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

(11) Publication number: **0 149 756**
**A2**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **84114249.0**

(22) Date of filing: **26.11.84**

(51) Int. Cl.[4]: **F 24 F 3/14**

(30) Priority: **28.11.83 IT 2391683**

(43) Date of publication of application:
**31.07.85 Bulletin 85/31**

(84) Designated Contracting States:
**AT BE CH DE FR GB LI LU NL SE**

(71) Applicant: **RC CONDIZIONATORI S.p.A.**
**Via Roma, 10**
**I-27010 Salimbene (Pavia)(IT)**

(72) Inventor: **Caciolli, Rodolfo**
**Via Roma, 10**
**I-27010 Salimbene (Pavia)(IT)**

(74) Representative: **Dr. Ing. A. Racheli & C.**
**Viale San Michele del Carso, 4**
**I-20144 Milano(IT)**

(54) **Air conditioning system with refrigerant circuit and air reheater.**

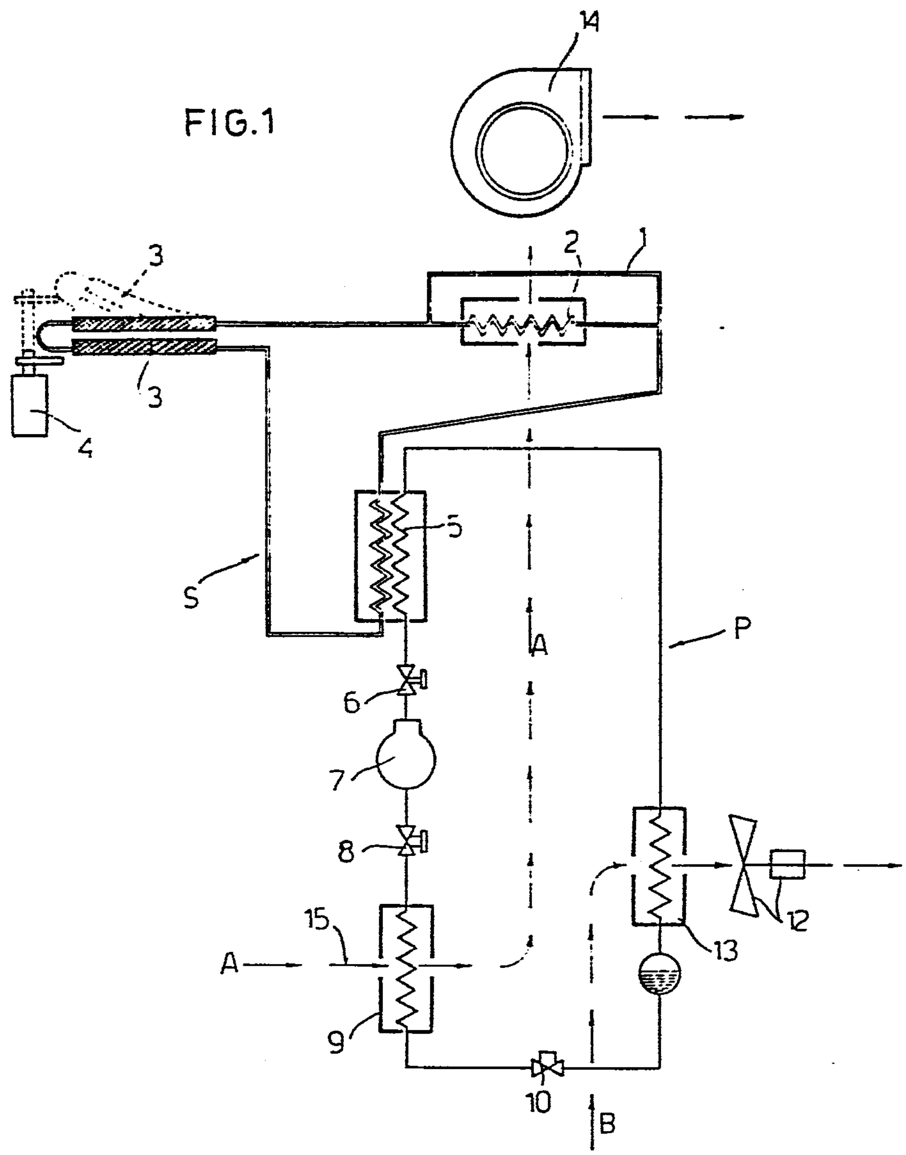
(57) This invention refers to a system for postheating already dehumidified air which uses a known normal refrigerating circuit (main circuit P), which is connected to a secondary circuit (S) through at least one two-phase exchanger element (5), situated downstream of the main circuit evaporator (15). The dehumidified air is thus heated by a condenser-exchanger (2), placed in the secondary circuit. According to this invention an economical and reliable postheating system is achieved. The heating capacity of the postheating condenser-exchanger (2) is regulated by a new mechanical device (3,4), which allows proportional regulation.

