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(54) No– frost plural– compartment refrigerator.

(57) The refrigerator comprises at least two com– partments (1, 2), one (1) at lower temperature and the other (2) at higher temperature, and a frigorific circuit (8) including an evaporator (7) in a position of thermal exchange with the compartment (1) at lower temperature, a condenser (10) and a compressor (9) that can be disconnected periodically when the temperature inside the compartment (1) at lower temperature falls below a pre– set minimum value. A fan (16) determines a forced circulation of air through said evaporator (7) and inside said com– partments (1, 2). There are valve means (22) that, when the compressor (9) is disactivated, are in a position where they close the compartment (1) at lower temperature against said forced circulation of air and where they convey all said air to the com– partment (2) at higher temperature.

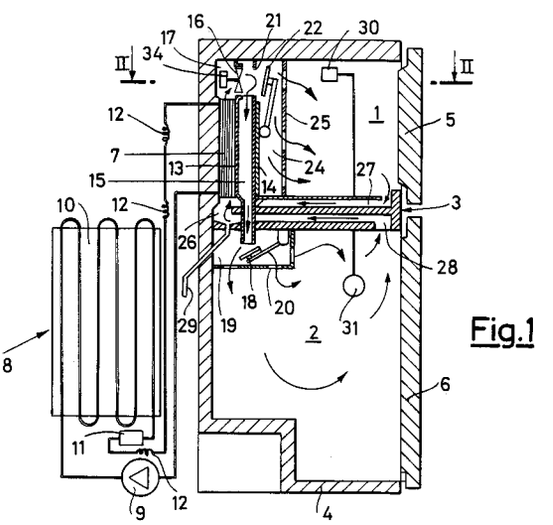

Fig.1

EP 0 541 172 A2

The present invention relates to a no-frost plural-compartment refrigerator.

Current refrigerators for home use comprise normally at least two compartments at different temperatures, one at higher temperature (typically +5°C) for fresh food, the other at lower temperature (typically −18°C) for frozen and deep-frozen food. Each of the two compartments is provided with a respective evaporator, or with a respective portion of the same evaporator, that forms part of a usual refrigerating circuit provided with a compressor and a condenser.

The tendency has recently developed of manufacturing so-called "no-frost" refrigerators, that is provided with means suitable for preventing the formation of frost on the wall of the evaporator.

For this purpose in the compartment at lower temperature there is a so-called "ventilated" evaporator, that is, subjected to forced circulation of air. With such an evaporator there is usually associated an electrical resistance that, at given intervals set by a timer, warms the air in the proximity of the evaporator so as to accelerate the process of defrosting the same. The use of such an electrical resistance is clearly the source of a consumption of energy that it would be desirable to avoid.

In view of this state of the art, the object of the present invention is that of accomplishing a refrigerator with at least two compartments at different temperatures, wherein the absence of frost is obtained without any waste of energy and the desired degree of humidity is also assured in the compartment at higher temperature.

According to the invention such object is attained with a refrigerator with at least two compartments, one at lower temperature and the other at higher temperature, comprising at least one evaporator in a position of thermal exchange with the compartment at lower temperature and inserted in a refrigerating circuit also including a condenser and a compressor that can be disconnected periodically when the temperature inside the compartment at lower temperature falls below a preset minimum value, and a fan for the forced circulation of air through said evaporator and inside said compartments, characterized in that it comprises valve means that, when the compressor is disactivated, are in a position where they close the compartment at lower temperature against said forced circulation of air and where they convey all said air to the compartment at higher temperature.

In this way, during the intervals when the compressor is stopped to defrost the evaporator the air destined for defrosting is heated no longer by an electrical resistance but by the simple flow through the compartment at higher temperature. There is thus obtained a substantial saving of energy, while inside the compartment at higher temperature a circulation of relatively humid air is constantly ensured that maintains fresh food in perfect condition.

