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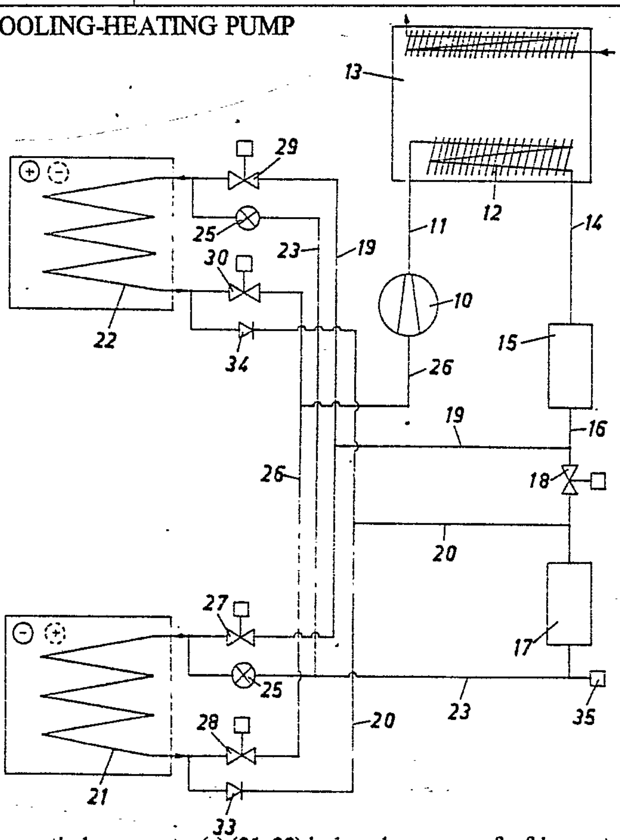

(57) Abstract

The defrosting of the evaporators by means of hot high pressure liquid from the compressor has previously been done either by reversing the plant, that is alternating use of the condensers as evaporators and evaporators as condensers and vice versa or by doubling the evaporators, one of them being active while the other is defrosted. There are disadvantages with both systems and the purpose of the invention is to eliminate these disadvantages and to provide a plant, which is simple as far as construction and operation is concerned and which gives a high average factor a year for the heating effect emission. This has been achieved by the fact that the evaporators (21, 22), which are to work as heat emitters at defrosting are essentially completely emptied from the refrigerant, which after compressing and condensing is stored in a container (15). The defrosting of the emptied evaporator(s) (21, 22) is done by means of refrigerant condensate under high pressure from the container (15), and supercooled condensator is added to the evaporators, being under heat-absorption, from the defrosted evaporators via an operation container (17). Refrigerant condensate is also led via the operation container (17) to the one or those evaporators (21, 22) intended as heat absorbers and/or heat emitters.

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A METHOD FOR RUNNING A COOLING-HEATING PUMP

Background of the invention

The present invention refers to a method of running a cooling-heating pump plant with an improved heat recovery and defrosting, said plant comprising one compressor, at least one condenser and at least two evaporators, said components being connected to each other via necessary conduits and said evaporators being defrosted by means of hot high-pressure liquid from the compressor. The invention also refers to a cooling-heating pump plant for performing the method.

At previously known heat recovery systems with cooling-heating pumps the defrosting is done by reversing a valve so that the working medium in form of hot gas rushes into the exterior battery, which before the reversing was active as an evaporator. The reversing is done very quickly and may result in a serious shock in the system and consequently a shortened length of life. The sudden pressure rise in the cold exterior battery may cause a steam collapse, which results in a momentary change of high pressure and suction pressure, and an expansion will be achieved in the compressor instead of a compression. In the exterior battery, working as an evaporator before the reversation, there is always a large amount of liquid refrigerant left, and a sudden change of the reversing valve may, unless certain measure are taken, empty liquid refrigerant into the compressor resulting in a compressor damage. The reversing valve used at known system is a four-way valve, through which high-pressure gas from the compressor as well as low-pressure gas from the exterior battery flows. The temperature of the high-pressure gas can be about 90^{o}C, while the temperature of the low-pressure gas is about $\pm 0^{o}$. Thus there is a larg difference of temperature between the two refrigerants in one and same valve, which naturally demands a lot from the reversing valve, where at the same time heat losses arise. Moreover it is not possible to arrange heat exchangers downstream of the battery for supercooling of the refrigerant, and there is also a great risk of overheating of the low-pressure liquid of the evaporator battery.

