(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 306 800 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.01.2024 Bulletin 2024/03

(21) Application number: **23184939.9**

(22) Date of filing: **12.07.2023**

(51) International Patent Classification (IPC):
F04B 17/03 *(2006.01)* ***F04B 23/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04B 23/025; F04B 17/03

(84) Designated Contracting States:
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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **15.07.2022 IT 202200014926**

(71) Applicant: **ZF AUTOMOTIVE ITALIA S.R.L.**
10129 Torino (IT)

(72) Inventors:
- **DI PIETRO, Dario**
  10129 TORINO (IT)
- **POMPILIO, Alessandro**
  10129 TORINO (IT)
- **ZAMBARDI, Roberto**
  10129 TORINO (IT)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) ELECTRIC PUMP, IN PARTICULAR FOR OPERATING A LIFTING CYLINDER OF A SHOCK ABSORBER FOR VEHICLES

(57) An electric pump has a containing tank (4) for an operating fluid (5), a feeding pump (6) to feed the operating fluid (5) from the containing tank (4) to a user, and a hydraulic circuit (7) to connect the containing tank (4), the feeding pump (6), and the user to one another; the containing tank (4) housing, on the inside, a floating piston (9) designed to divide the containing tank (4) into a first chamber (10) to contain the operating fluid (5) and into a second chamber (11) communicating with the outside and, hence, at atmospheric pressure.

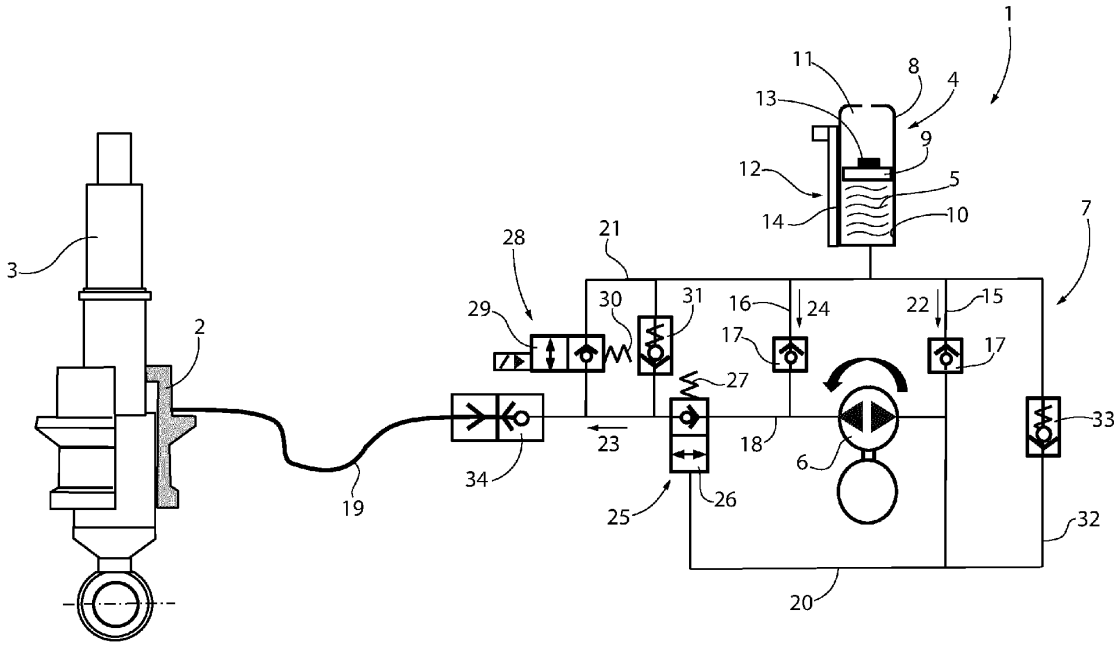

FIG.1

EP 4 306 800 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102022000014926 filed on July 15, 2022, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to an electric pump, in particular for operating a lifting cylinder of a shock absorber for vehicles.

BACKGROUND

[0003] In general, the present invention is particularly advantageous for application in an electric pump for feeding and operating a hydraulic actuator cylinder of a vehicle.

[0004] In particular, the present invention relates to an electric pump of the type comprising a containing tank for an operating fluid, in the case in question oil; a feeding pump to feed the operating fluid from the containing tank to a user, in particular the lifting cylinder of the shock absorber of a vehicle; an electric motor for operating the feeding pump; and a hydraulic circuit to connect the containing tank, the feeding pump, and the user to one another.

