

(19) World Intellectual Property Organization
International Bureau



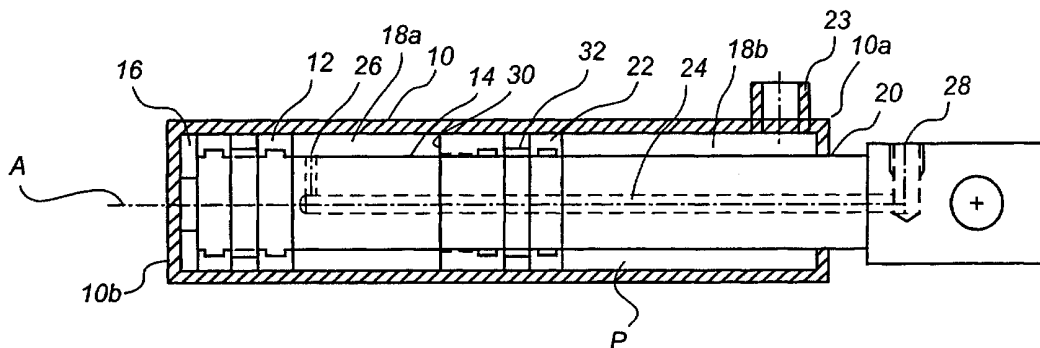
(43) International Publication Date
26 April 2001 (26.04.2001)

PCT

(10) International Publication Number
WO 01/29329 A1

- (51) International Patent Classification⁷: E02F 3/85
- (21) International Application Number: PCT/SE00/02013
- (22) International Filing Date: 18 October 2000 (18.10.2000)
- (25) Filing Language: Swedish
- (26) Publication Language: English
- (30) Priority Data:
9903794-7 19 October 1999 (19.10.1999) SE
- (71) Applicant (for all designated States except US): VRETEN AB [SE/SE]; S-541 94 Skövde (SE).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): AXELSSON, Lennart [SE/SE]; Prästbol, S-669 91 Deje (SE).
- (74) Agent: AWAPATENT AB; Box 11394, S-404 28 Göteborg (SE).
- (81) Designated States (national): AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KR (utility model), KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: HYDRAULIC ACTUATOR



(57) Abstract: The invention relates to a hydraulic actuator (3) with a casing (10), a piston (12) which is movable in the casing and divides it into a first chamber (18) and a second chamber (16), and a piston rod (14) fixedly connected with the piston (12). Moreover the piston is movable towards an abutment surface (30) which is adapted to take up, against spring action, part of the weight of the appliance when the appliance (2) is in the second lowered position. Preferably the actuator has a second piston (22) which runs along the piston rod (14) and which is adapted to divide the first chamber into a third chamber (18a) and a fourth chamber (18b), a surface of said second piston facing the first piston constituting said abutment surface (30). The actuator is intended to be used to operate a vertically adjustable appliance which is mounted on a vehicle.

WO 01/29329 A1

HYDRAULIC ACTUATORField of the Invention

The present invention relates to a hydraulic actuator in connection with an appliance which is intended to be advanced by a vehicle. The appliance is movable
5 by means of the actuator between a first raised position, in which the appliance is out of contact with a base, the ground, and a second lowered position, in which the appliance is in contact with the ground and is pressed against the ground by its own weight. The actuator com-
10 prises a casing with two ends, a piston which is movable in the casing and divides it into a first chamber between the first end of the casing and the piston, and a second chamber between the piston and the second end of the casing, and a piston rod fixedly connected with the piston
15 and extending from the piston through the first chamber and out of the casing, the piston rod end located outside the casing being connected with the appliance.

The invention relates specifically to a hydraulic actuator adapted to actuate a ploughshare on a tractor.

20 The invention also relates to a vehicle provided with an actuator as described above.

Background Art

There are a large number of appliances which in use
25 are advanced by a vehicle, such as a tractor or the like, and press against the ground with their own weight. Examples of such appliances are graders, road making ploughs etc.