It is also known (Swedish patent No. 358.025) to double the number of evaporators and to defrost the one that is inactive for the moment. At defrosting hot high-pressure gas is led from the compressor to the intake side of the evaporator. The hot high-pressure gas, however, has a considerably worse defrosting effect than a corresponding high-pressure liquid, and as the evaporator, the receiver and the connected pipe system are filled with high-pressure gas, the defrosting requires considerable time. After the defrosting the condensate from the receiver must be forced to circulate through the evaporator once more before it, via the expansion valve, can be provided to the suction side of the compressor in an expanded state, that is as low-pressure gas. The bringing back of the condensate to the system and the storing of said condensate in the receiver takes plenty of time. During the whole defrosting cycle the evaporator is inactive, which can only be accepted at such systems where a doubling of one and the same function unit is done. When it is desired to utilize every evaporator at a maximum, such a long stoppage cannot be allowed.

Letting the high-pressure gas from the compressor pass through the condenser to the receiver and from there achieve a defrosting of any evaporator is not possible, as the throttle means will expand the refrigerant so that the evaporators work as heat absorbers instead of heat emitters, thus increasing the frost formation instead of achieving a defrosting.

Summary of the invention

The purpose of the previous invention is to eliminate the above mentioned disadvantages and to provide a method and a cooling-heating pump plant, which is simple as far as construction and operation is concerned and which gives a high average factor a year for the heating effect emission. This task has been solved by the fact that the one or those of the evaporators working as heat emitters (e.g. at defrosting) are emptied from essentially all the refrigerant, which after compressing and condensing is stored in a container, that the defrosting of the emptied evaporator(s) is done by means of refrigerant condensate under high pressure from the container, and supercooled refrigerant condensate is added to the evaporator(s) being under average running heat absorption from said defrosted evaporators via an operation container, and that, (if necessary) after repeating the first phase, the refrigerant condensate is led via the operation container to the evaporator(s) intended as heat absorbers and/or heat emitters. The cooling-heating pump plant distinguishes itself by the characteristics stated in claim 2.

By first emptying the system from the refrigerant, at the same time as the compressed refrigerant is condensated and stored in the container, the hot high-pressure liquid will, when the valves are opened, rush into the evaporator which is to be defrosted, and as the liquid is many times over a more effective heat carrier than gas, an immediate defrosting will occur. The supercooled high-pressure liquid from the defrosted evaporator is not led back to the compressor but is led directly to an operation container, from which the refrigerant can be distributed to other evaporators of the system or to the evaporator, which has been defrosted.

By the particular design of the cooling-heating pump plant the refrigerant will always be led against the current relativt to the air or to the refrigerant which smears the battery, and this results in a higher degree of efficiency and causes that standard flange batteries can be used as evaporators or condensors. Furthermore conventional, high-capacity liquid distributors to the batteries can after the expansion valve be used during the cooling, heating as well as defrosting period, which is not possible with conventional cooling-heating pump plants. It is also possible and quite advantageous to let the high-pressure liquid to the evaporator as well as the low-pressure liquid from said evaporator pass through a heat exchanger, whereby a supercooling of the high-pressure liquid is achieved as well as a separation of gas from the low-pressure liquid, and by this a protection of the compressor against hammering.

One of the advantages of the heat exchanger is also a quich return of oil. As any four-way-reversation valve is not used, any losses of capacity on the hot gas side are not acquired, when the oil passes the valve, and special oil or heat separators can also be dispensed with.

The system will be relatively inexpensive as it includes mainly standard components or modified ones.

Brief description of the drawings

The description will herebelow be further described with reference to enclosed drawings illustrating some embodiments.

Figure 1 schematically shows the construction of a cooling-heating pump plant, where cooling as well as heating requirements can exist, Figure 2 shows a somewhat modified embodiment of the plant illustrated in figure 1.