[0005] The containing tank accommodates, on the inside, the operating fluid, and is connected to a compressed air pneumatic device designed to feed the operating fluid to the outside of the containing tank.

[0006] Known electric pumps of the type described above have some problems mainly deriving from the fact that the containing tank is a pressurized containing tank, is relatively complex and costly, and requires isolation of at least part of the electric motor from the operating fluid.

[0007] When the pressurized containing tank is replaced with a containing tank with a free surface, known electric pumps of the type described above have some problems, mainly deriving from the fact that the use of a containing tank with a free surface causes problems of suction of the operating fluid in certain driving conditions of the vehicle and from the presence of air in the operating fluid fed into the hydraulic circuit.

SUMMARY

[0008] The object of the present invention is to provide an electric pump, in particular for operating a lifting cylinder of a shock absorber for vehicles, which solves the problems described above and which is simple and inexpensive to implement.

[0009] According to the present invention, there is provided an electric pump, in particular for operating a lifting cylinder of a shock absorber for vehicles, as claimed in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention will now be described with reference to the accompanying drawings, which show a non-limiting example of embodiment thereof, wherein:

Figs. 1, 2, and 3 schematically illustrate a preferred embodiment of the electric pump of the present invention in four different operating modes.

DESCRIPTION OF EMBODIMENTS

[0011] With reference to Figs. 1, 2, and 3, the reference number 1 indicates, as a whole, an electric pump for operating a lifting cylinder 2, which defines part of a shock absorber 3 for a vehicle (not illustrated), and allows the lifting and lowering of a chassis (not illustrated) of the vehicle (not illustrated) to be selectively controlled.

[0012] The electric pump 1 comprises a containing tank 4 for an operating fluid 5, in this case oil, of the cylinder 2; a feeding pump 6 to feed the operating fluid from the tank 4 to the cylinder 2; and a hydraulic circuit 7 to connect the tank 4, the pump 6, and the cylinder 2 to one another.

[0013] The tank 4 comprises a container 8 and a floating piston 9 made of a plastic material.

[0014] The piston 9 is mounted inside the container 8, is coupled in a fluid-tight manner with the container 8 through an annular gasket (not illustrated) mounted on the piston 9, and defines inside the container 8 a first variable volume chamber 10 containing the fluid 5 and a second variable volume chamber 11, communicating with the outside through a vent valve (not illustrated) designed to keep the chamber 11 at atmospheric pressure.

[0015] The tank 4 is further provided with a detection device 12 to detect the position of the piston 9 along the container 8.

[0016] In this case, the device 12 comprises at least one magnet 13 fixed to the piston 9 and a linear position sensor 14, which is mounted on the container 8, extends along the container 8, and cooperates with the magnet 13 to detect the position of the magnet 13 and, hence, of the piston 9 along the container 8.

[0017] The pump 6 is a two-way gear pump configured to rotate both in clockwise and in counter-clockwise direction.

[0018] The hydraulic circuit 7 comprises a first branch 15 and a second branch 16 mounted in parallel with each other between the tank 4 and the pump 6 and each provided with a respective suction valve 17, in particular a non-return valve.

[0019] Opening of the valves 17 and, hence, flow of the operating fluid along the branches 15, 16 are controlled selectively according to the direction of rotation of the pump 6.

[0020] The circuit 7 further comprises a third branch

18 to connect the pump 6 and a branch 19 for inflow of the fluid 5 into the lifting cylinder 2 to one another; a fourth branch 20 to connect the first branch 15 and the third branch 18 to one another; and a fifth branch 21 to connect the tank 4 and the third branch 18 to one another.

[0021] The fourth branch 20 is connected to the first branch 15 downstream of the relative suction valve 17 in a flowing direction 22 of the fluid 5 from the tank 4 to the pump 6 along the first branch 15.

[0022] The fifth branch 21 is connected to the third branch 18 downstream of the fourth branch 20 in a flowing direction 23 of the fluid 5 from the pump 6 to the shock absorber 3 along the third branch 18, and is also connected to the second branch 16 upstream of the relative suction valve 17 in a flowing direction 24 of the fluid 5 from the tank 4 to the pump 6 along the second branch 16.

