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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Apparatus for Recovering Water from Air and Method of Water Recovery

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(73) Same as inventor

(57) 15 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for the recovery of water vapour from atmospheric air, for condensation into liquid water and having a housing for passage of air, a water vapour adsorbent cell in the housing to adsorb water vapour from air passing therethrough, inlet and outlet openings in the housing, so that air can be introduced through the inlet and passed through the adsorbent cell, and exited through the outlet, a cell fan for passing air through the adsorbent cell, closures for closing and opening the openings, a cell heat exchanger incorporated in the adsorbent cell, so that heat generated by the adsorption of water vapour from air may be transferred so as to maintain the temperature of the adsorption cell substantially constant within a predetermined range during adsorption, a radiator connected to the cell heat exchanger means, for disposing of heat transferred from the cell, a heating element associated with the adsorbent cell, and operable so as to heat the cell to remove water vapour, a condensing heat exchanger to receive heated air carrying water vapour from the adsorption cell and chill it so as to condense that water vapour in the air.

FIELD OF THE INVENTION

The invention relates to the recovery of water from atmospheric air for drinking and other purposes, and to a method of water recovery.

BACKGROUND OF THE INVENTION

It is well-known that atmospheric air contains greater or lesser quantities of water vapour, depending upon climate weather conditions, and the like. However even in the hottest countries and also in cold climates, there are substantial volumes of water vapour present in atmospheric air at all times. The recovery of such water vapour from atmospheric air, and the conversion of it into liquid water by conventional means appears to require the consumption of large quantities of power. Therefore, as such, water vapour carried in atmospheric air does not appear to offer an economical source of water for human consumption. Clearly however it is desirable to provide some economical means for the recovery of water vapour and its condensation into liquid water, from atmospheric air. The supplies of such water vapour are obviously virtually unlimited, since as fast as water vapour is recovered from the air, more water will be evaporated into the air from any surrounding bodies of water, even many hundreds of miles away. The simple laws of thermodynamics will ensure that the vapour pressure of water vapour within the air will remain substantially stabilized at any given time and place, no matter how much water vapour is extracted for drinking purposes.

In order to operate economically, and also in order to operate at all in remote areas, the apparatus must be capable of being operated without only a modest input of power.

For domestic use, such a device will have great advantages over existing water filtering, sterilizing or distillation apparatus which is presently on the market. In almost all such apparatus, municipal water is first of all vaporized, and is then condensed. These systems consume power. In addition, any contaminants in the water, which are removed by vaporization, must then be flushed out periodically. Consequently, such domestic sterilization devices are relatively expensive and do not achieve wide distribution. Water filters, sterilizers or distillers for use in remote areas, where there is no safe drinking water source are dependent first of all upon the availability of water which can then be sterilized, or desalinated, and also upon the availability of substantial power to operate the systems.

In many areas, particularly desert areas, there is no available source of water whether contaminated or not, and constantly such systems are of no use.

For all of these reasons therefore the recovery of water vapour from the air, and its condensation into water, in an economical and efficient manner, presents very substantial advantages from many points of view.

BRIEF SUMMARY OF THE INVENTION

With a view therefore to overcoming the various problems discussed above, the invention comprises an apparatus for the recovery of water vapour from atmospheric air, for condensation into liquid water and in turn comprising, housing means adapted for passage of air therethrough, a water vapour adsorbent cell in said housing, adapted to adsorb water vapour from air passing therethrough, inlet and outlet opening means in said housing, whereby air can be introduced through said inlet opening means, and passed through said adsorbent cell, and exited through said outlet opening means, cell fan means for passing air through said adsorbent cell, closure means for closing and opening respective said opening means, heat exchanger means incorporated in said adsorbent cell, whereby heat generated by the adsorption of said water vapour from said air may be transferred therefrom, whereby to maintain the temperature of said adsorption cell substantially constant within a predetermined range during adsorption, radiator means connected to said heat exchanger means, for disposing of heat transferred from said adsorption cell, heating element means associated with said adsorbent cell, and operable whereby to heat the same, condensing heat exchanger means located in said housing means, and adapted to receive heated air carrying water vapour from said adsorption cell and chill the same, thereby condensing water vapour in said air, and at the same time increasing the temperature of said air, said air being continuously recycled through said adsorption cell and said condensing heat exchanger, while heating said adsorption cell, thereby removing said adsorbed water vapour from said adsorption cell, and condensing same in said condensing heat exchanger, and, collecting said condensed water.

The invention further comprises such water vapour recovery apparatus wherein said condensing heat exchanger is coupled to said radiator, whereby to discharge latent heat of vaporization of said water vapour, when the same is condensed into liquid by said condensing heat exchanger.

The invention further comprises such water vapour recovery apparatus and including pumping means for pumping heat exchange fluid from said adsorption cell through said radiator and from said radiator through said condensing heat exchanger.

The invention further comprises such water vapour recovery apparatus and including radiator fan means, and motor means operable to operate said radiator fan means, whereby to force air flow through said radiator for further rejecting heat therefrom, and motor means for driving said cell fan.

The invention further comprises such water vapour recovery apparatus and including power operated means for opening and closing said closures for said opening means.

The invention further comprises such water vapour recovery apparatus and including a generally upwardly tapering passageway, being connected at its wider end to said adsorption cell, and at its narrower end to said cell fan.

The invention further comprises such water vapour recovery apparatus including liquid water collector chamber means, at a lower end of said housing, and means for removing liquid collected therein.

The invention further comprises such water vapour recovery apparatus and including first and second said housing means located adjacent one another, first and second water vapour adsorbent cells in respective first and second housing means, respective inlet and outlet opening means in respective first and second housing means, whereby air can be selectively passed through one or other of respective first and second adsorbent cells, first and second fan means for passing air through said first and second adsorbent cells, closure means for closing said inlet and outlet opening means, heat exchanger means incorporated in respective said adsorbent cells, radiator means on said first and second housing means, and connected to both said first and second adsorbent cells, for disposing of heat transferred therefrom, heating element means associated with each of said first and second adsorbent cells, first and second condensing heat exchanger means located in respective first and second housing means, and means for passing a heat exchange fluid from both said first and second condensing heat exchanger means to said radiator means, whereby to maintain said condensing heater exchanger means within a predetermined chilling temperature range.

The invention further comprises such water vapour recovery apparatus and including control means adapted to sense the condition of each of said first and second adsorption cells, and adapted to produce a signal, whereby to close said respective closures on said respective housing means when said respective adsorption cell has adsorbed predetermined volume of water vapour, and at the same time adapted to cause opening of respective said closures on respective said inlet and outlet opening means on the other said housing means, thereby permitting air to be drawn through said other housing means, thereby causing adsorption of water vapour in said other adsorption cell means, whereby said adsorption cell means and condensing heat exchangers in respective first and second housing means may be operated alternately, so that while one adsorption cell is adsorbing water vapour, the other said adsorption cell is releasing water vapour, and said water vapour is being condensed, thus providing for an essentially continuous operation.

The various features of novelty which characterize the invention are pointed out with more particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

IN THE DRAWINGS

Figure 1 is a front perspective illustration of a water vapour extraction apparatus in accordance with the invention;

Figure 2a is a section along the line 2-2 of Figure 1;

Figure 2b is a section corresponding to Figure 2a, showing the apparatus in another mode of operation;

Figure 4 is a schematic circuit diagram, showing the hydraulic connections between the various components;

Figure 5 is a perspective illustration of a further embodiment of the invention in which two water vapour extraction assemblies are operated side by side;

Figure 6a is a sectional illustration along the lines 6-6 of Figure 1 showing the embodiment of Figure 6 operating in one condition;

Figure 6b is a section corresponding to Figure 6a, showing the apparatus operating in another mode, and,

Figure 7 is a schematic diagram, showing the components of the Figure 6 embodiment, and their hydraulic connection to one another.

