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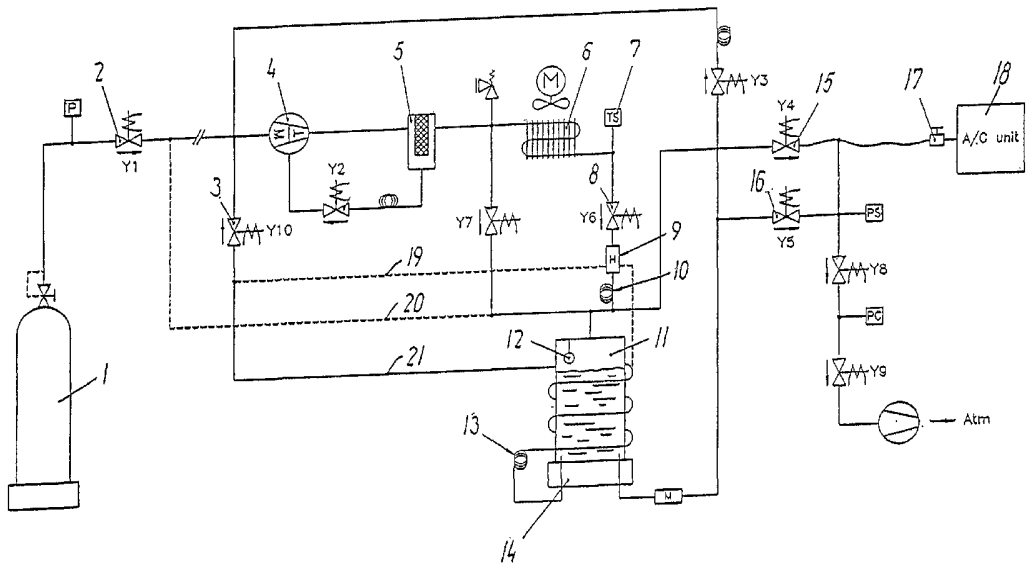
(54) **Title:** A METHOD AND A SYSTEM FOR FILLING A REFRIGERATION SYSTEM WITH REFRIGERANT



(57) **Abstract:** When according to the invention, using a method and a system comprising a compressor (4) for filling CO_2 into an air conditioning system (18) via an oil filter (5) and a gas cooler (6), CO_2 may be pumped to an internal pressure container (11), and from there the system (18) may be filled with CO_2 in gas form via valves (15). When the system is extended with a heat exchanger (9), the temperature may be controlled in the pressure container (11) so that it does not exceed 31.8°C, whereby CO_2 may be filled into the system (18) in liquid form.

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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.

A METHOD AND A SYSTEM FOR FILLING A REFRIGERATION SYSTEM WITH REFRIGERANT

The prior art

The invention relates to a method of filling refrigerant, such as CO_2, into a refrigeration system, such as an air conditioning system in a vehicle, from an external pressure bottle to an internal pressure bottle in which the filled amount of CO_2 is recorded prior to the filling, as well as a system for performing the method.

Systems for filling refrigerant, such as CO_2, from an external pressure bottle into an air conditioning system are known.

The problem of the filling of CO_2 is that it is very volatile in the usual temperature range between 10 and 50 °C, which constitutes the "over-critical" temperature range, whose range is above 31.8 °C, where CO_2 cannot be compressed to a liquid, but is in gas form.

Filling therefore involves the problem that the refrigerant may be either liquid or gas depending on the temperature. This necessitates systems which use either liquid or gas.

WO 89/03963 discloses a system for the filling of refrigerants, where the critical point of the refrigerant about 100 °C or above is higher than the ambient temperature, which is typically 10 – 60 °C.

This is not the case with CO_2, where the critical point is 31 °C. Therefore, it is not possible to condition CO_2 in this known system, as the pressure in the container cannot get below the critical point and thereby cause CO_2 to assume liquid form.

Accordingly, the system can only operate in gas form, but not in liquid form for refrigerants, whose critical point is higher than the ambient temperature.

Further, US 5,186,017 discloses a system whose circuits may be filled in gas form, but not in liquid form.

The object of the invention

The object of the invention is to ensure the physical conditions and thus that refrigerant is filled in either liquid form or gas form, and that it is ensured that the filling is precise in both states of the refrigerant.