These and other features of the present invention shall be made evident by the following detailed description of some of its possible embodiments illustrated as non-limiting examples in the enclosed drawings, wherein:

Fig. 1 shows a vertical sectional view, under normal operating conditions, of a first embodiment of a refrigerator with two compartments according to the present invention;

Fig. 2 shows the compartment at lower temperature of the same refrigerator, sectioned horizontally along the line II-II of Fig. 1;

Fig. 3 shows said compartment at lower temperature sectioned vertically as in Fig. 1, but under defrosting conditions;

Fig. 4 shows an embodiment of an electrical diagram that may be used in the refrigerator of the preceding figures;

Fig. 5 shows a vertical sectional view, under normal operating conditions, of a second embodiment of a refrigerator with two compartments according to the present invention;

Fig. 6 shows the same refrigerator sectioned along a vertical plane other than that of Fig. 5;

Fig. 7 shows the same refrigerator sectioned along a vertical plane perpendicular to those of Fig.s 5 and 6;

Fig. 8 shows a variant with more than two compartments of the refrigerator of Fig.s 5-7;

Fig. 9 shows a vertical sectional view, under normal operating conditions, of a third embodiment of a refrigerator with two compartments according to the present invention;

Fig. 10 shows the same refrigerator sectioned along a vertical plane other than that of Fig. 9;

Fig. 11 shows the same refrigerator sectioned along the line XI-XI of Fig. 9;

Fig. 12 shows the compartment at lower temperature of the same refrigerator, sectioned horizontally along the line XII-XII of Fig. 9;

Fig. 13 shows the same refrigerator sectioned vertically as in Fig. 9, but under defrosting conditions;

Fig. 14 shows the compartment at lower temperature of said refrigerator, sectioned as in Fig. 12 but under defrosting conditions.

Fig.s 1-3 show a refrigerator with two compartments 1 and 2, at a lower and at a higher temperature, respectively, separated by a horizontal dividing wall 3 inside a common cabinet 4. Said compartments are normally closed by respective independent doors 5 and 6.

On the rear wall of the compartment 1 at lower temperature there is an evaporator 7, that forms

part of a refrigerating circuit 8 shown in Fig. 1 and also comprising, in a manner known in itself, a compressor 9, a condenser 10, a dehydrating filter 11 and flow laminators 12.

In front of the evaporator 7 there is a wall 13, that together with a parallel wall 14 defines a vertical channel 15 for the flow of air made to circulate by a fan 16 in a space 17 above the evaporator 7 and in communication with the upper extremity, always open, of the channel 15.

The lower end of the latter, in a manner adjustable with a self-sensitive shutter 18, in turn communicates with a space 19 in the compartment 2 at higher temperature and in communication with it through drilled walls 20.

The upper space 17 also communicates, through an inlet that is opened and closed by a shutter 22, with a front space 24 that in turn communicates with the compartment 1 at lower temperature through a drilled wall 25.

Both the compartments 1 and 2 communicate with a space 26 at the lower end of the evaporator 7 through respective horizontal channels 27 and 28 obtained in the dividing wall 3. Said space 26 also communicates with the outside of the cabinet 4 through a channel 29 for the discharge of the evaporator's condensate water.

A sensor 30 is housed in the compartment 1 at lower temperature to read the temperature in said compartment and to communicate it to a thermostat 31 housed in the compartment 2 at higher temperature.

The correct operation of the refrigerator illustrated in Fig.s 1-3 is ensured by a suitable electrical circuit whose details are shown in Fig. 4. It comprises a pair of supply terminals 32 and 33, between which a motor 34 for the operation of the fan 16 is interposed. To the terminal 32 there is also connected the thermostat 31, that drives the parallel of the compressor 9 and of a relay 23 whose excitation causes the shutter 22 to open.

During the refrigerator's normal operation, the sensor 30 keeps the thermostat 31 in the closed position, so that the compressor 9 is in operation and allows the evaporator 7 to withdraw heat from the environment where it is housed. The relay 23 is excited and keeps the shutter 22 in the position wherein the inlet 21 is open, as shown in Fig.s 1 and 2. The fan 16 is lastly in operation and determines a forced circulation of air (highlighted by the arrows of Fig. 1) along the evaporator 7 and in the two compartments 1 and 2, passing through the inlet 21, the space 24 and the horizontal return channel 27 and through the vertical channel 15 (with the lower extremity kept open by the self-sensitive shutter 18), the space 19 and the horizontal return channel 28, respectively. Such circulation of air prevents the formation of frost.

