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(54) **DEVICE AND METHOD FOR THE RECOVERY OF LUBRICANT AND/OR REFRIGERANT IN INSTALLATIONS COMPRISING A REFRIGERATION CYCLE**

(57) Device and process for recovering lubricant and/or refrigerant in installations that comprise a refrigerating cycle.

Device for the recovery of oil and/or refrigerant from installations that comprise a refrigerating cycle, of the type that comprises connection means to said installation, expansion means for a refrigerant substance from said installation, evaporation means for said substance, separation means for separating lubricant from said substance and compression means for said substance after passing through the separation means, **characterised in that** said compression means comprise a rotary-type compressor and said evaporation means are able to obtain heat for evaporation from a heat exchanger intended to cool said compressor, together with an operating process for said device.

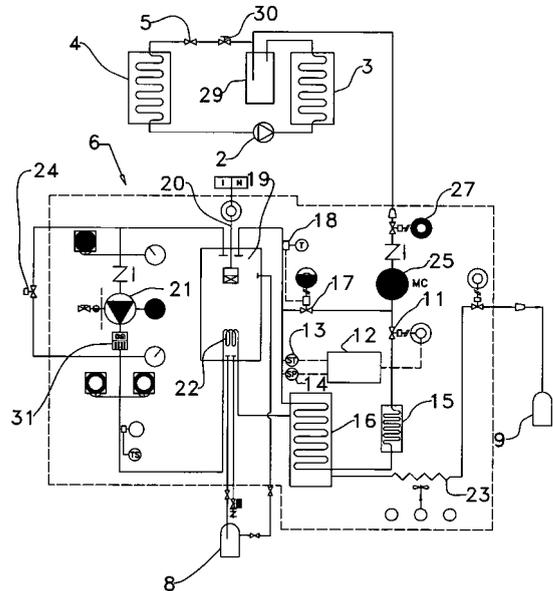


FIG.3

## Description

**[0001]** The present invention relates to a device for the recovery of lubricant and/or refrigerant in installations that include a refrigerating cycle, such as, for example, refrigerating equipment and heat pumps, and also to processes used by said device. Said device and processes are useful in operations relating to maintenance, recycling and changing refrigerant in said installations.

**[0002]** Environmental requirements have led to the adoption of international agreements for the progressive elimination of refrigerants that contain chlorine, known as CFCs (chlorofluorocarbons) and HCFCs (hydrofluorocarbons), to be replaced by refrigerants known as HFCs (hydrofluorocarbons). HFC refrigerants do not contain chlorine and therefore do not contribute to the destruction of the ozone layer that surrounds the planet and protects it from ultraviolet rays from the sun.

**[0003]** A problem common to all three types of refrigerant referred to above is that if there is water in the refrigeration circuit, hydrofluoric and/or hydrochloric acid is produced therein. These acids attack the protective varnish of the electric motors of the compressors, which therefore burn out by short-circuiting. Once the compressor has burnt out, the oil must be changed to eliminate the acid responsible for the fault in the circuit.

**[0004]** In addition, the new HFC refrigerants require, for the compressors in the installations, the use of lubricants different from those that have been used for CFC and HCFC refrigerants (principally mineral oils (MO) or alkylbenzene oils (AB)). In particular, polyester oils (POE) must be used with HFC refrigerants. This means that when retrofitting or converting refrigeration equipment to HCF refrigerants, which are more environmentally friendly, all the oil must be removed and replaced by a polyester oil (POE).

**[0005]** However, polyester oils are hygroscopic and this brings about a new operational problem that did not exist previously, since if they come into contact with air, which contains a certain percentage of humidity, the oil breaks down, its viscosity quickly deteriorates and corrosion occurs in the equipment in the long term. The appearance of this problem again requires that the lubricant in the refrigerating equipment be changed.

**[0006]** However, removing the oil is a problematic process, since there are low areas from where it is not possible or viable to remove the lubricant simply by the action of gravity. This is particularly relevant if the oil needs to be replaced, since over 95%, and preferably over 99%, of the old oil must be removed.

**[0007]** The change to HFC refrigerants has therefore increased the number of cases where it is necessary to change the lubricant in a refrigeration system.

**[0008]** Finally, another problem associated with refrigerating equipment consists of recycling them, since the oil and refrigerant must be recovered before they are scrapped, to avoid discharges harmful to the environment. However, there is no equipment that guarantees

economic recovery and therefore during recycling of said refrigerating equipment noxious emissions of refrigerants and oil are produced.

**[0009]** Traditionally, oil is removed from the equipment by washing the refrigeration circuit, in open circuit, with a refrigerant in which the lubricant is soluble and which is denser than the lubricant and that, in addition, has a boiling point at atmospheric pressure higher than the ambient temperature, such as R-11 (CFC) or R-141b (HCFC). After passing through the circuit, the oil separates from the refrigerant in an open tank because of their different densities. This system has two drawbacks. Firstly, it does not solve all the problems, since it is not possible using this method to remove the refrigerant generally used in the circuit, removing from it the lubricating oil dissolved in it. Secondly, the environmental problems arising from the use of refrigerants in open circuit has led to their prohibition in many countries, particularly in the European Union.

**[0010]** As a result of the aforementioned problems, owners of refrigerating installations require devices that allow oil to be changed and refrigerants to be recovered from their refrigerating installations, that are valid for all their installations, regardless of the refrigerant used therein, and that allow the refrigerant to be changed in installations using obsolete refrigerants in a manner that is technically and economically viable.

**[0011]** Document ES2137254 discloses a device for removing lubricating oil from a refrigeration system or heat pump system, that is connected to said system to be cleansed and has a compressor intended to wash said system with circulating refrigerant capable of raising and drawing out oil from the circuit, and that also has an expansion valve and evaporator unit to evaporate the mixture of refrigerant and oil leaving the system and an oil separator to separate the oil from the refrigerant-oil mixture that was previously evaporated, from where the refrigerant is returned to said compressor possibly to be returned to said system.

**[0012]** To remove the oil, the system first washes the refrigeration circuit with refrigerant that is denser than the lubricating oil, in sufficient quantity for it to raise and draw the lubricant up to a level that allows it to leave the refrigerant circuit in the direction of the device, expands and evaporates the mixture of oil and refrigerant removed, separates it in the oil separator, and takes the refrigerant back to the system through the compressor of the device, preferably following condensation thereof.

**[0013]** This device has serious limitations, since it is valid only for a particular expansion pressure, and, therefore for a very limited range of refrigerants, with the result that a device for each type of refrigerant would be needed. The versions marketed by the applicant of said patent ES2137254 had two mechanical expansion valves for medium and high pressure, and a reciprocating-type compressor. Owing to the machine requirements, i.e. that it must be portable, the compressor was a reciprocating compressor limited to a power of 1 h.p. Another problem

associated with the reciprocating compressor is that its mass capacity diminishes in inverse proportion to the absolute temperature of the refrigerant. When the rotary compressor is working at a high evaporation and condensation temperature, it is very limited, owing to its characteristics. Consequently, owing to its characteristics, the device could not cover more than the medium- and high-pressure ranges (up to 25 bar), and still with serious limitations as to compression capacity, depending on the application. Another limitation is that, although the device had two expansion valves for medium and high pressure, the operating parameters of said valves could only be optimised for a particular refrigerant within each pressure range, since its parameters, especially the discharge and compression parameters were fixed and constant.

