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⑤④ **Hydraulic system with a double section telescopic piston for the movement of loads in unstable conditions.**

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DE-C- 929 148
FR-A-2 129 936
GB-A-1 526 563
US-A-2 517 153
US-A-2 897 791
US-A-3 415 169
US-A-3 603 207
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Description

The invention relates to a hydraulic actuating system comprising a telescopic cylinder and piston assembly for displacing a heavy load about a pivot axis, whereby the center of gravity often moves overcenter, and comprising a control apparatus for supplying pressurized fluid to and exhausting fluid from the telescopic assembly; said telescopic assembly including a plurality of stages, the last stage thereof having a double-acting piston carrying an output rod provided with a first passage serving to supply pressurized fluid to the head end of the telescopic assembly for expanding the latter and also serving as an exhaust passage and provided with a second fluid passage serving to supply pressurized fluid to the rod end of the last stage and also serving as an exhaust passage.

The problem of controlled displacement of large loads is presently very important in different technical fields, in particular in all those in which the transport of objects (loads) of large dimensions is carried out by lorries, platforms on wheels etc. Usually the technical problem consists of rotating a load, with its lower part fixed to a hinge, from a horizontal position to a vertical position close or beyond the PMS (point of unstable equilibrium).

An operation such as lifting of the movable carriage of a lorry is normally carried out with simple action hydraulic telescopic piston.

In this case, however, the rotation of the carriage must be limited to a position just before the centre of gravity reaches the vertical above the hinge (PMS). A rotation beyond this point is in fact undesirable since it will result in an uncontrolled fall, since the simple action piston, due to its nature, is incapable of exercising controlled pulling action.

In the case of incoherent loads, such as wet sand, the above impossibility renders unloading by gravity very critical, and thus the operator is often forced to exercise sharp up and down movements until the load is "freed" from the carriage which could not be sufficiently lifted.

The problem becomes completely unsolvable with a simple action piston, when particular loads (i.e. telescope towers for telecommunication, vertical axis launchers for missiles, etc.) must be lifted from the platform of transport vehicle, or at least from the horizontal position right up to the vertical position with the added difficulty of the hinge for which the fall is not only uncontrollable beyond the PMS position but also impossible to reverse. To this day, to resolve the problem of rotation of particularly heavy and critical loads, several different techniques were used. One technique is that of a crane external to the trailer or lorry, which must manoeuvre with successive translation and lifting movements, to try and generate as near as possible, a trajectory of movement similar to the circumference arc generated by the load in rotation. This operation is very long and difficult to carry out, and even

though it is done with much care and precision, there is always an instant of incontrollability which coincides with the instant of direction change of the crane's lifting force, from which abrupt accelerations of the manoeuvre can be generated which could prove harmful to the structure of object being moved. Another technique adopted is that of using a double-action-non-telescopic piston, which due to its limited extensions (because of the limited dimensions due to installation problems) must be positioned close to the hinge and thus generates very large forces for movement. This results in an overdimensioning of the chassis system (mobile and fixed) which must be capable of supporting very large forces concentrated at the application points of the pistons.

It is obvious that such overdimensioning has a damaging effect on the weight dimensions and on cost of the chassis.

The problems associated with the techniques presently adopted to obtain the displacement of large loads in unstable conditions can therefore be summarized by the following points.

a) the volume available for housing the hydraulic lifting system is rather limited;

b) the trajectory, and in general the kinematics of the movement from the horizontal to the vertical position necessarily implies, at a certain stage in the manoeuvre, the control of the applied force to the load, and its inversion from a drive force to a retaining or braking force, to avoid the uncontrolled fall of the load.

The hydraulic actuating system of the type described in the first part of claim 1 is known from US—A—2 897 791.

Said known hydraulic actuating system is provided with a cushioning sleeve slidable positioned in the cylinder and on the piston head. The inner surface of said sleeve is provided with two pairs of diametrically opposed columns of recesses arranged longitudinally of the sleeve. Said recesses decrease in depth and length from one end of the sleeve toward the other end thereof. When the center of gravity of the load moves past the point of unstable equilibrium, said sleeve moves over the piston head and consequently the fluid flows from the cylinder into the recesses and out the passage where it is discharged. The sleeve moving over the piston head provides a cushioning means to cushion the cylinder and piston assembly.

A similar device is disclosed in US—A—3 415 169. In this known device, a valve assembly for decreasing the speed of cylinder contraction is located in the first passage and includes an open-ended flow control valve slidably mounted in the passage and formed with a plurality of elongated slots. A spring biases the flow control valve whereby the slots are located outside of the associated passage when the cylinder is expanded. In order to expand said cylinder, pressurized fluid is pumped through both passages and consequently both ends of said piston head are admitted.