When the temperature inside the compartment 1 reaches a pre-set minimum value, the sensor 30 drives the opening of the electrical contacts of the thermostat 31 with the consequent stoppage of the compressor 9 and the disexcitation of the relay 23. The refrigerating circuit 8 thus starts a defrosting stage and the shutter 22 closes the inlet 21, excluding the compartment 1 from the circulation of air, that through the vertical channel 15 and then through the horizontal return channel 28 flows through the compartment 2 only, as well as naturally through the evaporator 7, as shown in Fig. 3.

In this way the relatively warm air of compartment 2 speeds up the defrosting process of the evaporator and at the same time it gains humidity, advantageously enhancing the relative humidity inside compartment 2.

With respect to the normal "no-frost" refrigerators there is thus obtained a substantial saving of energy, while the fresh food kept in the compartment at higher temperature are kept under perfect conditions.

Many are the variants that may be made to the basic construction outline of the refrigerator shown in Fig.s 1-4.

In particular, as shown in Fig.s 5-7, the vertical channel 15 for introducing air in the lower compartment 2 may be incorporated in the rear wall of the cabinet 4 and extend from an upper inlet 41 communicating with the space 24 to a lower inlet 42 communicating with the compartment 2. The return channel 28 can itself also be incorporated in the rear wall of the cabinet and extend from a lower inlet 43 to the space 26, where, through the holes 44 and 45, the return air from the compartment at lower temperature 1 also arrives.

Instead of just one compartment 2 at higher temperature, there can be two, as shown in Fig. 8, where they are indicated with 2' and 2'', respectively. In such case there are two admission inlets 42' and 42'' and two return outlets or channels 43' and 43''.

As a further alternative, shown in Fig.s 9-14, the evaporator 7, instead of on the rear wall of the compartment at the lower temperature 1, is in a space 51 obtained behind the rear wall of the high-temperature compartment 2. Such space 51 communicates at the lower end with the compartment 2 through inlets 52 and at the upper end with a space 53 housing the fan 16. Such space 53 in turn communicates, through an inlet 54 operated by the self-sensitive shutter 18, with a further space 55 in turn communicating with the compartment 2 through an inlet 56. The same space 53 also communicates with a vertical channel 57, that through an inlet 58 opened and closed by the shutter 22 (Fig.s 12 and 14) communicates with a space 59 altogether similar to the space 24 of Fig.

1 and then through inlets 60 with the low-temperature compartment 1. A pair of inlets 61, a vertical channel 62 incorporated in the rear wall of the cabinet 4 and an inlet 63 take back to the evaporator 7 the air thus introduced into compartment 1.

The manner of operation of the refrigerator of Fig.s 9-14 is clearly identical with that, already described, of the refrigerator illustrated in Fig.s 1-4.

Other variants can easily come to mind to an expert of the art without going outside the object and the spirit of the present invention, as it appears from the final claims.

In particular, as an example, the fan 16 can be either upstream or downstream from the evaporator and the same can be said for the opening with the shutter 22 that regulates the flow of air in the low-temperature compartment.

The flow of air with the shutter 18 for one of the compartments at higher temperature should always be opened when the compressor is not in operation; for the other compartments at higher temperature, when they are present, such flow may be opened or closed in relation to the thermal and humidity features that are to obtain in the compartments themselves.

The fan 16 is generally always in operation, but its switching off may be provided for in the case where all compartments have reached sufficiently low temperatures.

Even though the usual defrosting resistance is not strictly necessary because its function is carried out by the relatively warm air arriving from the compartment at higher temperature, its use may on the other hand be provided for so as to further facilitate the defrosting of the evaporator and curtail the intervals when the compressor is not in operation.

To facilitate defrosting it is also possible to provide ports that allow the withdrawal of warm air from outside the cabinet, in particular in the proximity of the compressor and of the condenser, and to lead it to the evaporator.

