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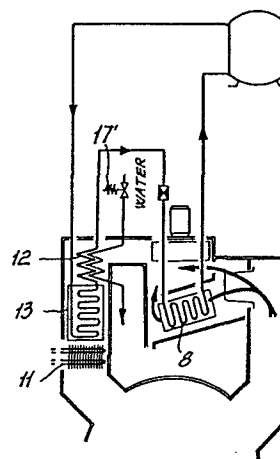
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54 **Heat recovery system for a dry cleaner drying and deodorizing circuit.**

57 An improved heat recovery system for a dry cleaner drying and deodorizing circuit is described, which can afford substantial energy savings during the drying step and the deodorizing step of the articles of clothing being cleaned. The system comprises two condensers (12, 13) located in a conduit (5) connecting the air outlet (4) and inlet (3) of a drum (2), between an evaporator (8) and a heating battery (11) for delivering heat to the air prior to its re-introduction into the drum (2). Advantageously one (12) of the condensers is of the water-cooled type.



DRYING : 17' CLOSED
 DEODORIZATION : 17' OPEN

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"HEAT RECOVERY SYSTEM FOR A DRY CLEANER DRYING AND
DEODORIZING CIRCUIT"

This invention relates to an improved heat recovery system for a dry cleaner drying and deodorizing circuit.

As is known, in dry cleaners techniques, on completion of the cleaning step, a drying step is next carried out to remove, from the cleaned articles of clothing, most of the solvent and moisture present therein, which is followed by a deodorizing step directed to remove from said articles of clothing even the last traces of solvent.

The drying and deodorizing steps have optimum operating temperatures, depending on the type of solvent being used.

In both such steps, hot and dry-as-possible air is introduced into the cleaning drum, and the mixture of air-moisture and solvent coming out of the drum is cooled to separate the air from the solvent and moisture; with certain dry cleaners, arrangements are made for the air-solvent mixture to be dispersed to the outside during the deodorizing step. Also in order to avoid dispersing of the deodorizing air to the outside, dry cleaners have been tested by the applicants, which are provided with a refrigerating machine having its evaporator located in the conduit which connects the outlet to the inlet for the air into the drum, which evaporator separates the solvent and moisture by condensation in cooling down the air-solvent-moisture mixture.

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Other dry cleaners have been tested by the Applicants, wherein the condenser of the refrigerating machine is located in the conduit connecting the outlet to the inlet to the drum at a position near the drum inlet to recover a part of the heat generated therewith and heat the air and reduce the power consumption of a heating unit, usually including electric resistance heaters, which is arranged in the conduit near the air inlet to the drum.

10 The tests carried out by the applicants have shown that in order to provide an effective cooling action for the deodorizing step, also advantageous has been found the use, in the refrigerating machine, of a second water-cooled condenser which is located on the outside of the cited conduit.

15 Dry cleaners with such construction operate quite well but involve a more than indifferent energy consumption during the drying and deodorizing steps.

Accordingly, the task of this invention is to provide an improved heat recovery system for a dry cleaner drying and deodorizing circuit, which can afford substantial energy savings both during the drying step and deodorizing step.

20 Within said task, it is an object of the invention to provide a simple structure which can be implemented with relative ease, is safe to use and effective in operation, and can afford comparatively low installation and operation costs.

25 These task and object are achieved by an improved heat recovery system for a dry cleaner drying and

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deodorizing circuit having, in a connection conduit of the air outlet and inlet of a cleaning drum, an evaporator of a refrigerating machine and a heating battery, characterized in that said refrigerating
5 machine has at least two condensers, one of which is advantageously cooled by a cooling fluid, which are located in said conduit between said evaporator and said heating battery and which exchange heat with the air prior to its re-introduction into the drum.

10 Further features will be more clearly apparent from the following detailed description of preferred, though not limitative, embodiments of a recovery system according to the invention, as illustrated by way of example only in the accompanying drawing, in
15 which:

Fig. 1 shows a schematical front view of a dry cleaner incorporating an improved recovery system according to one embodiment of the invention;

Fig. 2 shows another embodiment of the invention
20 represented in a manner similar to Fig. 1;

Figures 3 and 4 show details of comparative circuit portions previously tested by the applicants but not adopted in this invention;

Figures 5 and 6 show circuit portions adopted in
25 this invention.