DESCRIPTION OF A SPECIFIC EMBODIMENT

As has been explained above, the apparatus in accordance with the invention is designed for extracting water vapour from atmospheric air, so as to create a source of potable water, which does not require to be connected to another source of water.

Referring first of all to Figure 1, this generally illustrates a single water vapour recovery apparatus in accordance with the invention. It will be seen to comprise in general terms an essentially closed rectangular housing 10. The housing comprises planar side walls 12 and 14, a bottom wall indicated by the arrow 16, an end wall 18, and a front wall 20, a top wall 22 extends from end wall 16. Extending upwardly from the housing 10, there is a radiator support frame 24-24, supporting a radiator indicated generally as 26. As shown in the partially cut away portion, a fan 28 driven by a motor 30 is supported beneath the radiator 26 on the top wall 22 of the housing.

Air flow grilles 32-32 are provided for intake of air, and a similar grille 34 is provided above the radiator 26 for the exhausting of air.

In order to permit air flow through the housing 12, the housing is provided with an inlet opening 36 and an outlet opening 38. Respective closures 40 and 42 are adapted to close the respective openings. The closures are operated by any suitable power operated means indicated as 44 and 46

(Figures 2a and 2b).

Referring now to Figures 2a and 2b, these are both sections along the line 2-2 of Figure 1. Figure 2a shows the apparatus in its water vapour recovery mode, and Figure 2b shows the apparatus in its water vapour condensation/regeneration mode.

As shown in Figure 2a, and in 2b, within the housing 10 there is supported a water vapour adsorbent cell indicated generally as 50. Cell 50 is illustrated in more detail in Figure 3. However, for the purposes for the present explanation it is sufficient to say that it contains a water adsorbent material, such as silica, packed within a series of heat exchanger fins (Figure 3). It is supported transversely across the interior of housing 10, stretching from one side wall 12 to the other, and being supported on front wall 20, but terminating short of back wall 16. Suitable frame members 52 spaced apart between the walls 12, and support the free edge of cell 50.

Below cell 50, there is a sloping collector wall 54, for reasons to be described below.

Upwardly of cell 50, there is an air guide wall 54 which provides a generally upwardly tapering passageway. The wall 54 is supported at its lower edge, around the upper side of the cell 50.

The lower side of the cell 50 faces downwardly into a generally hollow interior chamber indicated as 58.

At the upper end of the tapering wall 56, there is an air opening 60. Supported on top of the wall 56, there is a fan 62. The fan 62 in this embodiment is shown as a typical squirrel-cage fan.

It will thus be seen that what has been described so far and is illustrated in Figure 2a, is that when the two closures 40 and 42 are opened, and the fan 62 is operated, air will be drawn in through lower opening 36 and drawn through the cell 50 and expelled by the fan 62 out through the opening 38.

This is what is illustrated in Figure 2a by the arrows A1 and A2.

As already described located above the housing 10, supported above top wall 22 there is a fan 28 driven by a motor 30, which is adapted to draw air in through opening 32 and force it outwardly through radiator 34. This is illustrated by the heat flow arrows H1-H1 and H2-H2.

The motor 30 is connected to the shaft 64, so that operation of the motor 30 operates both fan 62 and fan 28 simultaneously.

It will of course be appreciated that as air, containing water, vapour is drawn through the cell 50, the water vapour becomes adsorbed by the silica within the cell. This however causes the release of the latent heat of vaporization inherent in the water vapour, and consequently the cell 50 will then heat up.

This is undesirable since it reduces the ability of the silica to take up more water vapour.

Thus in order to as far as possible maintain the silica in the cell 50 at a stable temperature, a coolant fluid is circulated therethrough by means as yet to be described in association with Figure 3.

However, the hydraulic pipes or lines by which such heat transfer fluid are carried are indicated in Figures 2 and 2a in schematic form.

Thus the left hand end of the cell 50 is provided with a pipe 70, and the right hand end of the cell is provided with a pipe 72. Pipe 70 and 72 connect with flow control valves 74 and 76.

Valves 74 and 76 are in turn coupled to one another by pipe 78. Valve 74 is further connected by pipe 80 to pump 82 driven by motor 30.

Pump 82 is in turn connected by pipe 84 to the left hand end of radiator 34. The right hand end of radiator 34 is connected by pipe 86 to a condensation heat exchanger 90. The lower end of condensation heat exchanger 90 is connected by pipe 92 to valve 76. The condensation heat exchanger 90 is not illustrated in any detail since it may comprise any form of conventional radiator similar in general terms to the design of an automobile radiator. It will be noted that the heat exchanger 90 is supported at a angle relative to the vertical, for purposes to be described below.

It will thus be seen that by the operation of the pipe pump 82, fluid can be passed up through radiator 34 down through heat exchanger 90 through valve 76 and pipe 72 to the right hand end of the cell 50, and then through pipe 70 and valve 74 at the left hand end of the cell 50 and back up through pipe 80 to pump 82.

In this way, as the silica in the cell heats up due to adsorption of water vapour in the air being passed therethrough, the pump simultaneously circulates heat exchange fluid through the radiator 34, where heat in such heat exchange fluid is rejected or dissipated to atmosphere thereby cooling the heat exchange fluid. The heat exchange fluid then passes through the condensing heat exchanger 90. This performs essentially no chilling function in this mode of operation, but is merely a convenient way of circulating the fluid, and minimizing the number of valves required for its operation.

Chilled heat exchange fluid will thus be passed through the cell 50 from right to left in this mode of operation. In practice it is found that the cell 50 can be operated substantially isothermally, or at least within a minimum range of temperature rise. In this way large volumes of water vapour can be effectively adsorbed in the silica over a certain period of time, depending on the vapour pressure of the air in that location.

Referring now to Figure 2b, it was seen that in this illustration the two closures 40 and 42 are closed. This therefore prevents the entry of any fresh air into the housing 10.

In this mode of operation, heating elements (to be described in relation to Figure 3) are operated to heat the cell 50.

The valves 74 and 76 are operated so as to close off pipes 70 and 72. A branch bypass pip 94 connects between pipes 70 and 72 independently of the valve 74 and 76, and a pump 96 is located in the pipe 94.

By the operation of the pump 96, fluid within the heat exchanger in the cell 50 can simply be continuously circulated round and round so as to maintain an elevated temperature throughout the cell 50.

The motor 30 will continue to operate the fan 28 and the fan 62.

The pump 82 will continue to force fluid through the radiator 34 down through the heat exchanger 90, and back to pump 80 to valve 76, pipe 78, valve 74 and pipe 80.

The air flow caused by the fan 28 will be exactly the same as that illustrated in Figure 2a, thereby rejecting heat in the heat exchange fluid passing through the radiator 34.

However, within the chamber 10, the fan 62 will simply cause a circular air flow indicated by the arrows C. It will be remembered that the chamber 58 has openings through the support members 52, through which air can pass. Thus the fan will draw air upwardly through the cell 50 and then the air will flow in the direction of the arrow C through the upper half of the condenser heat exchanger 90, through the transfer chamber 98, and then be drawn through the lower half of the heat exchanger 90 back into the chamber 58 and thus up through the cell 50.

Bearing in mind that the cell 50 is being heated, and that the air flow is substantially continuous, water vapour will be driven off from the silica within the cell 50, and will be carried by the air stream through the heat exchanger 90.

The heat from the heat exchanger 90 is being transferred to atmosphere through the radiator 34 and thus the heat exchanger 90 will have the effect of chilling the water vapour in the air stream, causing it to condense and fall downwardly.

Water will then collect at the lowest point of the collector plate 54, and may be drawn off at the opening 100.

