

12

EUROPEAN PATENT APPLICATION

21 Application number: 82102038.5

51 Int. Cl.³: **F 25 B 41/04**
F 25 B 5/00

22 Date of filing: 13.03.82

30 Priority: 24.03.81 IT 5304581 U
09.06.81 IT 5333681 U

43 Date of publication of application:
29.09.82 Bulletin 82-39

84 Designated Contracting States:
DE FR GB IT NL

71 Applicant: **INDESIT INDUSTRIA ELETTRODOMESTICI**
ITALIANA S.p.A.
Str. Piosasco Km 17
I-10040 Rivalta Turin(IT)

72 Inventor: **Alluto, Luigi**
Strada Santa Brigida 37/4
I-10024 Moncalieri Torino(IT)

74 Representative: **Prato, Roberto et al,**
c/o Ingg. Carlo e Mario Torta Via Viotti 9
I-10121 Torino(IT)

54 Device for the adjustment of the refrigerating fluid flow in a apparatus for the production of cold or hot conditions and system for regulating such fluid flow.

57 A contrivance for the regulation of refrigerating fluid flow in an apparatus meant for the production of cold or heat is described hereinbefore.

The main characteristic of such a contrivance consists in the fact that it comprizes rather simple and cheap means for the regulation of said flow, such means including an electromagnetic valve interposed in a capillary tube (13) forming part of the refrigerating fluid circuit, said electromagnetic valve comprizing a mobile element (19) for regulating such flow, the position of which is controlled by an electric pulse or signal reaching a coil (16) of said valve and by the pressure of the fluid of the capillary tube (13).

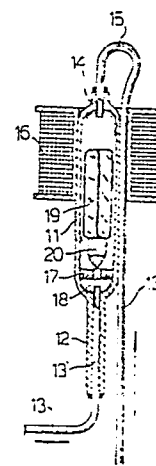


Fig.1

EP 0 061 104 A2

- 1 -

DEVICE FOR THE ADJUSTMENT OF THE REFRIGERATING FLUID FLOW IN AN APPARATUS FOR THE PRODUCTION OF COLD OR HOT CONDITIONS AND SYSTEM FOR REGULATING SUCH FLUID FLOW.

The present invention refers to a contrivance for the adjustment of the refrigerating fluid flow in an apparatus for the production of cold or hot conditions, and to a regulating system of the refrigerating fluid in a refrigerator comprizing at least two refrigerating cells evidencing different temperatures, each of which is cooled through an evaporator through which the refrigerating fluid is flowing, one of the said cells being meant for fresh food, whilst the other is intended for frozen food, further a condenser for the condensation of refrigerating fluid from the compressor and a system of capillary tubes for the transfer of the refrigerating fluid from the condenser to the evaporators.

It is known that in refrigerating circuits of household appliances the expansion valve was replaced by a capillary device, out of practical and money sparing reasons.

This capillary device evidences however some weak sides, which are essentially due to its scarce flexibility and adaptability to the different load conditions and to the different ambient temperature. As a matter of fact under light loads or with high ambient temperatures, it is possible that ^{by} outflowing from

the evaporator there could still be some refrigerating fluid in liquid conditions; this determines a considerable lowering of the refrigerator's performance and also the building up of hoarfrost on the backflow piping of the refrigerating flow returning to the compressor; it could even occur that some liquid penetrates into the compressor, damaging it.

Under heavy load conditions, or when ambient temperature is low, it is possible on the contrary that in the last portion of the evaporator there remains some refrigerating fluid as saturated steam with a limited cooling power. Under such conditions there would be an insufficient cooling of the cell to be cooled.

Furthermore the two doors refrigerators equipped with two cooling rooms, one for fresh foods and one for frozen ones (cell freezer) with a single compressor and only one refrigerating fluid circuit, raise the problem that by regulating temperature in one of the two cells, temperature changes also in the other cell, automatically. This link creates problems when for instance one must lower the temperature in the freezer cell (because some fresh food was introduced and is to be frozen), whilst the temperature in the fresh food cell is on desired level and is not to be further lowered. In such cases it would be very appropriate to be able to adjust the refrigerating fluid flow. To this end one could use either an expansion valve (replacing the capillary contrivance) or an electro-magnetic valve. However the expansion valves require a rather careful machining and are obtainable at high costs. The electro-magnetic valves instead could be inserted

0061104

and connected in series to the refrigerating circuit or on a branch line parallel to the evaporator. In the first case and considering that such valves have only two positions, one for opening and one for closing, regulation should occur through the opening and the closing of the valve in a rapid sequence and with the desired frequency. However such a kind of operation would imply within a short lapse of time a damage to the valve; in the second case regulation should occur through opening for a necessary lapse of time the valve (normally closed) in order to "short" the evaporator, which under such conditions would no longer cool the cell. But in this case it would be necessary to supply the refrigerating circuit with an additional branch, thus increasing production costs.