With particular reference to the drawing generally indicated at 1 is a dry cleaner portion incorporating the improved heat recovery system for a drying and deodorizing circuit according to the invention.

30 The dry cleaner 1 has a cleaning drum chamber 2



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shown only in part and provided with an inlet 3 for the drying air and an outlet 4 for the air-moisture and solvent mixture; the outlet 4 and inlet 3 are interconnected externally to the chamber 2 by a composite conduit 5 extending from the outlet 4 to the inlet 3 and having a first section 5a, a second section 5b and a third section 5c. The second section 5b comprises two passages in by-pass relationship to each other and shown by arrows A1 and A2. In the section 5b a fan 6 is operative to drive the airflow in the direction of the arrows A1 and A2. Located between sections 5a and 5b of conduit 5 is a filter 7. After the filter 7, the airflow A is divided into two branches A1 and A2.

The second section 5b of the conduit 5 has an evaporator 8 of a refrigerating machine R positioned in the passage A1 and which is provided to lower the air-solvent-moisture mixture temperature and cause the moisture and solvent present in the mixture to be condensed; the condensed moisture and solvent are collected on an inclined wall 9 underlying the evaporator and removed through a pipe union 10 toward a station (not shown) for separating the solvent from water.

Mounted near the conduit inlet 3 is a heating battery 11, advantageously of the electric resistance heater type, for the air prior to its re-introduction into the drum; in practice, both during the drying step and during the deodorizing step the air is admitted into the drum in a hot state to promote

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removal of the moisture and solvent present in the articles of clothing being cleaned, and is then cooled by the evaporator 8 upon leaving the drum to condense the moisture and solvents present in the air.

5 The optimum temperatures of the mixture at the introduction into the drum and at the condensation zone vary when passing from the drying step to the deodorizing step, depending on the solvent used. For solvents of the type of perchloroethylene, the temperature during the drying step is at the entrance of
10 65-70° C and in the condensation zone of 25-30° C, whereas for the deodorizing step they are of 40° C and 15° C, respectively.

 Arranged in the section 5c of conduit 5, downstream of the fan 6 and upstream of the battery 11,
15 are two condensers 12 and 13 of the refrigerating machine R: the condenser 12 is of the water-cooled pipe coil type and is advantageously located upstream of the air condenser 13, the latter being in turn
20 located near the inlet 3; the condensers 12 and 13, as the machine refrigerating mix is being cooled, are a source of heat which is in practice fully utilized to heat the air prior to its re-introduction into the drum. The condensers 12 and 13 may be either assembled
25 in series (Fig. 1) or in parallel (Fig. 2), and in either cases valve means 15,16,17,17' are provided which are adapted to: either cut off, during the drying step, the waterflow to the condenser 12 such that the latter can transfer all the calories produced to the
30 drying air (thus recovering almost all of the energy



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normally dissipated in those systems which have said condenser located externally to the drying conduit); or, during the deodorizing step, supply said condenser 12 with cooling water, thereby providing, on the one
5 side, faster cooling of the air, and on the other side, recovery of energy by virtue of the cooling water frigories being reused which with conventional systems (having the condenser 12 on the outside) are dissipated.

It will be understood that with reference to
10 Fig. 1 during the drying step valve 17' is closed, whereas during the deodorization step the valve 17' is open. With reference to Fig. 2, during the drying step valve 15 is open and valves 16 and 17 are closed, whereas during the deodorization step valve 15 is closed
15 and valves 16 and 17 are open.

It will be noted that the so called secondary condenser 12, both in case in which it is series connected or connected in parallel with the main condenser 13, is active in the deodorizing step. Its
20 function is to absorb the heat taken by the evaporator 8 from the air, so as to allow the air which passes through the evaporator 8 to reach in a very short time of a few minutes very low temperature levels, which make it possible to completely recover the solvent con-
25 tained therein. Instead, during the drying step, since it is necessary to recover heat in order to raise the temperature of the air, the condenser 12 is closed.

This is the reason why, in case of the two con- denser series connected, during the drying step, water
30 is caused to flow through the condenser 12 in the same

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manner as in the case of parallel connection, whereas during the drying step such condenser is shut off.

