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(54) Household clothes drying machine with two-stage condenser

(57) A clothes drying machine comprises a drum (1), a first fan (5) blowing a first flow of drying air through a drying-air conduit (2), a condenser (3) through which said flow of drying air "A" passes, a cooling-air conduit (4) conveying a second flow of fresh air through said condenser, said second flow being circulated by a second fan (6), and a motor (7) adapted to drive said fans. There is provided a second condensation element (11) run from circulation of drying air (A), and an auxiliary second cooling-air conduit (12) connecting said second condensation element to said second fan; a valve (13) is also placed into said auxiliary second cooling-air conduit, being able to selectively open/close said auxiliary second cooling air conduit.

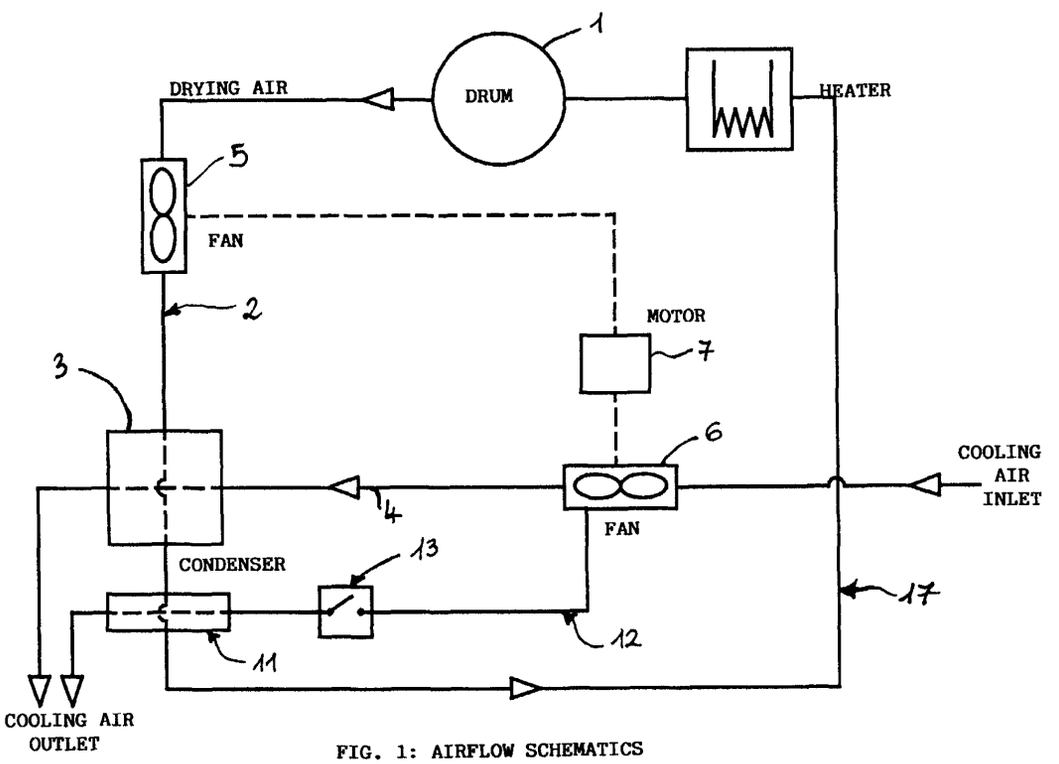

FIG. 1: AIRFLOW SCHEMATICS

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Description

[0001] This invention refers to an improved kind of clothes drying machine, preferably of the type for use in households, which is provided with an improved condenser in order to reduce the energy consumption and in the same time also the time required to perform a normal drying cycle.

[0002] The known condenser drying machines are generally provided with means for removing the moisture from the drying air comprising a condenser through which there is conveyed, further to the flow of the drying air itself, a second flow of cooling air, occurring of course separately from said flow of drying air, which is taken in from the outside ambient and appropriately delivered to flow through and, as a result, cool down said condenser.
Although reference to an autonomous, i.e. self-standing clothes drying machine will be made throughout the following description, it shall be appreciated that what is set forth below may similarly be applied to and, therefore, be suitable for combined clothes washing and drying machines.
The machines, which the present invention refers to, are generally known in the art. They have on the other hand been described, along with a detailed discussion of a technical nature on the advantages and the drawbacks of a number of different variations in the design and general embodiment thereof, in the European patent application no. 03028410.3 filed by this same Applicant with the title "Household clothes drying machine with improved condenser", to which reference should therefore be made for reasons of greater convenience and brevity in this description.
The present invention preferably applies to clothes drying machines which, further to a condenser, are also provided with:

- two distinct fans for blowing the drying air and the condenser cooling air, respectively,
- a single motor adapted to drive both said fans at the same time,
- said motor being adapted to be controlled so as to selectively rotate in the two opposite directions.

