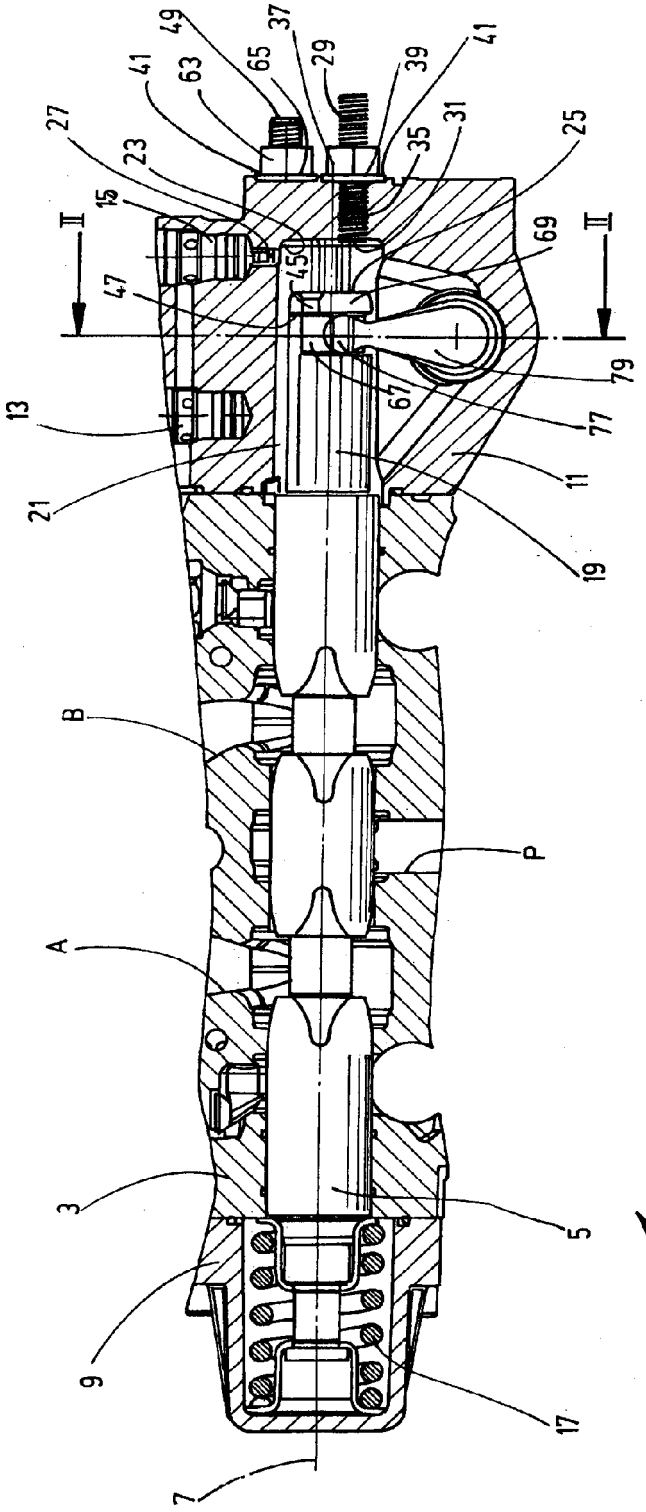
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Fig.1

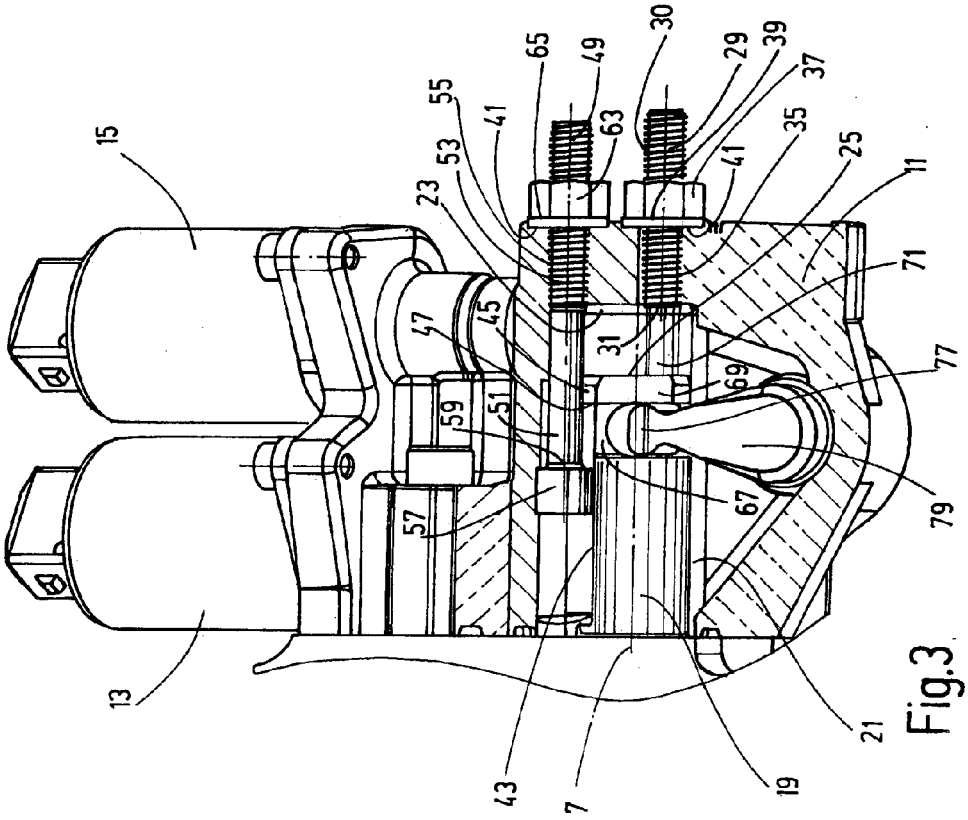
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Fig.3