Claims

1. Refrigerator with at least two compartments (1, 2), one (1) at lower temperature and the other (2) at higher temperature, comprising at least one evaporator (7) in a position of thermal exchange with the compartment (1) at the lower temperature and inserted in a refrigerating circuit (8) also including a condenser (10) and a compressor (9) that can be disconnected periodically when the temperature inside the compartment (1) at lower temperature falls below a pre-set minimum value, and a fan (16) for forced circulation of air through said evaporator (7) and inside said compartments (1, 2), characterized in that it comprises valve means (22) that, when the compressor (9) is disactivated, are in a position where they close the compartment (1) at lower temperature against said forced circulation of air and where they convey all said air to the compartment (2) at higher temperature.

2. Refrigerator according to claim 1, characterised in that said evaporator (7) is housed inside said compartment (1) at lower temperature.

3. Refrigerator according to claim 1, characterised in that said evaporator (7) is housed inside a space (51) of a wall of the compartment (2) at higher temperature.

4. Refrigerator according to claim 1, characterised in that said fan (16) is housed in a space (17, 53) at one end of said evaporator (7) in the direction of said forced circulation of air and communicating with said compartment (1) at lower temperature through said valve means (22), said space (17, 53) being also in communication with said compartment (2) at higher temperature through outgoing and return inlets (15, 28; 54-56, 52) not in communication with said compartment (1) at lower temperature.

5. Refrigerator according to claim 1, characterised in that it comprises thermostat means (31) that react to a thermal sensor (30) housed in said compartment (1) at lower temperature so as to deactivate said compressor (9) and place said valve means (22) in a position of closing said communication between said evaporator (7) and said compartment (1) at the lower temperature when the temperature inside the compartment (1) at lower temperature falls below a pre-set minimum value.

