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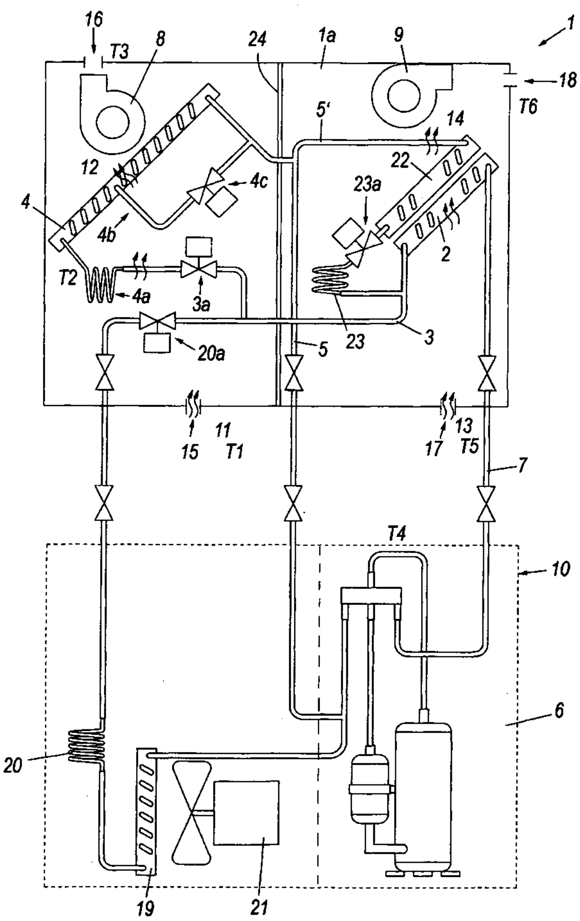
(54) Kitchen hood recovering a quantity of heat

(57) A kitchen hood (1) for recovering a heat quantity contained in a gas mixture, the hood (1) being provided with a housing (1a) which comprises a recovery heat exchanger (4) for subtracting a first heat quantity from said gas mixture (11) withdrawn from above the cooking hob, said recovery heat exchanger (4) being connected to compression means (6). These compression means (6) are connected to an internal heat exchanger (2) for exchanging a second heat quantity, proportional to that recovered in said recovery heat exchanger (4), against a gas mixture (13) originating from the internal environment in which said hood (1) is located, said internal heat exchanger (2) being connected to said recovery heat exchanger (4) via a throttling device (4a). A vector fluid flows through said heat exchangers (2, 4), through said throttling device (4a) and through said compression means (6) to perform a thermodynamic cycle with compression of the saturated vapours of the vector fluid.



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Description

[0001] The present invention relates to a kitchen hood for recovering a heat quantity contained in a gas mixture which would otherwise be dispersed by the hood when this is in operation, in accordance with the introduction to the main claim.

[0002] The problem of energy saving is known to be one of the most felt of the last few decades, hence the ability to recover energy dispersed, for example during food preparation and/or during air change, has become increasingly more interesting and important.

[0003] In addition, the reduction in the dimensions of available living accommodation is becoming increasingly greater.

[0004] There is therefore the need for a compact device which combines various functions while being able to utilize the energy dispersed during the use of the hood.

[0005] The object of the present invention is therefore to provide a kitchen extraction hood for recovering a heat quantity contained in a gas mixture which would otherwise be dispersed by the hood when in operation, comprising a device in which a fluid is made to undergo a thermodynamic cycle such that by changing its state it absorbs heat from the hot moist gas mixture at a determined temperature, and yields heat, again mainly by changing its state, at higher temperatures to a different gas mixture.

[0006] This object is attained by a kitchen hood for recovering a heat quantity which would otherwise be dispersed by the hood when in operation, the inventive characteristics of which are highlighted by the accompanying claims.

[0007] The invention will be more apparent from the ensuing detailed description of one embodiment thereof provided by way of non-limiting example and illustrated in the accompanying drawing, in which:

> the figure shows a schematic view of a kitchen extraction hood for recovering a heat quantity which would otherwise be dispersed when the hood is in operation.

[0008] With reference to the figure, this shows a hood 1 for recovering a heat quantity contained in a gas mixture, with a housing 1 a which comprises an internal heat exchanger 2 connected by a conduit 3 to a throttling device 4a, itself connected to a recovery heat exchanger 4.