EP 0 149 756 A2

./...

Croydon Printing Company Ltd.

FIG.1



0149756



Applicant:

RC CONDIZIONATORI S.p.A.

IT-27010 SALIMBENE (Pavia)

Via Roma, 5

TITLE MODIFIED
see front page

"SYSTEM FOR POSTHEATING OF AIR, USABLE IN DIRECT-EXPANSION CONDITIONERS, COMPRISING AT LEAST AN INTERMEDIARY AUXILIARY EXCHANGER ELEMENT"

This invention refers to a system for postheating air, usable in direct-expansion conditioners, comprising at least one intermediary two-phase exchanger element for exploiting heat of condensation at no cost.

The system made in this way, which is an improvement on a conditioning system using a well-known refrigerating circuit, is suitable for being used in air-conditioning rooms which house data-processing units.

The air circulating in these rooms must have a clearly determined humidity content, normally at constant temperature. If, a normal refrigerating circuit is used, the air dehumidified through the evaporator is also cooled. This cooling is necessary for a certain time in order to dissipate the heat produced in the room to be kept under thermohygrometric control. However said cooling is sometimes not desirable or not needed during steady conditions.

In some systems the post-heating battery is electrical, this latter being costly.

Exploiting the heat collected or produced in the circuit, which is normally wasted, has already been thought of. In some systems on the market at present the heat of condensation and from the refrigerating compressor is used for postheating, the exhaust gas from the compressor being sent directly to a postheating battery and the functioning of the system being regulated with normally ON-OFF type solenoid valves. This system has the disadvantage of regulating the temperature of a room in steps and, since the postheating battery is included in the circuit, if there is a fault or leakage of refrigerating gas, the entire main refrigerating circuit breaks down. Furthermore, the refrigerating compressor must suppress the temperature peaks caused by the ON-OFF type regulation. This largely nullifies the advantage obtained from exploiting the condensation heat.

In addition, the presence of elements for by-passing or regulating the flow increases the possibility of malfunctions and may seriously undermine the entire system's reliability.

Therefore, the object of the present invention is to provide a system to be used in combination with a normal refrigerating system, which therefore comprises a compressor, an evaporator and a condenser connected by a circuit inside of which a refrigerating fluid flows, wherein all the defects occurring in known systems are eliminated, said system according to the invention being economical and exploiting to the maximum the heat of condensation.

A further object is to provide a system in which intercepting or by-pass elements are eliminated as far as possible, both in the main refrigerating circuit and in the circuit for achieving postheating.

Another object of this invention is to provide a system designed in such a way that, if there is a fault in the postheating circuit, the main refrigerating circuit continues to function.

The object of this invention is achieved by providing for at least one intermediary two-phase exchanger element to be fitted in a known main refrigerating circuit, in which a refrigerating fluid circulates, said exchanger element being situated downstream of the evaporator and connected to at least one secondary circuit, comprising at least one condenser-exchanger element for carrying out postheating; and also providing a device for regulating the heating capacity of said postheating condenser-exchanger element.

One embodiment provides for said secondary circuit being fed by the same refrigerating fluid as for the main circuit, which fluid consists of R 22 Freon gas.

Another embodiment, on the other hand, provides for a refrigerating fluid different from the one in the main circuit to circulate in said secondary circuit, said refrigerating fluid circulating in the secondary circuit having, however, a boiling temperature in the region of the boiling temperature of the fluid in the main circuit, the difference being no greater than ± 10%.