Tav. I

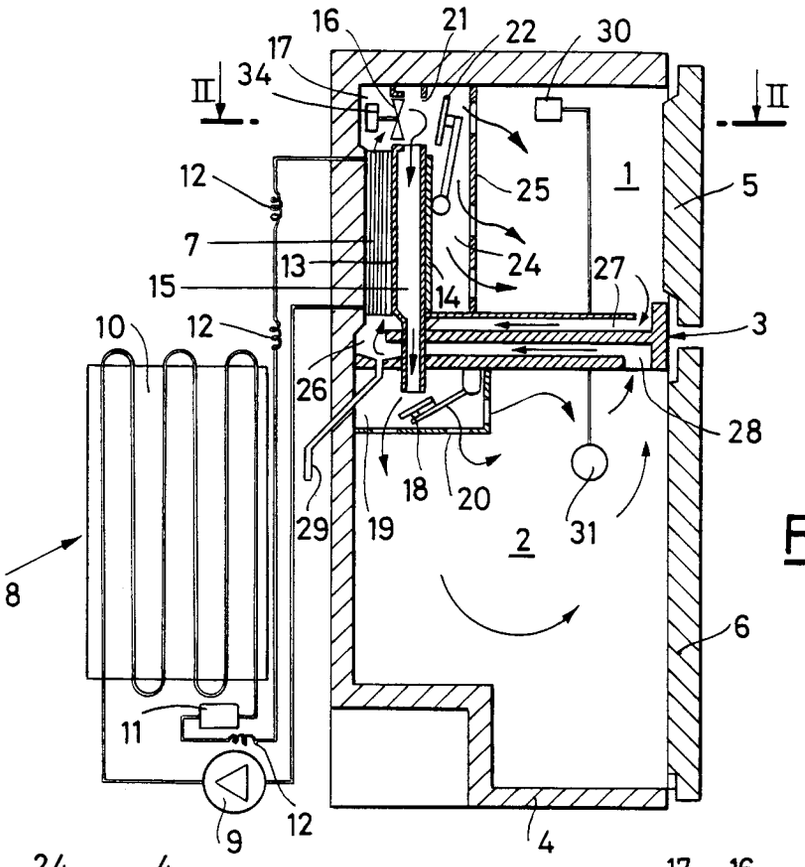

Fig.1

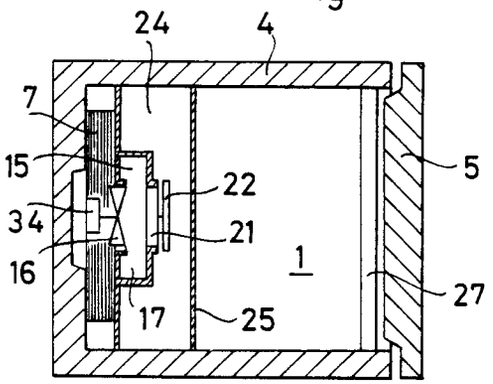

Fig.2

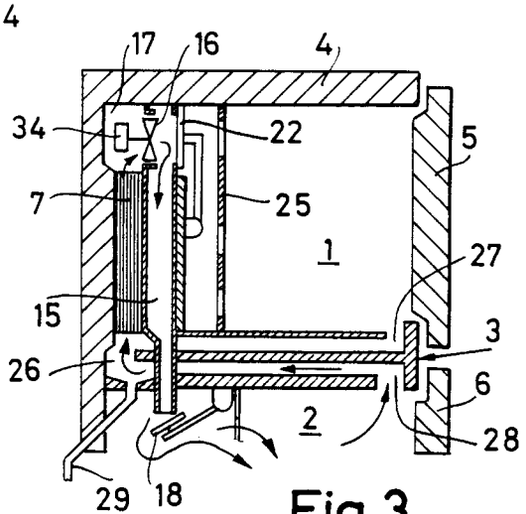

Fig.3

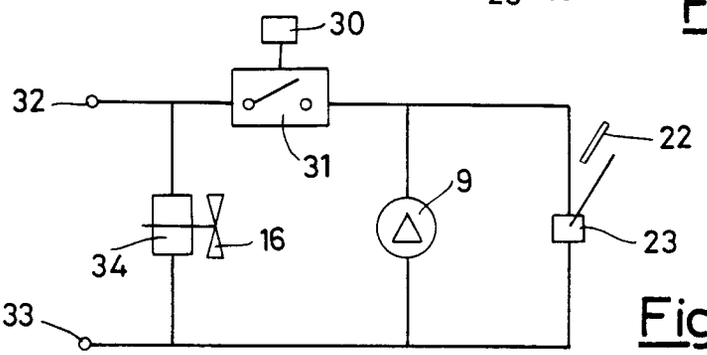

Fig.4

Tav.II

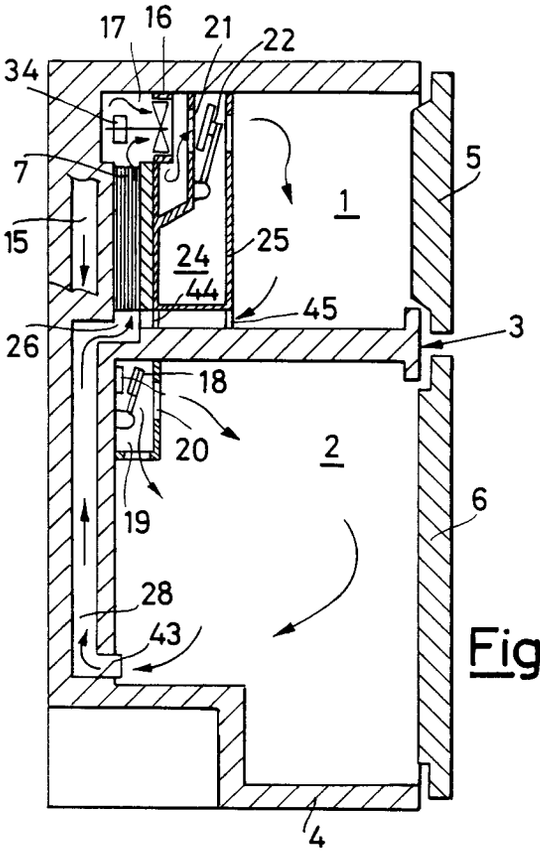