[0009] In this sense, a gas mixture means a mixture comprising air and possibly other gases, suspended aerosols, oily substances and water vapour.

[0010] Advantageously, the conduit 3 comprises recovery valve means 3a for intercepting the flow of a vector fluid, preferably represented by a two-way solenoid valve, to allow or prohibit the passage of the vector fluid between the heat exchangers 2, 4.

[0011] Preferably, these recovery valve means 3a for intercepting the flow are located between the throttling device 4a and the internal heat exchanger 2.

[0012] Advantageously, the recovery heat exchanger 4 comprises a turn-down circuit 4b comprising for example control valve means 4c, preferably represented by a two-way solenoid valve, for regulating the turn-down circuit 4b.

[0013] The recovery heat exchanger 4 is connected via a conduit 5 to compression means 6.

[0014] Advantageously, these compression means 6 are positioned outside the hood 1.

[0015] The compression means 6 are then connected via a further conduit 7 to the internal heat exchanger 2, such as to close the thermodynamic circuit of the invention.

[0016] In particular, a conventional vector fluid flows through the heat exchangers 2, 4, through the throttling device 4a and through the compression means 6 to form a thermodynamic cycle with compression of the saturated vapours of the vector fluid in the manner described hereinafter.

[0017] A first fan 8, or suction fan, is positioned in proximity to the recovery heat exchanger 4.

[0018] In particular, this suction fan 8 is that conventionally provided in extraction hoods.

[0019] For example, the suction fan 8 is positioned either above or below the recovery heat exchanger 4.

[0020] A second fan 9, or internal fan, is positioned in proximity to the internal heat exchanger 2.

[0021] For example, the internal fan 9 is positioned either below or above the internal heat exchanger 2.

[0022] Advantageously, if the internal fan 9 is positioned downstream of the internal heat exchanger 2 (with respect to the gas flow) the gas flow velocity distribution over the heat exchanger 2 is improved.

[0023] Again advantageously, in the housing 1 a first apertures 15 are provided to convey a gas mixture 11 withdrawn from above cooking hobs to the recovery heat exchanger 4, and second apertures 16 for expelling to the external environment the gas mixture 12 which has passed through the recovery heat exchanger 4.

[0024] Specifically, the gas mixture 11 withdrawn from above the cooking hobs is that of the internal environment itself if the cooking hobs are not functioning, whereas if they are functioning it also contains the products of combustion of the cooking hobs themselves.

[0025] The internal environment means the environment containing the hood, whereas the external environment is the external air.

[0026] Advantageously, between the recovery heat exchanger 4 and the first apertures 15 one or more filtration devices, for example oil removal filters, not shown in the figures for simplicity, are provided to ensure normal operability of the extraction hood.

[0027] Moreover, in the housing (1 a) third apertures 17 are provided to convey a gas mixture 13 from the internal environment to the internal heat exchanger 2, and fourth apertures 18 to expel that gas mixture 14 which has passed through the internal heat exchanger 2, to the outside of the hood, but still into the internal environment where the hood is located,.

[0028] In the hood housing 1a, at least one internal baffle 24 is provided to maintain the gas flow entering through the apertures 15 and leaving from the apertures 16 separate from the gas flow entering through the apertures 17 and leaving from the apertures 18.

[0029] In one embodiment of the invention, the hood 1 of the invention comprises only one fan both for expelling and for treating the gas mixtures.

[0030] For example, a double suction centrifugal fan arranged transversely to the housing 1 a can be used. The rear part of the fan is used for treating the gas mixture 11 while the front part is used for the gas mixture 13. The flow thus generated is divided into two by a separator baffle which extends into the fan volute. The first gas flow is expelled through the second apertures 16 while the second gas flow is expelled through the fourth apertures 18.

[0031] Advantageously, one or more filtration devices, not shown in the figures for simplicity, are provided between the internal heat exchanger 2 and the third apertures 17.

[0032] Again advantageously, one or more filtration devices, not shown in the figures for simplicity, are provided between the internal heat exchanger 2 and the fourth apertures 18.

[0033] Advantageously according to the invention, the internal heat exchanger 2, the compression means 6 and the second fan 9 can be combined into a conditioning/heat pump device of known type comprising an inner unit to be positioned inside the internal environment and an outer unit 10; in particular, the internal heat exchanger 2 and the fan 9 in the inner unit of the conditioning device are as used conventionally, while the compression means 6 provided in the outer unit 10 are a compressor.