This is achieved according to the invention by a method, in which

- the filling either takes place in gas form in that the filling pressure is established by means of a compressor, whereby CO_2 in a heated state is conveyed through an oil filter, a gas cooler and a valve to the internal pressure bottle, following which the CO_2 gas is returned via a pressure reduction unit and a valve for expansion for return flow at a lower pressure to the compressor, said circulation being maintained until a given temperature and weight have been achieved in the internal bottle, following which the actual filling of the air conditioning system begins by closing the valve, stopping the compressor and opening a valve for filling the system, until the weighing unit of the internal bottles records that the desired gas amount has been filled,
- or the filling takes place in gas form in that the compressor sucks CO_2 out of the external CO_2 bottle, whereby it is conveyed in a compressed and heated form to the gas cooler and an internal heat exchanger for heat exchange with the gas from the internal pressure bottle, whereby the gas expands through the pressure reduction unit for cooling below 31.8 °C and thereby partly condenses to liquid which is conveyed to the internal bottle, from which it is sucked back to the compressor such that CO_2 is sucked in

from the external bottle, and such that the temperature in the internal bottle is kept below 31.8 °C, following which filling of the system may be established when the necessary amount of CO_2 in the internal bottle is present.

This eliminates the known drawback of filling with gas that there is a so-called "dead" amount of gas in the connecting line between the internal refrigerant source and the system, which may vary much depending on temperature and pressure.

In case of liquid filling, the corresponding liquid amount will just depend on the temperature expansion of the liquid.

The great advantage of the method is that it is possible to select between filling with liquid or gas in an expedient performance of the method comprising the components necessary for this. This saves construction of various systems, and an advantage in terms of use is achieved by combining the two states in a system.

When, as stated in claim 2, a system is used for gas filling in which a suitable recirculation of the gas may be carried out, accurate filling is ensured at a specific temperature and weight, whereby the filling is controlled and as predetermined.

Finally, it is expedient, as stated in claim 3, to use a system in which a suitable amount of liquid refrigerant may be filled, which is ensured by using an internal pressure bottle for filling a specific liquid amount, which may be filled from there into the refrigeration system.

The drawing

A example of a method and a system for performing the method will be de-

scribed more fully below with reference to the drawing, which shows a diagram of the components included in the system and their mutual connections.

Description of an exemplary embodiment

An example of a system according to the invention is shown in the drawing, said system comprising a connected external pressure bottle 1, from which the CO_2 required for the filling is sucked out by means of a compressor 4.

Further, an oil filter 5, a gas cooler 6 and an internal pressure bottle 11 with a level sensor 12 and a weighing unit 14 as well as a pressure reduction unit 13, a magnetic valve 3 and a return line to the low pressure side of the compressor are mounted on the pressure side of the compressor 4.

Moreover, a pipe connection is provided between the internal pressure bottle 11 via a valve 15, a coupling 17 to the connected air conditioning system 18 which is to be filled with refrigerant.

The method will now be described with filling of CO_2 in gas form.

The system is connected to the internal pressure bottle 1 with CO_2 and the refrigeration system 18 via a coupling 17.

The valve 2 is opened, the compressor 4 is started, and CO_2 is sucked from the bottle 1 and is compressed, whereby it is heated.

The heated CO_2 is conveyed further on through an oil filter 5 and a gas cooler 6 and via a valve 8 to the internal bottle 11.

CO_2 is returned via the pressure reduction valve 13 and the valve 3 through

the line 21 to be expanded at a lower pressure back to the compressor 4.

This circulation is maintained until a given temperature and pressure have been achieved, which is recorded by sensors 7 and the weighing unit 14.

Then the actual filling of the system 18 is started in that the valves 2, 8 and 3 are closed, the compressor 4 is stopped, while the valve 15 is opened, whereby CO_2 via the coupling 17 is filled into the system 18.

The weighing unit 14 records when the desired gas amount has been filled, and then the valve 15 is closed, and the filling has been completed.

The process may be repeated as needed, until the necessary refrigerant amount has been filled into the system 18.

The method of filling refrigerant in liquid form will now be described.

The valve 2 is opened and the compressor 4 is started, whereby CO_2 is sucked out of the bottle 1 via the line 20 and the valve 3, whereby CO_2 is compressed and heated.

The heated CO_2 is then cooled partly in a gas cooler 6 and additionally in the internal heat exchanger 9 by heat exchange with the gas from the internal container 11 by return flow through the line 19.

The gas is then expanded through the pressure reduction valve 10, whereby the gas is cooled below the critical temperature of 31.8 °C, whereby it condenses partly to liquid. By determining the capacity of the unit 10 the liquid may be cooled to a desired temperature.

The liquid is conveyed to the internal bottle 11, and the gas is sucked back

by the compressor 4 via the valve 3 on the line 19.

CO_2 is thus sucked from the external bottle 1, and the temperature in the internal bottle 11 is kept below the critical temperature of 31.8 °C.