Fig.5

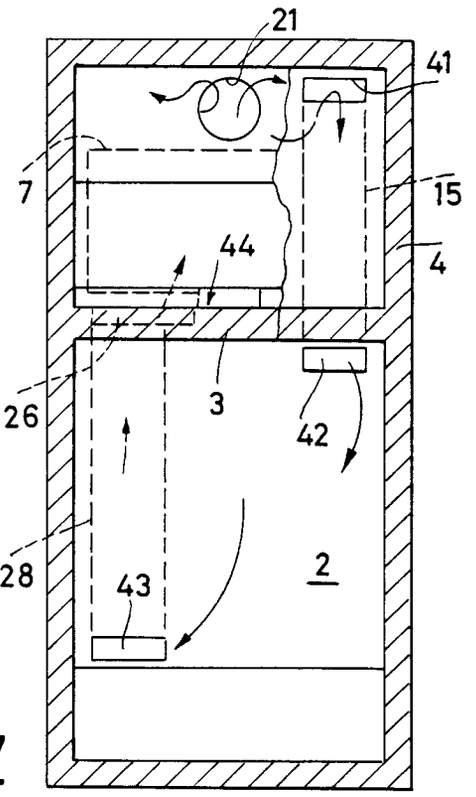

Fig.7

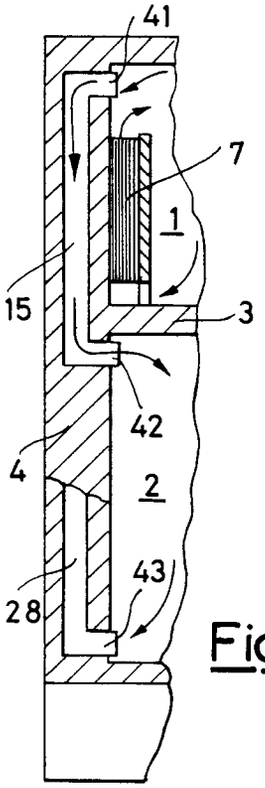

Fig.6

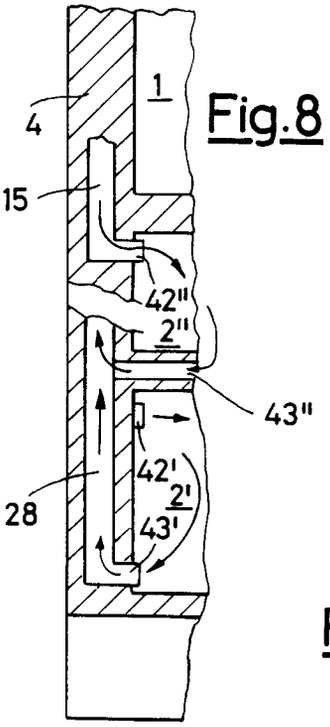

Fig.8

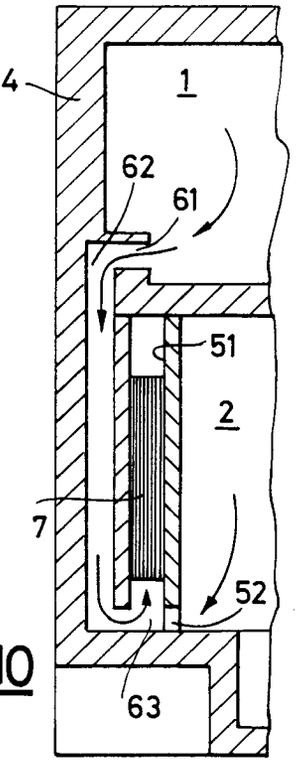

Fig.10

Tav. III