5 It should be further noted that the condenser 8 is in every case effective; during the drying step because of the exclusion of the condenser 12, it will cool the air to values of 5-6°C; during the deodorization, owing to the operation of the condenser 12, it will cause the air to reach far lower temperatures even below zero point.

10 It should be appreciated that the energy recovery enabled by providing the two condensers 12 and 13 in the conduit 5 is quite substantial, so much that the heating battery 11 may be a low power one and only be energized during the initial stage of the drying step
15 to reach operating temperature, thereafter it may be shut off without problem because the heat required to raise the air temperature prior to its re-introduction into the drum is supplied entirely by the condensers 12 and 13.

20 Black arrows in the drawing show the air-solvent-moisture mixture and white arrows show the drying and deodorizing air; the other components of the refrigerating machine are not shown in the figure because known per se.

25 With reference now to the comparative circuit portions previously tested but not adopted in this invention, as shown in Figures 3 and 4, it will be noted that only the condenser 13' and an auxiliary resistor heater 11' supply heat to the air current,
30 since the condenser 12' is outside the conduit 5.

Instead, as visible in Figures 5 and 6, showing the corresponding circuit portion of this invention, during the drying step an additional heat recovery is obtained, due to the contact of the air current with the condenser 12, within which highly compressed freon flows. The tests carried out have shown an average temperature increase of 5°C. Assuming that the temperature increase owing to the condenser 13 remains 30°C as in the previous comparative example, the air temperature downstream of the condenser 13 will be at a higher temperature than in the previous solution, so that a resistor heater 11 of smaller power may be used.

During the deodorization step of this invention, as shown in Fig. 6, the valve 17 is opened so that water is supplied to the condenser 12, so that the temperature of the air contacting the cool surface of the condenser 12 will sink and consequently a more rapid cooling thereof will ensue.

It will be understood from the foregoing that with the circuit according to this invention during the drying step recovery of heat is obtained and during the deodorization step recovery of frigories is obtained.

In this connection it should be noted that, as shown in Fig. 1 part of the air put in motion by the fan 6 by-passes the evaporator 8 as shown by the arrow A₂, in order to reduce the power of the compressor of the refrigerating machine. This part of air reaches the condenser 12 at high temperature so that the cooling efficiency is high (high temperature difference). Such effect is not obtained in the solution shown in



Figures 3 and 4, where the condenser 12 is outside the circuit of air.

In the table which follows an energy balance is given for the comparative case in which the condenser 12' is outside the air circuit and for the case of this invention where the condenser 12 is within the air circuit.

TABLE

10		Condenser 12' outside the air circuit	Condenser 12 within the air circuit
	Compressor power	2000 W	2000 W
15	Heater power	2400 W	1200 W
20	Recovery of frigories during deo- dORIZATION	---	400 KCAL/H

It should be noted moreover that the ratio of the rate of flow of the by-passing air according to arrow A2 to the flow of arrow A1 may be regulated according to the requirements by valve means not shown in the drawing so that the total reunited air flow reaching the condenser 12 may have the desired mean temperature for an advantageous energy recovery. In this connection the mean temperature should be considered only from



a theoretical point of view, while in actual practice the total air current reaching the condenser 12 may have partial air streams at higher and lower temperature as compared to the theoretical average temperature and this is the reason why the above explained effect occurs. It will be understood that for the purpose the mixing of hot and cool air streams which flow together after the by-passing portion may be regulated by suitable blending means, not shown in the drawing.

10 Thus, the invention achieves its objects.

The invention as described is susceptible of many modifications and variations without departing from the scope of its inventive concept. Further, all of the details may be replaced with other technically equivalent ones.

15 In practicing the invention, the materials used, as well as the shapes and dimensions, may be any selected ones to meet individual requirements, without in so doing departing from the protection scope of the
20 appended claims.

CLAIMS

1 1. An improved heat recovery system for a dry
2 cleaner drying and deodorizing circuit having, in
3 a connection conduit (5) of the air outlet (4) and
4 inlet (3) of a cleaning drum (2), an evaporator (8)
5 of a refrigerating machine and a heating battery (11),
6 characterized in that said refrigerating machine has
7 at least two condensers (12,13), one of which is
8 advantageously cooled by a cooling fluid, which are
9 located in said conduit (5) between said evaporator
10 (8) and said heating battery (11) and which exchange
11 heat with the air prior to its re-introduction into
12 the drum (2).