However, it will be readily appreciated that the present invention may be equally applied to condenser-type clothes drying machines of a traditional kind, i.e. provided with a regular condenser, but lacking the other features as indicated above.-
Largely known in the art are clothes drying machines that operate either by condensing a flow of hot air, which is first blown into the clothes-holding drum and, while circulating therethrough, removes moisture from the same clothes, or by exhausting said flow of hot moisture-laden air directly outside.
Upon having been blown into the clothes-holding drum, the hot air causes the moisture contained in the clothes to evaporate, thereby becoming almost saturated, or even fully saturated, therewith. This hot, moisture-laden air is then pushed further by said fan, thereby creating a continuous flow that is eventually sent into an appropriate condensation arrangement, which is usually constituted by a heat-exchanger flown through - along the so-called "hot" path - by said flow of hot moisture-laden air and - along the so-called "cold" path - by a substantially continuous flow of fresh air that is taken in from the outside ambient and is exhausted again into the outside ambient upon having so flown through said heat-exchanger.
Usually, even said flow of fresh air in the so-called "cold" path is activated and maintained by a fan, which is driven in a traditional manner by a respective electric motor.
Largely known in the art is also the fact that, during the initial phase of the drying process, no need would be actually felt for the drying air to be caused to undergo such moisture-removal process by letting it pass through the condenser, since it in fact undergoes a certain extent of condensation by itself owing to a still quite low temperature prevailing in the machine. Moreover, during the initial phase of the drying process, the need arises for both the clothes to be dried and the drying air itself to be heated up to the steady-state temperature thereof, so that, in this initial period, condensation taking place at the condenser would anyway be quite limited and, therefore, would make a cooling down of the drying air plainly useless, if not even detrimental.
However, since the motor used to rotatably drive the clothes-holding drum is connected also with the fans circulating the flows of air in the aforecited "hot" and "cold" paths, it ensues that, even if not desired, the condenser is anyway flown through by the cooling air also during said initial period of the drying process.
In view of doing away with such inherent drawback, a solution is generally well known which enables the rotation of the cooling fan in its main operation mode to be fully eliminated during said initial period, while allowing it to only rotate in its secondary operation mode, so as to achieve the twofold advantage of a rather reduced operating noise and a reduction in the aggregate drying time, without suffering the penalty of a poorer condensation. However, another drawback is seen in this case, in that by so limiting the motor to operate in a single direction of rotation, albeit as far as only the initial phase of the drying process is concerned, a certain effect of entanglement of the clothes to be dried is brought about, and this effect is then only in part straightened out during the subsequent phases of the drying process.
In order to avoid such a problem a solution is known from the cited European Patent application n. 03028410.3 wherein means are provided for diverting a flow of air, which means are adapted to divert said flow of drying air or, alternatively, said flow of cooling air, in such a manner that either one or the other of said flows is prevented from flowing through said the condenser; said means are preferably consisting of a kind of further conduit for the cooling air or the drying air so arranged

as to by-pass the condenser, and preferably used in the initial phases of the drying cycle.

[0003] This solution would then allow the drum to rotate in both directions even in the initial phase.-

[0004] However this solution will suffer the unavoidable fact of requiring a remarkable production complexity and mainly of requiring a large additional room, placed close to said condenser, to lodge said by-pass means.-

[0005] Furthermore in the known drying machine a further drawback is observed in the central phase of the drying process: in facts in this period the air used for the condenser cooling is sucked from outside the same drying machine, but the conduit that leads this air-flow to the condenser passes through the inner volume of the machine that has been already heated to a higher temperature, and consequently it heats the air contained inside said conduit, sucked and used for the condenser cooling.-

[0006] In these conditions, this cooling air inside said conduit is brought normally at a temperature of about 40° C, and it is easily understood that such an unwanted high temperature remarkably deteriorates the condensing process of the humidity contained in the drying air.-

[0007] The final and unavoidable result of such situation is an increase of the time length of the drying cycle and an increase of the energy consumption.-

[0008] It would therefore be desirable, and it is actually a main purpose of the present invention, to provide a condenser-type clothes drying machine, which is provided with a single motor to drive both the drying-air fan and the cooling-air fan, is capable of ensuring a standard-level drying performance, and is however capable of eliminating the above-cited drawbacks of both the entangling of the clothes, mainly during the initial drying phases (consequence of the drum having to rotate in a single direction of rotation during said same initial phases) and of requiring an increase of the inside room for lodging the additional means, and an unwanted raise of the complexity and of the overall cost of the drying machine.-

[0009] According to the present invention, this aim is reached, along with further ones that will be apparent from the following description, in a condenser-type clothes drying machine incorporating the features as recited in the appended claims.