In view of this state of art, the present invention is based on the technical task of how to provide a cushioning effect just at the point of unstable equilibrium in a much more simple manner than in the prior art.

This problem is solved by the fact that, in order to raise the load from its normal position said control apparatus supplies pressurized fluid through the first passage into the head end until said load reaches the point of unstable equilibrium and then supplies fluid through the second passage to the rod end of the last stage thus determining a retaining-force for resisting movement of the load under its own weight.

According to the invention, the double-acting piston may be in a direct sliding contact with the inner surface of the stage next to the last, and no cushioning sleeve or the like is necessary in order to balance the pull of the load just past the point of unstable equilibrium.

The system of the invention is very compact and behaves, for the first half of the movement up to the point just before inversion of the driving force, as a simple-action telescope, whereas in the second half of the movement it behaves as a double-action piston which by generating a controlled counter-pressure, controls the movement of the load by generating a retaining or braking force, just near to the point of unstable equilibrium (PMS).

The hydraulic system of this invention is now described in more detail with reference to the drawings, in which:

Figure 1 illustrates schematically, by three phases a, b and c, the stages of the displacement of an ideal load by means of an ideal hydraulic system,

Figure 2 schematically illustrates the hydraulic system of the present invention,

Figures 3 to 7 schematically illustrate the different phases through which the controlled action of the hydraulic system of the present invention develops.

With reference to Figure 1a, an ideal load driven by a piston 1 and fixed at point C by a hinge is illustrated. The force F is such as to oppose the weight force P of the load, in fact it exceeds P and moves the load so as to bring about its displacement.

Figure 1b illustrates the position when the load has reached the point of unstable equilibrium (PMF). This condition of the weight force P, indicated by "X", passes the fixed point C of the hinge. Just after this situation the drive force F necessary for lifting, and thus for the displacement of the load, must be counter balanced by a retaining force R.

Figure 1c illustrates the retaining situation by means of the force R which keeps the load in equilibrium. It is necessary to point out that the most delicate part of the displacement is that in which the drive force F is substituted, in a controlled manner, by the retaining force R which avoids sharp movements or whatsmore falling of the load.

In Figure 2 a typical realisation of the hydraulic system of the present invention is schematically illustrated. The telescopic piston 1 shown has three sliding sections in the last of which is mounted a double-action piston supplied with two chambers 24 and 30 which are in fact necessary to attain the double effect. The simple-action sliding sections make use of the single chamber 21. These chambers are obviously utilised for the letting-in and out the compressed oil fed by means of pipeline 20.

The introduction of the compressed oil, or the exit of the returning oil passes through channel 31 and valve 27 respectively. The dotted lines illustrate, purely for an indicative purpose, two devices for the mounting of the piston to the load to be displaced and mounting to the sustaining plane, as indicated by 28 and 29.

Finally Q indicates, for explanatory purpose, the apparatus for controlling the oil pressure in the pipelines 20 and 25, which can be realised in a very conventional way.

Figure 2 illustrates the hydraulic system in its initial position in which the sliding sections are all closed, and the oil is in a rest condition in all the chambers.

During operation, the oil in pipeline 20 is put under pressure and introduced into chamber 21, which on expanding causes of the simple action sliding sections to lengthen until the end stops 23 are reached, and thus stopping the lengthening of the telescopic piston (Figure 3).

At this point the action of the double-action piston begins. The oil in pipeline 25, by means of valve 27, is put in counterpressure and is then, so to say, squeezed out from chamber 24, by means of valve 26 and chamber 30.

This causes further lengthening of the telescopic piston (Figure 4).

At this point, and here the control action which can be exercised on the displacement of the load in the vicinity of unstable equilibrium (PMS) can be noted, by changing the direction of the oil pressure in pipeline 25, a direction change in the force generated by the telescopic piston is attained. In fact putting the oil under pressure in this pipeline, forcing it into chamber 24 by means of valve 27, chamber 30 and valve 26, produces the expansion of said chamber.

Note that in this phase, pipelines 25 and 20 constitute the forward and return of the oil's counterpressure respectively (Figure 5).

The expansion of chamber 24, for the particular double-action piston configuration, generates a shortening of the piston, permitting the system to solicitate the load with a retaining or braking force for controlling the displacement of the load in the vicinity of the unstable equilibrium point (Figure 6).

Finally, Figure 7 illustrates the telescopic piston on returning to its rest position, when the oil in chamber 21 is withdrawn through pipeline 20.