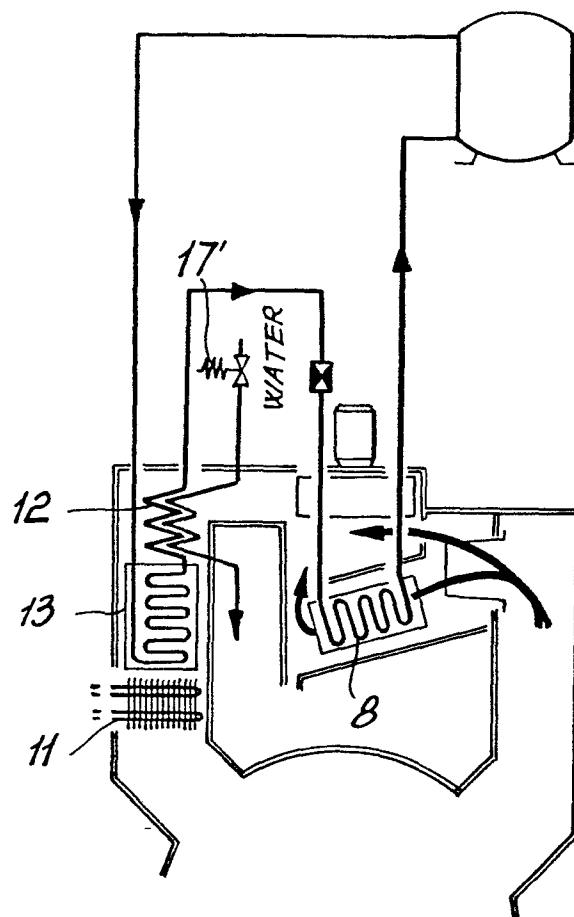
1 2. A system according to Claim 1, characterized
2 in that said heating battery (11) is a low power one
3 and is energized at the start of the drying step.

1 3. A system according to Claim 1, characterized
2 in that said condensers (12,13) are connected together
3 in series, and that during the drying step the flow
4 of cooling fluid into the fluid-cooled condenser (12)
5 is cut off.

1 4. A system according to Claim 1, and alter-
2 natively, according to Claim 3, characterized in
3 that said condensers (12,13) are connected together
4 in parallel, and that during the drying step the fluid-
5 cooled condenser (12) is by-passed.

1 5. A system according to Claims 1-4, characterized
2 in that a by-pass passage (A2) is provided in the air
3 circuit, past the evaporator (8) to regulate the air
4 temperature contacting the fluid-cooled condenser.