[0023] The circuit 7 further comprises a valve device 25, which is mounted between the third branch 18 and the fourth branch 20, and is provided with a slide valve 26 and with a spring 27 designed to move, and normally maintain, the slide valve 26 in a first operating position (Fig. 1), in which the slide valve 26 allows the fluid 5 to flow from the pump 6 to the cylinder 2 and prevents the fluid 5 from flowing from the cylinder 2 to the pump 6.

[0024] The slide valve 26 is movable, due to the thrust of the fluid 5 fed by the pump 6 along the fourth branch 20 and against the action of the spring 27, from the first operating position to a second operating position (Fig. 2), in which the slide valve 26 allows the fluid 5 to flow from the cylinder 2 to the pump 6.

[0025] The circuit 7 is further provided with a solenoid valve 28, which is mounted along the fifth branch 21, and comprises a slide valve 29 and a spring 30 designed to move, and normally maintain, the slide valve 29 in a closing position of the fifth branch 21 (Figs. 1 and 2).

[0026] The solenoid valve 28 is electrically powered to move the slide valve 29 against the action of the spring 30 from the closing position to an opening position of the fifth branch 21, in which the fluid 5 flows from the cylinder 2 to the tank 4 (Fig. 3).

[0027] The circuit 7 further comprises a maximum pressure valve 31 mounted between the third branch 18 and the fifth branch 21 and connected to the third branch 18 downstream of the fourth branch 20 in the flowing direction 23 of the fluid 5 from the pump 6 to the cylinder 2.

[0028] The circuit 7 further comprises a sixth branch 32, which connects the fourth branch 20 and the first branch 15 to one another, and is connected to the first branch 15 upstream of the relative suction valve 17 in the flowing direction 22 of the fluid 5 from the tank 4 to the pump 6 along the first branch 15.

[0029] The circuit 7 is further provided with a discharge valve 33, which is mounted along the sixth branch 32 to allow the fluid 5 to flow back to the tank 4, and has an opening pressure that is smaller than an opening pressure of the maximum pressure valve 31.

[0030] The setting of the opening pressure of the valve 33 depends on the maximum pressure in the branch 19 and in the branch 18 between the valve device 25 and the valve 34 and on the pilot ratio (ratio of the hydraulic thrust area) of the valve device 25 between the branch 18 and the branch 20.

[0031] The circuit 7 finally comprises a mechanical coupling valve 34 designed to connect the third branch 18 and, hence, the electric pump 1 to the branch 19 for inflow of the fluid 5 into the cylinder 2.

[0032] Following connection to the branch 19, the valve 34 is moved and maintained in an opening position, in which the valve 34 allows transfer of the fluid 5 between the third branch 18 and the branch 19.

[0033] The electric pump 1 has four different operating modes, which shall now be described with reference to Figs. 1, 2, and 3 and starting from an instant in which the valve device 25 is arranged in its first operating position and the solenoid valve 28 is arranged in its closing position.

[0034] With reference to Fig. 1, according to a first operating mode used to feed the fluid 5 to the cylinder 2 and, hence, lift the chassis (not illustrated) of the vehicle (not illustrated), the pump 6 is operated counter-clockwise so as to allow:

- the vacuum pressure generated by the pump 6 to open the valve 17 of the first branch 15 and to draw the fluid 5 into the pump 6; and
- the difference in pressure between the chamber 11 and the chamber 10 to maintain the piston 9 in contact with the fluid 5 and to facilitate suction of the pump 6.

[0035] The fluid 5 is pressurized by the pump 6 and fed along the third branch 18, through the valve 34, and to the cylinder 2 and allows the suction valve 17 of the second branch 16 to be maintained closed.

[0036] In a second operating mode illustrated in Fig. 1 and used to block the chassis (not illustrated) of the vehicle (not illustrated) in a raised position, the pump 6 is deactivated, return of the pressurized fluid 5 fed to the cylinder 2 is prevented both by the valve device 25, and by the solenoid valve 28, and the pressurized fluid 5 is contained between the cylinder 2, the valve device 25, and the solenoid valve 28.

[0037] According to a third operating mode illustrated in Fig. 2 and used to lower the chassis (not illustrated) of the vehicle (not illustrated) with a relatively low descent speed depending on the rotation speed of the pump 6, the pump 6 is operated clockwise so as to allow:

- the vacuum pressure generated by the pump 6 to open the valve 17 of the second branch 16 and to draw the fluid 5 into the pump 6; and
- the difference in pressure between the chamber 11 and the chamber 10 to maintain the piston 9 in contact with the fluid 5 and to facilitate suction of the pump 6.