**[0014]** It is important to point out in particular the limitation of said device in not being usable for all types of refrigerant, which prevents the recovery and reuse of very high-pressure refrigerants, and also its capacity limitations for high evaporation temperatures.

**[0015]** To summarise, although said device represented an important advance towards the solution required by the market, since it provided an environmentally correct solution that could be implemented in the form of a portable machine, it had various limitations, especially regarding the range of pressures, and was therefore not a complete solution to the current needs of the market. In particular, the device could not be an all-purpose device valid for maintenance, recycling and refrigerant changing operations for any type of refrigerating installation.

**[0016]** It is an object of the present invention to disclose a device that solves the aforementioned problems and does not have the drawbacks of the devices known up to now.

**[0017]** In particular, the present invention relates to a device for the recovery of refrigerant and/or lubricant from a system of installations that comprise a refrigerating cycle, of the aforementioned type, that comprises connection means to said installation, expansion means for a refrigerant substance from said installation, evaporation means for said substance, separation means for separating lubricant from said substance and compression means for said substance after passing through the separation means. The device according to the present invention is characterised in that said compression means comprise a rotary compressor and said evaporation means are able to obtain heat for evaporation from a heat exchanger intended to cool said compressor.

**[0018]** By means of this characteristic greater system functionality is achieved, allowing a compressor with power of over 1 h.p. to be placed in a portable device of this type but, in addition, allows a device to be produced that is valid for any type of refrigerant and in any range of pressures, up to at least 40 bars (very high pressure). Cooling is very important, since it allows continuous operation thereof without the need for stops owing to overheating, which would be drawbacks in operating the de-

vice.

**[0019]** Preferably, the expansion means will comprise an expansion valve, the operating parameters of which are variable and can be modified by electronic means, depending on the physical properties of the specific type of refrigerant used, thus optimising the operating conditions of the compressor.

**[0020]** This characteristic allows the overheating temperature to be adjusted to the specific properties of each refrigerant and, consequently, to minimise the temperature on entry to the compressor, so as to save energy and facilitate the continuous operation of the compressor.

**[0021]** Preferably, the device will also comprise sensors and electronic control means that allow it to automatically adjust the parameters and duration of the operating cycles, to suit the characteristics of the refrigerating installation to which the device is connected. Said characteristic allows the adjustment and precise optimisation of the operation of the device, since the optimal times of the operating cycles will depend on each particular application.

**[0022]** Preferably, the device according to the present invention will be configured as a portable device.

**[0023]** Finally the present invention makes known a device that has the following advantages:

- It allows the recovery and reuse of the recovered refrigerant, since this refrigerant is cleaned of lubricant during its removal.
  - It may be in the form of a portable device.
  - It is valid for any type of refrigerant, and allows the discharge and compression parameters to be adjusted according to the specific properties of each refrigerant.
- These three advantages mean that the present invention makes known a device that allows the recovery and reuse of any type of refrigerant.
- It is environmentally friendly and facilitates handling of contaminating waste.
  - It allows equipment to be recycled.
  - It is more flexible and efficient than devices known so far.

**[0024]** Moreover, the present invention also comprises processes for removing refrigerant and oil from an installation that comprises a refrigerating cycle.

**[0025]** In particular, the invention also comprises a process for removing the refrigerant from a refrigerating cycle. Said process comprises steps to remove the refrigerant from the refrigerating circuit of the installation, preferably in liquid phase, for subsequent expansion and evaporation, separate the lubricating oil contained in the refrigerant, then compress it and take it to a collection vessel, and is characterised in that the means for compressing the refrigerant are cooled using refrigerant from the refrigerating cycle, preferably from the aforementioned refrigerant expansion step. Preferably, the expansion conditions of the refrigerant removed from the re-

frigeration circuit will be adjusted, using automatic means, with data that include information on the properties of the refrigerant and of the pressure and/or temperature of the evaporated refrigerant, in order to optimise in terms of energy the expansion and subsequent compression process of the refrigerant.

**[0026]** The present invention also comprises a process for removing oil from an installation comprising a refrigerating cycle, of the type that comprises stages for injecting a refrigerant, that preferably can be mixed (miscible) with the lubricating oil to be removed and is denser than that oil, into the refrigeration circuit or a selected portion thereof, so that the refrigerant raises and draws the oil contained in the circuit, and on removing the mixture of refrigerant and oil thus produced, preferably through a low point of an oil housing, subsequently expanding and evaporating the mixture prior to separating the mixture of refrigerant and oil, and then returning the used refrigerant to a tank by compression means, characterised in that the compression means are cooled using refrigerant from the installation, preferably from the aforementioned expansion stage.

**[0027]** For a better understanding, the accompanying drawings are given as an explanatory but not limiting example of preferred embodiments of the present invention.

Fig. 1 is a sketch diagram illustrating a refrigerating installation to which is connected a device according to the present invention, provided in addition with a refrigerant lung tank, a refrigerant collection tank and another lubricating oil collection tank.

Fig. 2 is a sketch diagram similar to that of Fig. 1 detailing the internal elements of an embodiment of the device according to the present invention.

Fig. 3 is a sketch diagram showing the device according to the present invention of Fig. 2, connected to a refrigerating installation in a way that is particularly suited to the removal and recovery of the refrigerant of said refrigerating installation.

Fig. 4 is a perspective view of an embodiment of a portable, automatic device according to the present invention.

Fig. 5 is a diagram in front elevation of the embodiment shown in Fig. 3.

Fig. 6 is a side elevation of the embodiment shown in Fig. 3.

Fig. 7 is a perspective view of another embodiment of a portable, semi-automatic device according to the present invention.

Fig. 8 is an outline detail of the location of an additional oil separation device situated at the outlet of the installation compressor.

**[0028]** Fig. 1 shows, diagrammatically, an example of a refrigerating installation 1. As an example, a compressor 2, a condenser 3, an expansion valve 5 and an evaporator 4 of the refrigerating installation have been illustrated although, as will be understood, the particular type

of the refrigeration system 1 may vary for the purposes of the present invention. A device 6 according to the present invention is connected to said system 1. An oil recovery tank 8 is also connected, optionally, to the device 6, preferably a lung tank 7 and, optionally, a refrigerant collection tank 9. As can be seen in the figure, the device 6 has been connected to the refrigeration equipment 1 on the aspiration or inlet side of the device 6, with the compressor housing 2 of the refrigeration circuit, for example on the oil plug, the drainage valve or any other connection of the housing, while the discharge (return) of the device 6 is connected to the high valve (or equivalent) of the compressor. Logically, the optimum form of connection may vary depending on the characteristics of the equipment, so as to completely clean the circuit in the best possible conditions while constantly seeking to minimise the modifications to be carried out in the circuit. In all cases, the connection should, as far as possible, create the effect of raising and drawing the residual lubricant remaining in the installation 1 by a refrigerant injected and sucked cyclically by the device 6. Similarly, a filter 10 has been placed between the refrigerating equipment 1 and the device 6. In certain circumstances, said filter may be omitted or included inside the device 6. The device also comprises various safety mechanisms, such as the level switch 20 of the separator 19, for example.