[0010] Anyway, features and advantages of the present invention will be more readily understood from the description that is given below by mere way of non-limiting example with reference to the accompanying drawings, in which:

- Fig. 1 shows a schematic view of the different operational devices duly connected and used in a machine according to the present invention,
- fig. 2 is a top, cut-away view of a significant portion of the condenser and associated devices in a machine according to the present invention;
- Figure 3 is a perspective, partially see-through view of a portion of the back wall of the machine according to a preferred embodiment of the invention,
- fig. 4 shows a further improved embodiment of the back wall of the machine seen in fig. 3.-
- fig. 5 shows the compared diagrams of the condensed water quantity in a machine with and without the invention.-

[0011] In a clothes drying machine according to a prior-art embodiment there is provided a drum 1 adapted to hold the clothes to be dried, to which there is associated a conduit 2 for the circulation of the drying air; the latter flows also through a condenser 3, which is adapted to cause the moisture contained in the drying air flowing therethough to condense, said condenser being furthermore flown through by a flow of "cold" air, i.e. air taken in from the outside ambient and sent to said condenser 3 via a corresponding conduit 4. Both conduits 2 and 4 contain two respective fans 5, 6 therewithin, which are provided to circulate the drying-air flow and the cooling-air flow, respectively. Furthermore, the shafts of said two fans 5 and 6 are connected in any of the manners known as such in the art, even via appropriate mechanisms and gears, to a single motor 7 so that the rotation of this motor causes said two fans to correspondingly rotate in a synchronous manner. This motor 7 is controlled by appropriate control means (not shown), which are adapted to let it revolve in its two possible directions of rotation; as a result, this allows said two fans to be caused to selectively rotate in either direction, but in all cases in a mutually consistent manner (i.e., when a first fan rotates in a definite direction, the second fan will always rotate in a single and sole direction; and when the first fan changes its direction of rotation, the second fan will change its own direction of rotation, too).

In the traditional mode of operation, the motor driving the fan may also be used, via appropriate motion transmission means, to also rotatably drive the clothes-holding drum; in this connection, it is a common practice for said motor to be so controlled as to revolve for short periods of time in its normal, i.e. main direction of rotation, in which said short periods of rotation in that direction are alternated with other short periods during which said motor revolves in the opposite, i.e. secondary direction of rotation.

[0012] According to the present invention, said machine is improved in the following manner: with reference to Fig. 1, and remembering that the condenser 3 is flown through by two distinct streams of drying air and cooling air, there are provided means practically consisting of a second condensation element 11, placed in series with said condenser 3, meaning that it is crossed by the same drying air-flow crossing the condenser: said second condensation element 11 is cooled by an air-flow passing through a respective auxiliary second cooling-air conduit 12, placed downstream of said condenser 3 and that takes said air-flow from the same fan 6

which is blowing also into said conduit 4, as symbolically illustrated.-

[0013] Furthermore in the auxiliary second cooling-air conduit 12 there is provided a closing means, which is preferably constituted by a valve 13. This valve is adapted to receive the flow of cooling air coming from said fan 6, and to selectively stop it, or let it go, according to the working phase of the drying cycle.-

[0014] Preferably said valve comprises a moving partition, not shown, which, as appropriately actuated, is capable of selectively close or open said conduit 12, thereby enabling the flow of respective cooling air to be directed towards said second condensation element 11.-

[0015] Even if so simply described, the operation of said machine will be easily understood by any person skilled in the art; in the fact the operation period of the machine, in which a drying cycle is implemented, can be split into three sub-phases, that is in a first sub-phase in which the drying air is still quite cool and not yet laden with humidity, in a central phase where the air is being heated up gradually to its process temperature, while becoming increasingly laden with the moisture it removes from the clothes, and in a final phase wherein the drying air is very hot but less humid as the clothing is already almost fully dried.-

[0016] In the machine just described the operation during the first sub-phase is quite normal and said valve 13 stays closed; in the fact in this period the drying air is still cool and not humid, and therefore it doesn't need to be further cooled.

[0017] In the central sub-phase said valve 13 is opened, allowing the blowing of an outside fresh air flow towards said second condensation element 11, and as a consequence offers a supplementary condensation action and finally makes the whole drying process to be accelerated, bringing to the wanted reduction of the energy consumption.

[0018] To the likely objection that under this circumstance the fan 6 would work in a not optimised way, it can be answered by observing that the unbalance generated in the air flows is very weak and such not to change in a significant way the cooling air flow rate towards the condenser 3 through said conduit 4.