[0038] The pressurized fluid 5 is fed by the pump 6 along the fourth branch 20, allows the suction valve 17 of the first branch 15 to be maintained closed, and also allows the slide valve 26 of the valve device 25 to move from its first operating position into its second operating position.

[0039] Once the slide valve 26 has been moved into its second operating position, the fluid 5 is fed firstly from the cylinder 2 to the pump 6 along the third branch 18 and then from the pump 6 into the fourth branch 20 so as to open the discharge valve 33 and flow back once again into the tank 4.

[0040] In this regard it should be specified that the discharge valve 33 is configured so as to avoid instability and noise generated by discharge of the fluid 5 into the tank 4.

[0041] According to a fourth operating mode illustrated in Fig. 3 and used to lower the chassis (not illustrated) of the vehicle (not illustrated) with a relatively high descent speed, the pump 6 is deactivated, the slide valve 26 for distribution of the valve device 25 is moved again by the spring 27 into its first operating position so as to prevent the fluid 5 from flowing back into the pump 6 along the third branch 18, and the solenoid valve 28 is activated and moved into its opening position so as to allow the fluid 5 to flow back from the cylinder 2 into the tank 4 along the fifth branch 21.

[0042] The electric pump 1 has some advantages mainly deriving from the fact that:

the piston 9 is moved along the tank 4 only by a force generated by the combination of the suction pressure acting in the chamber 10 with the atmospheric pressure acting in the chamber 11 and without requiring any auxiliary thrust device, such as a spring;
the containing tank 4 at atmospheric pressure is relatively simple and inexpensive;
the fluid-tight coupling of the floating piston 9 with the container 8 allows elimination of the presence of air in the chamber 10 and, hence, in the fluid 5;
the detection device 12 allows detection of the position of the floating piston 9, the volume of fluid 5 contained in the tank 4, and, hence, the stroke of the lifting cylinder 2 of the shock absorber 2;
the solenoid valve 28 is normally arranged in its closing position and is only electrically powered in the operating mode used to lower the chassis (not illustrated) of the vehicle (not illustrated) with a relatively high descent speed;
the raised position of the chassis (not illustrated) of the vehicle (not illustrated) is maintained in a relatively simple manner by deactivating the pump 6 and the solenoid valve 28; and
the descent speed of the chassis (not illustrated) of the vehicle (not illustrated) in the aforesaid third operating mode is controlled selectively in a relatively simple and inexpensive manner by means of the rotation speed of the pump 6.

Claims

1. - An electric pump, in particular for operating a lifting cylinder (2) of a shock absorber (3) for vehicles, comprising a containing tank (4) for an operating fluid (5); a feeding pump (6) to feed the operating fluid (5) from the containing tank (4) to a user, in particular the lifting cylinder (2) of the shock absorber (3) for vehicles; and a hydraulic circuit (7) to connect the containing tank (4), the feeding pump (6) and the user to one another; and **characterized in that** the containing tank (4) accommodates, on the inside, a floating piston (9) designed to divide the containing tank (4) into a first chamber (10) to contain the operating fluid (5) and a second chamber (11) communicating with the outside and, hence, at atmospheric pressure.

2. - The electric pump according to claim 1, wherein the floating piston (9) is provided with a gasket to be coupled to the containing tank (4) in a fluid-tight manner and to divide said first and second chamber (10, 11) from one another in a fluid-tight manner.

3. - The electric pump according to claim 1 or 2 and further comprising a detection device (12) to detect the position of the floating piston (9) along the containing tank (4).

4. - The electric pump according to claim 3, wherein the detection device (12) comprises at least one magnet (13) mounted on the floating piston (9) and a linear position sensor (14) mounted on the containing tank (4) and associated with the magnet (13).

5. - The electric pump according to any one of the preceding claims, wherein the containing tank (4) and/or the floating piston (9) are made of a plastic material.

6. - The electric pump according to any one of the preceding claims, wherein the hydraulic circuit (7) comprises a first branch (15) and a second branch (16), which are mounted in parallel to one another between the containing tank (4) and the feeding pump (6) and are each provided with a respective suction valve (17), in particular a non-return valve; the feeding pump (6) being a two-way feeding pump to selectively control the suction of the operating fluid (5) along one of said first and second branch (15, 16).

