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(54) Title: GAS DISTRIBUTION SYSTEM FOR FEEDING GAS CONTAINED IN DIFFERENT TANKS TO AN ENGINE OF VEHICLE POWERED BY ALTERNATIVE GAS FUEL

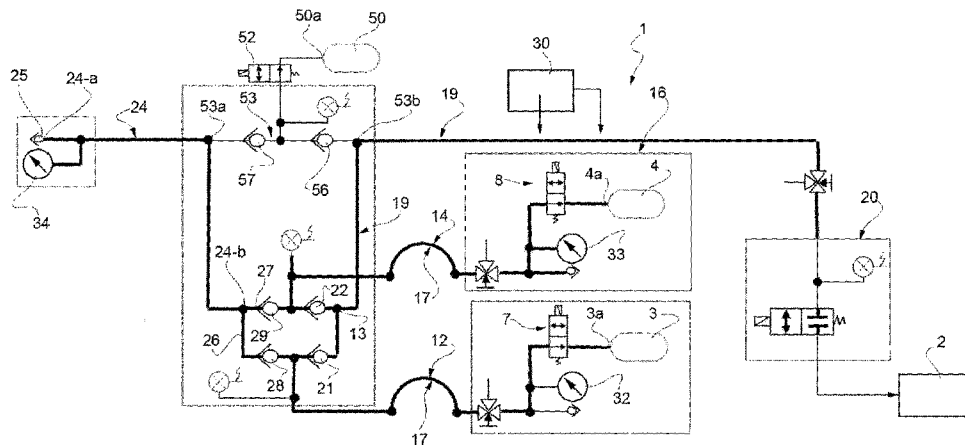


FIG. 1

(57) Abstract: Gas distribution system for feeding to an engine powered by alternative gas fuel (CNG, LNG), gas contained in a first gas tank (3) and at least in a second gas tank (4) and having a first gas conduit (12) connecting an output (3a) of the first gas tank (4) and a second gas conduit (14) connecting an output (4a) of the second gas tank (4). Valve device (7,8) are provided on the conduits (12,14) to select the gas (3,4) tank having the highest gas pressure and supplying to the engine (2) the gas provided by the selected tank.



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GAS DISTRIBUTION SYSTEM FOR FEEDING GAS CONTAINED IN  
DIFFERENT TANKS TO AN ENGINE OF VEHICLE POWERED BY  
ALTERNATIVE GAS FUEL

5        TECHNICAL FIELD

The present invention relates to a gas distribution system for feeding gas contained in different tanks to an engine of a vehicle powered by alternative gas fuel.

10       BACKGROUND OF THE INVENTION

Vehicles, tractors for instance, may be powered by using alternative gas fuel in order to reduce the emissions with respect to other typology of fossil fuels.

One example of alternative gas fuel is Compressed Natural  
15 Gas (CNG) (methane stored at high pressure) that is a fuel which can be used in place of gasoline, diesel fuel and propane/LPG.

Another example of alternative gas fuel is Liquefied  
Natural Gas (LNG) that is a natural gas  
20 (predominantly methane, CH<sub>4</sub>, with some mixture of ethane C<sub>2</sub>H<sub>6</sub>) that has been cooled down to liquid form for ease and safety of non-pressurized storage or transport.

Alternative gas fuel are contained in a number of **gas tanks** (two or more) that are carried by the vehicle or by a  
25 towed implement and are connected with the engine through a **gas distribution system**.

In some conditions, gas contained in different tanks may have different pressures; under the above conditions gas may flow from one tank (i.e. the tank having the highest pressure)  
30 to the other(s) tank(s) (i.e. the tank(s) having lower pressure).

This unwanted mixing of gas between tanks may produce a number of drawbacks including:

gas lamination with associated temperature reduction and potential damage of part of the gas distribution system;

unwanted noise in the gas distribution system;

potential intervention of the flow excess protection  
5 devices if installed in the gas distribution system; and

if different tanks contain different gases, unwanted mixing of gases resulting a non optimal mixing gas mixture supplied to the engine.

In view of the above, the need is felt to foresee an  
10 optimized gas distribution system avoiding the mixture of gas contained in different tanks when gas contained in the tanks have different pressures.

#### SUMMARY OF THE INVENTION

15 The above technical problem is solved by the present invention that relates to a gas distribution system for feeding gas contained in different tanks to an engine of vehicle powered by alternative gas fuel as defined in attached claim 1.