Description of the preferred embodiment

Referring to the drawings, 10 stands for a compressor, 11 for a high-pressure line, 12 a condenser, e.g. a finned element, arranged in a heater 13 for e.g. radiator hot water. The outgoing line 14 from the condenser 12 is connected to the upper part of a charging container 15 for the working refrigerant. A line 16 starts from the bottom side of the charging container and connects this container with the upper part of an operation container 17. A pilot valve 18 is arranged in the connection line 16 and on both sides of said valve there are two branching lines 19 and 20, which lead to a number of evaporating batteries 21 and 22 designed with a heat--absorbing as well as a heat-emitting function, at which the delivery line 19 is connected to the inlet side of the evaporators, respectively, and the return pipe 20 to the outlet side of the evaporators, respectively.

A feeding line 23 leaves the bottom part of the operation container 17, and a pressure control 35 is connected to said feeder, which also is connected to the inlet sides of the evaporators, respectively. In the feeding line 23, in close connection to the evaporators 21 and 22, respectively, a thermostatic expansion valve 25 is arranged. In the embodiment illustrated in figure 1 the evaporator 22 is designed as an air-cooled or air-heated heat exchanger, respectively, serving as a re-condenser or as an evaporator. The evaporator 21 forms for example the cooling battery of a freeze box, freezing chamber, freezing gondola or the like, and more than one evaporator can of course be connected to the system.

Furthermore a return line 26, leading to the suction side of the compressor 10, is connected to the outlet sides of the evaporator batteries 21 and 22. Pilot valves 27, 28, 29 and 30 are arranged in the delivery line 19 and in the return line 26, in close connection to the evaporators 21 and 22. In the return pipe 20 and in close connection to the evaporator batteries 21 and 22 there are arranged non-return valves 33 and 34, closing in the direction towards said batteries.

The cooling plant with heat production as well as heat recovery, illustrated in figure 1, is intended to be used in shops equipped with freezing gondolas or the like, where there is also a need of hot water for tapping and radiator hot water. The plant works in the following way.

The compressor 10 suctions vaporized working refrigerant from the evaporator batteries and pumps this via the pipe-line 11 to the condenser 12, where part of the heat is emitted to the surrounding water in the cold water stratum (layer) of the radiator heater 13. The high-pressure gas, coming from the compressor 10, is condensated mainly in the condenser 12, and the high-pressure liquid is led via the line 14 to the charging container 15, which has such a large volume that it holds an essential part of the total working refrigerant.

At refrigerating operation during the summer, when there is little tapping of hot water and no radiator heating is needed, it may be required to emit surplus heating to the outdoor air, at which the evaporator 22, designed as an air-cooler or an air-heater, respectively, is supplied with high-pressure liquid from the charging container 15, provided that the valve 18 is closed and the valve 29 in the supply line 19 of the evaporator 22 is open. High-pressure liquid can thus pass through the evaporator 22, and as the valve 30 is closed, the refrigerant can be led to the return pipe 20 via the non-return valve 34. The further cooled high-pressure liquid is thus led to the operation container 17, from where the refrigerant is led via the feeder 23 to the evaporation battery 21. As the valve 27 is closed, the refrigerant passes the expansion valve 25, which means that the evaporator 21 works as a heat absorber and cools the products in the freezing gondola. Low-pressure gas from the evaporator 21 is led through the open pilot valve 28 and back to the suction side of the compressor 10.

During the winter months it can be appropriate to let the evaporator battery work as a heat absorber, at which the valve 18 is open and high-pressure liquid can pass through the charging container 15 as well as the operation container 17, the high-pressure liquid then being led via the feeder 23 from the operation container to the expansion valve 25 of the evaporator 22. At this operation the valve 29 is closed and the valve 30 open.

In case the evaporation battery 21 is to be defrosted, this battery and its line-system will be emptied by closing the pilot valves 27, 29 and 30 and the control valve 18, while the pilot valve 28 is open. The compressor 10 will then such out all the low-pressure liquid from the system at the same time as high-pressure liquid is pumped to the charging container 15.

The defrosting is done by opening the valve 27 and closing the valve 28, so that high-pressure liquid from the charging container

15 can rush into the evaporator battery 21, where the hot refrigerant during very short time will defrost the evaporator, at which cooled high-pressure liquid is led to the operation container 17 via the non-return valve 33 and the return pipe 20. During the whole operation moment, that is the emptying, the charging and the defrosting, the evaporation battery 22 works as a heat absorber, provided that the valve 29 is closed and the valve 30 is open while the condenser 12 works as a heat emitter.