7. - The electric pump according to claim 6, wherein the hydraulic circuit (7) further comprises a third branch (18) to connect the feeding pump (6) and the user to one another, a fourth branch (20) to connect the first branch (15) and the third branch (18) to one another, and a fifth branch (21) to connect the containing tank (4) and the third branch (18) to one another.

8. - The electric pump according to claim 7, wherein the fourth branch (20) is connected to the first branch (15) downstream of the relative suction valve (17) in a flowing direction (22) of the operating fluid (5) from the containing tank (4) to the feeding pump (6) along the first branch (15).

9. - The electric pump according to claim 7 or 8, wherein the fifth branch (21) is connected to the third branch (18) downstream of the fourth branch (20) in a flowing direction (23) of the operating fluid (5) from the feeding pump (6) to the user along the third branch (18) and is further connected to the second branch (16) upstream of the relative suction valve (17) in a flowing direction (24) of the operating fluid (5) from the containing tank (4) to the feeding pump (6) along the second branch (16).

10. - The electric pump according to any one of the claims from 7 to 9, wherein the hydraulic circuit (7) further comprises a valve device (25) mounted between the third branch (18) and the fourth branch (20) and provided with a slide valve (26), which is normally arranged in a first operating position, in which the slide valve (26) allows the operating fluid (5) to flow from the feeding pump (6) to the user and prevents the operating fluid (5) from flowing from the user to the feeding pump (6), and is movable, due to the thrust of the operating fluid (5) fed by the feeding pump (6) along the fourth branch (20), to a second operating position, in which the slide valve (26) allows the operating fluid (5) to flow from the user to the feeding pump (6).

11. - The electric pump according to any one of the claims from 7 to 10, wherein the hydraulic circuit (7) further comprises a solenoid valve (28), which is mounted along the fifth branch (21), is normally arranged in a closing position closing the fifth branch (21) and is operated so as to move to an opening position opening the fifth branch (21) in order to allow the operating fluid (5) to flow from the user to the containing tank (4).

12. - The electric pump according to any one of the claims from 7 to 11, wherein the hydraulic circuit (7) further comprises a maximum pressure valve (31) mounted between the third branch (18) and the fifth branch (21) and connected to the third branch (18) downstream of the fourth branch (20) in the flowing direction (23) of the operating fluid (5) from the feeding pump (6) to the user along the third branch (18).

13. - The electric pump according to any one of the claims from 7 to 12, wherein the hydraulic circuit (7) further comprises a sixth branch (32) to connect the fourth branch (20) and the first branch (15) to one another; the sixth branch (32) being connected to the first branch (15) upstream of the relative suction valve (17) in the flowing direction (22) of the operating fluid (5) from the containing tank (4) to the feeding pump (6) along the first branch (15).

14. - The electric pump according to claim 13, wherein the hydraulic circuit (7) further comprises a discharge valve (33) mounted along the sixth branch (32) in order to allow the operating fluid (5) to flow back to the containing tank (4).

15. - The electric pump according to claim 14, when it depends on claim 12, wherein the discharge valve (33) has an opening pressure that is smaller than an opening pressure of the maximum pressure valve (31), in particular dependent on the maximum pressure in the third branch (18) downstream of the valve device (25) in the flowing direction (23) of the operating fluid (5) from the feeding pump (6) to the user and on the pilot ratio of the valve device (25) between the third branch (18) and the fourth branch (20).

16. - The electric pump according to any one of the preceding claims, wherein the floating piston (9) is configured to move inside the containing tank (4) only under the thrust of a force generated by the combination of suction pressure acting in the first chamber (10) with the atmospheric pressure acting in the second chamber (11).