[0034] In this latter embodiment, the conduit 5 is connected to the compressor 6 of the outer unit 10 of the conditioning device.

[0035] In this embodiment, an external heat exchanger 19 is connected to the internal heat exchanger 2 by a further throttling device 20.

[0036] Conditioning valve means 20a are provided between the external heat exchanger 19 and the further throttling device 20.

[0037] The external heat exchanger 19 is connected to the compression means 6 such that with the aid of a further external fan 21, it can operate as a conditioning device or as a conventional heat pump when the recovery valve means 3a are closed, whereas the conditioning valve means 20a are open.

[0038] In particular, the external heat exchanger 19, the further throttling device 20, the compression means 6 and the further external fan 21 are conventionally combined into an outer unit 10 of a conditioning device.

[0039] However in a particularly compact embodiment, there is nothing to prevent the outer unit 10 from being totally included in the housing 1 a of the hood 1.

[0040] In this variant, one or more conduits must be provided to connect the external heat exchanger 19 to the external environment.

[0041] Advantageously, the kitchen hood 1 of the invention further comprises an afterheater heat exchanger 22 connected to the internal heat exchanger 2 via a further throttling device 23.

[0042] Advantageously, this afterheater heat exchanger 22 is positioned downstream of the internal heat exchanger 2 with respect to the gas flow, such that the internal fan 9 can convey the gas mixture 13 drawn from the internal environment through both.

[0043] Below the heat exchanger 2 there is a condensate collector with the same characteristics as that positioned on the heat exchanger 4.

[0044] The afterheater heat exchanger 22 is connected to the compression means 6 by a further conduit 5'.

[0045] Further dehumidification valve means 23a for intercepting a vector flow, preferably a two-way solenoid valve, are provided between the afterheater heat exchanger 22 and the internal heat exchanger 2 to interrupt the vector fluid flow through them.

[0046] A first method of operating the kitchen extraction hood for recovering a heat quantity contained in a gas mixture, according to the invention, will now be described.

[0047] The aim is to recover that heat quantity which would otherwise be dispersed by the hood when in operation.

[0048] By activating the suction fan 8, that gas mixture 11 withdrawn from above the cooking hobs is forced to pass through the recovery heat exchanger 4.

[0049] The gas mixture 11 has a temperature T1 generally higher than or equal to ambient temperature, which for example is 18°C.

[0050] Advantageously, before reaching the heat exchanger 4 the gas mixture 11 is passed through one or more filtration devices conventionally provided in the hood 1, by which oily substances are removed.

[0051] The vector fluid which flows through the recovery heat exchanger 4, at a temperature T2 less than T1, absorbs a first heat quantity from the gas mixture 11 and then evaporates by conventional transformation of state, substantially at constant pressure and temperature.

[0052] The recovery heat exchanger 4 specifically operates as an evaporator.

[0053] The gas mixture 11 transfers to the vector fluid a heat quantity comprising two quantities: a first heat quantity, or sensible heat, which results in lowering of its temperature, and a second heat quantity, or latent heat, which results in condensation of the steam.

[0054] The gas mixture 12 leaving the recovery heat exchanger 4, which is at a temperature T3 much lower than the temperature T1, is then expelled to the outside, for example via an expulsion conduit.

[0055] The evaporated vector fluid is fed to the compressor 6 through the conduit 5, while the steam condensate is collected in collection means provided below the recovery heat exchanger 4 in accordance with the known art.

[0056] The compressor 6 compresses the evaporated vector fluid to raise it to a higher temperature and higher pressure, by almost isentropic transformation, and conveys it to the internal heat exchanger 2 through the conduit 7.

[0057] The internal fan 9 draws the gas mixture 13 from the internal environment and forces it to flow through the internal heat exchanger 2

[0058] Advantageously, the gas mixture 13 is passed through one or more filtration devices, disposed upstream and/or downstream (with respect to the gas flow) of the heat exchanger 2 and/or of the fan 9.

[0059] The gas mixture 13 has a temperature T5 lower than the temperature T4 of the fluid in the heat exchanger 2.

[0060] The superheated saturated vapour of the vector fluid which flows through the internal heat exchanger 2 transfers a second heat quantity to the gas mixture 13 to raise it to a temperature T6 higher than T5. This second quantity is evidently proportional to the first heat quantity acquired by the vector fluid in the recovery heat exchanger 4.