Referring now to Figure 3, the adsorption cell 50 is illustrated in more detail. It will be seen to comprise a generally rectangular structure somewhat similar to a radiator in design. That is to say it has two header tanks 110 and 112 one at each end. A series of heat exchange tubes 114 are connected between the two header tanks.

A plurality of spaced apart metal fins indicated as 116 provided with suitable holes (not shown) such as are well-known in the art, are slid onto the tubes 114 and are secured thereto in heat exchange relation.

The fins 116 are somewhat further apart than in a typical radiator design, and between the fins 116, there are packed a large number of particles of silica 118. The entire structure is enclosed within a metallic mesh material 120, having openings smaller than the particle size of the silica, but not so small as to restrict the passage of air therethrough.

Within the two header tanks 110 and 112 there are provided two electrical heating elements indicated as 122. The respective elements 122 are connected by means of cables 124, to a suitable source of power.

Any suitable fluid connection means such as the pipes 70 and 72 permit fluid to be passed through one header through the tubes 114 to the other header, in the manner of the conventional radiator.

In this way, the cell 50 during the adsorption mode (Figure 2a) can be cooled by passing chilled fluid through the tubes 114. When in the regeneration/condensation mode (Figure 2b) when the water vapour is being removed from the silica cell, heat can be supplied by the elements 122 to the fluid within the headers 110 and 112, and continuously circulated through the pipes 114 to heat up the silica 118, thereby causing it to release its adsorbed water vapour.

The basic hydraulic circuit diagram for the apparatus of Figures 1, 2, and 3 is illustrated in Figure 4. This is essentially a schematic diagram, in which 50 represents the adsorption cell, 34 represents the radiator, and 90 represents the condensing heat exchanger.

This diagram is indicated with the same reference numerals as are already referred to in connection with Figures 2a and 2b, but it is believed that it will materially assist in the understanding of the operation of the invention to show this circuit in isolation from the remainder of the structure.

It will be appreciated from the explanation so far that the basic apparatus as illustrated in Figures 1 to 4 may be operated either in the adsorption mode or in the regeneration-condensation mode, but not both. Consequently, the recovery of water will be intermittent.

In order to provide a more continuous operation, two such units 10 may be placed side by side, so that while one such unit is operating in the adsorption mode the other unit is operating in the regeneration mode and that when the adsorption is complete in one unit and the regeneration is complete in the other unit, and the controls may simply be reversed.

Such a "duplex" unit is illustrated in Figures 5, 6a, 6b, and 7.

In these figures, the components which are the same as in the Figure 1 embodiment are simply labelled with the same reference numbers, but with the suffix a and b.

Figure 6a, shows the two units side-by-side in operation. The left hand unit 10a is operating in the regeneration mode, corresponding to Figure 2b.

The right hand unit 10b is operating in the adsorption mode, corresponding to Figure 2a. The reverse is shown in Figure 6b. In Figure 6b the left hand (a) unit is operating in the adsorption mode, and the right hand (b) is operating in the regeneration/condensation mode.

It will however be observed that there is only one radiator 34, and one fan, for rejecting heat to atmosphere.

Certain differences between the Figure 1 and Figure 2 embodiments however should be mentioned.

For example, while there are two housings 10a and 10b, they have a common partition wall indicated as 130. It will also be observed that while the openings 36a-38a in the unit 10a, are on the left hand side of the unit, the opening 36b and 38b are on the right hand side of the unit 10b. This is simply for the sake of convenience in construction, so that the two units can be built as a single assembly.

There are also certain differences in function. As already explained, in the adsorption mode corresponding to Figure 2a, the condensation heat exchanger 90 simply acts as a conduit for the passage of fluid, and does not have any effect during the condensation mode. Thus the fact that during the condensation mode in the unit 10b (Figure 6a) the air inflow and outflow must pass through the heat exchanger 90b, this will not in fact effect the operation of the unit 10b.

It will also be noted that while there are two units 10a and 10b side by side, there is only one radiator 34, fan 28 and motor 30 and pump 82. This is located on top of the unit 10a simply for the sake of convenience.

The radiator 34 may be required to have a somewhat greater heat rejection capacity than in the case of the Figure 1 embodiment. A partitions wall 128 separates Unit 10a from unit 10g.

Both cell fans 62a, 62b, are driven by motor 30. A transmission shaft 132 connects fan 62b for the purpose.

In this embodiment, a vacuum pump 134 connects via pipes and valves 136 and 138 with respective units 10a and 10b.

It is operated during the condensation/regeneration mode of each unit, to reduce the pressure in that unit. This will improve the efficiency of the condensation/regeneration function, substantially.

The hydraulic circuit is somewhat different from the Figure 1 embodiment. The adsorbtion cells 50a and 50b are connected in a closed hydraulic loop by pipe 140 and 142. Fluid is continuously circulated by pumps 144 from one cell to the other. When one cell is in the adsorption mode, it is receiving the latent heat of vaporisation, and the heat of wetting, from the water vapour in humid air passing therethrough. The other cell is at the same time in the condensation/regeneration mode and requires heat. The heat from the cell in the adsorbtion mode is thus recycled to the cell in the regeneration mode. This will reduce the power requirement for additional heat input to the cell in the regeneration mode. In the embodiment both condensation heat exchangers 90a, 90b are coupled, in series, with radiator 34, by pipes 146, 148 and 150.

The pump 82 operates continuously to circulate fluid from radiator 34 to the condensation heat exchangers. In the unit ie. 10a (Fig. 6a) in the absorption mode, the heat exchanger 90a plays no function, while the heat exchanger 90b in the unit 10b in the condensation mode is required to chill the water vapour and condense it. Consequently in its basic elementary from this embodiment could operate simply passing fluid continuously through both heat exchangers 90a, 90b.

However, in the unit (ie 10a) in the adsorbtion mode, the upper region of the exchanger 90a will be subject to picking up some heat from the dried air exiting from the adsorbtion cell 50a, and this may slightly reduce the efficiency of the system. In order to overcome this each exchanger 90a, 90b, may be provided with a bypass pipe 152, 154. Pairs of valves 156-156 and 158-158 are provided at respective ends of the bypass pipes. By operation of the valves, one or others of the exchangers 90a-90b can be bypassed so as to avoid picking up the heat from the unit in the adsorbtion mode.

The efficiency of operation of both units 10a and 10b is materially improved by the vacuum pump. By reducing the pressure in the unit which is in the condensation/regeneration mode, the water vapour is released from the adsorbtion cell at a lower temperature, and at the same time condensation of the water vapour takes place more readily.

As will be seen from Fig. 5 the openings 38b and 40b and unit 10b are preferably located in one or other side wall 12.

Suitable controls such as 160 and 162 will be provided on or near the adsorbtion cells 50a, 50b for sensing when adsorbtion, or regeneration, is complete, and sending appropriate signals to change over operations between the two units.

The foregoing is a description of a preferred embodiment of the invention which is given here by way of example only. The invention is not to be taken as limited to any of the specific features as described, but comprehends all such variations thereof as come with in the scope of the appended claims.

IN THE CLAIMS

1. Apparatus for the recovery of water vapour for condensation into liquid water and comprising;

housing means adapted for passage of air therethrough;

a water vapour adsorbent cell in said housing, adapted to adsorb water vapour from air passing therethrough;

inlet and outlet opening means in said housing, whereby air can be introduced through said inlet opening means, and passed through said adsorbent cell, and exited through said outlet opening means; cell fan means for passing air through said adsorbent cell;

closure means for closing and opening respective said opening means;

heat exchanger means incorporated in said adsorbent cell, whereby heat generated by the adsorption of said water vapour from said air may be transferred therefrom, whereby to maintain the temperature of said adsorption cell substantially constant within a predetermined range during adsorption;

means, connected to said heat exchanger means, for disposing of heat transferred from said adsorption cell;

heating element means associated with said adsorbent cell, and operable whereby to heat the same;

condensing heat exchanger means located in said housing means, and adapted to receive heated air carrying water vapour from said adsorption cell, and chill the same, thereby condensing water vapour in said air, and at the same time increasing the temperature of said air, said air being continuously recycled through said adsorption cell and said condensing heat exchanger, while heating said adsorption cell, thereby removing said adsorbed water vapour from said adsorption cell, and condensing same at said condensing heat exchanger, and,

means for collecting said condensed water.