**[0029]** In Fig. 2 can be seen, as well as the elements mentioned above, the elements contained in an embodiment of the device 6 according to the present invention. The connections between equipment are similar to those of Fig. 1 and are intended to remove the lubricant present in the circuit. The device 6 shown has expansion means for the refrigerant or, more precisely, expansion means for the mixture of refrigerant and lubricant from the refrigeration circuit 1, illustrated in this case by a single electronic-type expansion valve 11, the discharge parameters of which are, in this case, determined by an electronic controller 12 that modifies them depending on the physical properties of the refrigerant in question, previously provided to the device, and on the pressure and/or temperature data supplied by sensors 13 and 14 each situated, preferably, behind the evaporator 16. Said valve 11 may be of a commercial type, such as, for example, a Danfoss brand AKV 10-7 electronic expansion valve, which although known per se, its use in the present invention involves novelty through its indiscriminate use for different refrigerants and changing its parameters for each use depending on the refrigerant to be treated. Downstream of the expansion means 11 are the evaporation means 15, 16. The evaporator 16 uses the compressed refrigerant from the compressor 21 of the device 6 as a heat source. In the example shown, the exchanger 15 has the compressor 21 of the device as a heat source, using the expanded refrigerant to cool the rotary compressor on the outside thereof. It should be understood that the invention may be produced without the need to produce two physically separate exchangers 15, 16, or that the evaporator 15 which uses the heat generated by

the compressor 21 may be situated parallel to the circuit, and not in sequence with it.

**[0030]** The device also has separation means for the lubricant mixed with the refrigerant, in this case an oil separator 19 situated downstream of the evaporator 16, in which the lubricating oil is separated from the refrigerant, and also a rotating-type compressor 21 which is cooled by the refrigerant itself, as previously indicated. The device shown has in addition an optional heat exchanger 22 situated downstream of the compressor 21 that supplies heat to the separator 19, and also a refrigeration device 23, such as, for example, a forced-convection exchanger, to ensure that the refrigerant carried to the lung vessel 7 or to the recovery vessel 9 or driven back to the circuit 6 is in a completely liquid state. The device also has a by-pass valve 17 for expansion valve 11 controlled by a temperature sensor 18. The decanter also has a set of safety systems, such as the level switch 20. Finally, the compressor 21 also has a by-pass valve 24, that can be used to temporarily connect the high pressure side of the device 6 (situated downstream of the compressor 21) to the low pressure side of the device 6 (upstream of the compressor 21), for example, to sweep clean the low-pressure portion. Finally, the inlet and outlet valves of the device 6 to the refrigerating installation 1 have been indicated by the numerals 27 and 26 respectively. In the example shown the valves may be governed by the electronic means 12.

**[0031]** Oils are cleaned using the device 6 preferably once the installation 1 has been emptied of refrigerant. Emptying may be carried out by a standard process or advantageously by using the device 6, as will be explained in connection with Fig. 3. Once the equipment has been connected in the form indicated in Fig. 2 or in an equivalent way, as has already been mentioned, refrigerant from the lung vessel 7 is injected into the installation 1 through the opening of the valve 26. In this way the injection phase begins. Preferably, a refrigerant than can be mixed with all the oils is used, such as R-141b or the actual refrigerant normally used for the installation 1. The object of this injection phase is to inundate the areas where there is oil that it has not previously been possible to remove so that the oil level rises and it can leave by the connection or connections in the direction of the device 6, drawn by the injected refrigerant. Injection continues until liquid refrigerant appears in the observation port 25 of the device 6, or the device sensors detect the presence of the liquid automatically. At that moment the valve 26 is closed and the aspiration phase begins, until the pressure reaches a minimum pressure level (for example 0.3 barg). During this phase, the refrigerant mixture is expanded in the expansion means 11. As mentioned previously, said expansion means comprise, preferably, an electronic-type valve, the operating parameters of which have been modified providing the device 6 with information on the refrigerant used. In this way the heat at which the refrigerant reaches the compressor 21 is minimised. Once expanded, the mixture of oil and re-

frigerant is evaporated by the evaporation means 15, 16, cooling the outside of the compressor 21 as it passes, and is taken to the separator 19, where the lubricant is separated and taken to the outside tank 8.

**[0032]** The refrigerant from the separator 19 is carried through the compressor 21 and the corresponding heat exchangers 22, 16, 23 to the lung vessel 7. During this process, in a known manner for refrigeration cycles, the bypass valve 17 will be opened depending on the temperature of the evaporated refrigerant detected by the sensor 18, while the opening of the valve 11 will also be controlled by data provided by the sensors 13 and/or 14. Once the action of the compressor 21 has created a minimum required pressure level in the device 1, the aspiration phase ends, and a new injection cycle can begin, either directly or after a cleaning step for the separator 19, by temporary connection of the high and low pressure portions of the device 6 by opening the valve 24. Advantageously, the cycles will be controlled by the controller 12, which will determine automatically the times of the injection and aspiration cycles, which are dependent on the characteristics of the installation 1, optimising the process from the thermal, technical and economic point of view. The cycles must be repeated until the refrigerant entering the device 6 is completely clean, which can be checked through the observation port 25, or by monitoring the amounts of lubricating oil recovered, for example.

**[0033]** As can be seen, at the outlet of the compressor 21 a liquid/gas separator 31 may optionally be arranged. Said separator 31 separates the oil that may have been separated from the refrigerant in the compressor 21.

**[0034]** In Fig. 3 can be seen a diagram for connecting the device 6 to an installation that comprises a refrigeration cycle 1, which is aimed at removing the refrigerant used in said installation 1. Accordingly, the inlet valve 27 to the device 6 has been connected to the liquid intake of the refrigerant tank 29 of the installation 1. To recover refrigerant (and the oil mixed therewith) an indication must be given to the device 6, firstly, what the refrigerant to be treated is, so that the device adjusts the operating parameters accordingly, especially the parameters of the expansion means 11. The outlet valve 30 of the liquid tank 29 is closed and, by the operation of the compressor 21, the refrigerant is sucked from the installation to be cleaned. If the refrigerant enters the device 6 in the liquid state, it is made to pass through the expansion valve 11 and through the evaporator 15, 16 from where it passes to the separator 19, and once oil-free, passes to the compressor where it is compressed, and after passing through the corresponding refrigeration means 22, 16, 23, passes to the refrigerant reception tank 9, in liquid state. For its part, the lubricating oil separated in the separator 19 passes to the lubricating oil reception container 8. If the refrigerant is introduced in the gaseous state, the device shown is able to open the bypass valve 17 on indication from the temperature sensor 18. Preferably, the order provided by the temperature sensor 18 to the bypass valve 17 will be processed by a programmable

robot or equivalent (not shown) which will make a decision depending on the pressure and temperature signal of the fluid and on the data previously introduced identifying the refrigerant. Because of this system, the device allows the refrigerant to be recovered virtually free from lubricating oil (<300 ppm) and collects it in liquid form, making it suitable for subsequent use. As has been indicated previously, the device advantageously uses the refrigeration of the compressor 21 and electronic means to optimise and automate the process.