[0061] In particular, in this embodiment, the internal heat exchanger 2 operates as a condenser because in its interior the vector fluid changes state from vapour to liquid.

[0062] The air flow 14 at temperature T6 which leaves the internal fan 9 is then returned to the internal environment.

[0063] The saturated vapour of the vector fluid at temperature T4, which flows through the internal heat exchanger 2, transfers a first sensible heat quantity in cooling down, and a second latent heat quantity in condensing. It is hence retransformed into a liquid fluid, and is fed to the throttling device 4a where it expands to reduce its pressure and temperature.

[0064] The vector fluid is then fed to the recovery heat exchanger 4 to recommence the thermodynamic cycle.

[0065] Advantageously according to the invention, the thermodynamic cycle just described takes place in accordance with known modalities of refrigeration cycles.

[0066] Advantageously according to the invention, by activating the control valve means 4c only a portion of the heat exchanger 4 is involved in vector fluid circulation. In this manner the heat quantity absorbed by the vector fluid can be regulated, with fine regulation of the heat recovery achieved by the hood 1 of the invention.

[0067] In conclusion, the hood 1 of the invention enables a series of devices to be installed in its interior enabling a thermodynamic cycle for saturated vapour compression (also known as a heat pump) to be achieved which enables a large part of the contained heat to be extracted from the gas mixture (moist air), and/or from the other gaseous substances or suspended aerosols produced by the cooking hob and evacuated towards the outside, using a vector fluid as the medium for transferring the heat to the internal environment.

[0068] In particular, the lowering of the temperature of the gas mixture 11 originating from the cooking hob and/or from the internal environment, determined by the evaporator 4 of the heat pump cycle, enables recovery both of the sensible heat (by temperature difference) and of the latent heat (by condensing the moisture and the other vapours dissolved in the gas mixture) of the gas mixture itself. The recovered heat is again transferred (in the form of sensible heat) to the gas mixture of the internal environment by the internal heat exchanger 2 of the heat pump.

[0069] Advantageously, this thermodynamic process results in a high efficiency in the recovery of heat from the flow 11, heat which would otherwise be dispersed to the external environment, and prevents any mixing between the gas mixture 11 originating from the cooking hob and the gas mixture from the internal environment, with consequent prevention of any contamination because of the absence of physical mixing either direct or indirect between the moist air flow and gaseous substances 11 and the gas flow 13 of the internal environment.

[0070] A second method of operation of the invention will now be described, comprising closing the recovery valve means 3a and the conditioning valve means 20a, while the dehumidification valve means 23a are open.

[0071] On activating the internal fan 9, the gas mixture 13, which has a determined temperature and a determined degree of humidity, is made to pass through the internal heat exchanger 2, to transfer a heat quantity to the vector fluid flowing through this internal heat exchanger 2.

[0072] By transferring heat, the gas mixture 13a firstly cools and then on reaching the dew point causes the water vapour contained in it to condense. The condensate water is then drained by collection means pertaining to the known art. The vector fluid heats up and evaporates to become saturated vapour.

[0073] The vector fluid in the saturated vapour state is fed to the compression device 6 where it is compressed and superheated.

[0074] This superheated saturated vapour is then fed to the afterheater heat exchanger 22. The cooled and dehumidified gas mixture 13a is forced through the afterheater heat exchanger 22 where it acquires a heat quantity from the vector fluid. By means of this process the temperature of the gas flow 14 returns to values close to that of the gas flow 13.

[0075] The vector fluid in the superheated saturated vapour state, after being cooled and condensed, is fed to the throttling device 23 to undergo temperature and pressure reduction before being returned to the internal heat exchanger 2 to recommence the thermodynamic cycle.

[0076] According to this method, the hood 1 of the invention can also reuse the heat extracted from the gas mixture 13 during the dehumidification stage, to then heat it before feeding it to the internal environment and then activate a process of dehumidification alone without ambient temperature variation.

[0077] This internal transfer of heat is effected by a fluid which performs the function of thermal vector within the heat pump cycle.

[0078] This avoids the use of energy for afterheating by the gas mixture 13 while simultaneously preventing heat dispersion during the condensation stage, in contrast to that which occurs in conventional dehumidification devices integrated into common atmospheric air conditioners in which the heat quantity absorbed during air dehumidification is dispersed into the external environment and hence constitutes an energy loss from the system. It also prevents the dehumidified air, which is at lower than ambient temperature, from being fed into the environment and lowering its temperature.