2. Water vapour recovery apparatus as claimed in claim 1 wherein said condensing heat exchanger is coupled to radiator means, whereby to discharge latent heat of said water vapour, when the same is condensed into liquid by said condensing heat exchanger.

3. Water vapour recovery apparatus as claimed in claim 2, and including pumping means for pumping heat exchange fluid from said adsorption cell through said radiator means and from said radiator means through said condensing heat exchanger.

4. Water vapour recovery apparatus as claimed in claim 3, and including radiator fan means, and motor means operable to operate said radiator fan means, whereby to force air flow through said radiator means for further rejecting heat therefrom, and motor means for driving said cell fan.

5. Water vapour recovery apparatus as claimed in claim 1, and including power operated means for opening and closing said closures for said opening means.

6. Water vapour recovery apparatus as claimed in claim 1, and including a generally upwardly tapering passageway, being connected at its wider end to said adsorption cell, and at its narrower end to said cell fan.

7. Water vapour recovery apparatus as claimed in claim 1, including liquid water collector chamber means, at a lower end of said housing, and means for removing liquid collected therein.

8. Water vapour recovery apparatus as claimed in claim 2 wherein said adsorbent cell is coupled to said radiator means, and to said condensing heat exchanger means.

9. Water vapour recovery apparatus as claimed in claim 8 including bypass pipe means coupling said cell heat exchanger in a closed circuit, and pump means for pumping fluid continuously through said closed circuit, and valve means operable to open and close said bypass pipe means.

10. Water vapour recovery apparatus as claimed in claim 1 and including first and second said housing means located adjacent one another, first and second water vapour adsorbent cells in respective first and second housing means, respective inlet and outlet opening means in respective first and second housing means, whereby air can be selectively passed through one or other of respective first and second adsorbent cells, first and second fan means for passing air through said first and second adsorbent cells, closure means for closing said inlet and outlet

opening means, heat exchanger means incorporated in respective said adsorbent cells, heating element means associated with each of said first and second adsorbent cells, first and second condensing heat exchanger means for respective first and second housing means, radiator means associated with connected to both said first and second condensing heat exchangers means, for disposing of heat transferred therefrom, and means for passing a heat exchange fluid from both said first and second condensing heat exchanger means to said radiator means, whereby to maintain said condensing heater exchanger means within a predetermined chilling temperature range.

11. Water vapour recovery apparatus as claimed in claim 10 and including control means adapted to sense the condition of each of said first and second adsorption cells, and adapted to produce a signal, whereby to close said respective closures on said respective housing means when said respective adsorption cell has adsorbed a predetermined volume of water vapour, and at the same time adapted to cause opening of respective said closures on respective said inlet and outlet opening means on the other said housing means, thereby permitting air to be drawn through said other housing means, thereby causing adsorption of water vapour in said other adsorption cell means, whereby said adsorption cell means and condensing heat exchangers in respective first and second housing means may be operated alternately,

so that while one said adsorption cell is adsorbing water vapour, the other said adsorption cell is releasing water vapour, and said water vapour is being condensed, thus providing for an essentially continuous operation.

12. Water recovery apparatus as claimed in claim 10 including vacuum pump means connectable to each said unit, and operable to reduce the pressure in one said unit during its condensation/regeneration mode.

13. Water recovery apparatus as claimed in claim 10 including pipe means connecting said first and second adsorbent cells together in a closed loop, and pump means for circulating fluid therethrough.

14. Water recovery apparatus as claimed in claim 10 and including pipe means connecting said first and second condensation heat exchanger in series with said radiator means.

15. Water recovery apparatus as claimed in claim 14 including by-pass loop pipe means, and valve means, for each said condensation heat exchanger.

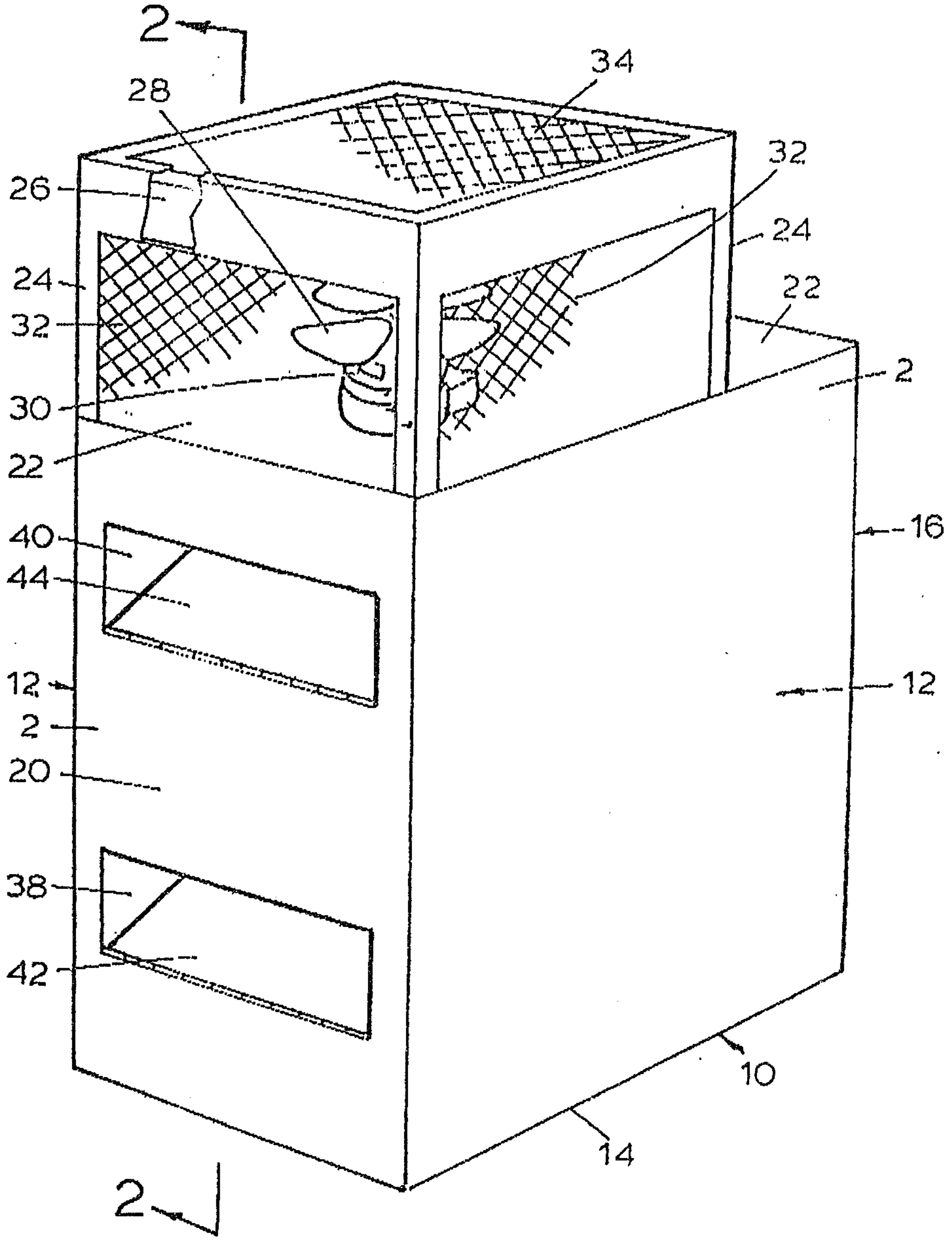
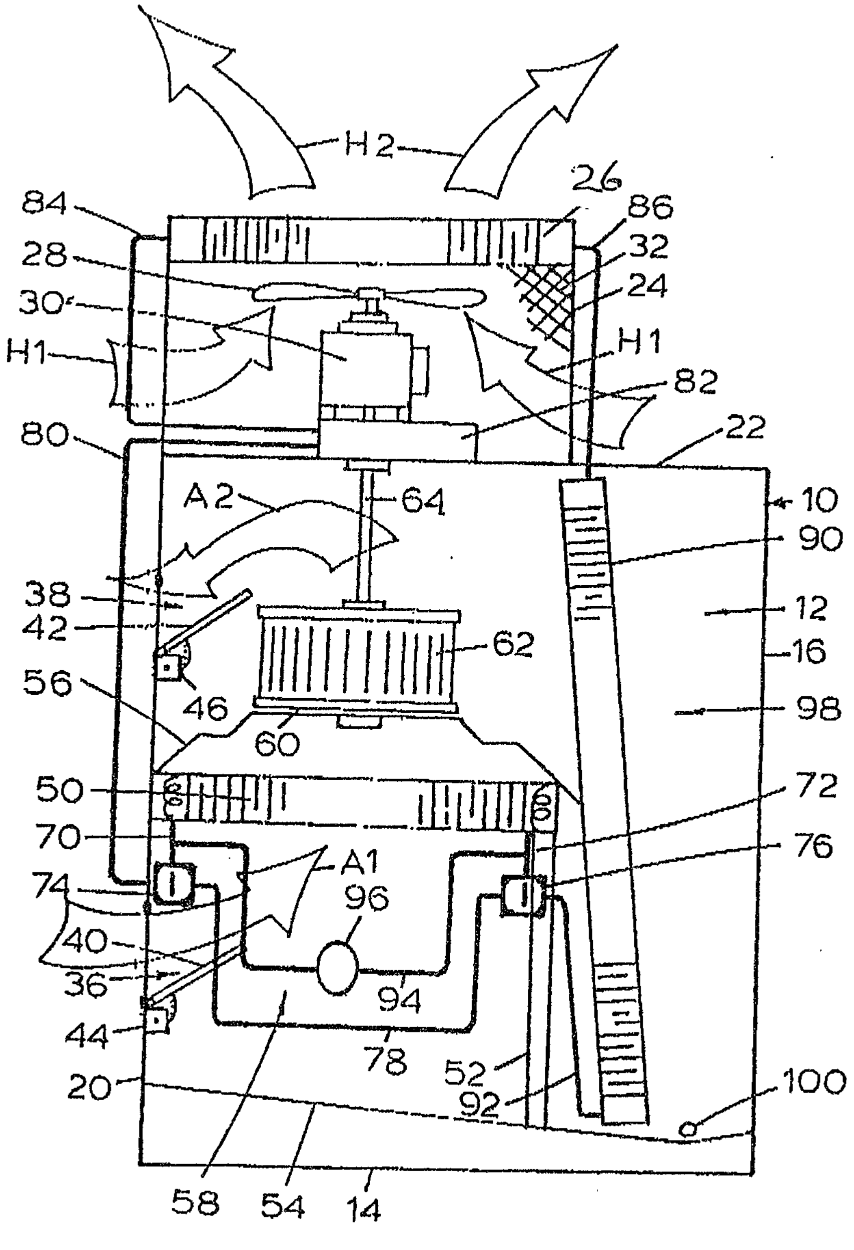