**[0035]** Figs. 4 to 6 show an example of an embodiment of the device 6 according to the present invention, characterised in that it is an automatic, portable device. The device has wheels 61 and a handle 62 to transport it. It also has a control panel 68 with a touch screen 63 giving information to the user and allowing him to vary the parameters and monitor the process. An emergency stop button 67 can also be seen. On the front panel 64 there are connections with the different items of equipment (refrigeration circuit, lubricating oil collection tank and/or refrigerant lung tank and/or refrigerant collection tank). On the upper panel there may be written information 66 for the user, such as, for example, an operating diagram for the various items of equipment and/or safety instructions. The device 6 shown also has a standard connection with an electrical energy source or socket 65 and additional devices 69 to facilitate transport of the device 6.

**[0036]** Finally, Fig. 7 shows an alternative embodiment of the device 6 according to the present invention. Like elements have been numbered with like numerals. The most significant difference between this embodiment and the one shown in Figs. 4 to 6 is that the machine shown in Figs. 4 to 6 is semi-automatic, the control panel 68 having similar elements, and also slight changes in design, such as those that can be seen in the handles 69.

**[0037]** In general, Figs. 4 to 7 show embodiments of the device 6, with a volume of under 0.2 m<sup>3</sup> and therefore transportable, making it suitable for maintenance operations on all types of equipment.

**[0038]** In Fig. 8 can be seen a particularly advantageous embodiment of the arrangement of the liquid/gas separator 31 at the outlet of the compressor 21.

**[0039]** In particular, this particular embodiment of the separator device 31 is made up of a series of "racing"-type rings 313 separated by a membrane 312 from one or more metal sponges 311, said separator 31 being arranged higher than the compressor 21 and between it and the bypass valve 24 branch. The separator 31 separates the oil from the refrigerant coming from the compressor. When the bypass solenoid valve 24 of the compressor 21 opens. Using the arrangement shown for the separator 31, the retained oil falls by gravity to the oil tank of the compressor 21 through the refrigerant outlet conduit of the compressor 21. This embodiment has the advantage of being simple and economic to produce and of not needing an increased number or length of installation conduits, and also reducing the oil content at the compressor outlet to lower levels than those obtained by

known devices.

**[0040]** Many variants of the example shown here are possible. For example, an additional oil separator may be included after the compressor 21, in such a way that the refrigerant is also cleaned of oil that it may have been able to capture when passing through said compressor. It will also be possible to connect the installation 1 to the device 6 without the need for the intermediate lung tank 7, and other variant connections disclosed in the aforementioned document ES2137254. It is also possible, for small installations, to use the device according to the present invention without the need for the oil reception tank 6. It will also be possible to include some of the elements shown, such as the external tanks 7, 8, 9, in the device 6, or arrange externally some of the elements shown as internal to the device 6, all without departing from the scope of the present invention.

## 20 Claims

1. Device for the recovery of oil and/or refrigerant from installations that comprise a refrigerating cycle, of the type that comprises connection means to said installation, expansion means for a refrigerant substance from said installation, evaporation means for said substance, separation means for separating lubricant from said substance and compression means for said substance after passing through the separation means, **characterised in that** said compression means comprise a rotary-type compressor and said evaporation means are able to obtain heat for evaporation from a heat exchanger intended to cool said compressor.
2. Device according to claim 1, **characterised in that** said expansion means for said substance comprise an expansion valve, the operating parameters of which are variable and can be modified by electronic means, depending on the physical properties of the specific type of refrigerant being used, thus optimising the operating conditions of the compressor.
3. Device according to claim 1 or claim 2, **characterised in that** said device comprises sensors and electronic control means that allow it to automatically adjust the parameters and duration of the operating cycles, to suit the characteristics of the refrigerating installation to which the device is connected.
4. Device according to any one of claims 1 to 3, **characterised in that** it is in the form of portable apparatus.
5. Device according to any one of claims 1 to 4, **characterised in that** the compressor has a power of over 1 h.p.

6. Device according to any one of claims 1 to 5, **characterised in that** it has a gas/liquid separator at the outlet of the compressor.
7. Device according to claim 6, **characterised in that** the separator is arranged so that the oil held in the separator can return, by gravity, to the compressor tank through the refrigerant outlet conduit of the compressor.
8. Device according to claim 7, **characterised in that** the separator comprises a set of "racing"-type rings, a separating membrane and one or more metal sponges.
9. Process for recovering a refrigerant from an installation that comprises a refrigerating cycle, said process comprising the steps of: removing the refrigerant from the refrigerating circuit of the installation, preferably in liquid phase; expanding and evaporating said refrigerant; separating the lubricating oil contained in the refrigerant; then compressing the refrigerant and taking it to a collection vessel, **characterised in that** it comprises a step for refrigerating the compression means of the refrigerant with refrigerant from the installation.
10. Process according to claim 9, **characterised in that** using automatic means, the expansion conditions of the refrigerant removed from the refrigeration circuit are adjusted with data that includes information on the properties of the refrigerant and on the pressure and/or temperature of the evaporated refrigerant, so that the expansion and subsequent compression process of the refrigerant is optimised from the energy point of view.
11. Process according to claim 9 or claim 10, **characterised in that** the refrigerant used to cool the compression means comes from said expansion phase.
12. Process according to claims 9 to 11, **characterised in that** it comprises a phase for separating the oil from the refrigerant at the outlet of the compression phase.
13. Process for cleaning lubricant oil from a refrigeration circuit, of the type that comprises the stages of: injecting a refrigerant, preferably miscible with the lubricating oil to be removed and denser than that oil, into the refrigeration circuit or a selected portion thereof, so that the refrigerant raises and draws the oil contained in the circuit; extracting the mixture of refrigerant and oil thus produced, preferably through a low point of the oil housing; expanding and evaporating the mixture; separating the mixture of refrigerant and oil, and returning the used refrigerant to a tank using compression means, **characterised in that** the compression means are cooled by refrigerant from the installation.
14. Process according to claim 13, **characterised in that** using automatic means, the expansion conditions of the refrigerant removed from the refrigeration circuit are adjusted with data that includes information on the properties of the refrigerant and on the pressure and/or temperature of the evaporated refrigerant, so that the expansion and subsequent compression process of the refrigerant is optimised from the energy point of view.
15. Process according to claim 13 or claim 14, **characterised in that** the refrigerant used to cool the compression means comes from said expansion phase.
16. Process according to claims 13 to 15, **characterised in that** it comprises a phase for separating the oil from the refrigerant on exit from the compression phase.