[0019] In the final sub-phase said valve 13 is let open, or it is again closed, according to the balance, case by case, of the condensing ability of the condenser 3 with respect to that of said second condensing element 11.

[0020] In the above proposed embodiment the present invention allows further advantageous improvements to be added: with reference to figures 2 and 3 said second condensing element 11 is placed soon downstream the condenser 3, so that the relevant conduit 12 is practically void, and so the benefit is obtained that the airflow "B" that is blown towards said second condensation element 11 is not submitted to any heating action.

[0021] A second improvement consists in that the collecting reservoir 14 of the condensing water of the condenser 3 is used also as a collecting reservoir of said second condensation element 11, therefore saving apparent production costs.

[0022] With reference to figures 3 and 4, such possibility is achieved with a machine construction wherein the drying air-flow "A", leaving the condenser 3 to be blown into said conduit 16 leading into the drum, before being blown in said conduit 16 is brought into a short intermediate conduit 17 that is merely a part of said conduit having a side 18 forming a delimiting wall of said second auxiliary conduit wall 12 (see fig. 3).

[0023] As a matter of fact, said side 18 does materialise said second condensation element 11, as it will be soon apparent from the figure 3.

[0024] It has to be noted that the whole second condensing element 11 is represented in fig. 3 from the closed and dashed line "C".

[0025] As a consequence, the drying air-flow "A" licks said auxiliary conduit 12, so to enable the effect of an additional condensation phase.

[0026] A third improvement is intended to prevent a too strong cooling of the drying air-flow leaving the condenser 3 and that is blown into said conduit 16 before entering the drum (possibly passing on the heating resistors, not shown); with ref. to fig. 4, it may be observed that said second auxiliary conduit 12 is extended and shaped in a way that said wall 18, delimiting said second conduit 12 with respect to the above conduit 17 going out form the condenser, be as wide as possible.

[0027] Preferably said second auxiliary conduit 12 should be stretched along the whole outside course of said conduit 17.

[0028] A further improvement can be obtained providing that said condenser 3 and said side wall 18 are thermally insulated; the benefit of it is that the higher temperature of the condenser 3 is prevented from being transferred to said side wall 18, therefore holding it at a lower temperature, that moreover is kept at a room and so constant temperature, being lodged outside the machine.

Due to the fact that the air-flow passing through said conduit 12 is slightly heated as it runs close to the intermediate conduit 17 coming out from the condenser 3 and bringing the drying air-flow "A" (obviously warmer of the room air), it effectively makes up a means of thermal insulation for said drying air-flow "A" with respect to the surrounding room; therefore a reduction of the temperature lowering of said air-flow "A" downstream the heater is obtained.

[0029] Basically, said second auxiliary conduit 12 works both as a further cooling means of the drying air-flow, generating a supplementary condensation, and as an indirect heating means, as it generates a reduction of the natural cooling of the drying air-flow "A" in said conduit 16, but only downstream said heater.

[0030] The benefit of the invention can be well described in the fig. 5; it represents the quantity of the wa-

ter that is condensed in a drying machine in the two different tests referred to two different conditions, i.e. when the condenser 3 only operates, and when both the condenser 3 and the second condensation element 11 are activated in the same time; of course to be technically correct, the two tests have been made on the same machine, and with all the other conditions unchanged : it is apparent the increase of around 3 % of the condensed water at the end of the test, that corresponds to a typical drying cycle. -

[0031] It is also well known to the man skilled in the art that said improved drying performance can be used and exchanged to shorten instead the total drying time, or alternatively to save energy, or even to make drying machines with slower speed of fan rotation and so more silent.-

Claims

1. Clothes drying machine, or combined clothes washing and drying machine, comprising a drum (1) holding the clothes to be dried, a conduit (2) for the circulation of the drying air, a first fan (5) adapted to blow a first flow of drying air through said drum and into said conduit (2), a condenser (3) through which said flow of drying air is caused to pass, a cooling-air conduit (4) conveying a second flow of fresh air through said condenser (3), said second flow being circulated by a second fan (6) associated to said cooling-air conduit (4), a motor (7) adapted to selectively rotate in a main rotating mode and in a secondary rotating mode opposite thereto, and to jointly drive drive said first and second fans (5, 6), **characterized in that** are provided:

   - a second condensation element (11) crossed or licked from said circulation of drying air (A),
   - an auxiliary second cooling-air conduit (12) connecting said second condensation element (11) to said second fan (6), so that its working will send a respective air-flow to said second condensation element (11) through said auxiliary second cooling air conduit (12).-