FIG. 1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H1
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62
16
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46
98
60
50
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92
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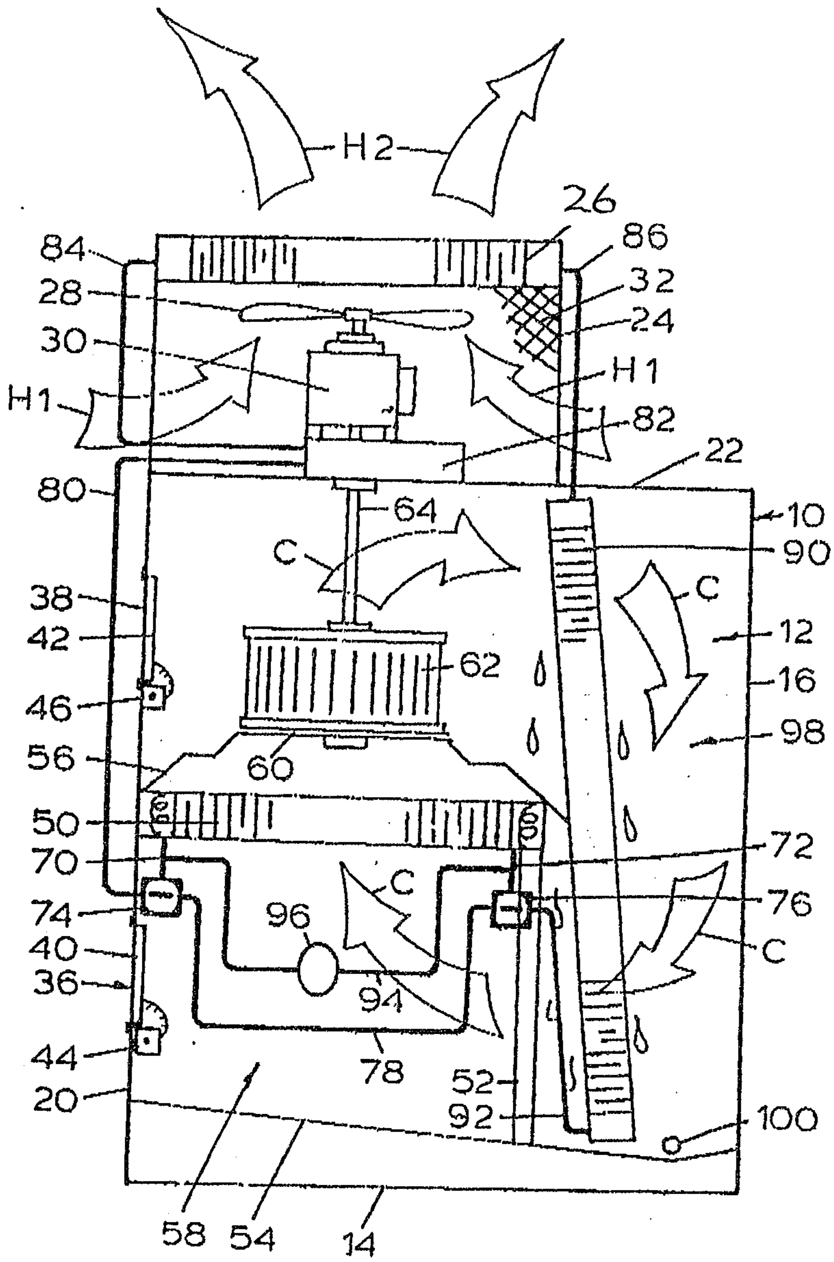
58
54
14