20

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention shall be described in the accompanied drawings that represent a non-limiting example of the invention wherein:

25 Figure 1 represents schematically a gas distribution system for feeding gas contained in different tanks to an engine of vehicle, a tractor for instance, powered by alternative gas fuel;

Figure 2 represents schematically the gas distribution  
30 system in a first working phase (gas recharge phase); and

Figure 3 represents the gas distribution system in a second working phase (gas supply phase).

DETAILED DESCRIPTION OF THE INVENTION

In **figure 1** numeral 1 indicates, as a whole, a gas distribution system for feeding gas to an engine 2 (of known kind represented schematically) of a vehicle (a tractor for instance) powered by alternative gas fuel gas contained in a first gas tank 3 and in at least a second gas tank 4. Alternative gas fuel may be Compressed Natural Gas (CNG) (methane stored at high pressure) that is a fuel which can be used in place of gasoline, diesel fuel and propane/LPG. Another example of alternative gas fuel is Liquefied Natural Gas (LNG) that is a natural gas (predominantly methane, CH<sub>4</sub>, with some mixture of ethane C<sub>2</sub>H<sub>6</sub>) that has been cooled down to liquid form for ease and safety of non-pressurized storage or transport.

The first gas tank 3 has a gas outlet 3a that communicates with a first valve 7 movable between a first rest position wherein gas may flow only along one direction to be supplied to the gas tank 3 and a second position wherein gas may flow in different directions through the first valve 7.

The second gas tank 4 has a gas outlet 4a that communicates with a second valve 8 movable between a first rest position wherein gas may flow only along one direction to be supplied to the gas tank 4 and a second position wherein gas may flow in different directions through the second valve 8.

A first gas conduit 12 extends between the first valve 7 and a merge point 13 and a second gas conduit 14 extends between the second valve 8 and the merge point 13; accordingly the first gas conduit 12 connects the gas outlet 3a of the first gas tank 3 and the merge point 13 and the second gas conduit 14 connects the gas outlet 4a of the second gas tank 4 and the merge point 13.

Each gas conduit 12/14 may comprise a number of pipes connected together comprising rigid pipes and flexible pipes.

If the gas tanks 3,4 are carried by a tender 16 (represented schematically) towed by a vehicle (not shown) flexible pipes 17 may be placed between the vehicle and the tender 16.

5 A supply gas conduit 19 connects the merge point 13 and a pressure regulator 20 (of known kind) supplying the gas to the engine 2. A first check valve 21 is interposed in the first gas conduit 12 and a second check valve 22 is interposed in the second gas conduit 14 so that the first and the second valves 21, 22 are placed on opposite sides of the merge point  
10 13 and may be opened by the difference of pressure of the gas in the first/the second gas conduit 12 e 13 and the merge point 13.

The first check 21 valve is normally closed and allows the flow of gas only in one direction, i.e. toward merge point  
15 13. The second check valve 22 is normally closed and allows the flow of gas only in one direction, i.e. toward merge point 13.

**According to the present invention the first check valve 21 is interposed in the first gas conduit 12 and the second  
20 check valve 22 is interposed in the second gas conduit 14 so that the first and the second valves 21, 22 realize valve means to select the gas tank 3,4 having the highest gas pressure and supplying to the engine 2 the gas provided by the selected tank 3 o 4.**

25 The supply gas conduit 19 contains the gas originated by the gas tank 3, 4 having the highest pressure as the valve wherein the pressure difference between both ends of the valve opens.

30 A gas recharge conduit 24 has one end 24-a provided with a check-valve 25 and another end 24-b that bifurcates in a first branch 26 that is connected with the first gas conduit 12 in a position between the first check valve 21 and the first gas tank 3 and a second branch 27 that is connected with

the second gas conduit 14 in a position between the second check valve 22 and the second gas tank 4.

The check valve 25 is normally closed and allows the flow of gas only in one direction, i.e. toward end 24-b.

5       The first branch 26 is provided with a third check valve 28 that is opened when pressurized gas is supplied to the gas recharge conduit 24 and is kept in the closing position by the gas present in the first gas conduit 12.

10       The second branch 27 is provided with a fourth check valve 29 that is opened when pressurized gas is supplied to the gas recharge conduit 24 and is kept in the closing position by the gas present in the second gas conduit 14.