A problem in these types of appliance is that the
30 pressure exerted by the appliance on the ground is too great in some situations. One example is a snow plough which when successfully used is brought into contact with the ground by its own weight, without interfering with the ground. If the pressure is too great, the

ground, for instance a gravel road or a lawn, can be damaged. In particular regarding snow ploughs, one reason for the problem is that the clearance work to an increasing extent is carried out by contractors with a small, non-specialised vehicle, for instance a tractor, on which a detachable ploughshare is mounted when needed. These relatively mobile vehicles can be driven in places where larger, more permanently equipped snow ploughs cannot be driven, such as narrow roads, footpaths, parks etc. In these places, the ground is often more sensitive to the scraping effect of the ploughshare, which means the above problem will be extremely pronounced. A tractor with a ploughshare which could clear the snow from a relatively narrow path may be prevented from doing so owing to the risk of the ploughshare completely destroying the path.

Summary of the Invention

The object of the present invention is to solve the above problem and enable a reduction of the pressure exerted to the ground by an appliance by its own weight.

This object is achieved by a device of the type defined by way of introduction, which is characterised in that the piston is movable towards an abutment surface which is adapted to take up, against spring action, part of the weight of the appliance when the appliance is in the second lowered position.

Thus, it is still the weight of the appliance that causes the pressure on the ground, but this pressure is reduced by the abutment surface taking up against spring action at least part of the weight of the appliance. The spring action allows the appliance to follow the contour of the ground within given limits. In a cavity, the appliance can go down, thereby additionally reducing its weight on the ground, and on an elevation the appliance can be pressed upwards, thereby additionally reducing its weight on the ground.

According to a preferred embodiment, the actuator comprises a second piston which runs along the piston rod and which is adapted to divide the first chamber into a third chamber between said first and second pistons and
5 a fourth chamber between said second piston and the first end of the casing, a surface of said second piston facing said first piston constituting said abutment surface. By this second piston being freely movable along the piston rod independently of the first piston, the abutment sur-
10 face can be spring-loaded quite independently of the raising function of the first piston.

According to an embodiment of the invention, a first duct is arranged to connect the third chamber with a hydraulic system, and a second duct is arranged to con-
15 nect the fourth chamber with an accumulator which is adapted to produce said spring action. The first duct comprises, for instance, a longitudinal bore in the piston rod, which has a first opening adjacent to the piston and a second opening outside the casing.

20 The fact that separate ducts lead to the respective chambers makes it possible to control the pressure in the chambers independently of each other. By the first duct extending in the piston rod, with an opening close to the first piston, it is ensured that the hydraulic system is
25 always in communication with the third chamber, independently of the position of the two chambers.

The accumulator preferably contains a compressible fluid, preferably gas, which can be pressurised to the desired level. After the accumulator, and thus the fourth
30 chamber, has been pressurised with a suitable pressure for the specific application, the appliance can, by a pressure change in the third chamber, be moved between the raised and the lowered position. The spring force acting on the ground is maintained during raising as well
35 as lowering. Thus the accumulator acts pretty much like an inflated cushion, which reduces the pressure exerted by the appliance to the ground to the correct level.

Brief Description of the Drawings

The present invention will now be described in more detail with reference to the accompanying drawings, which by way of exemplification show preferred embodiments of the invention.

Fig. 1a shows a vehicle with an appliance in a first lowered position.

Fig. 1b shows the vehicle in Fig. 1a with the appliance in a second raised position.

Fig. 2a shows an actuator according to an embodiment of the invention, in a first extracted position.

Fig. 2b shows the actuator in Fig. 2a in a second, retracted position.

Fig. 3 shows generally how the actuator in Figs 2a-b is connected with the hydraulic system.

Description of a Preferred Embodiment

In the example shown in Figs 1a, 1b, the vehicle is a tractor 1 and the appliance is a ploughshare 2. The ploughshare 2 is in known manner vertically adjustable by the action of a hydraulic actuator 3.

According to the preferred embodiment, the actuator 3 is a hydraulic actuator, with a piston which is adapted, by fluid pressure on one side, to be pressed into the cylinder.