FIG. 2A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14

FIG. 2B

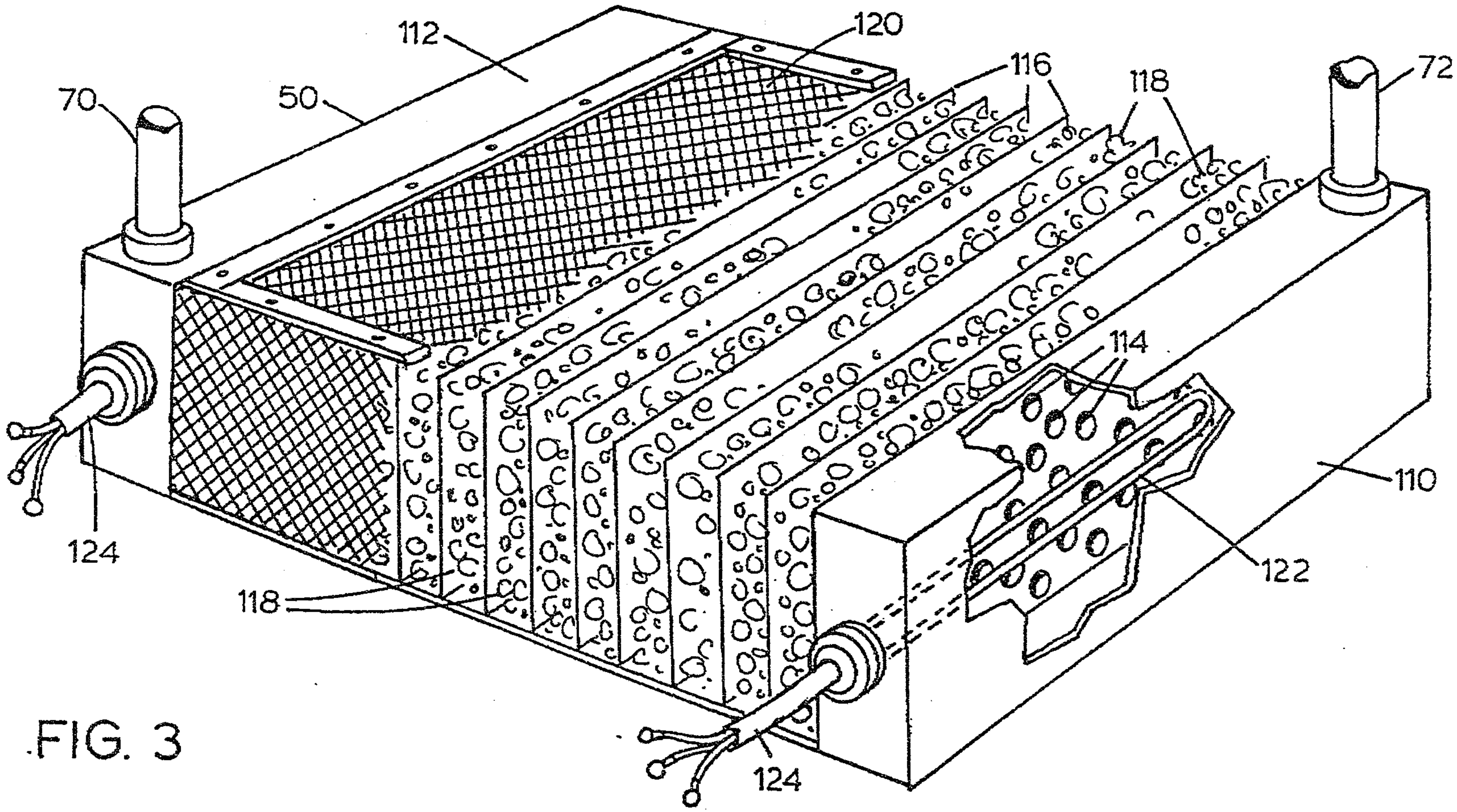

FIG. 3

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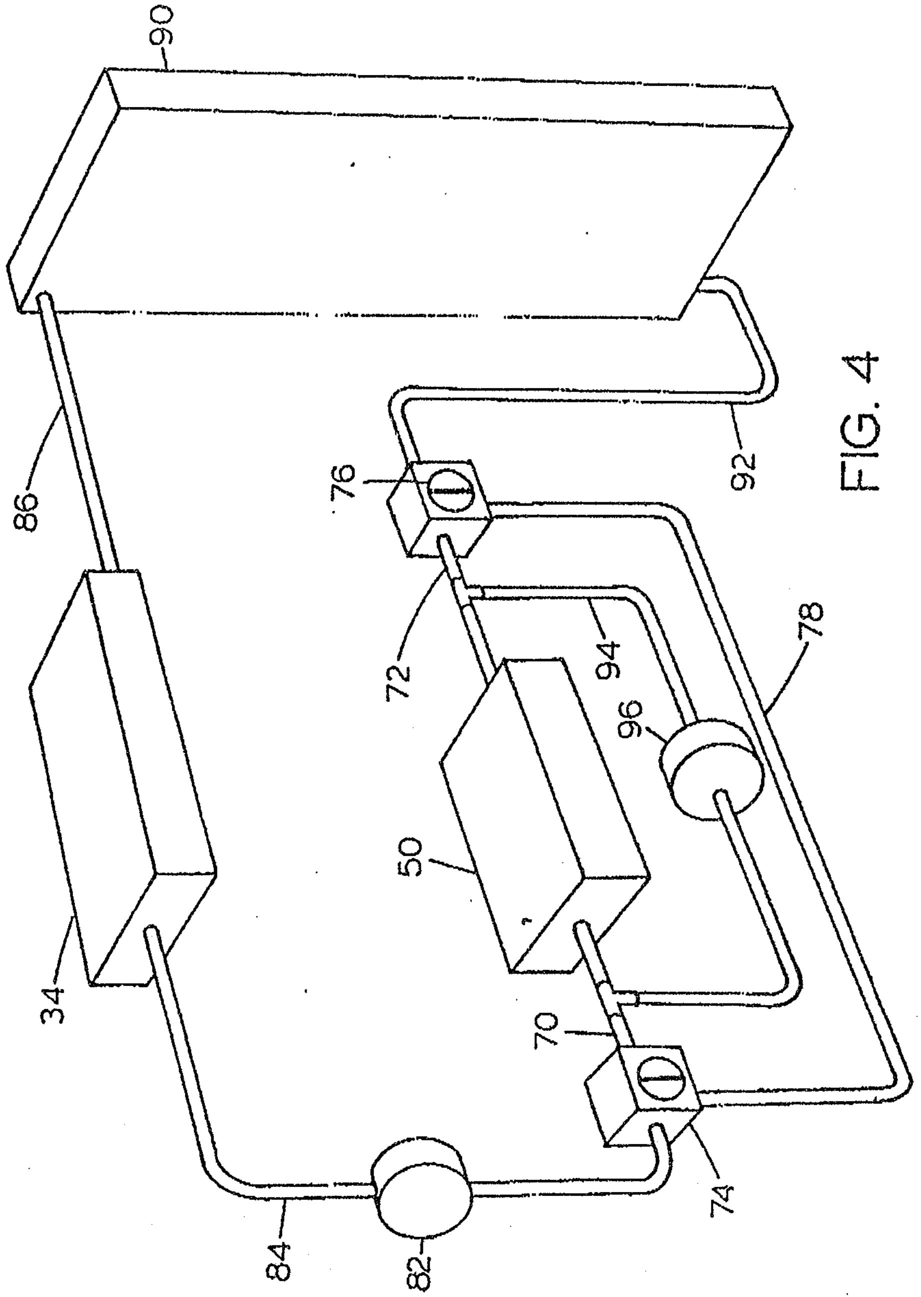