In order to definitely ensure an effective separation of gas from the low-pressure liquid to protect the compressor against hammering, it is favourable to connect a heat exchanger 36 in the line system in front of the evaporator batteries, as schematically illustrated in figure 2. Hereby three important functions are achieved, that is a supercooling of the high-pressure liquid on its way to the evaporator, an effective separation of the gas from the low-pressure liquid so that only dry, well saturated gas returns to the suction side of the compressor, and a guaranteed good oil return to the compressor during the whole cooling period.

The embodiment according to figure 2 differs from the one shown in figure 1 only by the fact that said heat exchanger is connected to the system in front of each evaporator, and that the plant comprises three evaporators of which the evaporator 24 is designed as an air-cooled or air-heated exchanger, while the evaporators 21 and 22 are included in the refrigerating producer of the cooling plant. In other respects the function of the plant is the same as has been described in connection to figure 1.

The invention is not limited to the described embodiments but a number of modifications are possible within the scope of the claims.

CLAIMS

1. A method of running a cooling-heating pump plant with improved heat recovery and defrosting, said plant comprising a compressor, at least one condenser in the form of an inner flanged battery and at least two evaporators in the form of outer flanged batteries, said components being connected to each other via required lines and said evaporators being defrosted by means of hot high-pressure liquid from the compressor, characterized thereby, that the one or those evaporators (21, 22), intended to work as heat emitters (e.g. at defrosting), are essentially completely emptied from the refrigerant, which after compressing and condensing is stored in a container (15), that the defrosting of the one or those emptied evaporators (21, 22) is done by means of a refrigerant condensate under high pressure from the container (15), and supercooled refrigerant condensate is supplied to the one or those evaporators (21, 22) being under average running (heat absorption) from the said defrosted evaporators via an operation container (17) and that, perhaps after a repeating of the first phase, the refrigerant condensate via the operation container (17) is led to the one or those evaporators (21, 22) intended as heat absorbers and/or heat emitters.

2. A cooling-heating pump plant for performing the method according to claim 1, comprising a compressor (10), at least one condenser (12) in the form of an inner flanged battery and at least two evaporators (21, 22) in the form of outer flanged batteries, which components are connected to each other via necessary lines and which evaporators are defrosted by means of hot high-pressure liquid from the compressor, characterized thereby, that a charging container (15) for the working refrigerant is arranged in the line between the condenser (12) and the evaporators (21, 22 etc), that an operation container (17) for the refrigerant is connected in series after the charging con-

tainer (15) and a control valve (18) is arranged in the connection line (16) between these containers, that said connection line (16) after the control valve (18) is branched, and the branching line (20) via a non-return valve (33, 34) each being connected to the outlet side of the evaporators (21, 22), respectively, that a feeding line (23) starting from the bottom part of the operation container, is connected to the inlet sides of the evaporators, respectively, via one expansion valve (25) each.

3. A cooling-heating pump plant according to claim 2, characterized thereby, that pilot valves (27, 29 and 28, 30 respectively) are arranged in the supply line (19) and the return line (26) of the evaporators, in the flow direction seen before and after the defrostable evaporators (21, 22), respectively.

4. A plant according to claims 2 and 3, characterized thereby, that a heat exchanger (36) is connected to the feeder (23) starting from the bottom part of the operation container (17), before the expansion valve (25). The heat exchanging refrigerants consist of a working refrigerant (low-pressure liquid), coming from the belonging evaporator, as well as of a working refrigerant, (high-pressure liquid), coming from the operation container (17).

5. A plant according to claims 2-4, characterized thereby, that the condenser (12) consists of a finned element arranged in a cold water stratum of a hot-water heater or a regenerator (13).

6. A plant according to any of the previous claims, characterized thereby, that a pressure watch (35) is arranged in the feeder (23), starting from the operation container (17), said pressure watch intended to control the start and stop of the compressor and the turning on and off of the evaporators and the defrosting.

7. A plant according to the claims 2-6, c h a r a c t e r i z e d t h e r e b y, that at least one evaporator (46) is arranged as a heat exchanger in a waste water tank (47), air delivery channel, ground conduit or the like, the return line of said evaporator being connected to the compressor (10) via a pressure regulator.