When the desired amount of CO_2 is present in the container 11, which may be recorded by means of the weighing unit 14 and/or the level sensor 12, filling may begin.

The filling amount may either be weighed by means of the weighing unit 14 or another unit and takes place via the valve 16, until the desired refrigerant amount has been filled into the system 18.

In summary, it may be concluded that refrigerant in either gas or liquid form may be filled with the system according to the invention.

Neither a pump nor a heat generator is used for achieving the necessary filling pressure, but just a compressor.

The system ensures uniform conditions at each filling, and the "dead" volume will be the same before and after a filling.

The system is independent of which size the external pressure bottle 1 has, and, therefore, all available bottle sizes and types may be connected with the system.

The compressor may empty the external bottle, which is otherwise impossible without leaving a residual amount of the order of 50 to 95 volume percent.

Finally, by means of the compressor it will be possible to obtain an indica-

tion of the filling state of the refrigeration system before filling is started in that the system is emptied by means of the compressor.

Conclusively, it may thus be observed

- that either a gas or a liquid phase may be run with the system according to the invention,

- that it is possible to empty the supply bottle via the compressor, which will not be possible with other principles, such as heating members or filling directly from bottle. When filling directly from bottle there will, depending on the need for filling density in the air conditioning system, be a residual amount in the supply bottle of the order of 50%, which will be below 5% with the compressor,

- that a conditioning takes place by the use of a compressor such that the conditions at each filling are the same above the critical point, thereby allowing dispensing of an accurately metered filling amount in gas form via a weighing unit,

- that a heat exchanger, which is arranged after the gas cooler, ensures that conditioning may take place to a temperature which is lower than the ambient temperature, which is the critical quantity in this circuit using CO_2 as a refrigerant. This applies to refrigerants which have the critical point below the ambient temperature, and

- that a conditioning takes place using a compressor such that the conditions at each filling are the same below the critical point, which allows dispensing of an accurately metered filling amount in liquid form.

PATENT CLAIMS

1. A method of filling a refrigerant, such as CO_2, into a refrigeration system, such as an air conditioning system in a vehicle, from an external pressure bottle to an internal pressure bottle in which the filled amount of CO_2 is recorded prior to the filling, c h a r a c t e r i z e d in that

- the filling either takes place in gas form in that the filling pressure is established by means of a compressor (4), whereby CO_2 in a heated state is conveyed through an oil filter (5), a gas cooler (6) and a valve (8) to the internal pressure bottle (11), following which the CO_2 gas is returned via a pressure reduction unit (13) and a valve (3) for expansion for return flow at a lower pressure to the compressor (4), said circulation being maintained until a given temperature and weight have been achieved in the internal bottle (11), following which the actual filling of the air conditioning system (18) begins by closing the valve (2, 8, 3), stopping the compressor (4) and opening a valve (15) for filling the system, until the weighing unit (14) of the internal bottle (11) records that the desired gas amount has been filled,
- or the filling takes place in liquid form in that the compressor (4) sucks CO_2 out of the external CO_2 bottle (1), whereby it is conveyed in a compressed and heated form to the gas cooler (6) and an internal heat exchanger (9) for heat exchange with the gas from the internal pressure bottle (11), whereby the gas expands through the pressure reduction unit (10) for cooling below 31.8 °C and thereby partly condenses to liquid which is conveyed to the internal bottle (11), from which it is sucked back to the compressor (4) such that CO_2 is sucked in from the external bottle (1), and such that the temperature in the internal bottle (11) is kept below 31.8 °C, following which the filling of the system (18) may be established when the necessary amount of CO_2 in the internal bottle (11) is present.

2. A system for performing the method according to claim 1, wherein the system is used for filling refrigerant in gas form, c h a r a c t e r i z e d in

that the system comprises a compressor (4) which compresses the gas from an external pressure bottle (1) to the filling pressure, a pipe connection (21) between the compressor (4) and the filling place to the air conditioning system (18) and with an oil filter (5) and a gas cooler (6) as well as with an outlet for returning the gas to the low pressure side of the compressor (4), which branch contains a valve (3) and a throttle unit (13).

3. A system for performing the method according to claim 1, wherein the system is used for filling refrigerant in liquid form, c h a r a c t e r i z e d in that the system comprises a compressor (4) which sucks and compresses the gas from an external pressure bottle (1), a pipe via a gas cooler (6) and a heat exchanger (9) which conveys the gas to a pressure reduction unit (10) for cooling below 31.8 °C, and with a pipe to the low pressure side of the compressor (4), from where CO_2 is sucked in and is temperature-maintained in liquid form in the internal pressure bottle (11), and with a filling branch with a valve (15) for filling the air conditioning system (18).