According to a preferred embodiment it is provided for said intermediary two-phase exchanger element to be placed at least 0.5 m lower than the postheating condenser-exchanger element.

According to a preferred embodiment the device for regulating the heating activity of the postheating condenser-exchanger is mechanical and is made up of at least one flexible section of the pipe for the refrigerating fluid, which can be displaced by an actuating device, so as to selectively place it at a higher level than that of the postheating condenser-exchanger and thus cause at least partial flooding of said condenser- exchanger.

According to a preferred embodiment said actuating device consists of a servomotor.

For a clearer understanding of this invention the accompanying drawings are now referred to, which show a non-binding exemplary embodiment, in which:

Fig. 1 represents the schema of a system according to the invention; and

Fig. 2 shows a temperature chart of the air flow upstream and downstream of the postheating battery, according to the invention.

In Fig. 1 a known type of refrigerating circuit, which is called a main circuit, is indicated with a P. Said circuit comprises a refrigerating compressor 7, an exchanger for evaporating the refrigerating fluid or evaporator 9, an exchanger for dissipating the condensation heat or condenser 13 and an auxiliary two-phase exchanger 5, which is added to the circuit according to the invention. If required, taps, indicated by reference numbers 6 and 8, and a thermostatic valve 10 can be added.

The two-phase exchanger device 5 connects the main circuit P to a secondary circuit S which comprises a postheating condenser-exchanger 2. There is an anti-syphon by-pass 1.

There are also electric fans 12 and 14 for driving the air which flows through this circuit.

In the secondary circuit a section of piping (globally indicated by 3) is provided which is flexible, so that it can be selectively moved to the position indicated by the broken lines (shown in the figure) by means of an actuating device, consisting of a servomotor 4.

The same type of refrigerating fluid may circulate in the main circuit P and in the secondary circuit S. According to this solution said fluid consists of R 22 Freon gas. Another type of refrigerating fluid may circulate in the secondary circuit, provided the boiling temperature is in the region (± 10%) of that of the fluid circulating in the main circuit.

Obviously, the size of the various components is such as to allow correct functioning of the circuit. This comes within the knowledge of a technician in this field.

According to a preferred embodiment the refrigerating compressor 7 is a 5-ton Copeland YR 500 and the evaporator 9 is made of aluminium copper, with 12 mm tube diameter and 2.5 mm spacing between fins, in 4 rows with flow rate of treated air about 6000 $m^3/h$. The front speed on the evaporating battery is 1.8 m/sec.

The air-ventilated condenser 13 is made up of a condensing battery with the same constructional characteristics as the evaporator, front speed on the condensing battery of 3 m/sec and propeller fan for a flow rate of 6000 $m^3/h$.

The two-phase exchanger 5 is the type with welded copper plates which have 0.4 $m^2$ exchange surfaces.

The condenser-exchanger 2 is made with 12 mm diameter copper pipes and compact aluminium finning with 2.5 mm spacing in 2 rows. The inlet and outlet manifolds are fitted in said condenser-exchanger in such a way as to facilitate draining the fluid.

in the secondary circuit the steam delivery pipes have a diameter of 36 mm and those for return of liquid 18 mm.

The diameter of the anti-syphon pipe 1 is 12 mm.

The flexible pipes 3 have an internal tomback covering and a stainless-steel mesh outer casing. The regulating motor 4 is the thermal, modulating type, controlled by an electronic regulator with voltage variation from 0 to 10 V.

The way the system operates will now be described according to the invention, in which the air flow A is dehumidified and fed back into the same room at the required temperature. If dehumidifcation of the air is required, which enters at point 15 at a temperature (t) of 25°C and humidity content (x) of 12 g of $H_2O$ per kg of air, it is necessary to cool the air, by causing it to pass through evaporator 9, to a temperature of 15°C, to which corresponds a humidity of 10 g of $H_2O$ per kg of air. The outgoing air flow from the evaporator, therefore, certainly has a smaller humidity content, but it is colder and so, if the outgoing air flow from the evaporator 9 were fed into the room without further heating, it would cause the room to cool down. This cooling is not always desirable.