A hydraulic actuator according to an embodiment of the invention is shown in Figs 2a and 2b. In a casing in the form of a cylinder 10, a piston 12 with a fixedly connected piston rod 14 is arranged, the piston dividing the cylinder into two chambers 16, 18, one on each side of the piston 12. The piston rod 14 extends from the piston 12, through one chamber 18, and out through an opening 20 in one end 10a of the cylinder 10. A second piston 22 is adapted to be movable along the piston rod 14 between the first piston 12 and the first end 10a of the cylinder. The chamber 18 is thus divided into two smaller chambers 18a, 18b, one on each side of the second

piston 22. An inlet 23 is formed at the end 10a of the cylinder which opens into the chamber 18b. The piston rod 14 is formed with a duct 24 whose first opening 26 opens into the chamber 18a which is positioned between the
5 pistons 12 and 22 and whose second opening 28 opens outside the cylinder 10. This duct 24 can thus be used to introduce a fluid into the chamber 18a. The duct 24 is in the example shown a bore positioned close to the centre axis A of the piston rod 14.

10 The second piston 22 has a surface 30, which, when the first piston 12 is moved towards the second piston 22, abuts against the first piston 12. The abutment surface 30 is separated a distance from the sealing area 32 of the piston 12 against the cylinder 10, so that the
15 chamber 18a has a predetermined minimum volume when the pistons 12 and 22 are brought into contact with each other. The first opening 26 of the duct 24 is positioned between the abutment surface 30 and the sealing area 32.

The outer opening 28 of the duct 24 and the inlet 23
20 are via lines 35, 37 connected to a valve means 36, such as a slide valve, which in turn is connected to a hydraulic system 38, for instance the existing hydraulic system of the tractor. The hydraulic system 38 has an operating means 39 to increase or reduce the pressure in the sys-
25 tem.

The valve means 36 is adapted to selectively connect the chamber 18a or the chamber 18b with the hydraulic system 38. For example, the valve means 36 consists of two two-way directional control valves 33, 34, preferably seat valves, which are operable between three different positions. In a first position, the first valve 33 is open and the second valve 34 is closed, whereby the hydraulic system 38 communicates with the chamber 18b. In
30 a second position, the first valve 33 is closed and the second valve 34 is open, whereby the hydraulic system 38
35 communicates with the chamber 18a. In a third position,

both valves are open, the chambers 18a and 18b communicating with each other and with the hydraulic system 38.

An accumulator is connected along the line 35 between the chamber 18b and the valve means 36. The
5 accumulator is adapted to allow against spring action the introduction of a pressurised fluid. Spring action is obtained in the shown example by the accumulator comprising a chamber 41 with compressible gas, for instance nitrogen gas, and a chamber 42 which is connected to the
10 fluid in the line 35. The chambers are separated by a partition 43, for example a rubber diaphragm. Alternatively, the accumulator could comprise a spring means which is adapted to be compressed against fluid pressure.

The function of the device will be described below.
15 The steps as described and their relative order are selected to render the function of the device clear. According to the circumstances, one or more steps can be omitted, and the sequential order can be varied.

First, the valve means 36 is actuated to its second
20 position, so that merely the chamber 18a is connected to the hydraulic system 38, whereupon the operating means 39 is opened. The chamber 18a is in this position not pressurised and the ploughshare 2 is pressed by its own weight down to the position shown in Fig. 1a. At the same
25 time the actuator 3 is made to take the position shown in Fig. 2a, where the piston 12 abuts against the abutment surface 30 of the piston 22.

Subsequently the valve means 36 can be placed in its third position to connect the two chambers 18a and 18b
30 with the hydraulic system 38. Both chambers can thus be ventilated by the action of the operating means 39. In this fashion, the system is "reset", both chambers 18a and 18b being pressurised at a common pressure relatively close to atmospheric, and the entire weight of the
35 ploughshare 2 resting on the ground.