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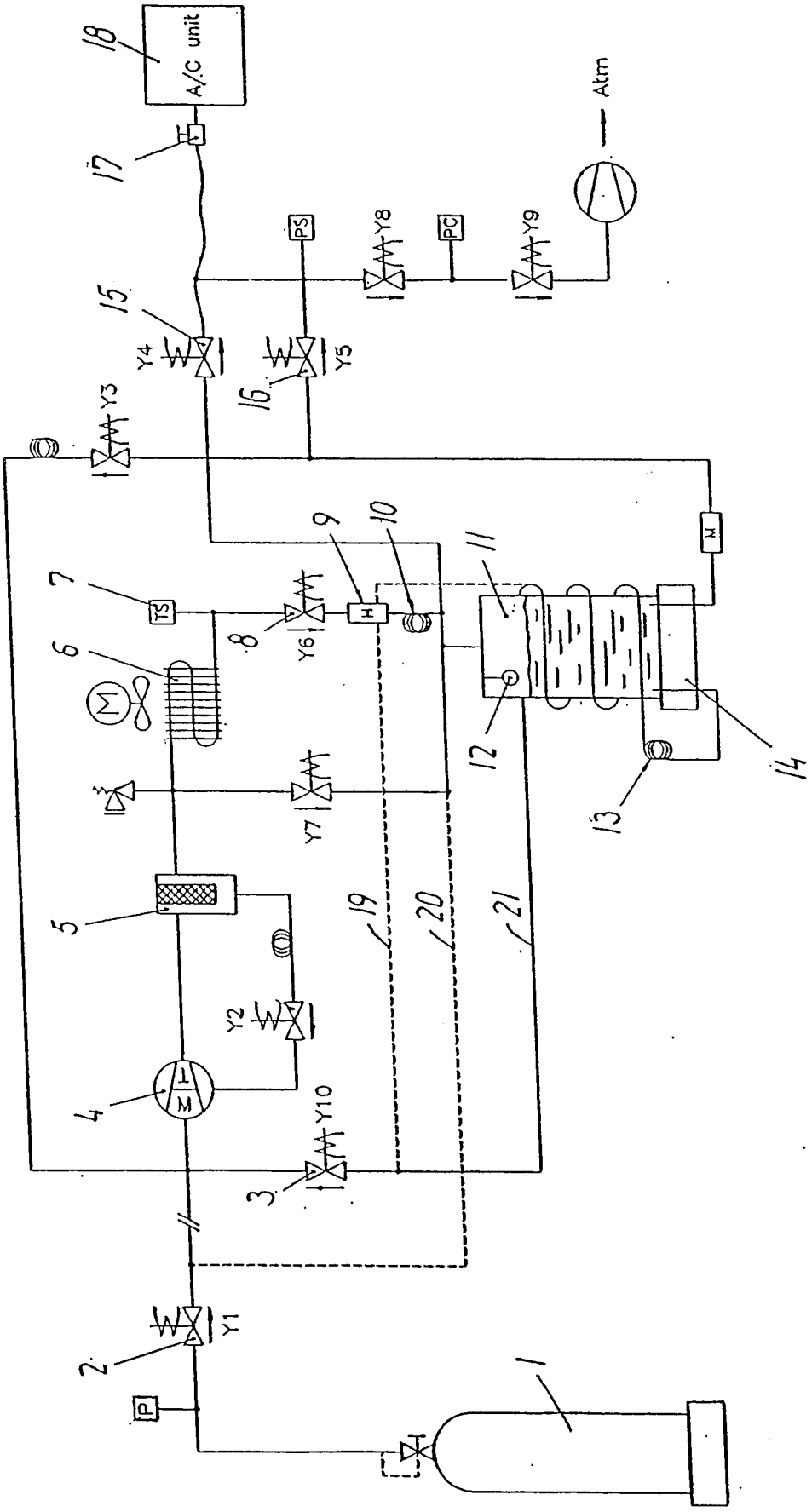
A/C unit
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2005/000789

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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)

IPC: F25B, B60H

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)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20010025496 A1 (BIMBOES ET AL), 4 October 2001 (04.10.2001), figure 1, paragraph (0046)-(0053) --	1-3
A	DATABASE WPI Week 200440 Derwent Publications Ltd., London, GB; Class Q75, AN 2004-425780 & JP 2004163037 A (OSAKA GAS CO LTD), 10 June 2004 (2004-06-10) abstract, fig. 1 --	1-3
A	US 6112532 A (BAKKEN), 5 Sept 2000 (05.09.2000), column 2, line 46 - column 6, line 20, figures 1-4 --	1-3

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

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Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2006	03 -04- 2006
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International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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