The condenser-exchanger 2 shown in circuit S serves precisely to heat the air from a temperature of 15°C to 25°C, so as to alter only the humidity level in a room and not its temperature. As can be seen in Figure 1, said condenser-exchanger 2 transfers a large part of the heat, eliminated from the air flow through evaporator 9. In fact, the waste refrigerating gas from the compressor in the main circuit P, which flows out at an average temperature of between 80 and 100°C, passes through the two-phase exchanger 5 and causes the fluid in the secondary circuit to boil. Steam rises and fills the condenser-exchanger 2, over which flows dehumidified air at a low temperature, causing the said fluid to condensate. The secondary circuit is arranged so as to slope down towards the two-phase exchanger 5 and so the fluid in the secondary circuit, after changing into a liquid, returns into the two-phase exchanger 5 and closes the cycle. The condenser 13 of the main refrigerating circuit is, in turn, cooled by a flow of air B according to the path shown in Figure 1.

It is important, however, that the exchange capacity of said condenser-exchanger 2 can be regulated according to requirements. In order to do this, instead of using the ON-OFF type valves which do not allow proportional-type regulation, a regulating means is used according to this invention, which is made up of a flexible section 3 of piping, said section being selectively moved by the actuating device 4. In this way, if section 3 is raised to a higher level than that of the condenser-exchanger 2, the condensed fluid in the postheating condenser-exchanger 2 returns to the two-phase exchanger 5, only after having partially flooded the exchanger, or it does not return at all, if the piping is raised in such a way that, even with the condenser-exchanger 2 completely full of liquid, the latter cannot transfer into the two-phase exchanger 5.

The raising of the said flexible section by means of the pneumatic or electric type servomotor allows a selective proportional, not ON-OFF, type regulation. The flooding of the condenser-exchanger withdraws the liquid from the two-phase exchanger 5, reducing its exchange surface for the boiling action. In this way the supplied heating capacity is regulated. The diagram in Figure 2 shows an example of programming the system's functioning. In said diagram area A1 refers to the use of postheating, area B1 refers to inactivity due to no requirement for postheating and C1 is the modulation area. In Figure 2 the sign (o) represents the temperature of the air flow upstream of exchanger 2 and the sign (x) indicates the temperature downstream of exchanger 2. The $\Delta t$ obtained is on average 5°C. At a flow rate of 6000 $m^3/h$ about 8500 Kcal/h are recovered.

It is evident that in this way postheating can be achieved by recovering heat from the refrigerating circuit which would otherwise be wasted. Such a system is, therefore, economical. In addition, if there is a malfunction in the secondary circuit S, the main circuit P continues to function normally. Therefore, if a postheating battery of, for example, the electric type is provided, the system is able to function well without having to stop.

It is evident that in this way all the pre-established objectives are achieved.

RC CONDIZIONATORI

IT - 27010 SALIMBENE (Pavia)

C L A I M S

1. System for postheating air in direct-expansion conditioners, usable in combination with a normal refrigerating circuit (P), comprising a compressor (7), a condenser (13), and an evaporator (9), characterized by the fact that in said refrigerating circuit at least one intermediary two-phase exchanger element (5) is included, situated in the circuit downstream of the evaporator (9), said exchanger element being connected to at least one secondary auxiliary circuit (S) comprising a condenser-exchanger element (12), suitable for carrying out the postheating, and a means (3, 4) for regulating the heating capacity supplied from the postheating condenser-exchanger element.

2. A system according to claim 1, characterized by the fact that in said secondary circuit (S1) the same refrigerating fluid circulates as in the main circuit (P).

3. A system according to claim 1, characterized by the fact that in said secondary circuit (S1) a refrigerating fluid circulates, different from the one flowing in the main circuit (P), said refrigerating fluid in the secondary circuit (S) having a boiling temperature in the region of $\pm$ 10% of the boiling

temperature of the refrigerating fluid in the main circuit.

4. A system according to claim 1, characterized by the fact that said intermediary two-phase exchanger (5) is placed at least 0.5 m lower than the condenser-exchanger (2) of the postheating secondary circuit.

5. A system according to claim 1, characterized by the fact that the regulating means in the secondary circuit (S) is mechanical and made up of at least one flexible section (3) of the piping which receives the refrigerating fluid, said flexible section (3) being selectively moved by an actuating device (4), so as to be placed at a level higher than that of the postheating condenser-exchanger (2) and thus cause at least partial flooding of said postheating condenser- exchanger (2).