The valve means 36 is then placed in its first position, so that merely the chamber 18b is connected to the

hydraulic system, and the pressure in the chamber 18b is controlled with the aid of the operating means 39. As the pressure P in the chamber 18b is being increased, the force F1 exerted by the piston 22 on the piston 12 increases. This force F1 corresponds to a reduction of the force F2 exerted by the ploughshare on the ground. Depending on how the ploughshare is connected with the piston rod 14, the exact relationship between the force F1 and the force F2 on the ground may vary, but the greater the force F1 the lesser the force F2.

At the same time as the pressure P in the chamber 18b is being increased, and the weight of the ploughshare on the ground decreases, the gas in the chamber 41 of the accumulator 40 is compressed, and it may be said that the spring action of the accumulator is precharged.

The pressure P in the chamber 18b is increased until the force F2 on the ground is assessed to be appropriate. This assessment can be made by an operator monitoring how the appliance and the ground interact, for instance to which extent the appliance presses down the ground. Alternatively, the accumulator pressure can be related, e.g. by a graduated pressure transducer (not shown), to absolute values of the force F2 on the ground, in which case the operator can set a value of the force F2 which is predetermined for the ground.

When the pressure in the chamber 18b has been set at a suitable level, the valve means 36 is placed in the second position, so that merely the chamber 18a is connected to the hydraulic system. The ploughshare 2 can now be raised and lowered with the aid of the operating means 39.

To raise the ploughshare 2, the operating means 39 is used to increase the pressure in the chamber 18a so that the pistons 12 and 22 are pressed apart. The pressure in the chamber 18b also increases since the ground does not take up part of the weight of the ploughshare any longer. The piston 22 is therefore pressed further

towards the end 10a of the cylinder, and the gas in the accumulator 40 is further compressed.

To lower the ploughshare 2, the operating means 39 is used to reduce the pressure in the chamber 18a, preferably to essentially atmospheric pressure. The ploughshare 2 is thus pressed down by its own weight, and the piston 12 abuts against the piston 22 as described above. The compressed gas in the accumulator 40 then acts as a "cushion", which dampens the strain on the actuator 3 and the remaining system.

In operation, when the ploughshare is lowered, the "cushion" causes a spring action, which helps the ploughshare follow the ground. The ploughshare can by its own weight go down still more in a cavity in the ground, resulting in additionally compressed gas in the accumulator and a reduced pressure on the ground. However, there is a limit to how far the ploughshare can be lowered, which limit depends on the pressure with which the operator has precharged the accumulator. In the same way, the ploughshare can be made to go up if there is an elevation on the ground, resulting in a reduced pressure in the accumulator and an increased pressure on the ground.

The valve means 36 can be arranged in a suitable position on the vehicle 1 or the ploughshare 2, or be integrated with the actuator 3. If the user can visually decide when an advantageous pressure on the ground has been attained, it may be particularly convenient to arrange the valve means 36 in connection with the ploughshare.

The actuator 3 can also be arranged to apply a pressure in the opposite direction and thus also press the ploughshare 2 more firmly against the ground.

CLAIMS

1. A hydraulic actuator (3) in connection with
5 an appliance (2) which is intended to be advanced by
a vehicle (1), which appliance (2) is movable by means
of the actuator (3) between a first raised position, in
which the appliance is out of contact with a base, the
ground (4), and a second lowered position, in which the
10 appliance is in contact with the ground and is pressed
against the ground by its own weight,

said actuator comprising a casing (10) with two
ends (10a, 10b), a piston (12) which is movable in the
casing and divides it into a first chamber (18) between
15 the first end of the casing and the piston, and a second
chamber (16) between the piston and the second end (10b)
of the casing, and a piston rod (14) fixedly connected
with the piston (12) and extending from the piston (12)
through the first chamber and out of the casing (10), the
20 piston rod end located outside the casing being connected
with the appliance (2),

characterised in that

the piston is movable towards an abutment surface
(30) which is adapted to take up part of the weight of
25 the appliance against spring action when the appliance
(2) is in the second lowered position.