Claims

1. Hydraulic actuating system comprising a telescopic cylinder and piston assembly (1) for displacing a heavy load (P) about a pivot axis (C), whereby the center of gravity often moves over-center, and comprising a control apparatus (Q) for supplying pressurized fluid to and exhausting fluid from the telescopic assembly (1); said telescopic assembly (1) including a plurality of stages, the last stage thereof having a double-acting piston carrying an output rod provided with a first passage (31) serving to supply pressurized fluid to the head end (21) of the telescopic assembly (1) for expanding the latter and also serving as an exhaust passage and provided with a second fluid passage (30) serving to supply pressurized fluid to the rod end (24) of the last stage and also serving as an exhaust passage, characterized in that in order to raise the load (P) from its normal position said control apparatus (Q) supplies pressurized fluid through the first passage (31) into the head end (21) until said load (P) reaches the point of unstable equilibrium (X) and then supplies fluid through the second passage (30) to the rod end (24) of the last stage thus determining a retaining-force (R) for resisting movement of the load (P) under its own weight.

2. Hydraulic actuating system as claimed in claim 1, wherein the double-acting piston is in sliding contact with the inner surface of the stage next to the last.

3. Hydraulic actuating system as claimed in claim 1 or 2, wherein the piston rod is provided, adjacent the double-acting piston, with a radial bore (26) connecting the second passage (30) and the rod end (24).

Patentansprüche

1. Hydraulische Einrichtung mit einer teleskopischen Kolben-Zylinder-Einheit (1) zum Bewegen einer schweren Last (P) um eine Schwenkachse (C), wobei sich der Schwerpunkt häufig über das Gleichgewichtszentrum hinaus bewegt, und mit einer Steuereinheit (Q) für die Zufuhr eines Druckmediums zu der Einheit (1) und dessen Rückführung von der Einheit (1), welche mehrere Abschnitte hat, von denen der letzte Abschnitt einen doppelwirkenden Kolben mit einer Kolbenstange aufweist, die eine erste Leitung (31) für die Zufuhr von dem teleskopischen Einheit (1) ausschließendem Druckmedium zu deren Kopfende (21) und für die Rückführung des Druckmediums sowie eine zweite Leitung (30) hat, die für die Zufuhr des Druckmediums zu dem Kolbenstangenende (24) des letzten Abschnittes und für die Rückführung des Druckmediums dient, dadurch gekennzeichnet, daß zum Anheben der Last (P) aus ihrer normalen Stellung die Steuereinheit (Q) Druckmedium durch die erste

Leitung (31) in das Kopfende (21) drückt, bis die Last (P) den labilen Gleichgewichtspunkt (X) erreicht, und dann Druckmedium durch die zweite Leitung (30) zu dem Kolbenstangenende (24) des letzten Abschnittes drückt, wobei eine Rückhalte-kraft (R) erzeugt wird, die einer Bewegung der Last (P) aufgrund ihres eigenen Gewichtes entgegensteht.

2. Hydraulische Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß der doppelwirkende Kolben in Gleitberührung mit der Innenseite des an den letzten Abschnitt anschließenden Abschnittes ist.

3. Hydraulische Einrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Kolbenstange in der Nähe des doppelwirkenden Kolbens eine Radialbohrung (26) hat, die die zweite Leitung (30) mit dem Kolbenstangenende (24) des letzten Abschnittes verbindet.

Revendications

1. Système de commande hydraulique comprenant un ensemble à cylindre et piston télescopique (1) pour déplacer une charge lourde (P) autour d'un axe de pivotement (C), le centre de gravité dépassant souvent le centre, et comprenant un dispositif de commande (Q) pour envoyer du fluide sous pression dans l'ensemble télescopique (1) et pour évacuer le fluide de cet ensemble, ledit ensemble télescopique (1) comprenant une pluralité d'étages, le dernier étage comportant un piston à double effet supportant une tige de sortie munie d'un premier passage (31) servant à l'alimentation en fluide sous pression de l'extrémité de tête (21) de l'ensemble télescopique (1) pour déployer ce dernier, et servant également de passage d'échappement, et munie d'un second passage à fluide (30) servant à l'alimentation en fluide sous pression de l'extrémité de tige (24) du dernier étage, et servant également de passage d'échappement, caractérisé en ce que pour soulever la charge (P) à partir de sa position normale, ledit dispositif de commande (Q) fournit du fluide sous pression par le premier passage (31) dans l'extrémité de tête (21) jusqu'à ce que ladite charge (P) atteigne le point d'équilibre instable (X) et fournit ensuite le fluide par le second passage (30) à l'extrémité de tige (24) du dernier étage, créant ainsi une force de retenue (R) pour résister au mouvement de la charge (P) dû à son propre poids.

2. Système hydraulique selon la revendication 1, dans lequel le piston à double effet est en contact coulissant avec la surface interne de l'étage adjacent au dernier.

3. Système hydraulique selon la revendication 1 ou 2, dans lequel la tige du piston est munie, à proximité du piston à double effet, d'un alésage radial (26) reliant le second passage (30) à l'extrémité de tige (24).