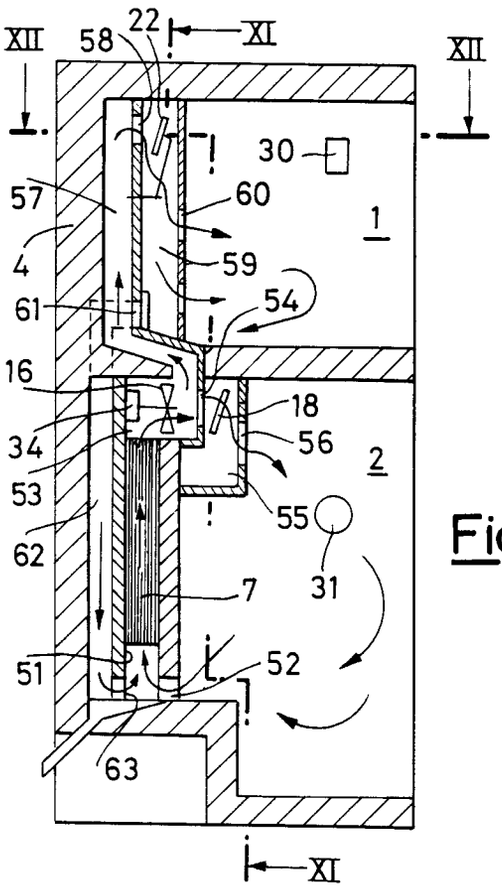

Fig. 9

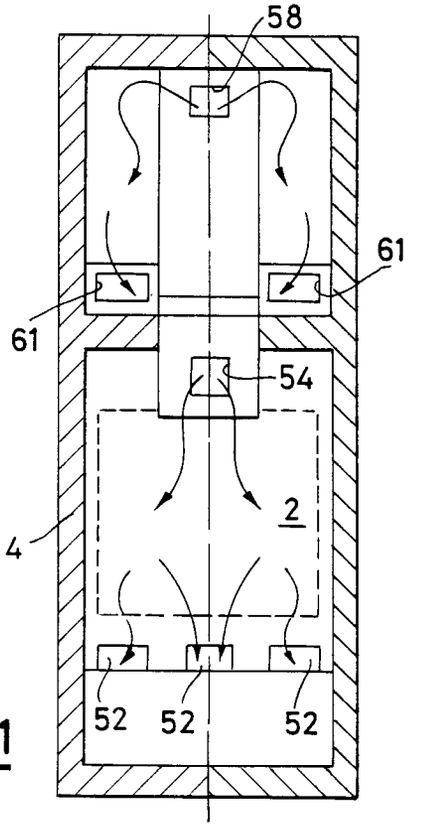

Fig. 11

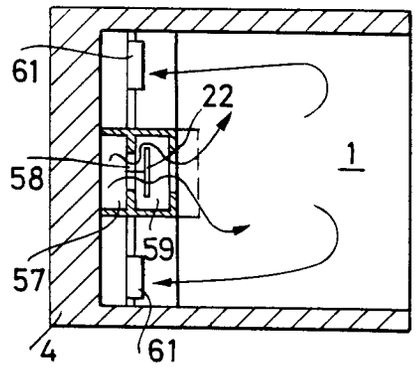

Fig. 12

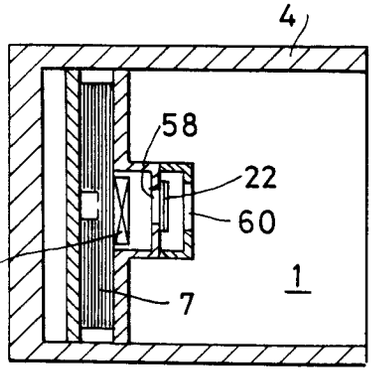

Fig. 14

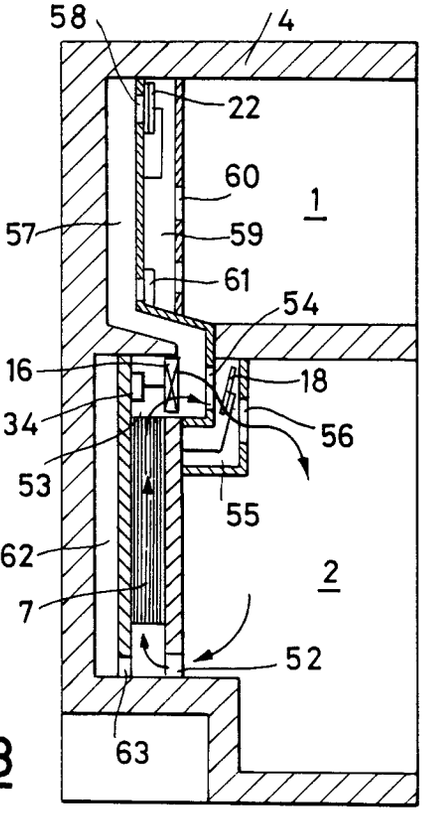

Fig. 13