2. Clothes drying machine, or combined clothes washing and drying machine, according to claim 1, **characterized in that** said second cooling air conduit (12) comprises a device, preferably a valve (13), that is arranged into said second cooling-air conduit and is adapted to selectively shut off (prevent) the passage towards said second condensation element (11).-

3. Clothes drying machine according to any of the claims 1 or 2, **characterized in that** said second condensation element (11) is separated from said conduit (2), for the circulation of the drying air, by a wall (18) placed outside said machine. -

4. Clothes drying machine according to the preceding claims, **characterized in that** said second condensation element (11) is set close downstream of said second fan (6).-

5. Clothes drying machine according to any of the preceding claims, **characterized in that** the collecting chamber (14) of the condensation water of said condenser (3) is able to collect also the water condensed by said second condensation element (11).-

6. Machine according to any of the preceding claims 3 to 5, **characterized in that** said wall (18) does extend basically for the whole outer course of said conduit (2) for the circulation of the drying air.-

7. Machine according to any of the preceding claims from b3 to 6, **characterized in that** said condenser (3) is thermally insulated from said wall (18).-

8. Machine according to any of the preceding claims from 2 on **characterized in that** it is able to automatically open said auxiliary second cooling-air conduit (12) during an intermediate phase of the drying cycle.-