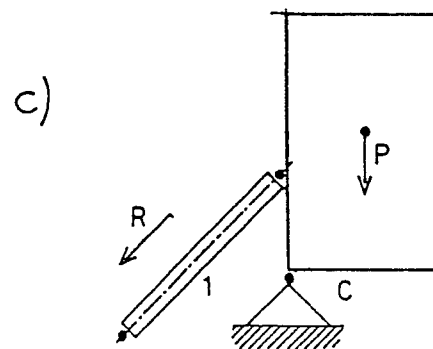
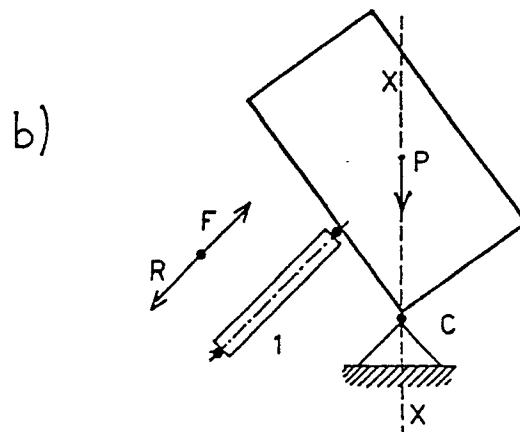
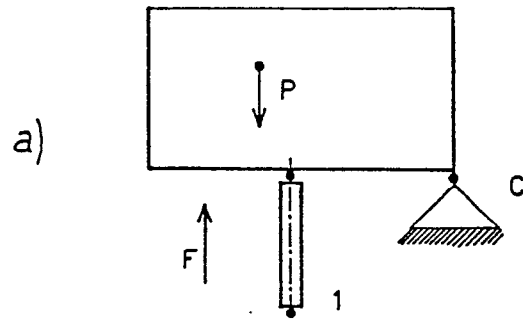