FIG. 4

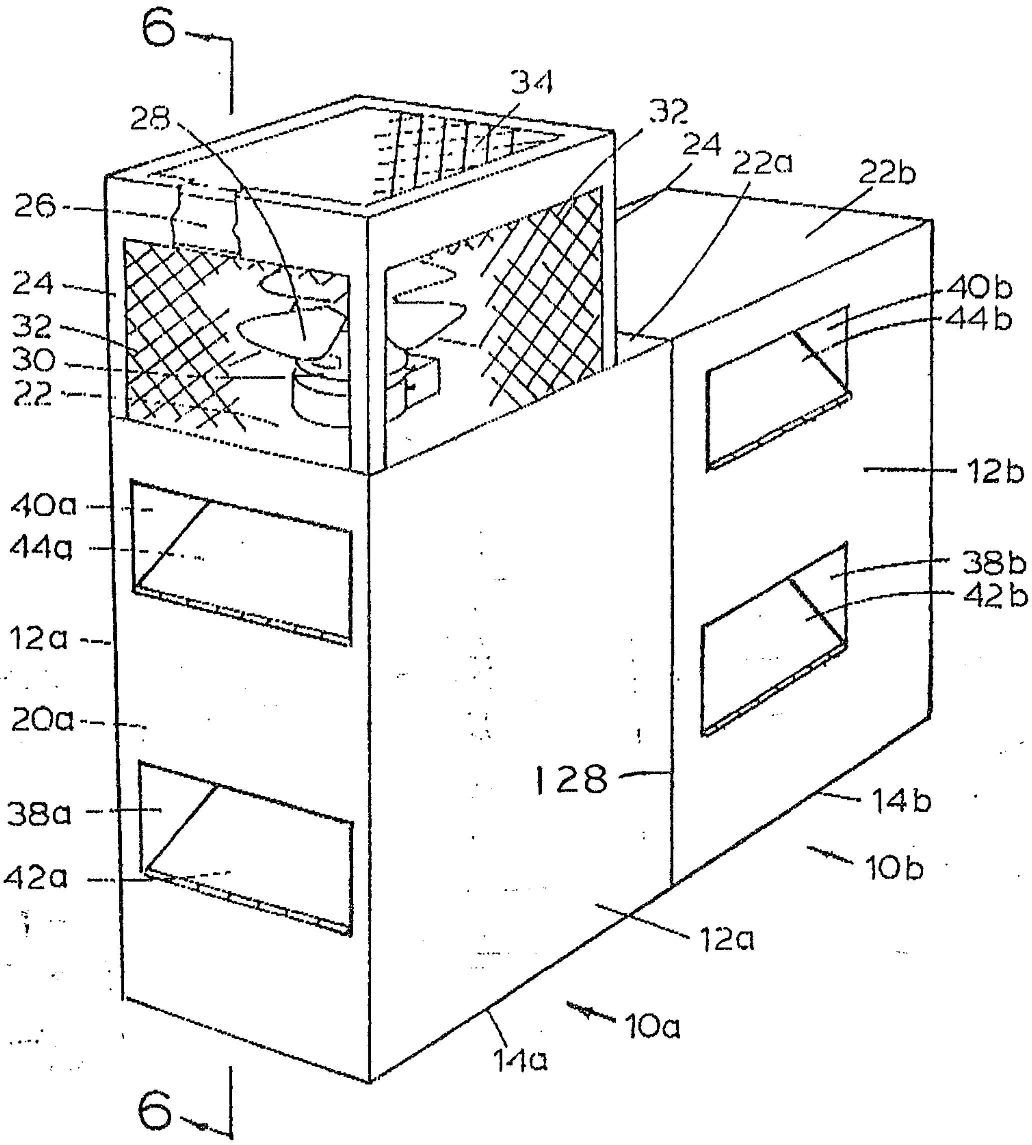
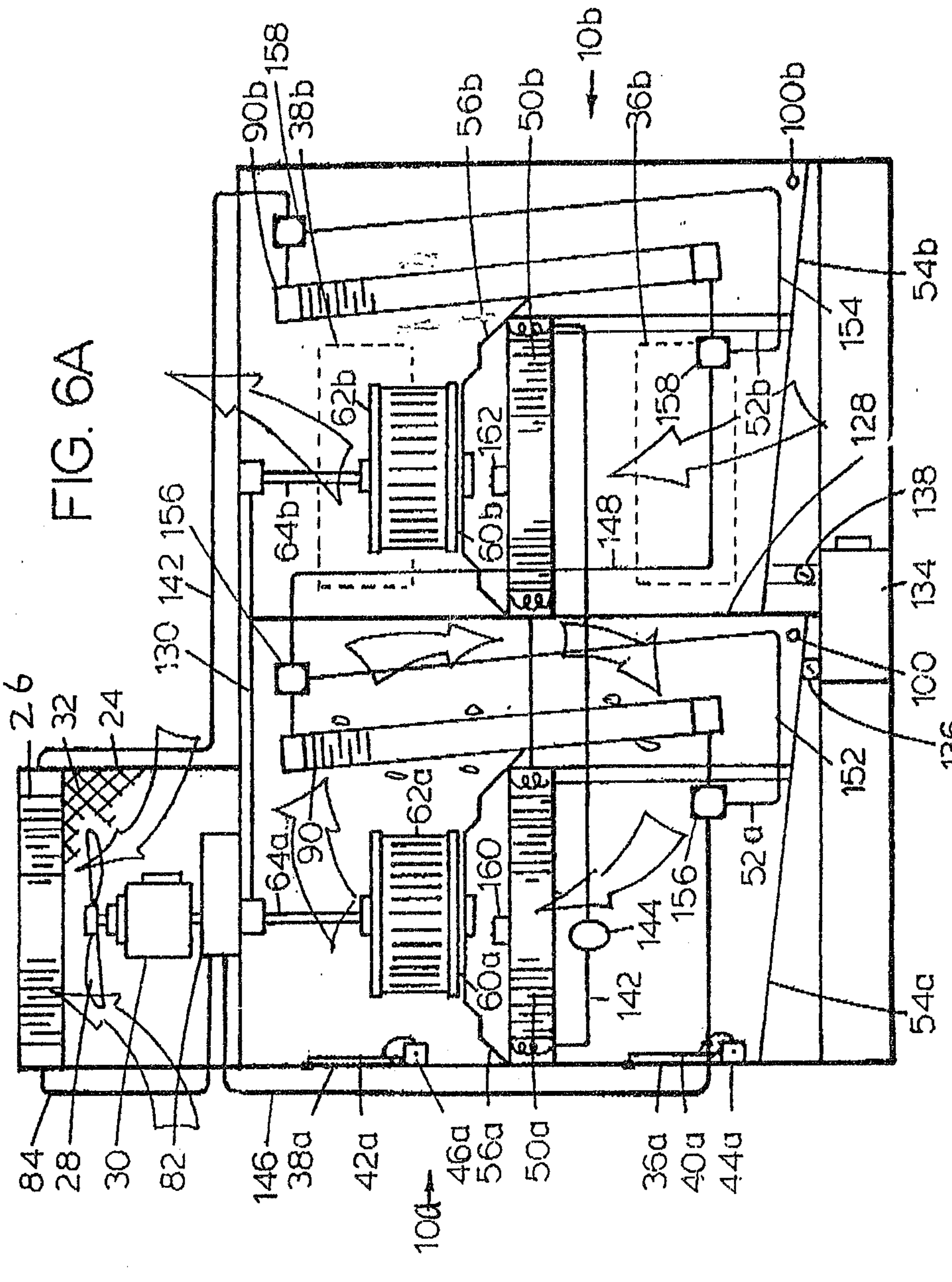

6
34
28
32
24
22a
22b
26
24
32
30
22
40b
44b
12b
40a
44a
38b
42b
12a
20a
128
14b
38a
10b
42a
12a
10a
14a
6