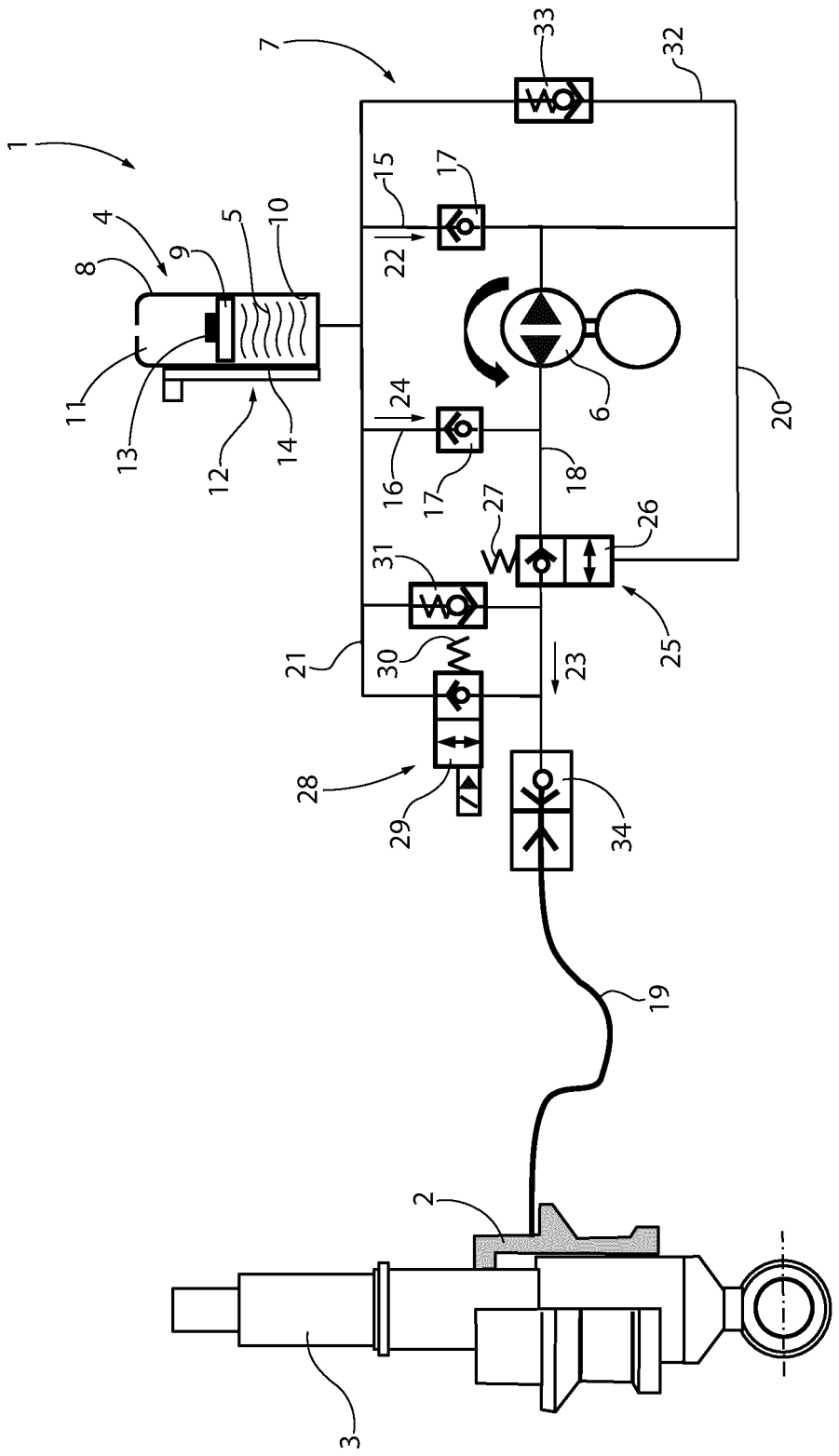
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