6. A system according to claim 5, characterized by the fact that said actuating device (9) is made up of an electric or mechanical type servomotor.

1/1

FIG.1

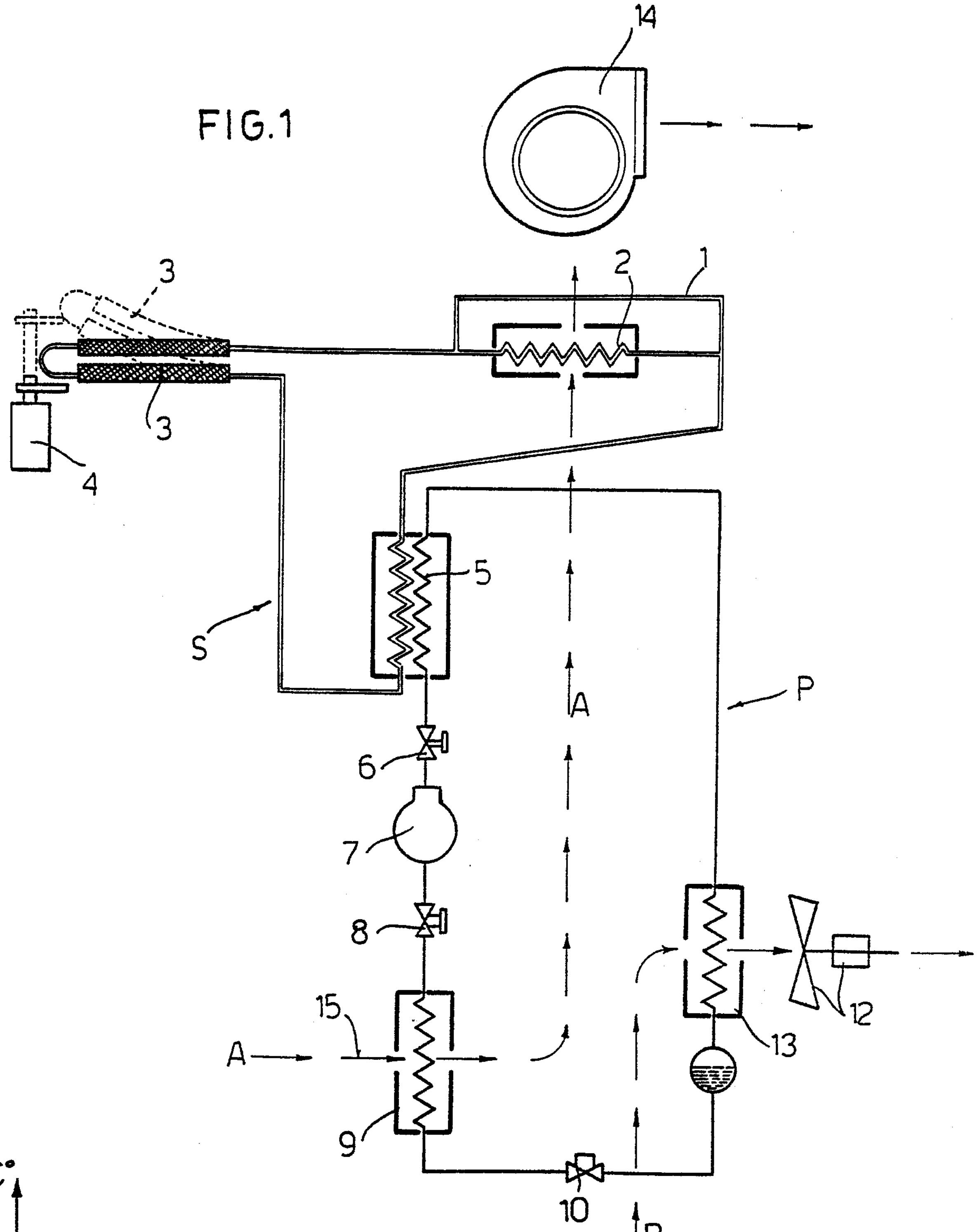



FIG.2