Considering that the two evaporators can be connected in series or in parallel, an independent functioning of the two cells can be obtained through two- three- or four-way valves of the electro-magnetic kind, connected in the refrigerating circuit and allowing the passing through, the stopping or the deviation of the refrigerating fluid in the two evaporators.

For instance by blocking the flowing of the refrigerating fluid into the evaporator of the fresh foods cell, it is possible to defrost said cell and to freeze the frozen foods cell alone. Such electro-magnetic valves involve however a notable drawback, especially in the case of refrigerating circuits of household appliances which are to be produced in large quantities and at limited prices, because they cost a lot and their use in



BAD ORIGINAL

the area of said appliances appears problematical.

Another drawback in the refrigerators mentioned above after the stopping of the compressor (i.e. during the equalization of the refrigerating fluid pressures) is due to the fact that such fluid during its transfer from the condenser to the evaporators conveys external heat and thus raises the temperature of the evaporators, degrading them in consequence.

The present invention aims therefore at the overcoming of the above drawbacks by building a contrivance for the regulation of the fluid flow in a refrigerating circuit at a very low cost, whilst in case of damage to the electrical component of the device (coil) this can be easily replaced without damaging the circuit of the refrigerating fluid.

Another scope of the present invention consists in setting up a refrigerating combined apparatus or a two doors one, in which the operation of the two cells used for cooling purposes is to be substantially independent, whilst the regulating system of the refrigerating fluid is in conditions to warrant the re-balancing of the pressures of the refrigerating fluid without degrading the evaporators. The device is finally to be notably money sparing through the use of electric valves having a low cost level.

To reach this target, the present invention proposes a contrivance for the regulation of the flow of a refrigerating fluid in an apparatus for the production of cold or heat, characterized by the fact that it comprizes rather simple and economic means

0061104

for the regulation of said flow, said means including an electro-
magnetic valve inserted into a capillary tube forming part of
the circuit of the refrigerating fluid and said electro-magne-
tic valve comprizing a movable component for the regulation of
5 said flow, the position of which is controlled through an
electric pulse addressed to the coil of said valve and through
the fluid pressure inside the capillary tube.

Further scopes and advantages of the present invention will
appear clearly from the detailed description hereinafter drawn
10 up and the enclosed drawings, which are to be understood
purely as examples without any specific limitation.

We have here three figure in, which:

In the figure 1 appears a cross section of the first realization
of the above mentioned contrivance forming the subject of the
15 present invention; in the figure 2 appears schematically a
refrigerator arranged according to the regulating system of
the refrigerating fluid subject of the present invention and
applying the device mentioned before and appearing on fig.1;
and in the figure 3 there appears a cross section of a second
20 form of realization of the contrivance covered by the present
invention.

With reference to figure 1 a cylindrical copper container
11 is shown, with two apertures 12 and 14 opened in its end
portions. In the lower aperture 12 a first part 13' of a
25 capillary tube 13 is inserted and welded, from which the
refrigerating fluid flows into the evaporator. In the upper aper

BAD ORIGINAL

Figure 14 a second part of the same capillary tube 13 is inserted and welded; it is bent so as to adhere to the container 11 and to remain parallel to the first part 13' of the capillary tube; from this part 15 arrives the refrigerating fluid proceeding from the condenser. Around the lower portion of the container 11 and of the capillary tube portion 15 a coil 16 is arranged, fed by a continuous electric voltage. Inside the container 11, and in its lower portion, there is a circular partition 17 with a hole 18 having a cylindrical shape, whilst in the upper part of the container there is an iron core 19 with a tip 20 in its lower part, having an adequate size for occluding the hole 18. The feeding of the coil 16 could also occur through a.c. , but in consideration of the fact that all the outer coating is a copper one, an a.c. feeding would generate induced currents which would cause losses. Furthermore the functioning would be very noisy.