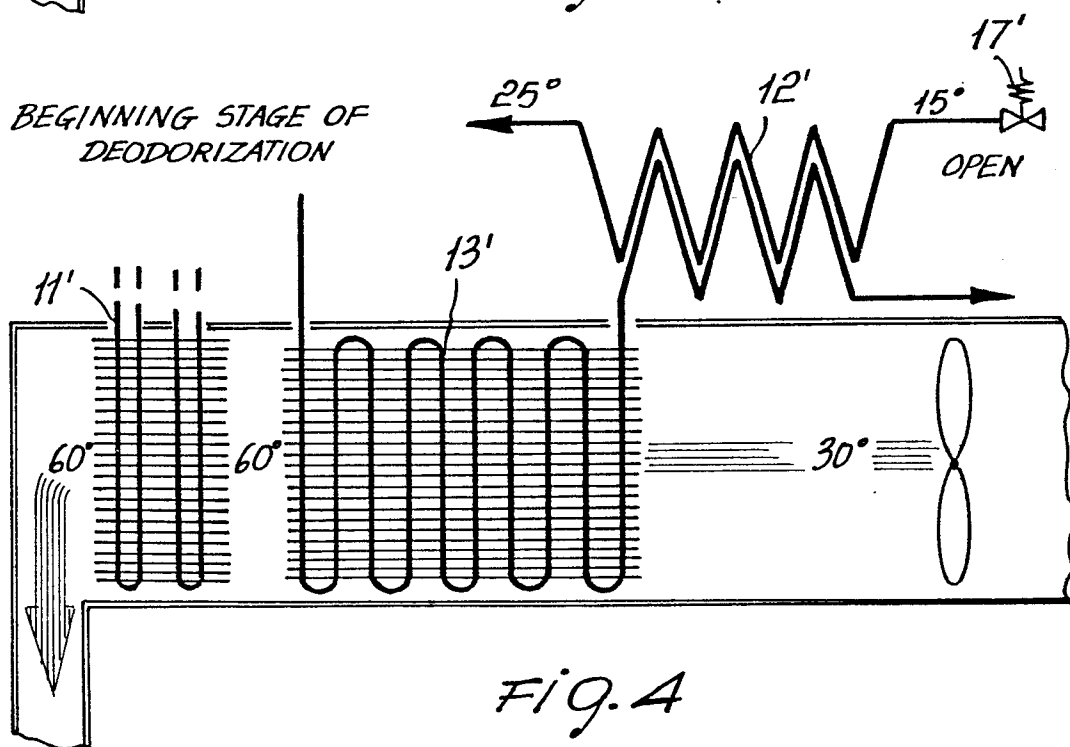
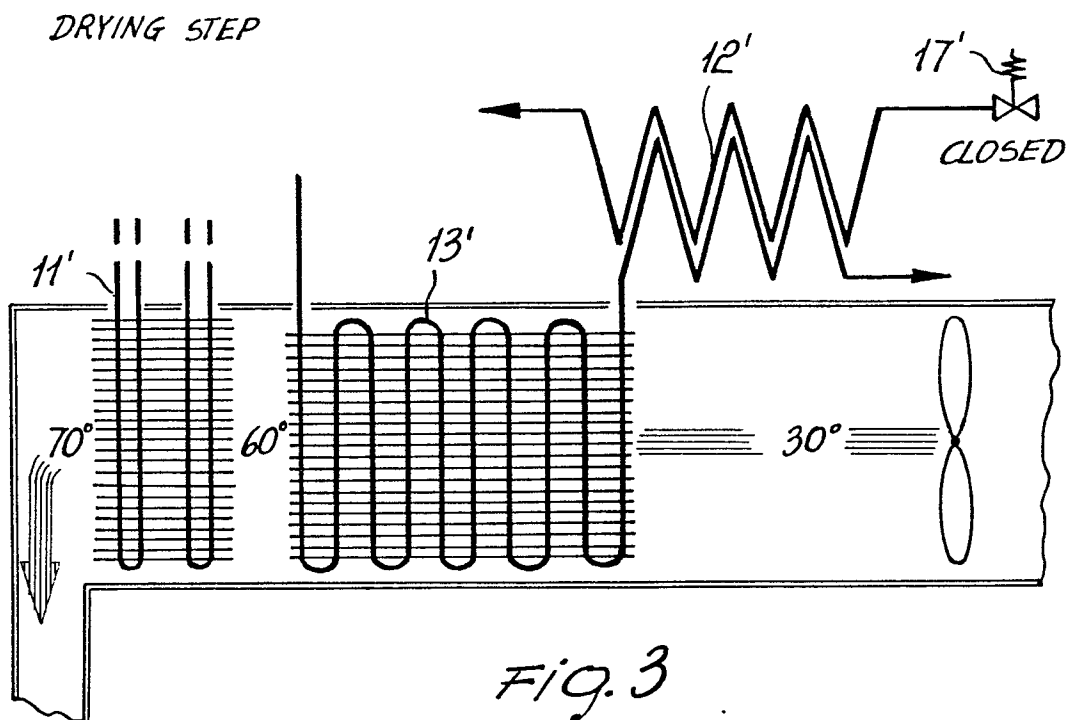