2. A hydraulic actuator (3) according to claim 1,
wherein spring action is produced by a pressurised, com-
pressible fluid, preferably gas.

30 3. A hydraulic actuator (3) according to claim 1 or
2, further comprising

a second piston (12) which runs along the piston rod
(14) and which is adapted to divide the first chamber
into a third chamber (18a) between said first and second
35 pistons (12, 22) and a fourth chamber (18b) between said
second (22) piston and the first end (10a) of the casing,

a surface of said second piston facing said first piston constituting said abutment surface (30).

4. An actuator according to claim 3, further comprising a first duct (24) which is arranged to connect
5 the third chamber (18a) with a hydraulic system (38), and a second duct (23) which is arranged to connect the fourth chamber (18b) with an accumulator (40) which is adapted to produce said spring action.

5. An actuator according to claim 4, wherein said
10 first duct comprises a longitudinal bore (24) in the piston rod (14), which has a first opening adjacent to the piston (12) and a second opening outside the casing (10).

6. An actuator according to claims 3-5, wherein the
15 accumulator (40) contains a compressible fluid, preferably gas.

7. An actuator according to any one of the preceding claims, wherein the appliance is a ploughshare (2).

8. A vehicle (1) provided with an actuator (3)
20 according to any one of the preceding claims.

1/3

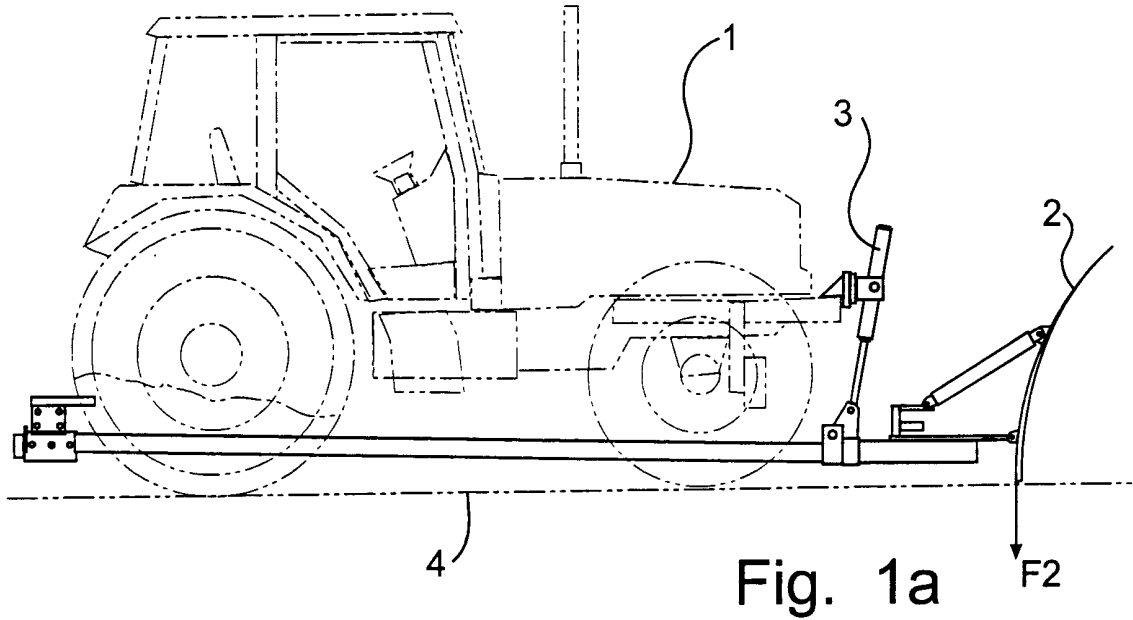


Fig. 1a

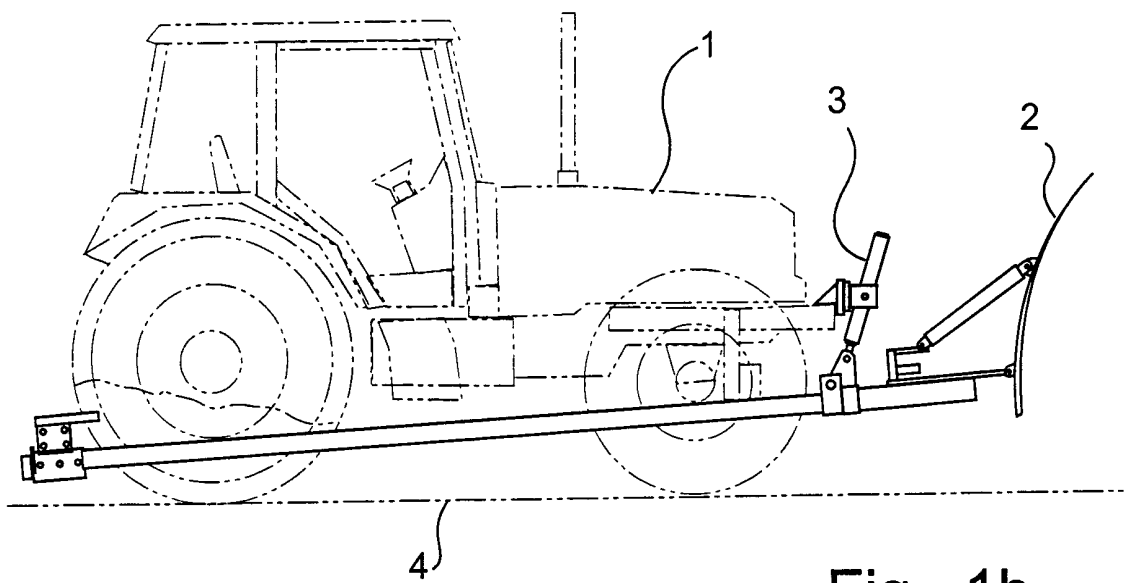


Fig. 1b

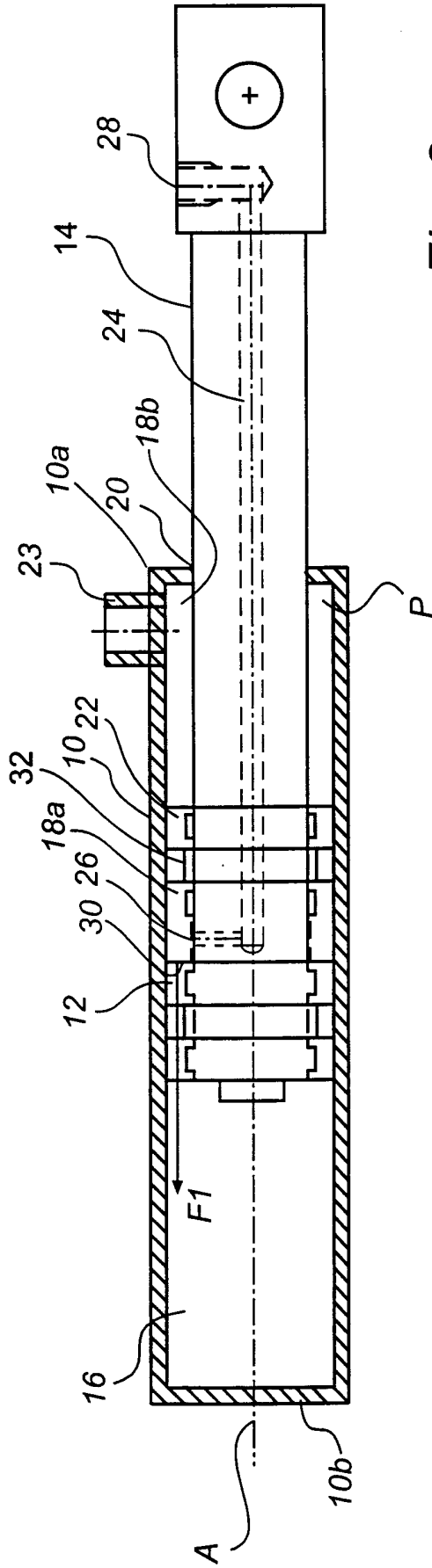