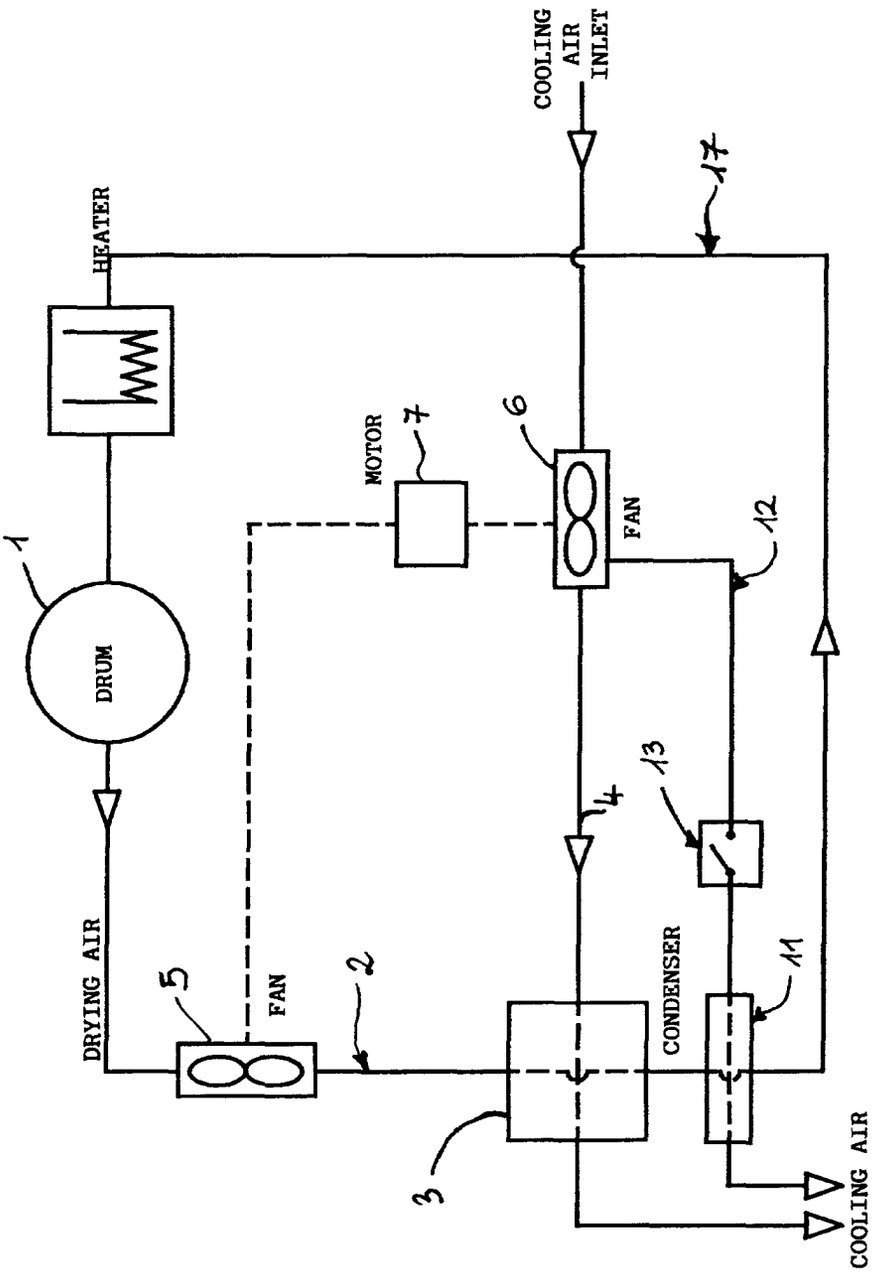


FIG. 1: AIRFLOW SCHEMATICS

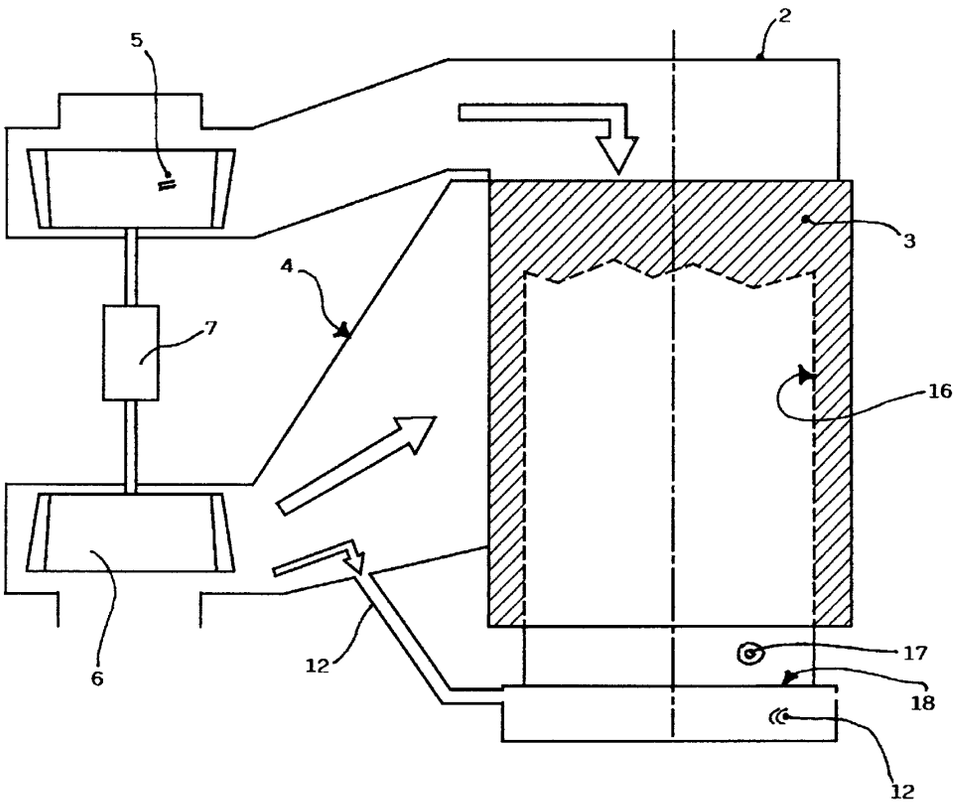


FIG. 2