DRYING : 17' CLOSED

DEODORIZATION : 17' OPEN

Fig. 1



DRYING STEP

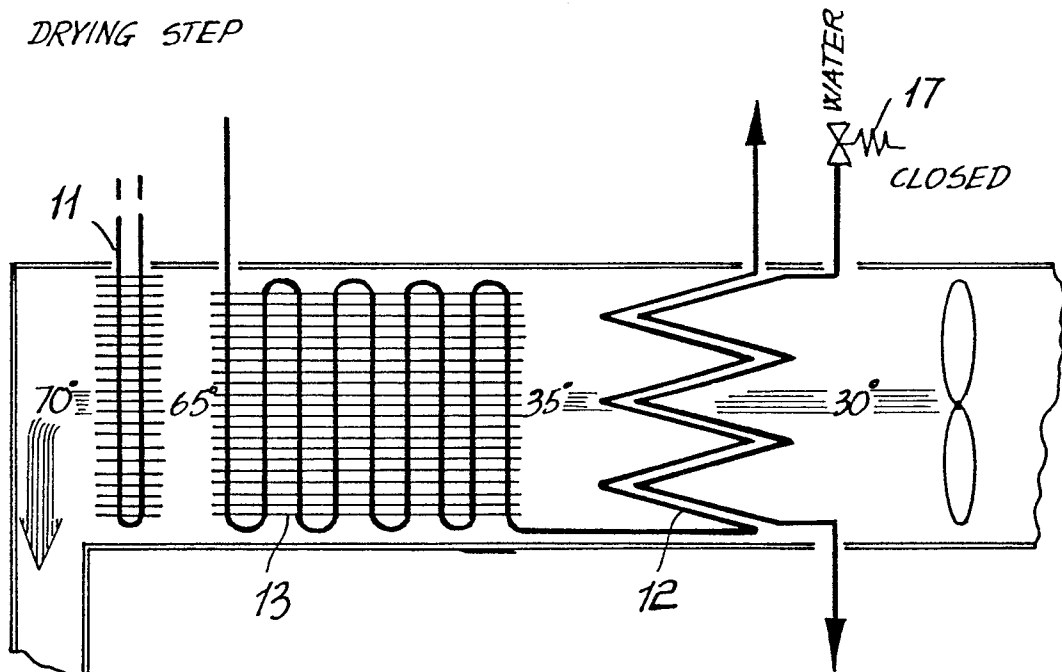


Fig. 5

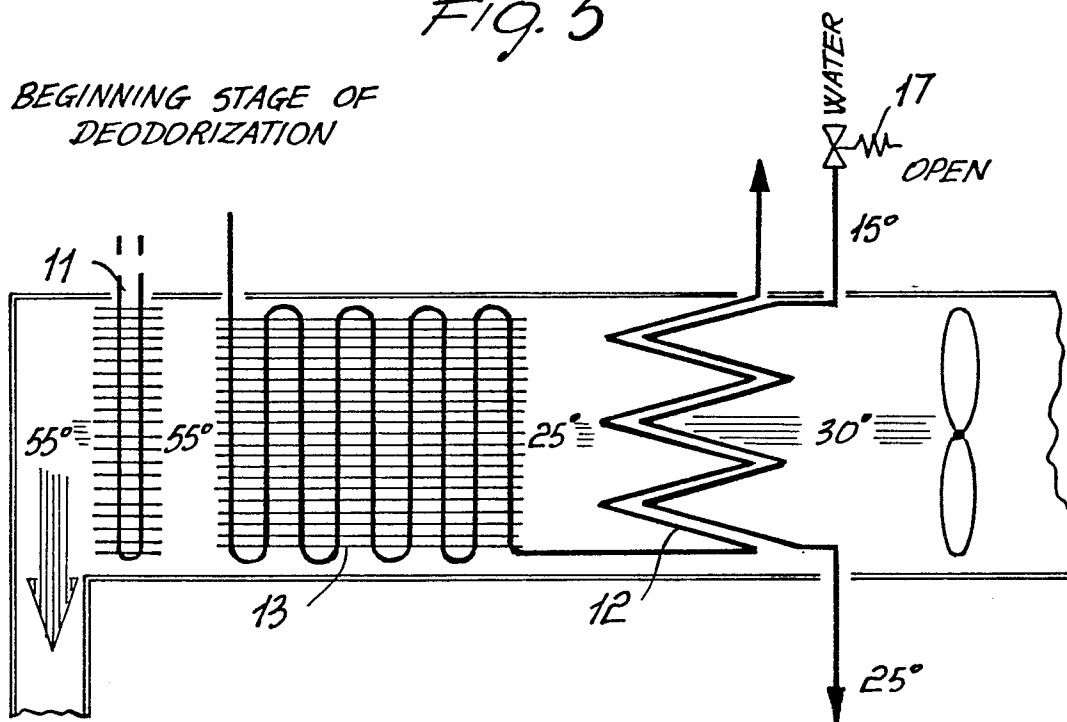
BEGINNING STAGE OF
DEODORIZATION

Fig. 6