[0079] Finally, as can be deduced from the description, by closing the recovery valve means 3a and the dehumidification valve means 23a and opening the conditioning valve means 20a, the hood of the invention can operate as a conventional conditioning device or heat pump, by using the internal heat exchanger 2 and the internal fan 9 for cooling and dehumidifying the air in summer or heating it in winter, while the further throttling device 20, the compression means 6, a further external fan 21 and the external heat exchanger 19 act as the external heat transfer unit of the conditioning device or heat pump.

[0080] Advantageously according to the invention, the valve means are connected to a control unit which causes them to open or close on the basis of the operating method required by the user. Moreover by providing external sensors which measure the parameters of the internal environment, of the external environment and the operating conditions of the hood 1 of the invention, al the functions necessary for controlling the temperature, the relative humidity and the heat recovery from the gas flow 14 expelled by the hood 1 can be automatically coordinated.

Claims

1. For recovering a heat quantity contained in a gas mixture, a kitchen hood (1) provided with a housing (1 a) which comprises a recovery heat exchanger (4) for subtracting a first heat quantity from said gas mixture (11) withdrawn from above the cooking hob, said recovery heat exchanger (4) being connected to compression means (6), said compression means (6) being connected to an internal heat exchanger (2) for exchanging a second heat quantity, proportional to that recovered in said recovery heat exchanger (4), against a gas mixture (13) originating from the internal environment in which said hood (1) is located, said internal heat exchanger (2) being connected to said recovery heat exchanger (4) via a throttling device (4a), wherein a vector fluid flows through said heat exchangers (2, 4), through said throttling device (4a) and through said compression means (6) to form a thermodynamic cycle with compression of the saturated vapours of said vector fluid.

2. A kitchen hood (1) as claimed in claim 1, wherein said compression means (6) are located outside said hood (1).

3. A kitchen hood (1) as claimed in claim 1, wherein said recovery heat exchanger (4) is connected to a turn-down circuit (4b) enabling only a portion of said recovery heat exchanger (4) to be used.

4. A kitchen hood (1) as claimed in claim 3, wherein said turn-down circuit (4b) comprises control valve means (4c) for regulating the vector fluid quantity flowing through said recovery heat exchanger (4).

5. A kitchen hood (1) as claimed in claim 1, comprising a suction fan (8) positioned in proximity to said recovery heat exchanger (4).

6. A kitchen hood (1) as claimed in claim 3, wherein said suction fan (8) is that conventionally provided in extraction hoods.

7. A kitchen hood (1) as claimed in claim 1, comprising an internal fan (9) positioned in proximity to said internal heat exchanger (2).

8. A kitchen hood (1) as claimed in claim 7, wherein said internal fan (9), said internal heat exchanger (2) and said compression means (6) are those conventionally provided in a conditioning device/heat pump.

9. A kitchen hood (1) as claimed in claim 1, wherein said hood (1) comprises first apertures (15) to convey said gas mixture (11) withdrawn from above cooking hobs to said recovery heat exchanger (4), second apertures (16) to expel to the outside of said hood (1) a gas mixture (12) which has passed through said recovery heat exchanger (4), third apertures (17) to convey said gas mixture (13) from the environment to said heat exchanger (2), and fourth apertures (18) to expel to the outside of said hood (1), but into the internal environment, a gas mixture (14) which has passed through said internal heat exchanger (2).