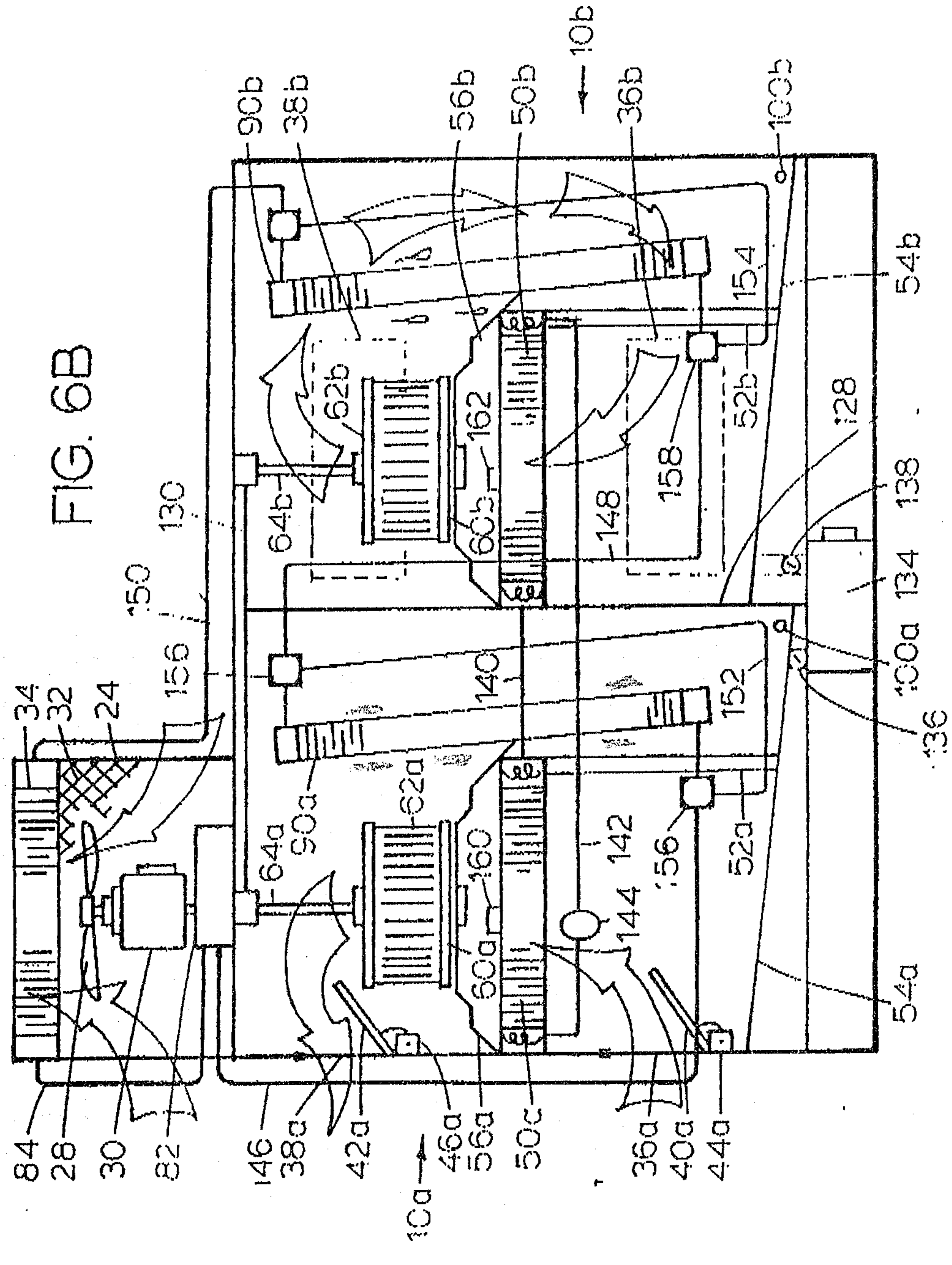
FIG. 5



90b
158
38b
56b
50b
10b
36b
100b
54b
154
62b
162
158
52b
128
64b
60b
148
138
134
156
142
130
100
136
152
2.6
32
24
62a
90
64a
160
156
52a
144
142
60a
54a
84
28
30
82
146
38a
42a
46a
56a
50a
36a
40a
44a
10a

FIG. 6A

FIG. 6B


10b
90b
38b
56b
50b
36b
100b
154
54b
52b
128
138
134
158
162
62b
64b
60b
148
130
150
156
140
100a
136
152
34
32
24
90a
62a
64a
160
142
156
52a
144
60a
54a
84
28
30
82
146
38a
42a
46a
56a
50c
36a
40a
44a
10a

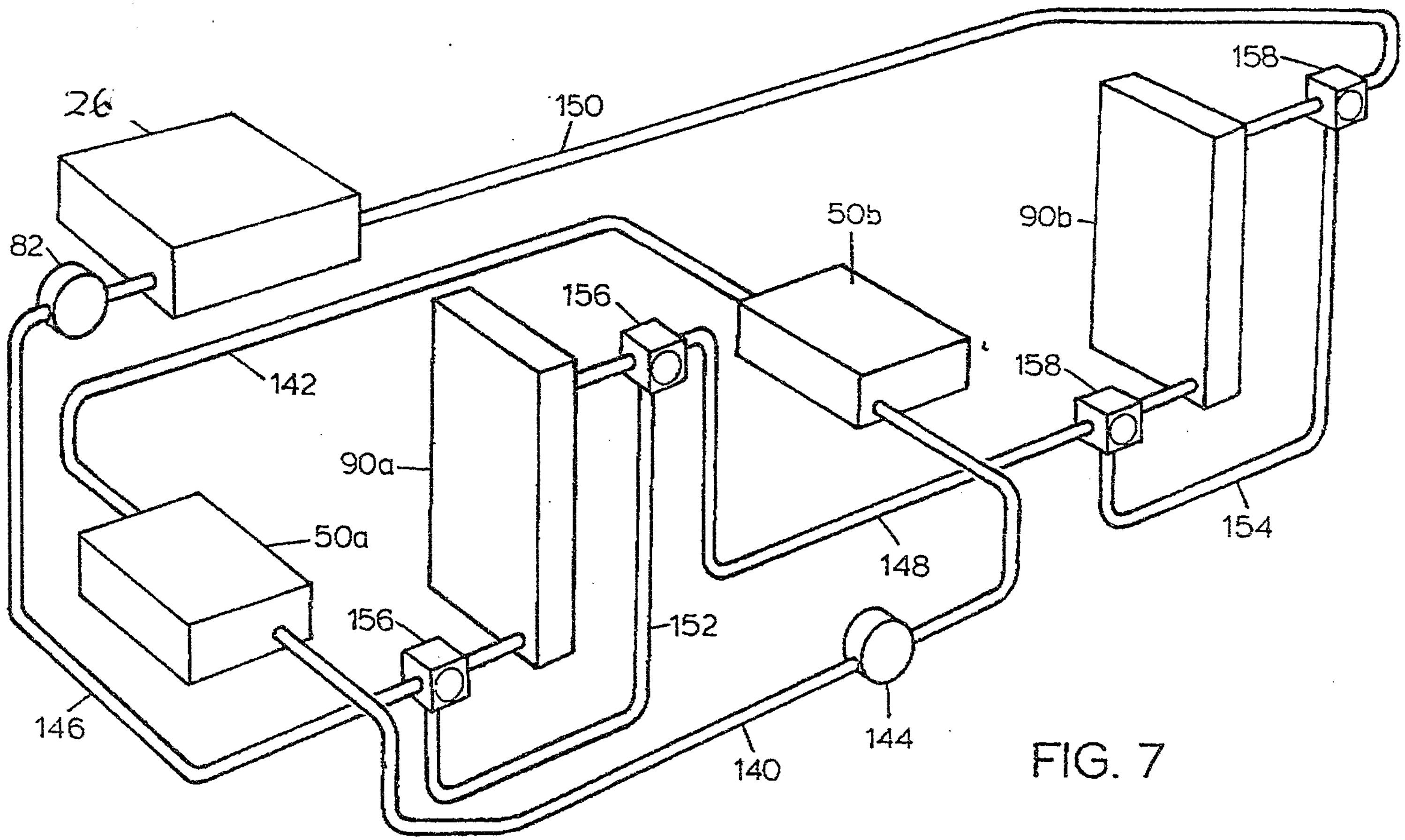

26
150
158
82
50b
90b
156
142
158
90a
50a
154
148
156
152
146
144
140

FIG. 7