FIG.1

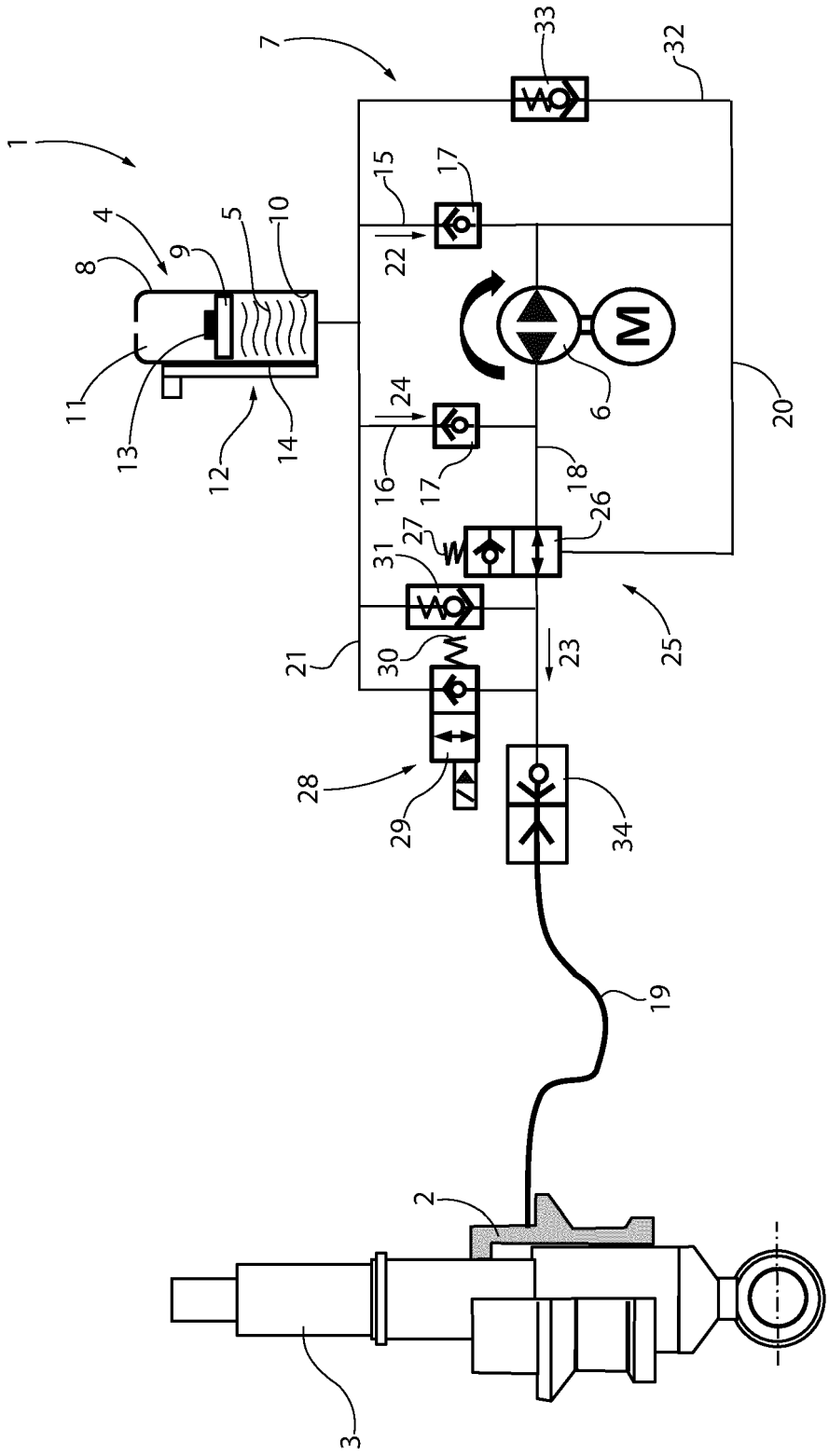
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