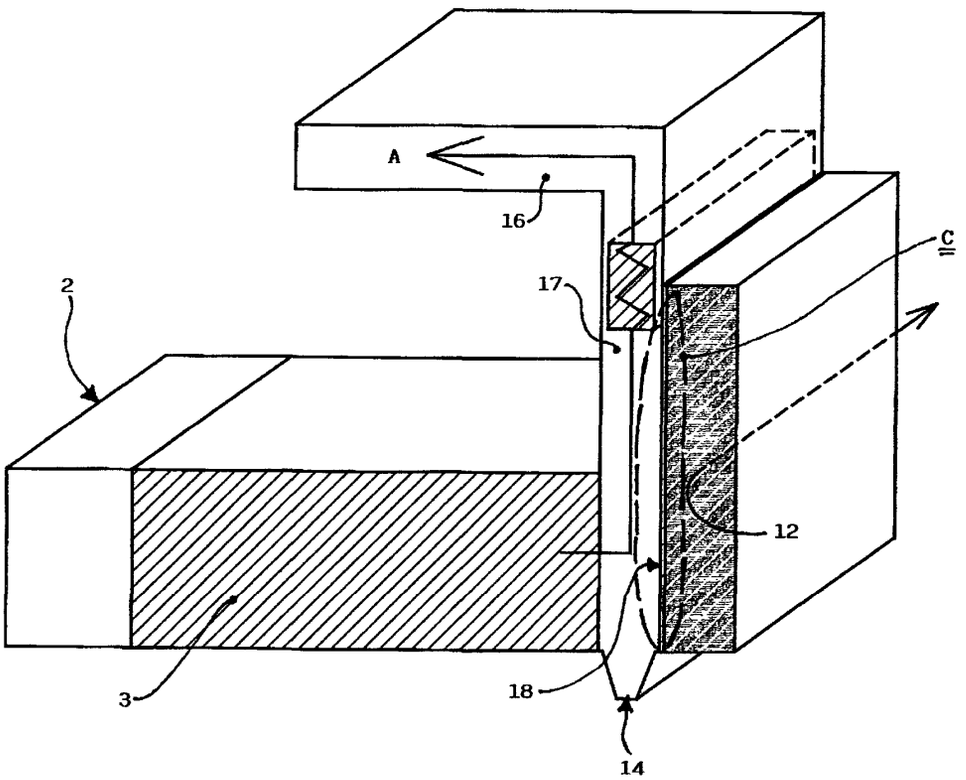


FIG. 3

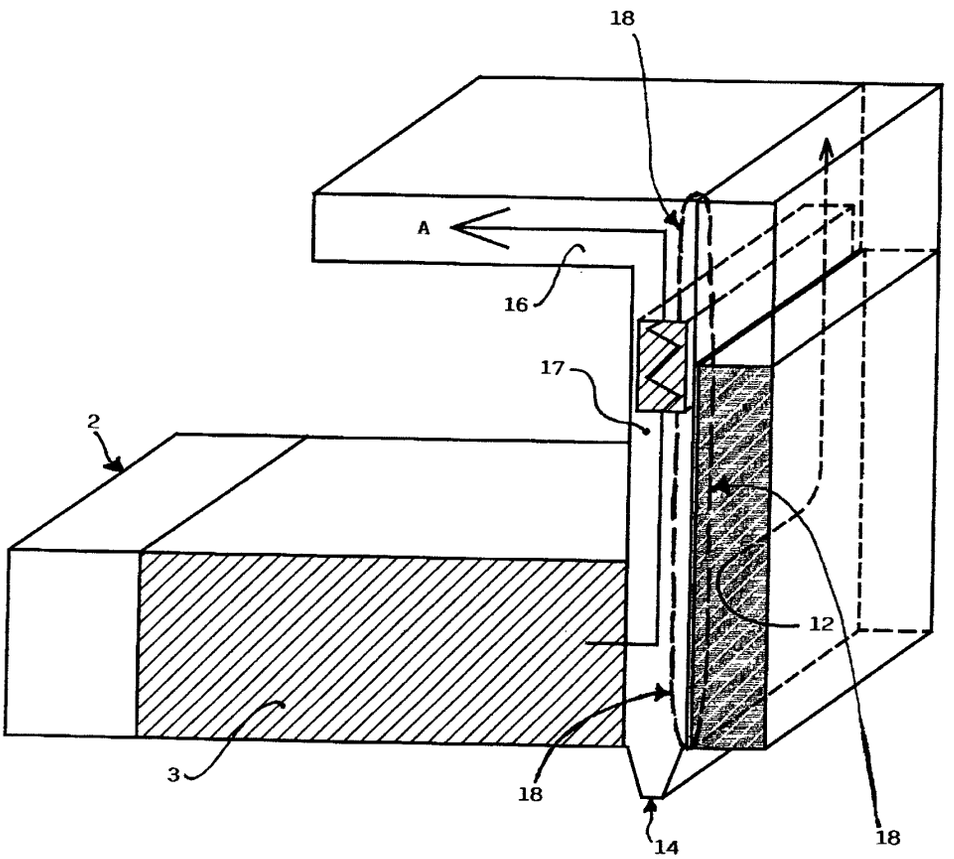
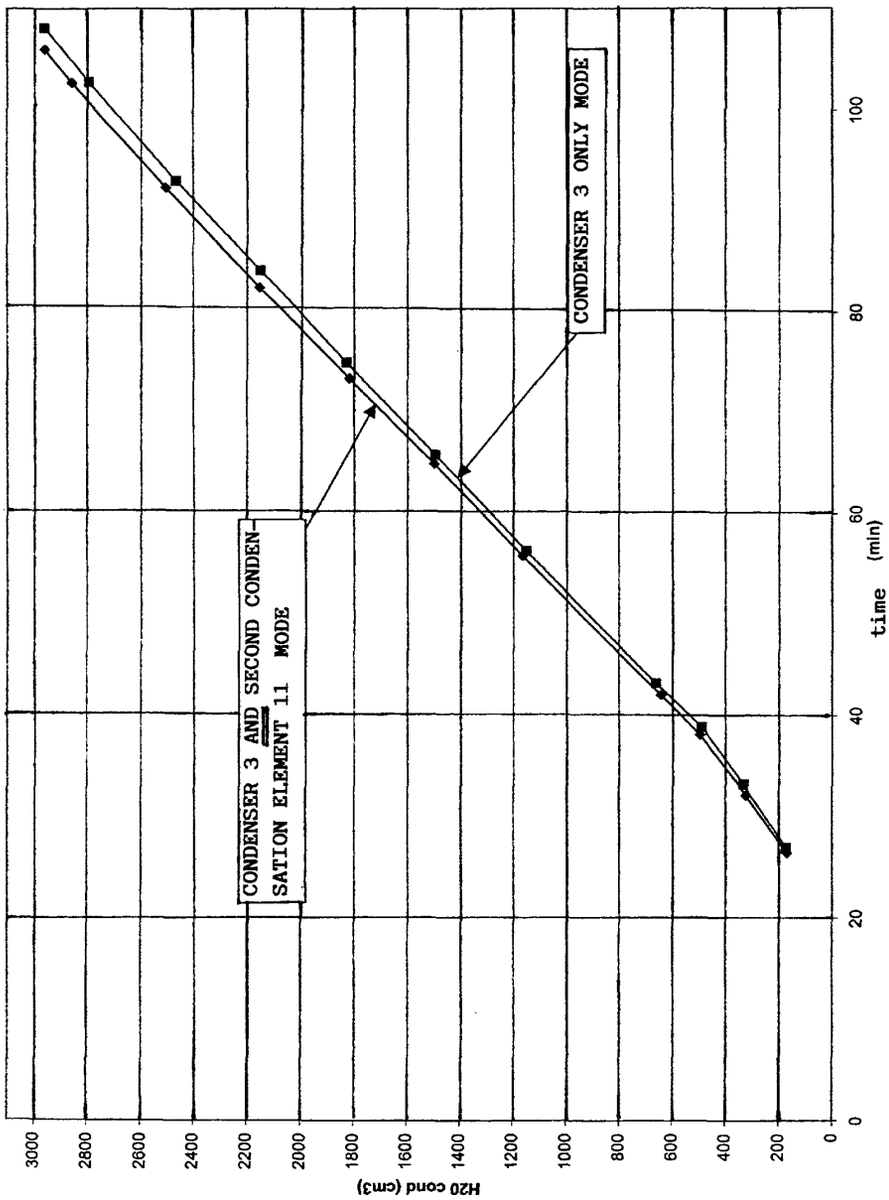