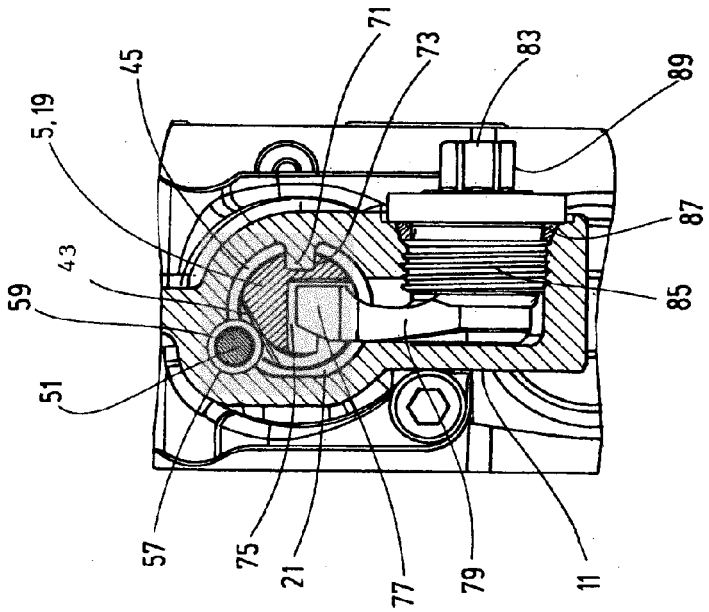
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Fig.2

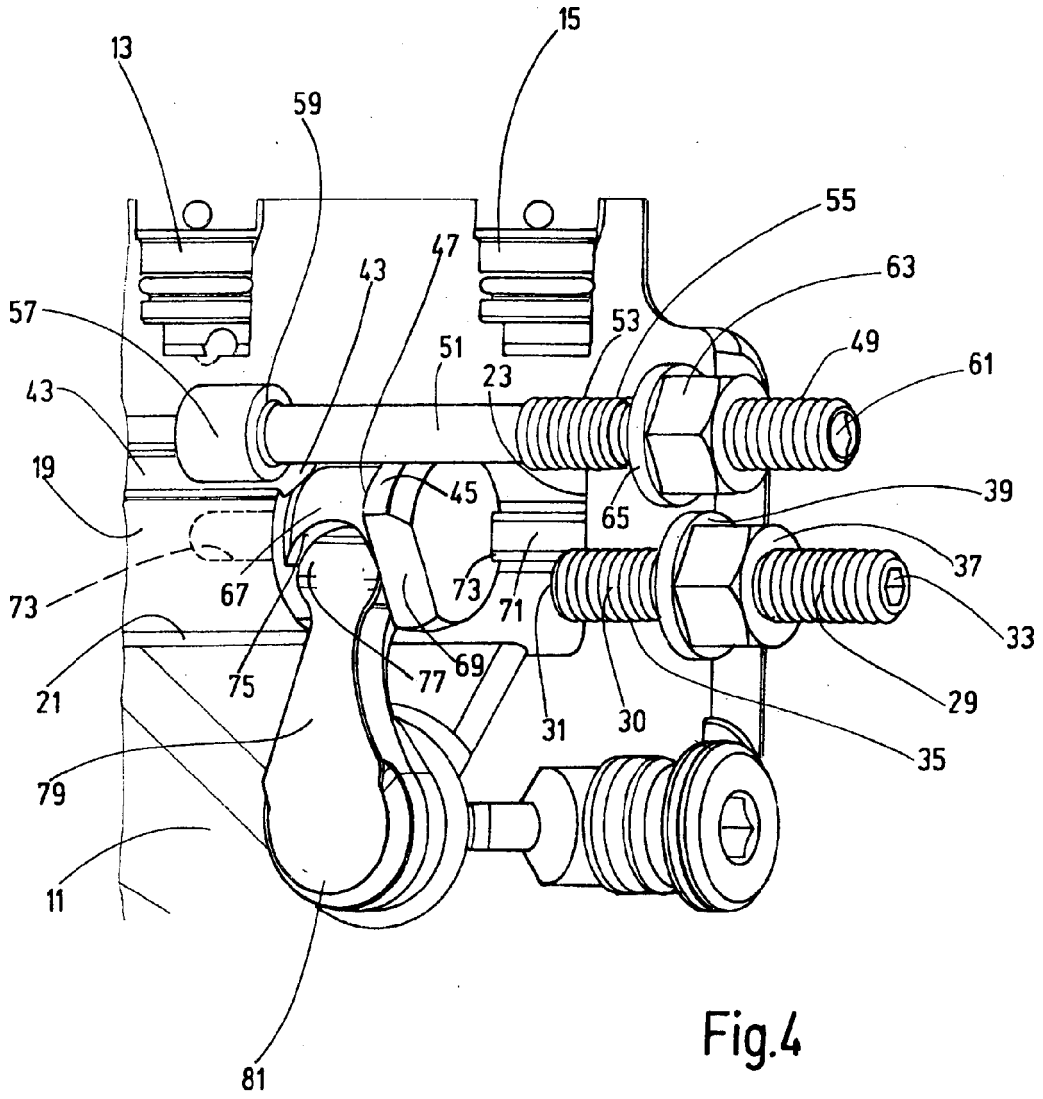
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Fig.4