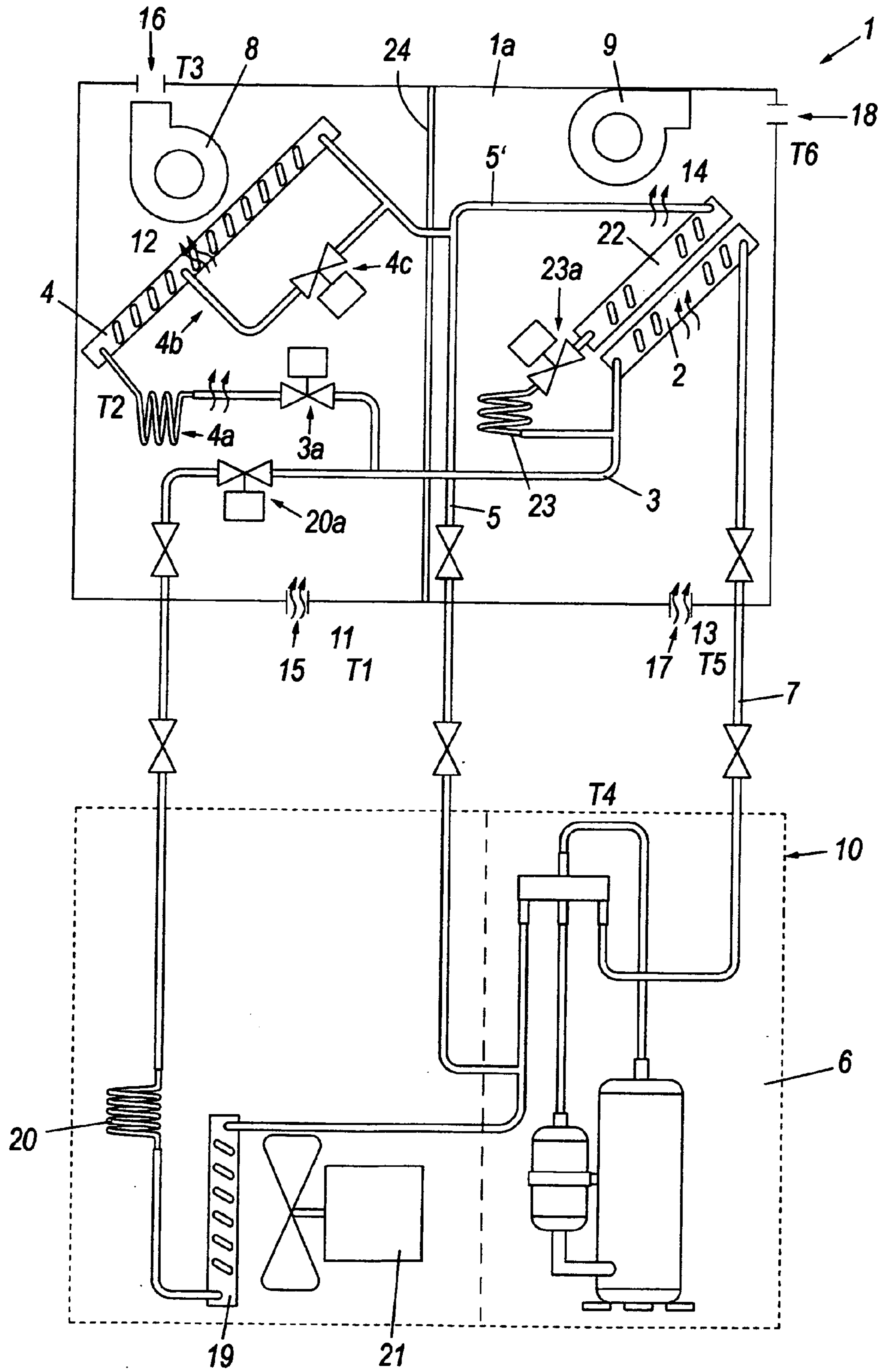
10. A kitchen hood (1) as claimed in claim 1, comprising, for intercepting the vector fluid, recovery valve means (3a) positioned between said recovery heat exchanger (4) and said internal heat exchanger (2).

11. A kitchen hood (1) as claimed in claim 1, wherein, in a further method of operation, an external heat exchanger (19) is provided connected to the internal

heat exchanger (2) via a further throttling device (20), said external heat exchanger (19) being connected to the compression means (6) such as to operate as a conventional conditioning device or heat pump when said recovery valve means (3a) for intercepting the vector fluid flow are closed.

12. A kitchen hood (1) as claimed in claim 10, wherein, in a further method of operation, an afterheater heat exchanger (22) is provided connected to the internal heat exchanger (2) via a further throttling device (23), said afterheater heat exchanger (22) being connected to the compression means (6) such as to operate as a dehumidifier device with afterheating when said second recovery valve means (3a) are closed.

13. A kitchen hood (1) as claimed in claim 9, comprising, within the housing (1 a), at least one internal baffle (24) which maintains the gas flow entering through the apertures (15) and leaving from the apertures (16) separate from the gas flow entering through the apertures (17) and leaving from the apertures (18).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