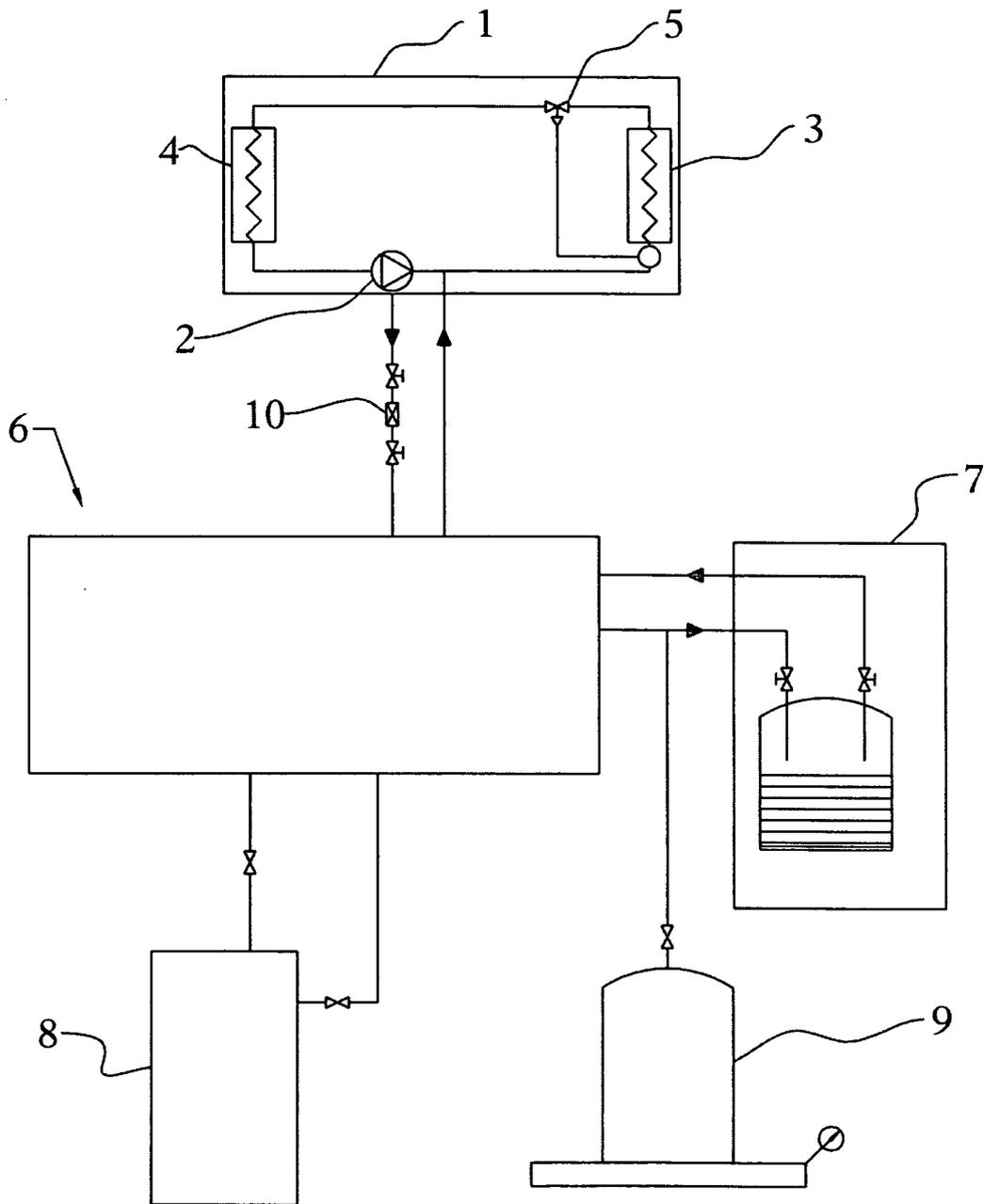


FIG. 1

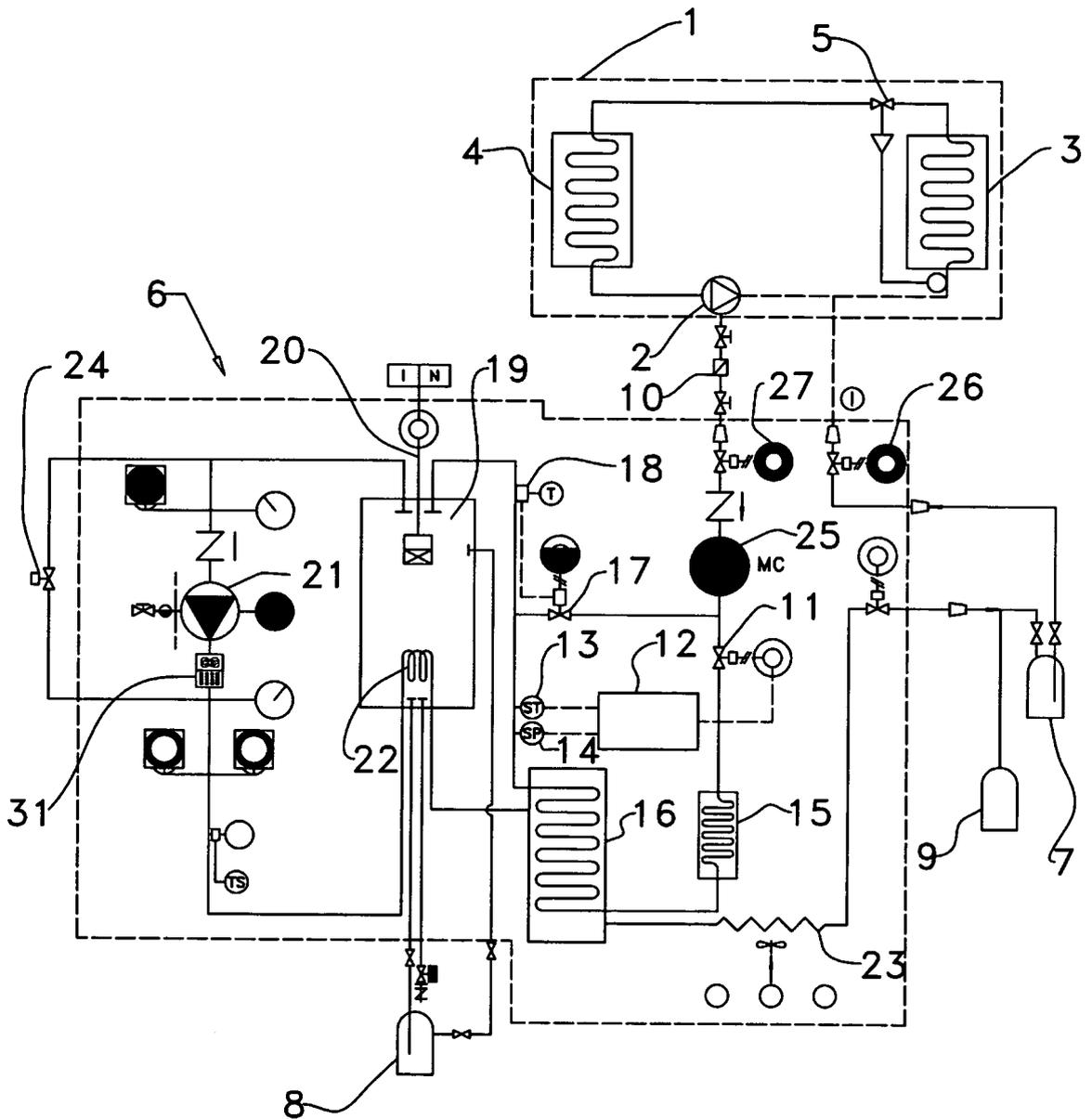


FIG.2

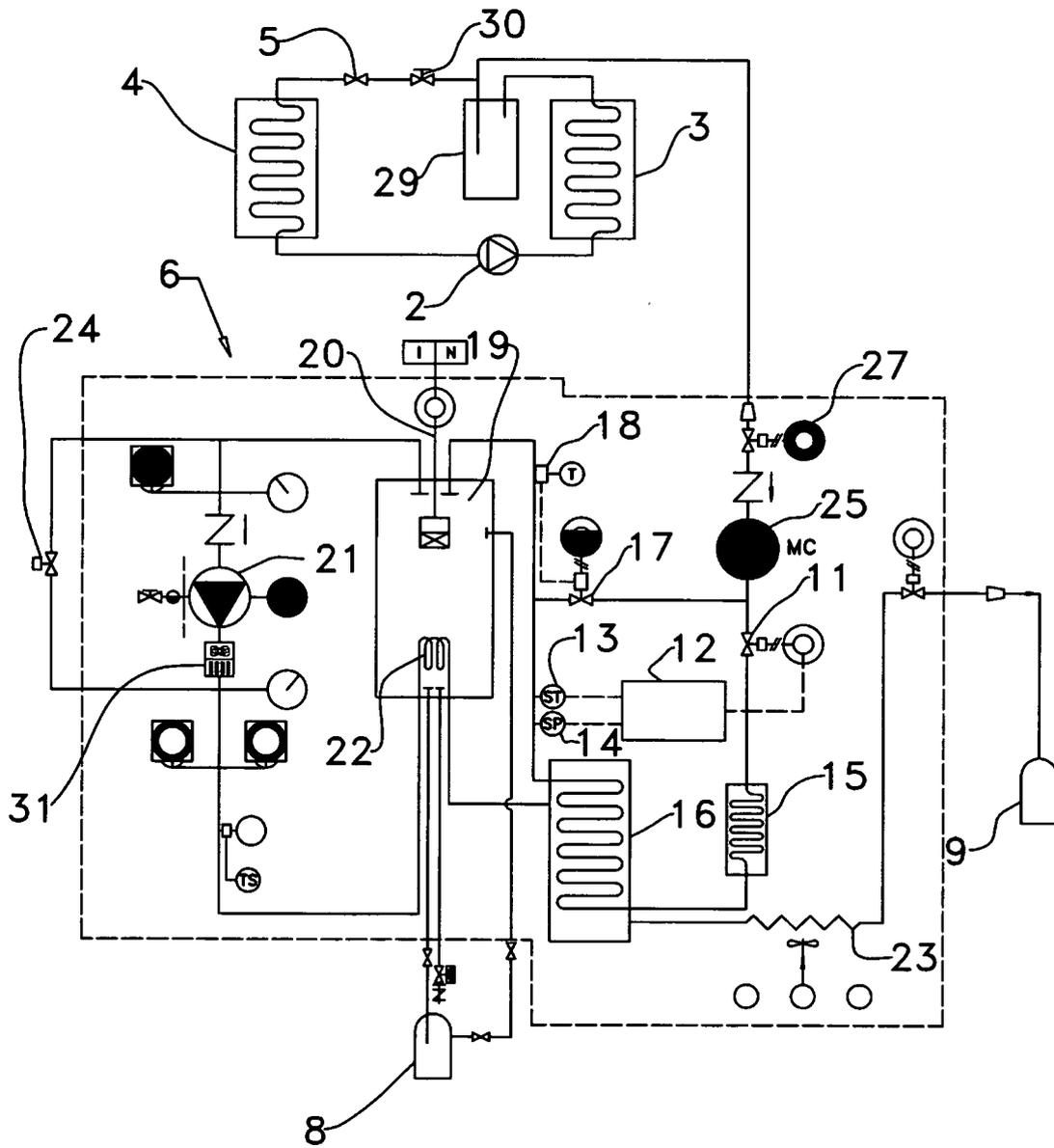


FIG.3

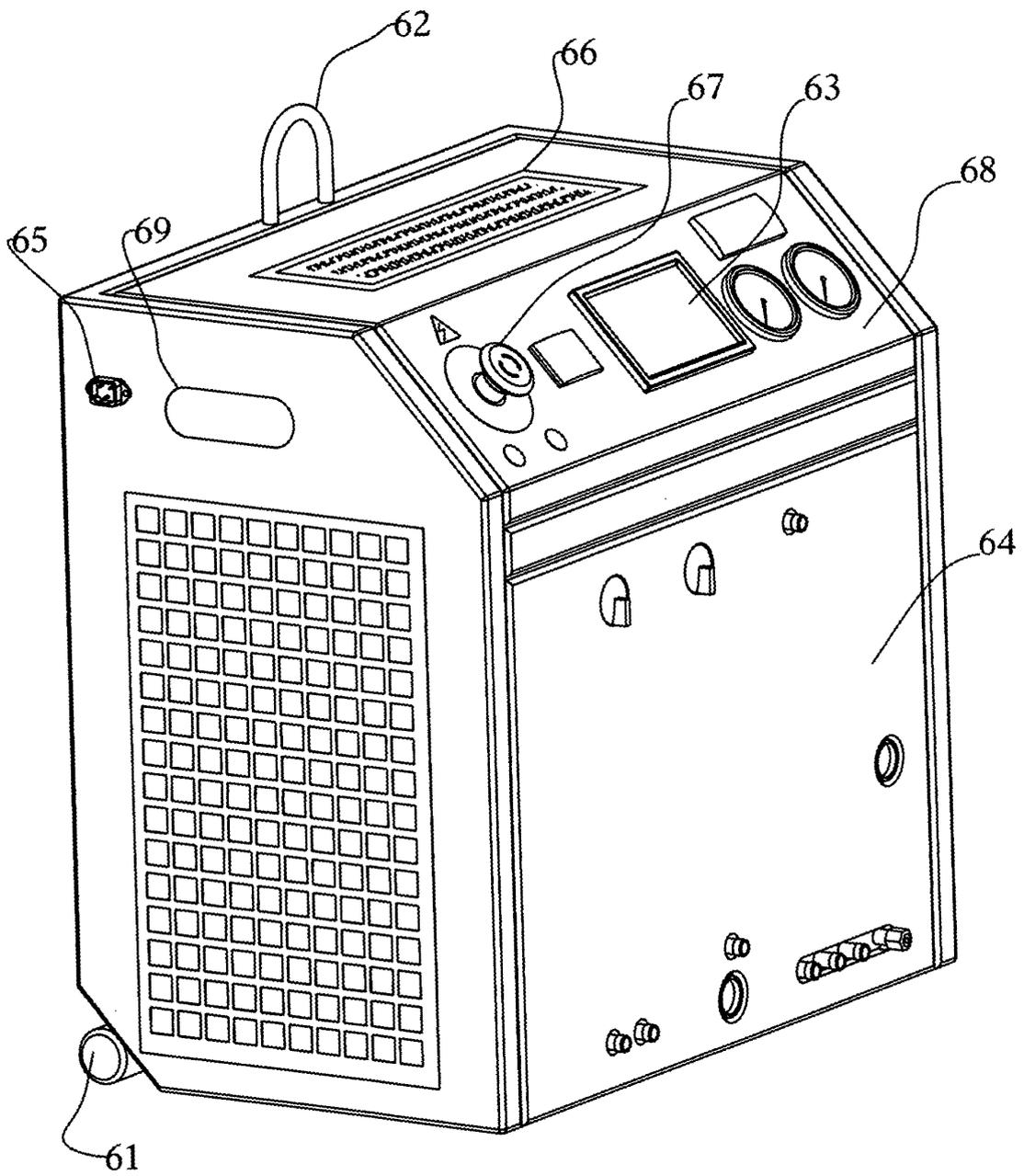


FIG. 4

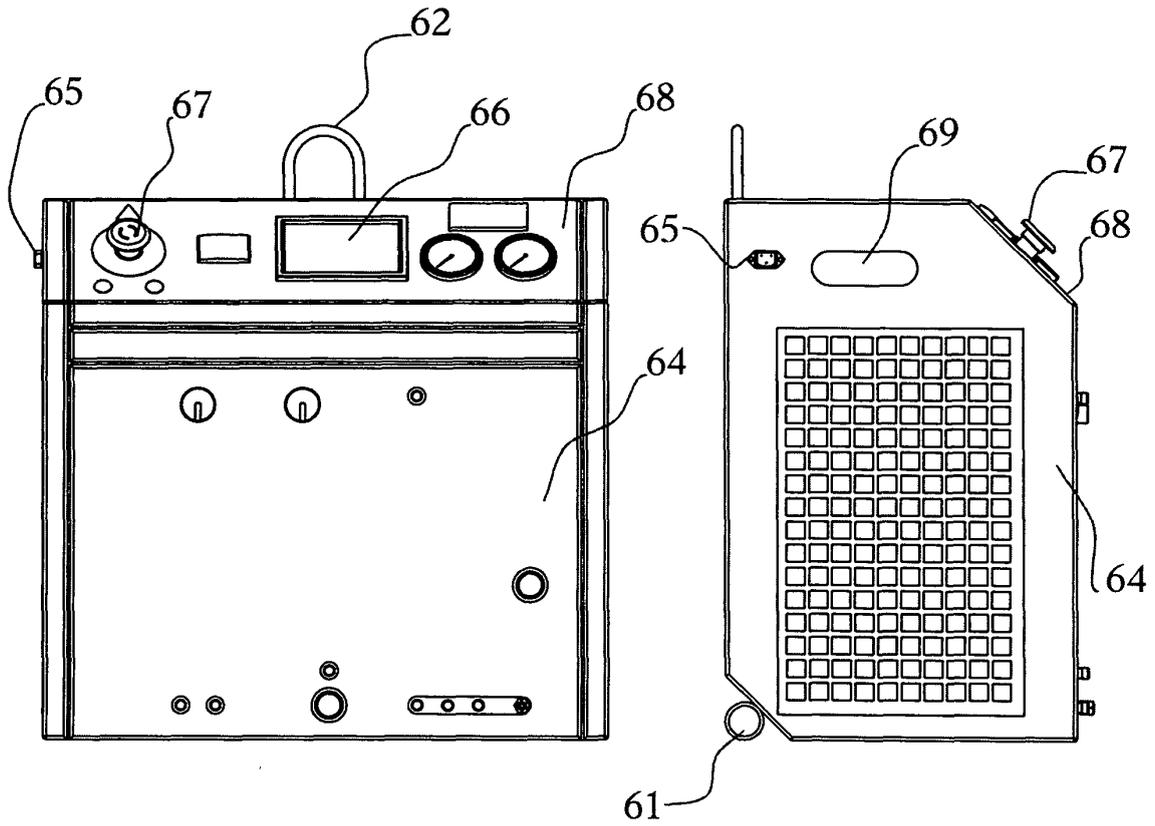


FIG. 5

FIG. 6

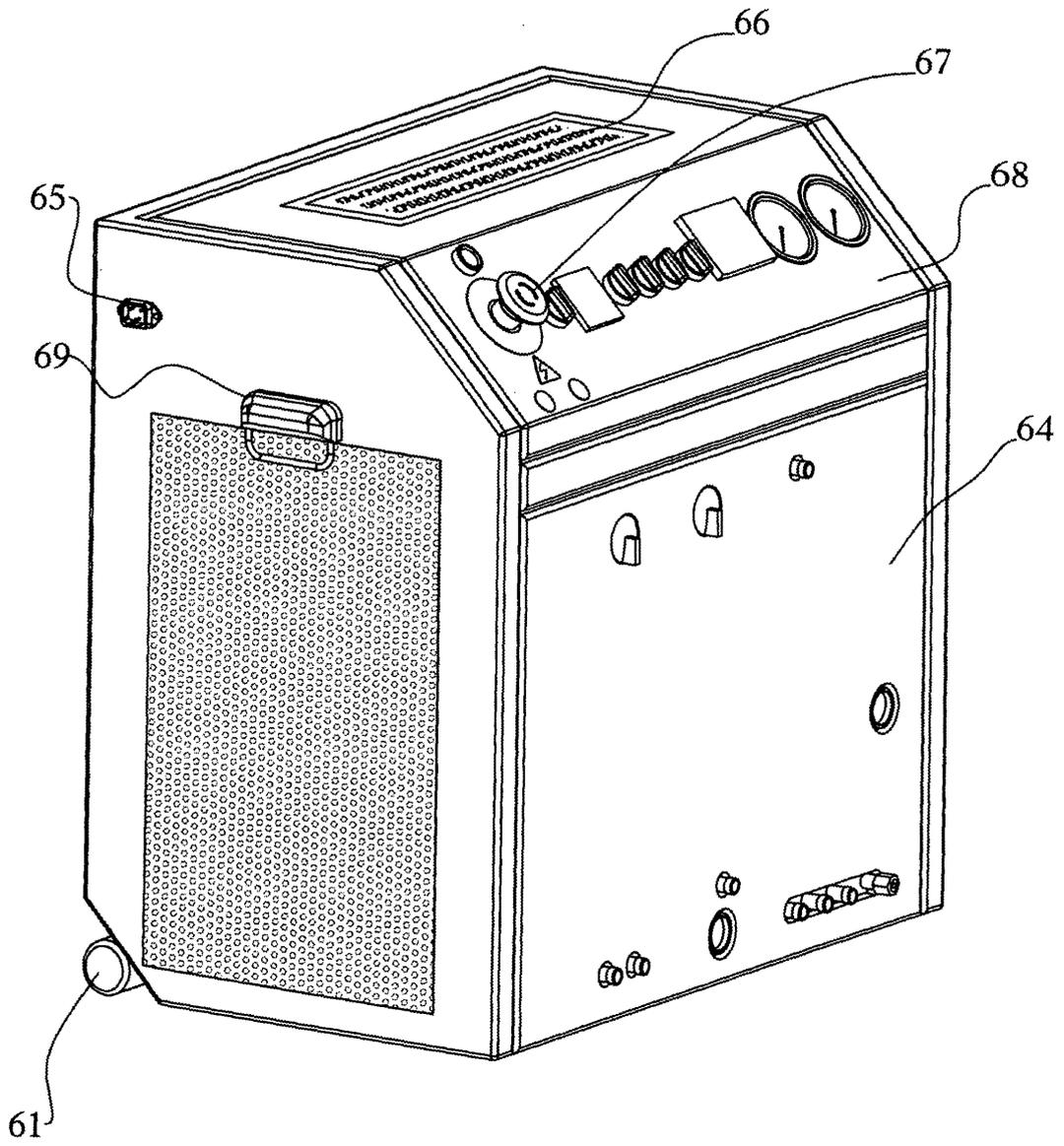


FIG. 7

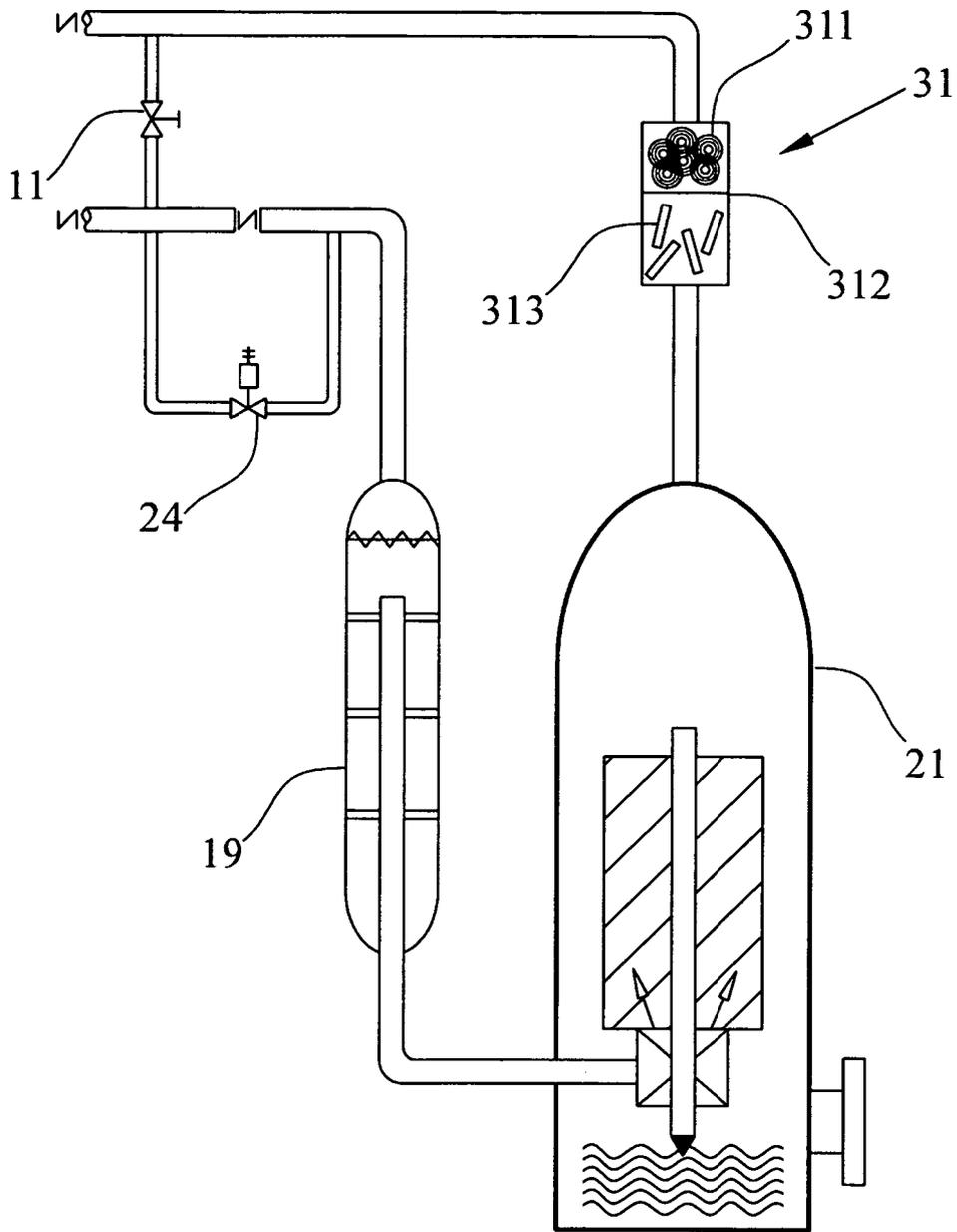


FIG.8

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/ ES 2006/000037

A. CLASSIFICATION OF SUBJECT MATTER		
F25B 45/00 (2006.01)		