FIG.2

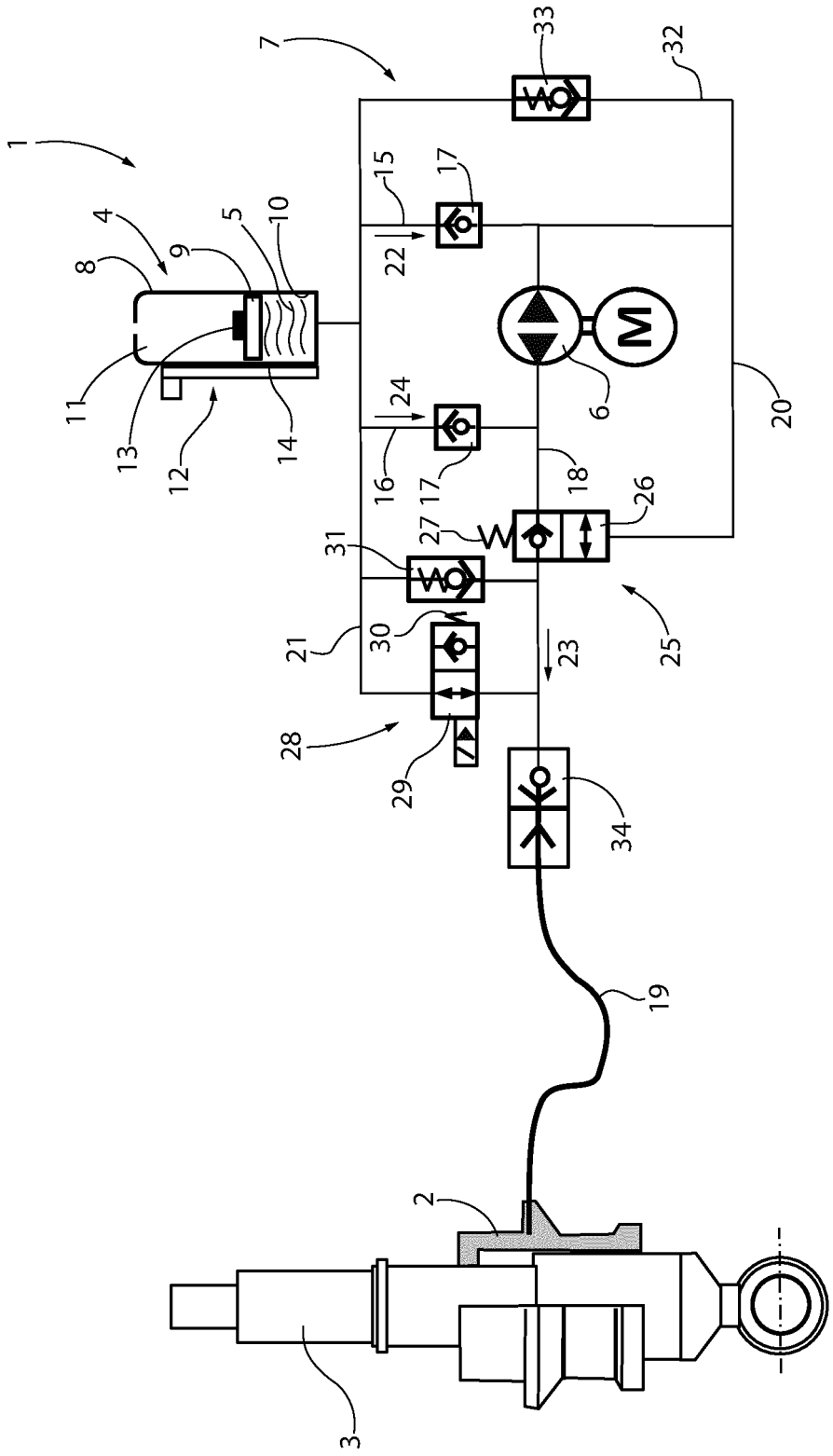
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34

FIG.3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 18 4939

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 276 172 A1 (DROPSA SPA [IT]) 31 January 2018 (2018-01-31)	1,2,5,16	INV. F04B17/03
A	* paragraphs [0003], [0012] - [0017]; figures *	3,4,6-15	F04B23/02
X	JP 2020 104833 A (ADVICS CO LTD) 9 July 2020 (2020-07-09)	1,2,5,16	
A	* paragraphs [0040] - [0046]; figure 4 *	3,4,6-15	
X	DE 10 2018 215132 A1 (FORD GLOBAL TECH LLC [US]) 12 March 2020 (2020-03-12)	1,2,5	
A	* paragraphs [0024] - [0027]; figure 1 *	3,4,6-15	
A	US 2017/037923 A1 (SIRVEN JACQUES [FR] ET AL) 9 February 2017 (2017-02-09) * abstract *; figures *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 October 2023	Pinna, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 18 4939

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-10-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3276172 A1	31-01-2018	CN 107664257 A	06-02-2018
		EP 3276172 A1	31-01-2018
		US 2018031179 A1	01-02-2018
JP 2020104833 A	09-07-2020	NONE	
DE 102018215132 A1	12-03-2020	CN 110878731 A	13-03-2020
		DE 102018215132 A1	12-03-2020
US 2017037923 A1	09-02-2017	CN 106662192 A	10-05-2017
		EP 3132157 A1	22-02-2017
		ES 2911272 T3	18-05-2022
		FR 3020104 A1	23-10-2015
		JP 6568203 B2	28-08-2019
		JP 2017511455 A	20-04-2017
		KR 20170027703 A	10-03-2017
		US 2017037923 A1	09-02-2017
		WO 2015158675 A1	22-10-2015

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- IT 102022000014926 **[0001]**