15       More specifically, the third check valve 28 is normally closed and allows the flow of gas only in one direction, i.e. toward the first conduit 12. The fourth check valve 29 is normally closed and allows the flow of gas only in one direction, i.e. toward the second conduit 14.

An electronic control unit 30 controls the first and the second valve 7, 8 to realize:

20       **A gas charging phase** (figure 2): in the gas charging phase valves 7 and 8 are placed in the first position. The end 24-a is connected with a source of pressurized gas (not shown); the force generated by pressurized gas produces the opening of check valve 25 and the gas is fed through the gas recharge conduit 24 to the third and fourth check valve 27, 26 that also open (see figure 2). The gas is then provided to the first gas conduit 12 and to the second gas conduit 14 so that it reaches the tanks 3 and 4 (that are recharged) passing through open valves 7 and 8. During this phase the gas may also flow towards  
25       the pressure regulator 20 through gas conduit 19. This does not constitute a problem as during tanks refilling the engine  
30       2 cannot operate.

**a gas delivery phase (figure 3):** in the gas charging delivering valves 7 and 8 are placed in the second position

and the gas contained in the tanks 3, 4 is fed to the first conduit 12 / and the second conduit 14 so that the third and fourth valves 28 and 29 remain closed and the first or the second check valve 21,22 associated to the tank having highest pressure is opened (in the example of figure 3, valve 21) due to the difference of pressure.

Pressure gauges 32, 33 and 34 are placed on first gas conduit 12, second gas conduit 14 and gas recharge conduit 24.

Additionally a third tank 50 may be used, the third gas tank having a gas outlet 50a that communicates with a third valve 51 movable between a first rest position wherein gas may flow only along one direction to be supplied to the gas tank 50 in the gas charging phase and a second position wherein gas may flow in different directions through the third valve 52 in the gas delivery phase.

Valve 52 communicates form one side with the third gas tank 50 and on the other side with a by-pass conduit 53 having one end 53a communicating with the gas recharge conduit 24 and another end 53b communicating with the supply gas conduit 19. End 53b also communicates with the merge point 13. A sixth check valve 56 is placed along by pass conduit 53 and interposed between the output of the third valve 52 and end 53b and a seventh check valve 57 is placed along by pass conduit 53 and interposed between the output of the third valve 52 and end 53a.

According to this embodiment the first check valve 21, the second check valve 22, the sixth check valve 56 have all one side communicating with respective tanks 3, 4 and 50 and the other side communicating with the supply gas conduit 19 so that the first, the second and the sixth valves 21, 22, 56 realize the valve means to select the gas tank 3,4,50 having the highest gas pressure and suppling to the engine 2 the gas provided by the selected tank 3, 4 or 50.



Check valve 57 has the same function of check valves 28 and 29 and is opened during the gas charging phase.

CLAIMS

1.- Gas distribution system for feeding to an engine powered by alternative gas fuel, gas contained in a first gas tank (3) and at least in a second gas tank (4), said system having a first gas conduit (12) connecting an output (3a) of the first gas tank (3) and a second gas conduit (14) connecting an output (4a) of the second gas tank (4), **characterized in that** valve means (7,8) are provided on the conduits (12,14) to select the gas tank (3,4) having the highest gas pressure and supplying to the engine (2) the gas provided by the selected tank.

2.- Gas distribution system as claimed in claim 1, wherein valve means comprise at least first check valve (21) that is interposed in the first gas conduit (12) and a second check valve (22) that is interposed in the second gas conduit (14) so that the first and the second valves (21, 22) are placed on opposite sides of a merge point (13) where the first conduit (12) and the second conduit (14) meet and may be opened by the difference of pressure of the gas in the first/the second gas conduit (12 e 14) and the merge point (13);

a supply gas conduit (19) connects the merge point (13) and a pressure regulator (20) supplying the gas to the engine (2); the supply gas conduit (19) contains the gas originated by the gas tank (3, 4) having the highest pressure.

3.- Gas distribution system as claimed in claim 2, wherein a gas recharge conduit (24) has one free end (24-a) provided with a check-valve (25) and another end (24-b) that bifurcates in a first branch (26) that is connected with the first gas conduit (12) in a position between the first check valve (21) and the first gas tank (3) and a second branch (27) that is connected with the second gas conduit (14) in a

position between the second check valve (22) and the second gas tank (4); the first branch (26) is provided with a third check valve (28) that is opened when pressurized gas is supplied to the gas recharge conduit (24); the second branch  
5 (27) is provided with a fourth check valve (29) that is opened when pressurized gas is supplied to the gas recharge conduit (24).