FIG 1

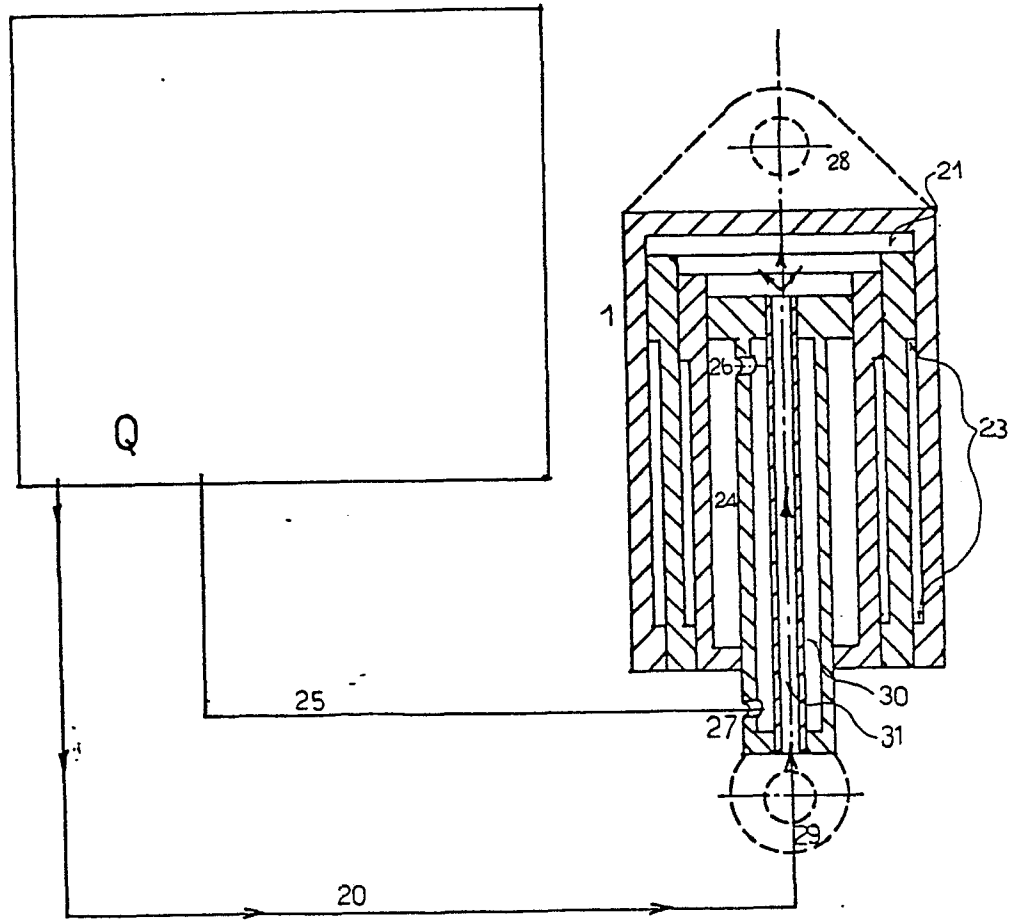


FIG 2

FIG 3