Fig. 2a

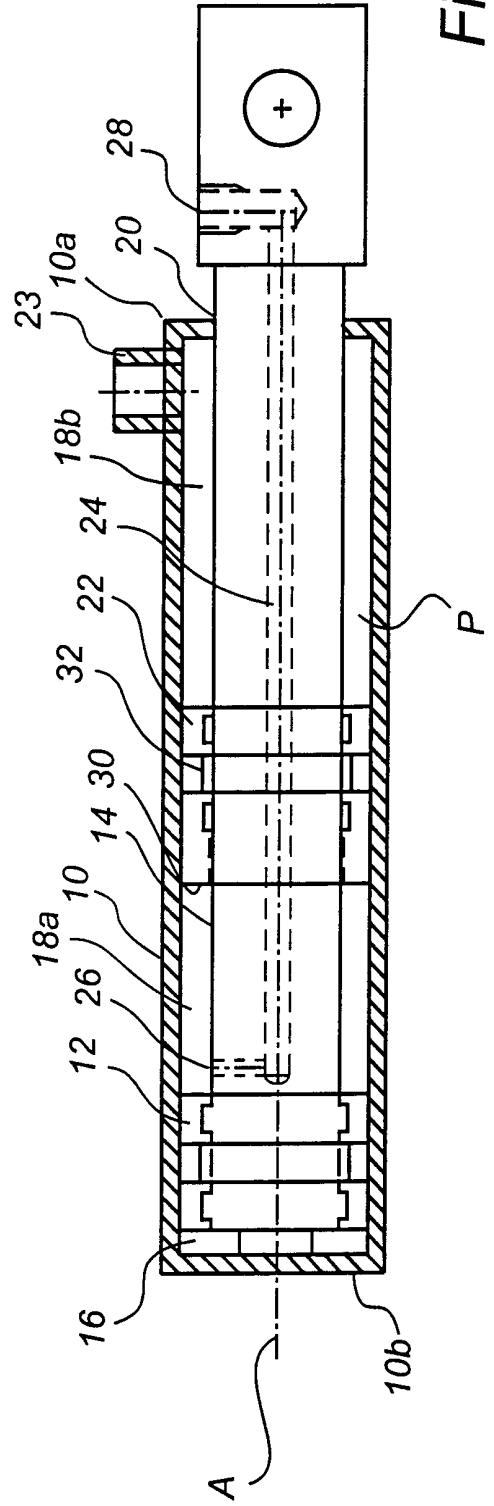


Fig. 2b

3/3

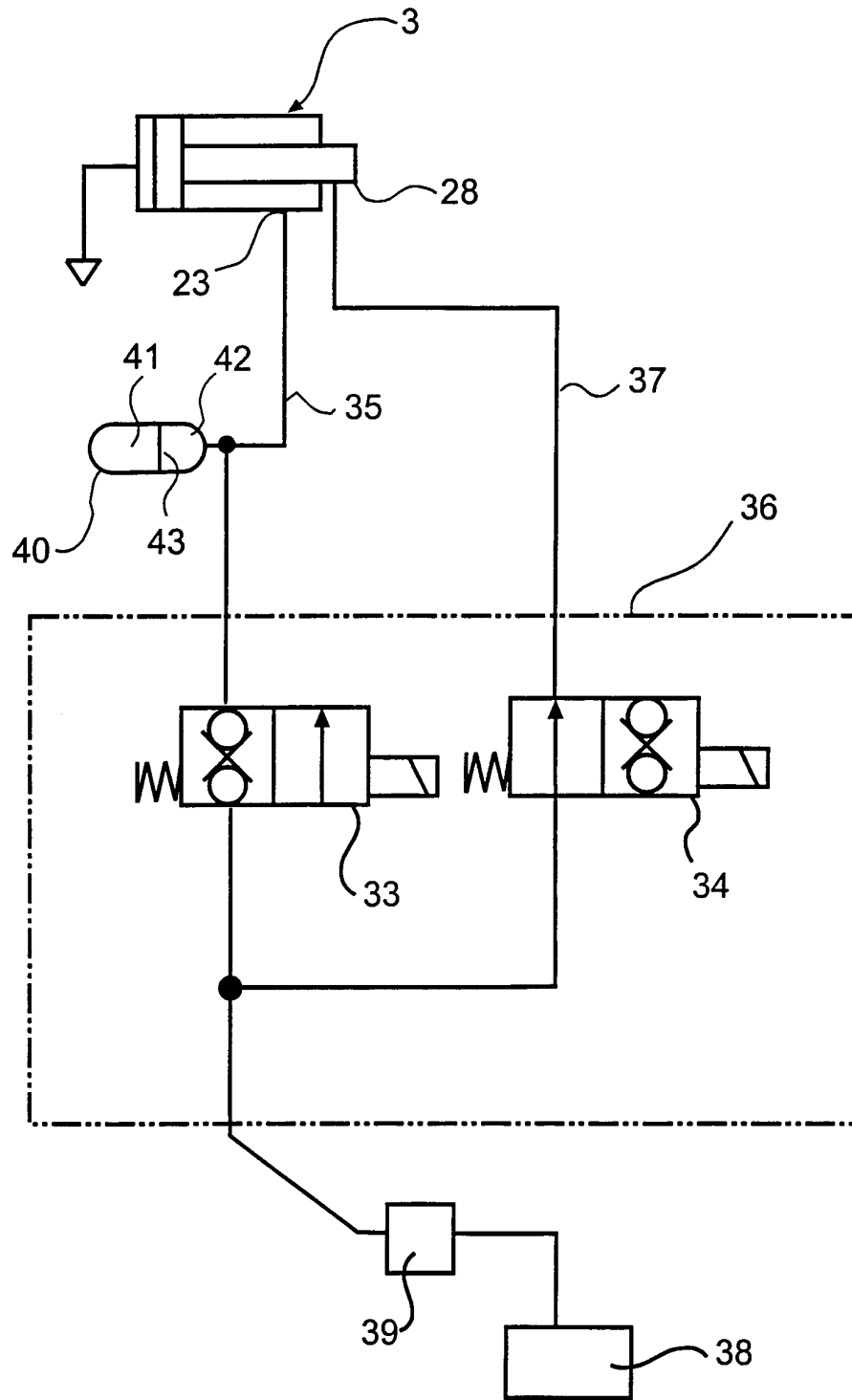


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02013

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E02F 3/85

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E02F, E01M, F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3893518 A (FARRELL), 8 July 1975 (08.07.75), column 1, line 6 - line 8; column 1, line 20 - line 30; column 4, line 43 - line 54, figure 9	1,3,7,8
Y	--	2,6
Y	US 4320589 A (PELAZZA), 23 March 1982 (23.03.82), column 2, line 41 - line 68; column 3, line 1 - line 2	2,6
A	US 4622884 A (BUCHL), 18 November 1986 (18.11.86), the whole document	1-8
	--	

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

22 January 2001

Date of mailing of the international search report

06-02-2001

Name and mailing address of the ISA/

Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Lars Björk / JA A
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02013

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5921010 A (SCHULTE ET AL), 13 July 1999 (13.07.99), the whole document --	1-8
A	GB 2016980 A (B & G HYDRAULICS LIMITED), 3 October 1979 (03.10.79), the whole document -- -----	1-8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3893518 A	08/07/75	NONE	
US 4320589 A	23/03/82	DE 2920345 A ES 480961 A FR 2426773 A IT 1107816 B IT 7868215 D	29/11/79 16/01/80 21/12/79 02/12/85 00/00/00
US 4622884 A	18/11/86	CA 1185877 A US 4423664 A	23/04/85 03/01/84
US 5921010 A	13/07/99	NONE	
GB 2016980 A	03/10/79	NONE	