FIG. 1

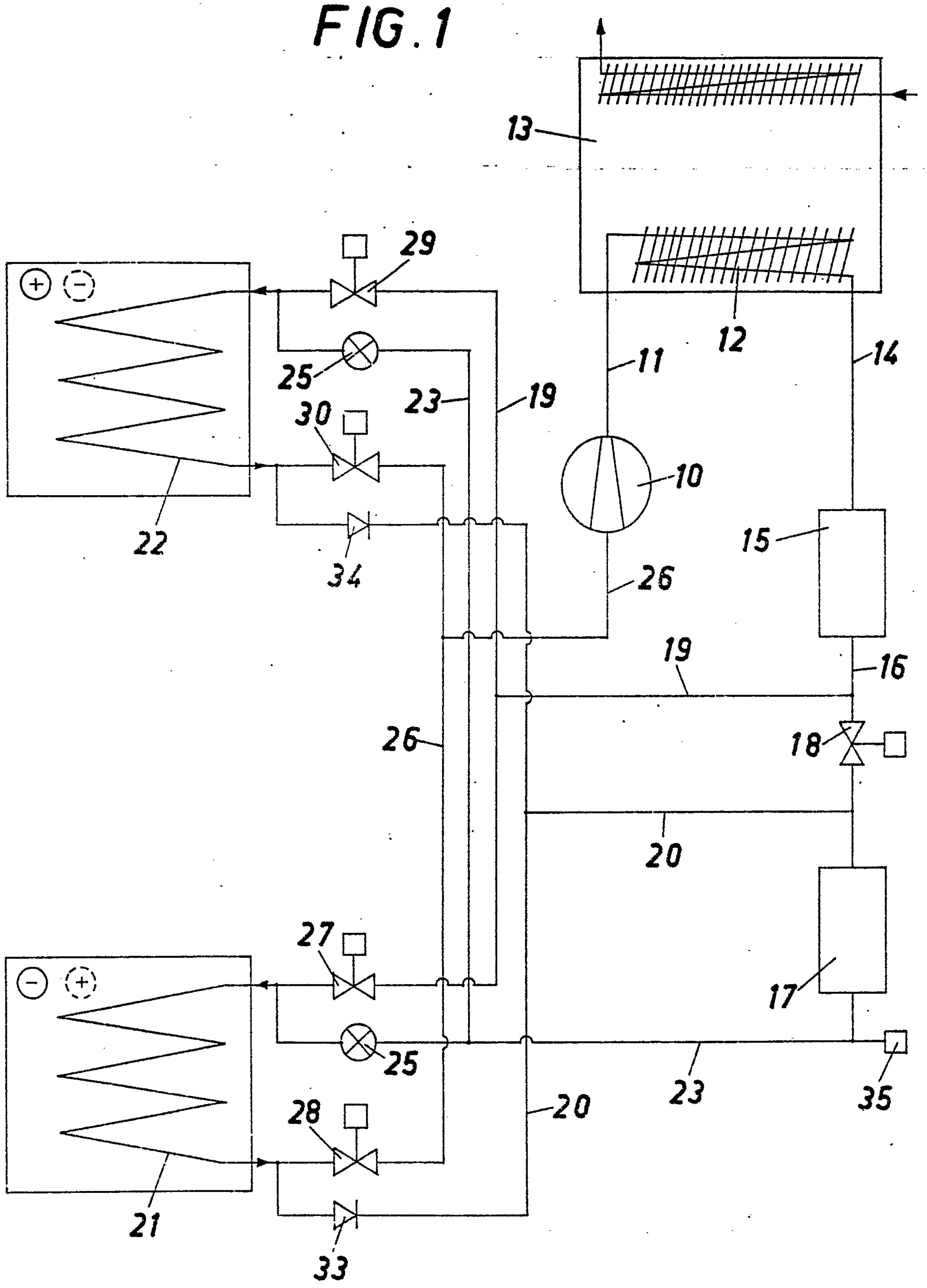
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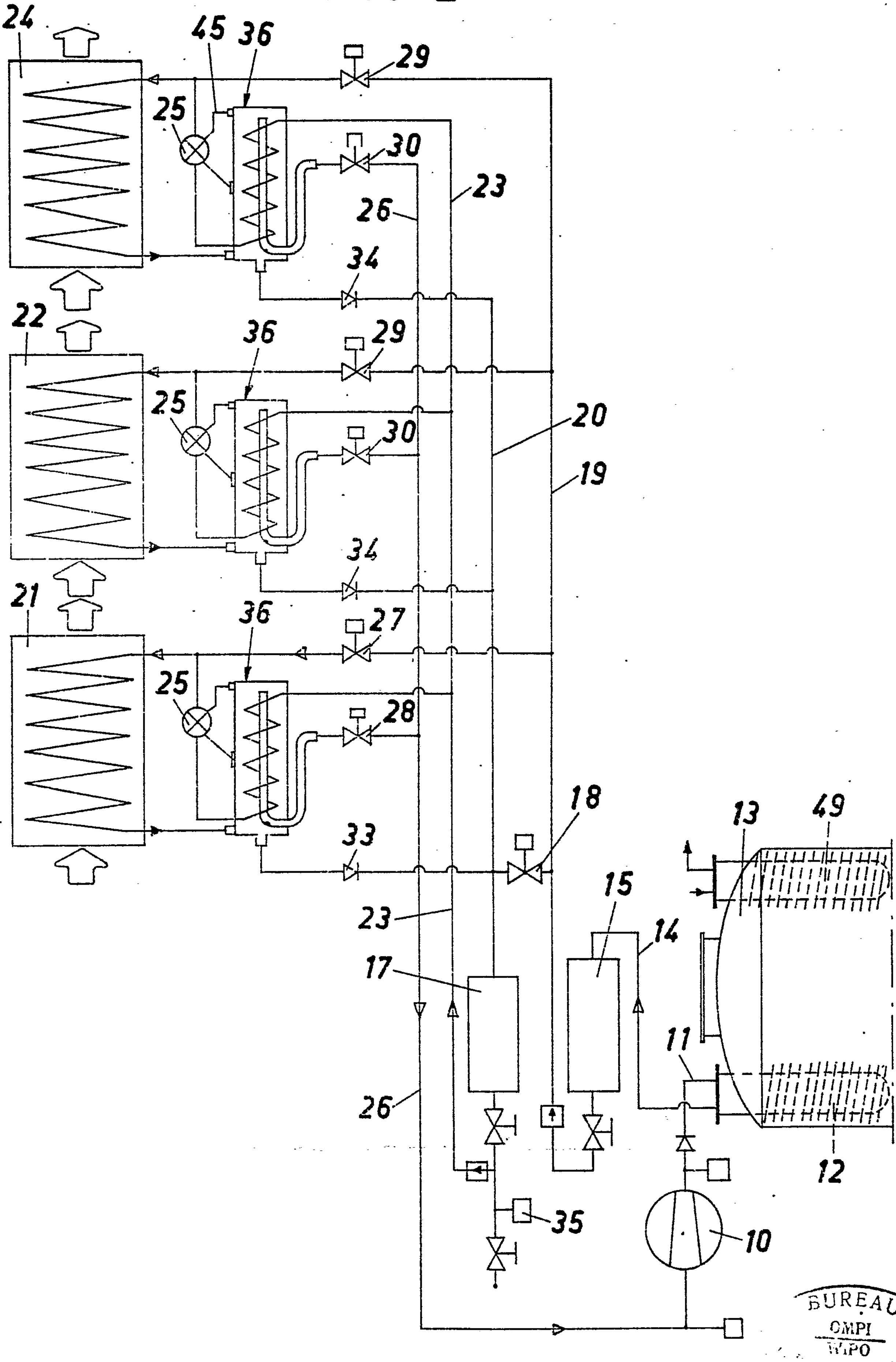
FIG. 2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INTERNATIONAL SEARCH REPORT

International Application No PCT/SE78/00079

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

F 25 B 29/00, 49/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	F 25 B 1/00, 5/00, 21/00, 49/00
Deutsche Kl	17a 4/01, 4/02
US Cl	62: 80, 81 117, 150-156, 159, 160, 272, 278

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, DK, FI, NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 2 713 249 published 1955, July 19, F J Schordine see column 2, lines 9-25	1, 2
A	US, A, 3 681 934 published 1972, August 8, Bangor Punta Operations Inc see column 2, line 63- column 3 line 14	1, 2
E	SE, A, 7705942-6 published 1978, November 21, H Göttinger	

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"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1979-05-28	1979-06-01
International Searching Authority [1]	**Signature of Authorized Officer [10]**
Swedish Patent Office	Koit Jaik K. Jaik

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