4.- Gas distribution system as claimed in claim 3,  
10 wherein a first gas tank (3) has a gas outlet (3a) that communicates with a first valve (7) movable between a first rest position wherein gas may flow only along one direction to be supplied to the gas tank (3) and a second position wherein gas may flow in different directions through the first  
15 valve (7); the second gas tank (4) has a gas outlet (4a) that communicates with a second valve (8) movable between a first rest position wherein gas may flow only along one direction to be supplied to the gas tank (4) and a second position wherein gas may flow in different directions through the  
20 second valve (8);

an electronic control unit (30) controls the first and the second valve (7, 8) to realize:

a gas charging phase wherein first and second valves (7,8) are placed in the first position so that when said free end portion (24-a) is connected with a source of pressurized  
25 gas, the gas is fed to the third and fourth check valve (27, 26) that open allowing the gas to flow in the first/second gas conduit (12,14) to reach respective first and second tanks (3,4) passing through open valves (7,8);

30 a gas delivery phase wherein first and second valves (7,8) are placed in the second position and the gas contained in the tanks (3, 4) is fed to the first conduit (12) and to the second conduit (14) so that the third and fourth valves (28, 29) remain closed and the first or the second check valve

(21,22) associated to the tank having highest pressure is opened.

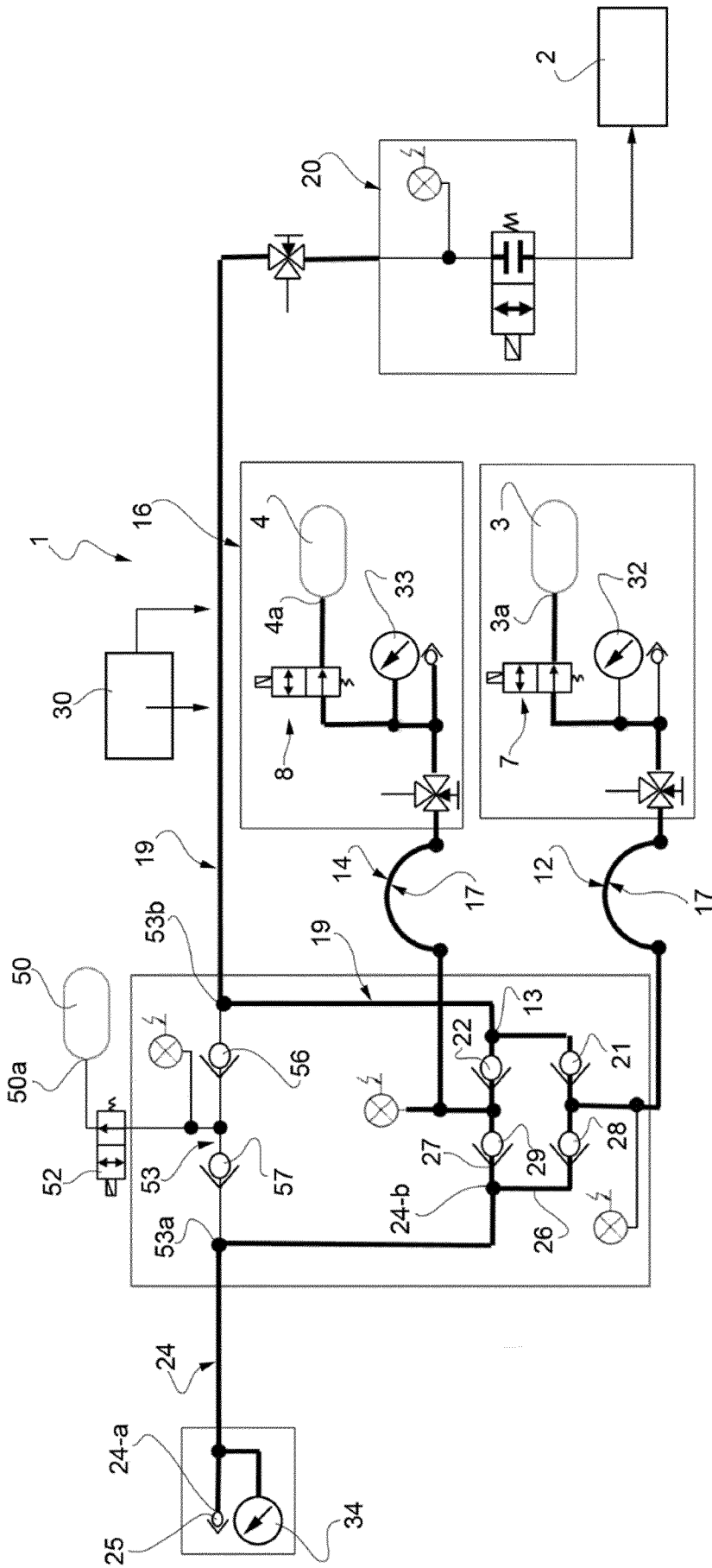


FIG. 1

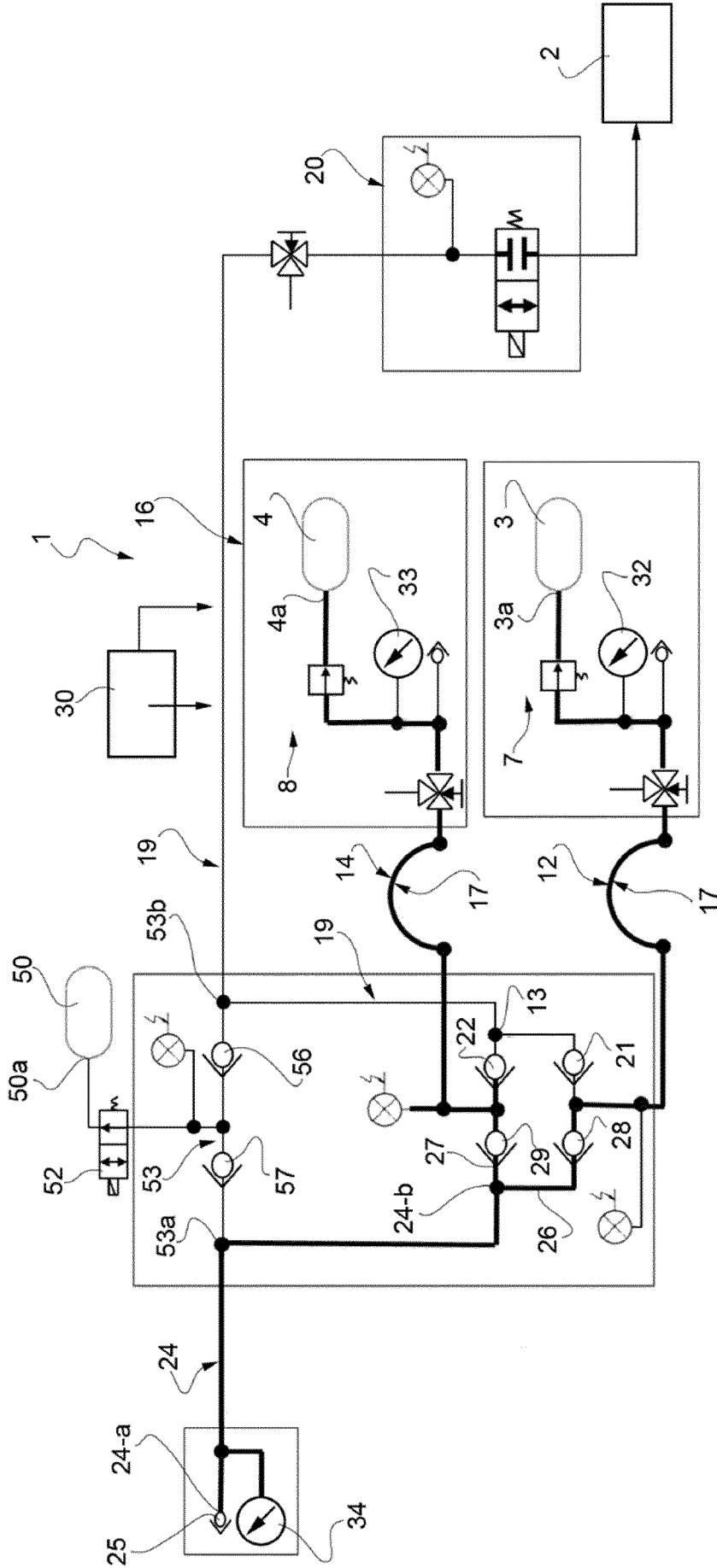


FIG. 2

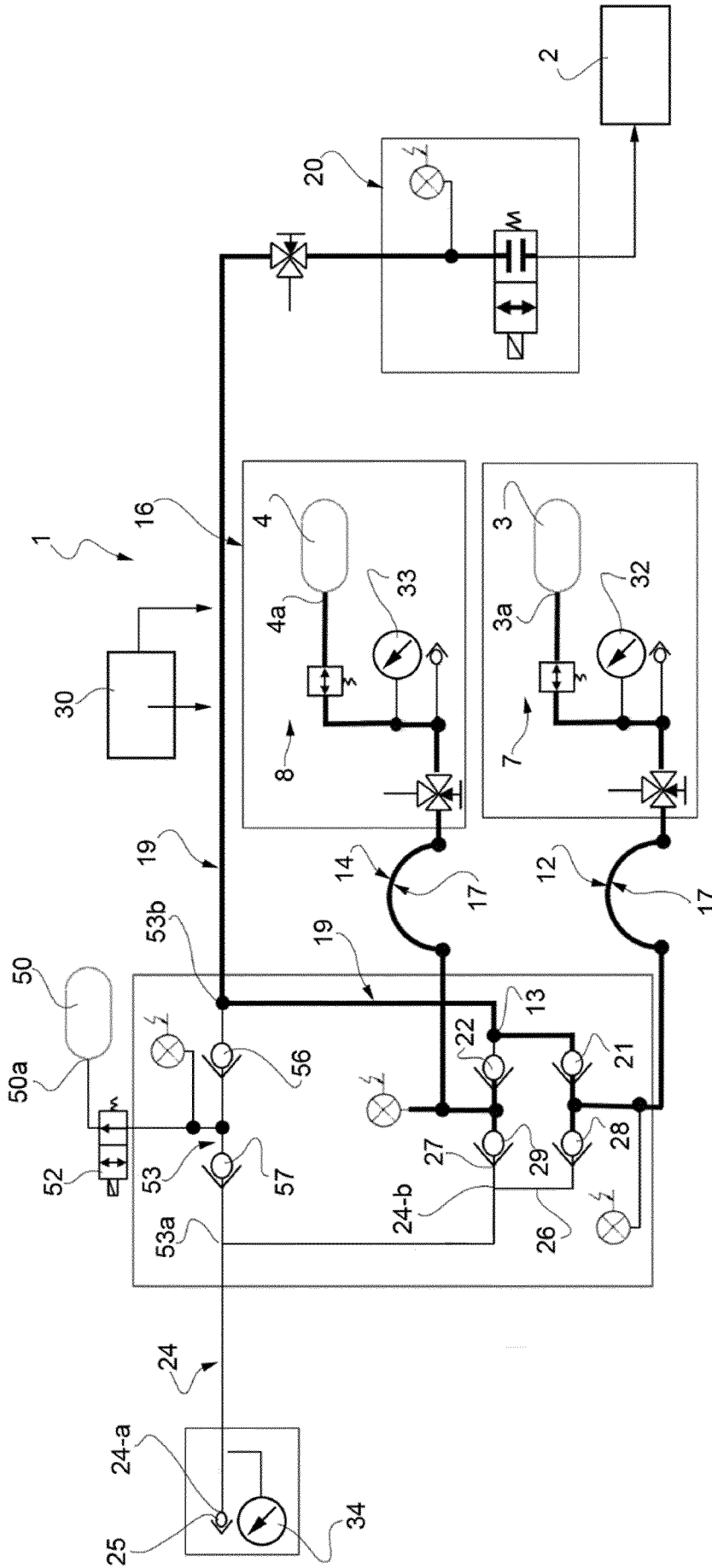


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2020/051459

A. CLASSIFICATION OF SUBJECT MATTER  
INV. F17C5/06 F17C7/00  
ADD.  
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)  
F17C  
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	page 10, line 20 - page 10, line 46; figure 1	3,4
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A	US 2016/116450 A1 (SAITO HIROMU [JP]) 28 April 2016 (2016-04-28)	1-4
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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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  7 February 2020	Date of mailing of the international search report  17/02/2020
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Forsberg, Peter
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## INTERNATIONAL SEARCH REPORT

International application No  
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

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