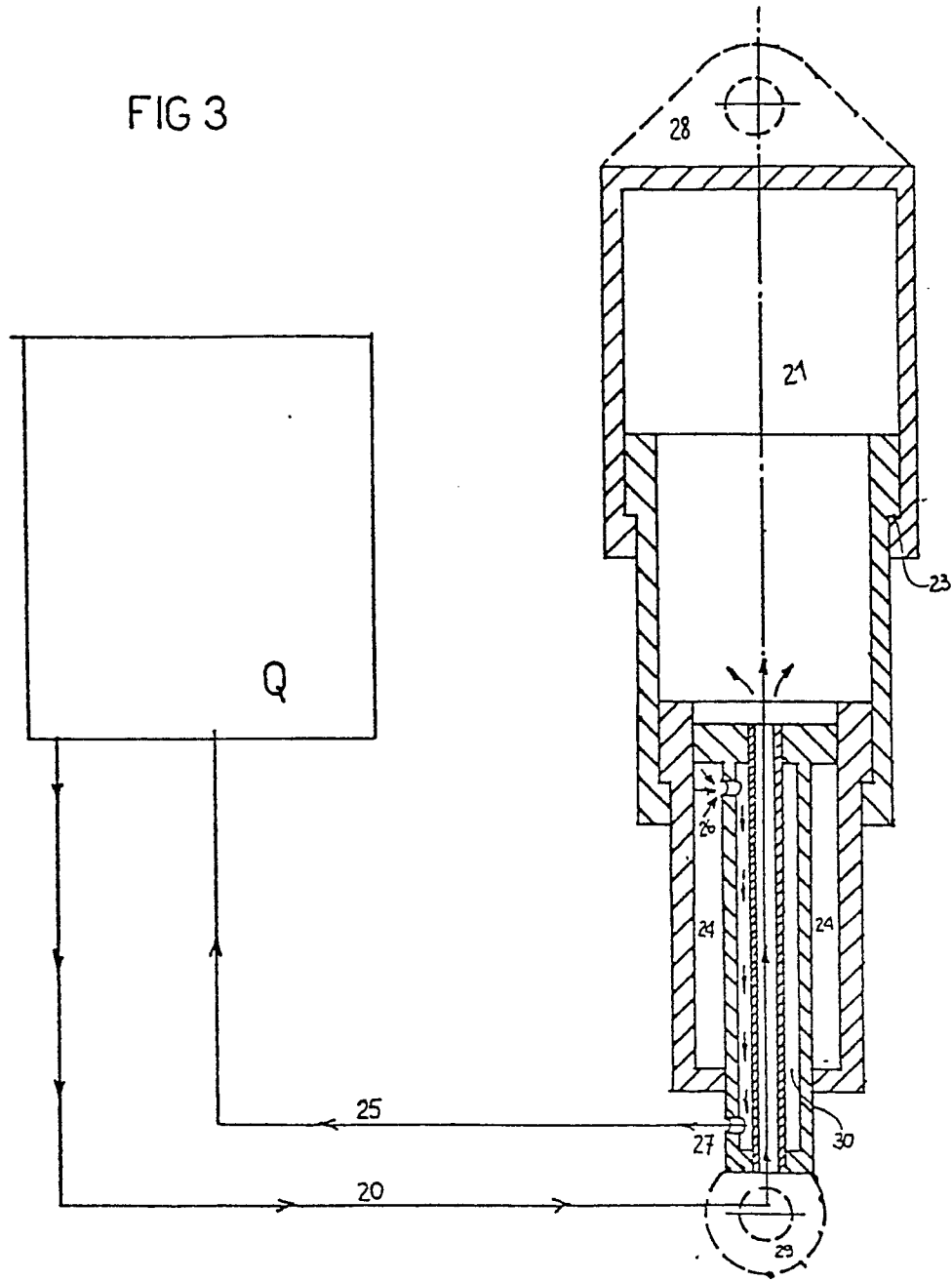


FIG 4

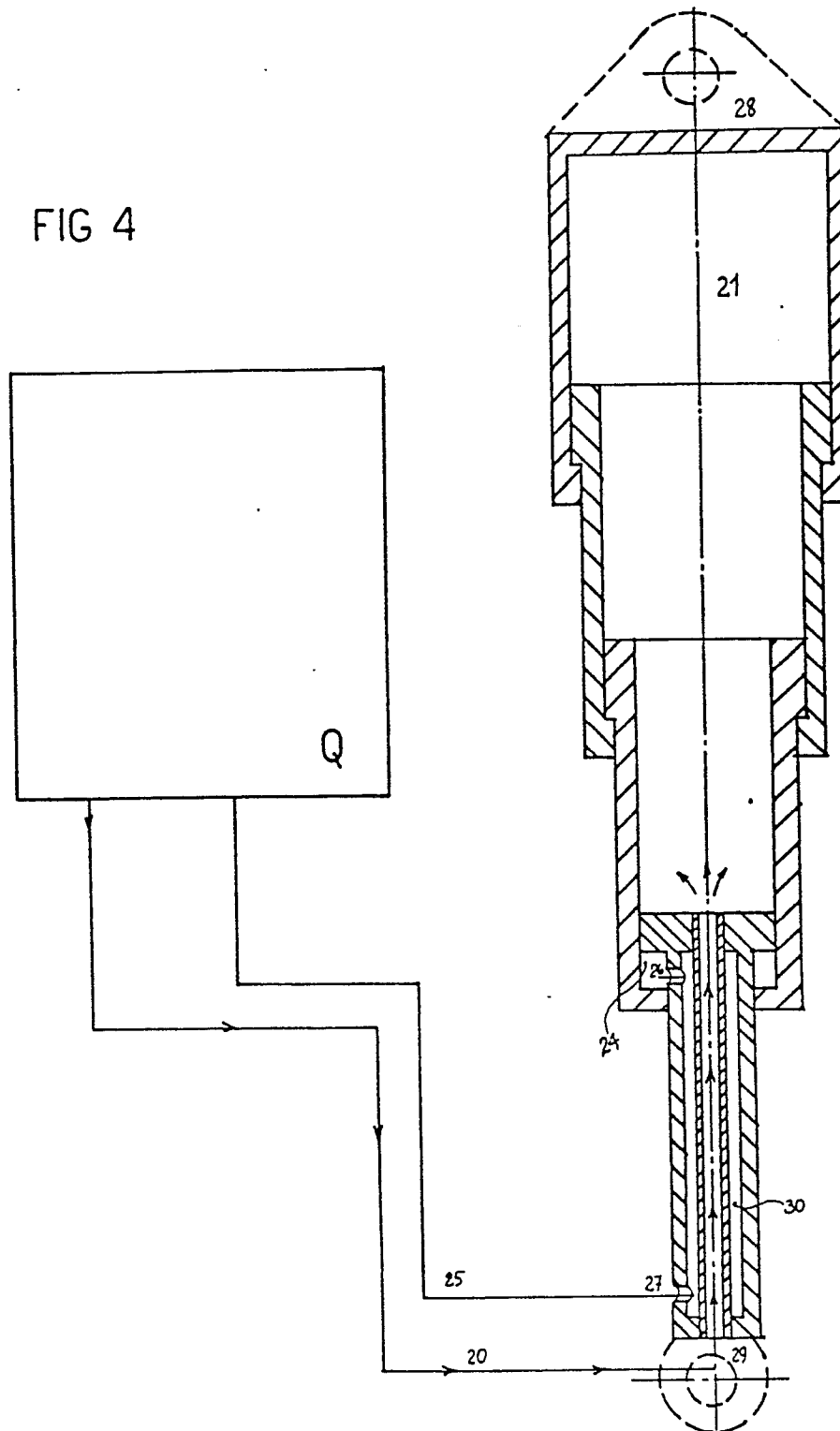


FIG 5