FIG. 4


H20 cond (cm3)
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2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
time (min)
CONDENSER 3 AND SECOND CONDENSATION ELEMENT 11 MODE
CONDENSER 3 ONLY MODE

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 04 10 1800

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 0031, no. 30 (M-078), 27 October 1979 (1979-10-27) -& JP 54 106960 A (HITACHI LTD), 22 August 1979 (1979-08-22) * figures 3-5 *	1,2,8	D06F58/24 D06F25/00
A	DE 199 04 993 A (MIELE & CIE) 10 August 2000 (2000-08-10) * the whole document *	1	
A	EP 1 108 812 A (BSH BOSCH SIEMENS HAUSGERAETE) 20 June 2001 (2001-06-20) * the whole document *	1	
A	EP 0 434 169 A (OCEAN SPA) 26 June 1991 (1991-06-26) * the whole document *	1	
A	GB 2 097 519 A (LICENTIA GMBH) 3 November 1982 (1982-11-03) * figure 1 *	3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) D06F
A	GB 2 059 035 A (ARENDT HANS F) 15 April 1981 (1981-04-15) * the whole document *	5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 September 2004	Ureta, R

CATEGORY OF CITED DOCUMENTS

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29-09-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 54106960 A	22-08-1979	JP 1297677 C	20-01-1986
		JP 60020036 B	20-05-1985
DE 19904993 A	10-08-2000	DE 19904993 A1	10-08-2000
		AT 244787 T	15-07-2003
		DE 50002805 D1	14-08-2003
		WO 0047810 A1	17-08-2000
		EP 1070165 A1	24-01-2001
		ES 2199785 T3	01-03-2004
		PL 343405 A1	13-08-2001
EP 1108812 A	20-06-2001	DE 19959977 A1	21-06-2001
		AT 274093 T	15-09-2004
		DE 50007458 D1	23-09-2004
		EP 1108812 A1	20-06-2001
EP 0434169 A	26-06-1991	IT 1237157 B	24-05-1993
		EP 0434169 A2	26-06-1991
GB 2097519 A	03-11-1982	DE 3115704 A1	04-11-1982
		NL 8201412 A	16-11-1982
GB 2059035 A	15-04-1981	DE 2936769 A1	19-03-1981
		CA 1139096 A1	11-01-1983
		DD 152982 A5	16-12-1981
		FR 2465174 A1	20-03-1981
		JP 56045699 A	25-04-1981
		NL 8004618 A	16-03-1981

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