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)		
f25b45,		
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)		
CIBEPAT,EPODOC,WPI,PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	<b>US 5226300 A (CHRISTENSEN JAMES P ; GORDON RICHARD F) 13.07.1993 *column 9, line 42 - column 11, line 25; column 12, lines 14-27; column 13, lines 29-30; figures 1,2,4*</b>	1-6 7, 9-16
Y A	<b>EP 0519859 AI (CARRIER CORP) 23.12.1992 *column 5, lines 25-49; column 6, lines 26-32; column 7, lines 21-44; column 8, line 55 - column 9, line 1 ; figure 1*</b>	1-6 7,9,12,13, 16
Y	<b>US 4993461 A (YAMANE MAKOTO) 19.02.1991, *column 2, line 37 - column 3, line 22; figures 1,2*</b>	1-6
Y A	<b>ES 2137254 T3 (AKA INDUSTRIPRODUKTER KYLA AB) 16.12.1999, *column 4, lines 23-55; figure 1*, <b>US 5415003 A (BERTVA JOHN T ; WHEELER DANNY A) 16.05.1995, *column 3, line 46 - column 4, line 2; figure 1*,</b></b>	1,6 7,9,11-13, 15,16 1,6
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&amp;" document member of the same patent family</p>		
Date of the actual completion of the international search		Date of mailing of the international search report
20 APR 2006 (20.04.06)		26 APR 2006 (26.04.06)
Name and mailing address of the ISA/		Authorized officer
S.P.T.O.		
Facsimile No.		Telephone No.

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Information on patent family members

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- ES 2137254 [0011] [0013] [0040]