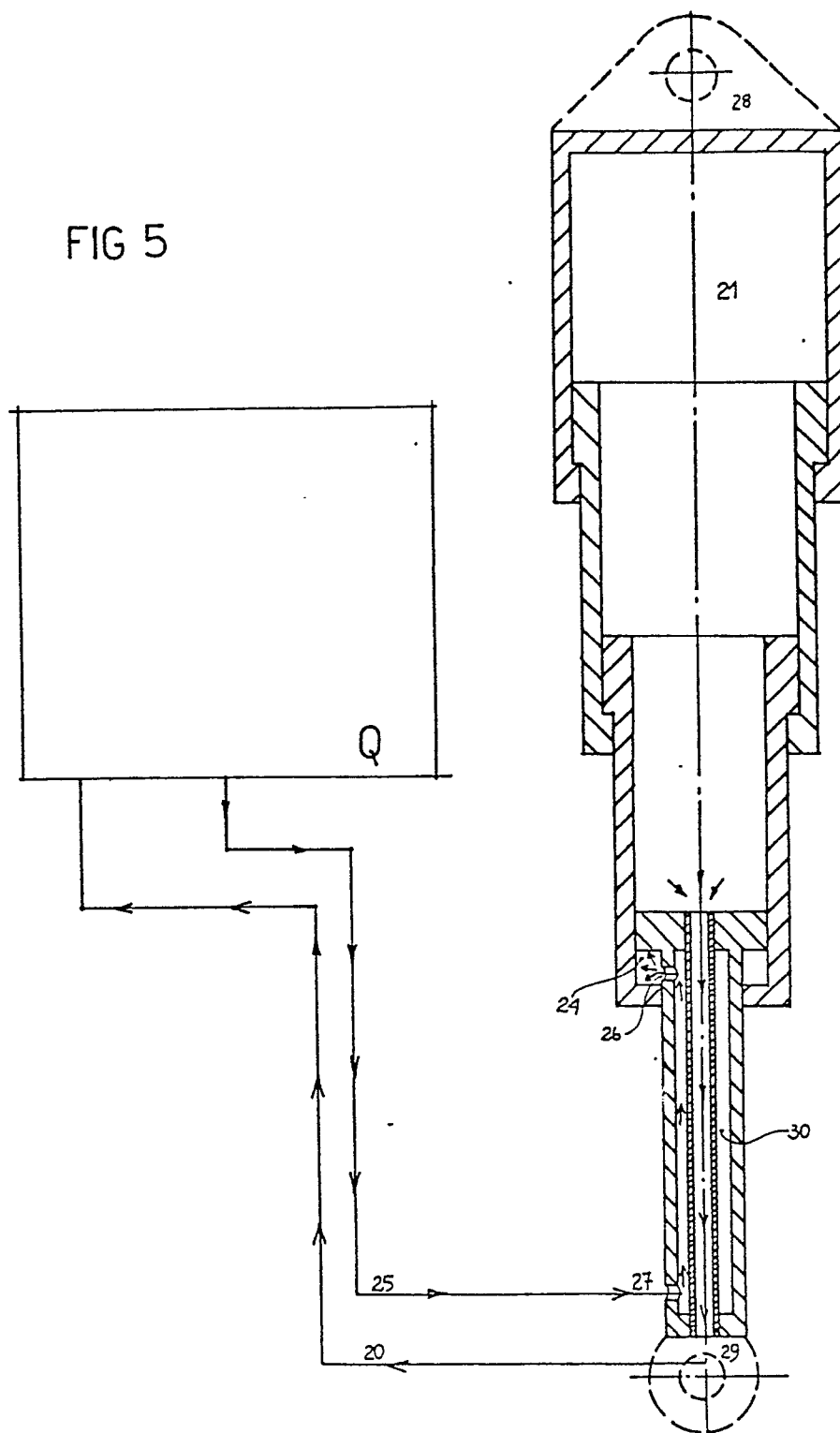
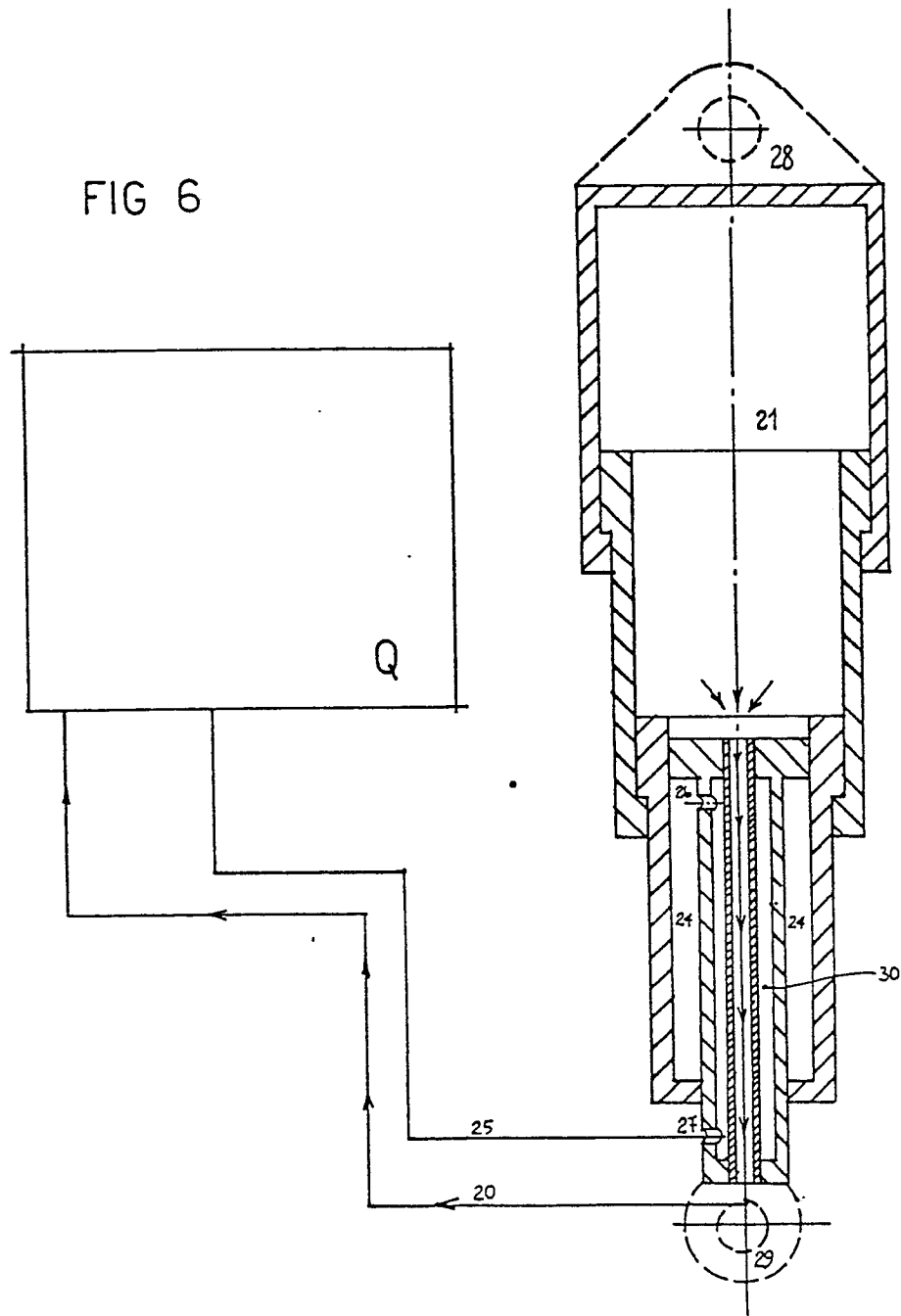


FIG 6



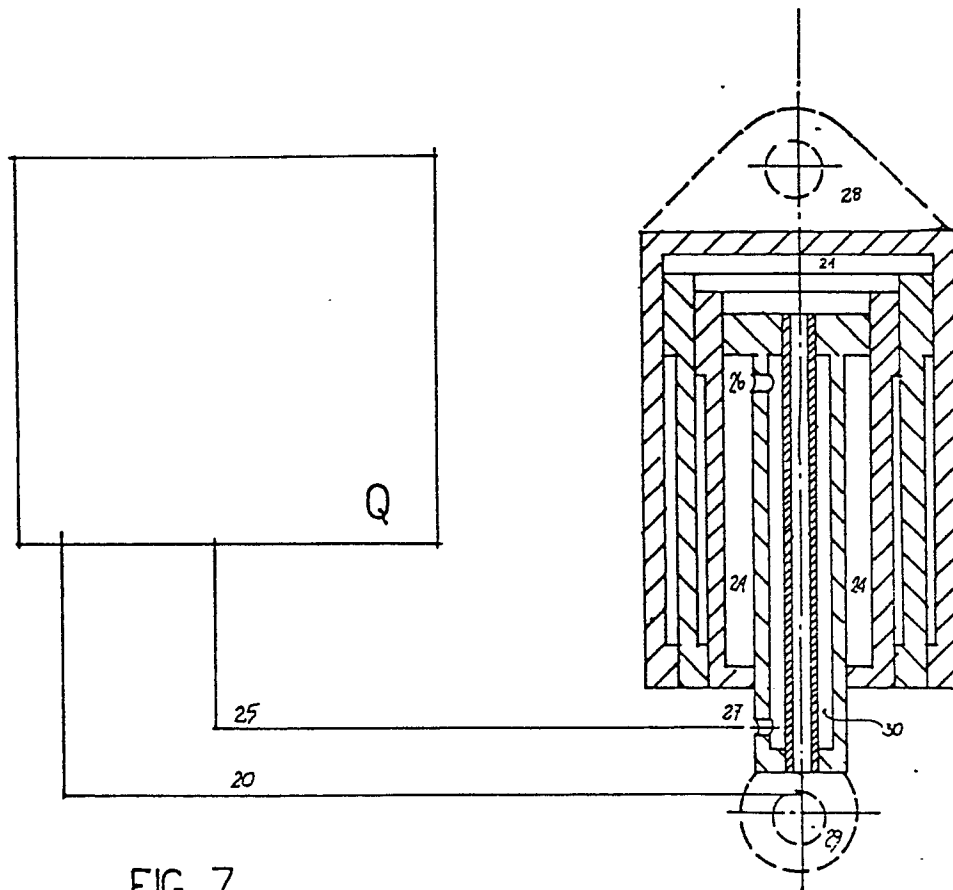


FIG 7