In rest conditions, when no current circulates inside the coil 16, the iron core 19 and its bit 20 occlude completely the hole 18 due to their weight and especially to the pressure of some atmospheres of the refrigerating fluid arriving from the condenser which press them downwards: in this way the electric valve remains closed and refrigerating fluid is not flowing through.

When coil 16 receives electric current, a magnetic flux is generated which in turn generates a force which attracts the iron core 19 and its bit 20 upwards, against the resistance



of the pressure of the refrigerating fluid arriving from the condenser and tending to thrust such components downwards: however the attraction strength in upward direction is such that it overcomes such resistance and the final effect is an upward movement of the components mentioned above, so that they no longer obstruct the hole 18. It is to be noted that the sustentation of the core 19 by the magnetic attraction of the coil 16 is made easier through the fact that the contrivance is inserted by cutting through the capillary tube so that same produces a decrease in the pressure exerted on the core 19 by the flow of refrigerating fluid. Furthermore when core 19 is completely lifted, the entire inner part of the container 11 is essentially under the same pressure. In this way the electrovalve is open and the refrigerating fluid can flow through. When the coil 16 is de-energized, bit 20 falls down but the pressure force of the fluid keeps it compressed against the hole 18 so that the electrovalve is maintained closed. With the above described contrivance appearing on figure 1, one obtains therefore a regulation called "digital" for the refrigerating fluid, because in consequence of control current reaching coil 16 and obviously in dependence on the pressure of the refrigerating fluid, the electrovalve remains open or closed. A continuous regulation of the refrigerating fluid flow, according to a system called "analogue", can be obtained by using the contrivance appearing on figure 3, slightly different from that of figure 1, where parts of capillary tubes 13' and 15 are exchanged in respect of

the end connections with the container 11. Part 15 through which arrives the fluid proceeding from the condenser is welded to the lower aperture of the container 11, whilst the part 13' through which fluid flows to the evaporator is welded to the upper aperture of the container 11. Moreover the coil 16 is arranged around the lower area of the container 11 and the hole 18' cut into the circular partition 17 assumes the form of a truncated cone whilst the bit 20 of the core 19 is adequately made of nylon. In this case, and in rest conditions, when no current passes through the coil 16, the iron core 19 and its bit 20 should close due to their weight the hole 18', but the pressure of the refrigerating fluid counterbalances the said weight, so that they assume a position which allows the flowing through of all the refrigerating fluid, thus permitting to obtain the maximum flow designed for the capillary tube.

When a determined quantity of current passes through the coil 16 an appropriate magnetic flux is generated which in turn generates a force attracting the iron core 19 and its bit 20, which occludes partially the hole 18', thus reducing the flow of the refrigerating fluid to a certain extent.

The displacement of the iron core 19 and of its bit 20, and therefore the size of the occlusion of the hole 18' are a function of the quantity of current circulating through the coil 16, so that by varying continuously such a current, one can vary with the same precision said aperture of hole 18'. In dependence on the size of the capillary tube 13 and of the

capillary tube 5 and on the opening of said hole 18' one can
obtain an exact regulation of the flow of the refrigerating fluid
which never lowers to nought due to the considerable contrary
force exerted by the refrigerating fluid in regard to the core
5 19 against which the flow is striking.

It is further to be noted that the different shape of the two
holes (18 is cylindrical and 18' has the form of a truncated cone)
has its importance, because the shape of a truncated cone
although useful in the instance of the figure 3 for an "analogue"
10 regulation of the flow, is no longer applicable in the case of
figure 1 for a "digital" regulation of same, in view of the
fact that the faying surface between bit 20 and hole 18 would
be then so large, that extremely strong currents should be fed
to the coil 16 to obtain a disjunction between such two components.
15 It is therefore usefull to have in this case a small faying or
contact surface between such components through a cylindrical
hole 18.

One can also note that the part of capillary tube which is
bent on the side of the container 11 allows an easy repla-
20 cement of the coil 16 (Figure 1 and 3) : as a matter of fact
should said coil 16 be damaged for a whatsoever reason and
be therefore replaced, it would be sufficient to extract it
from its position, without disturbing in the slightest the
refrigerating fluid circuit.

25 With reference to figures 2 we can observe: a compressor 1,
a condenser 2 connected to the outlet of compressor 1, a de-

0061104

hydrating strainer for the refrigerating fluid 3 on the outlet of the condenser 2, a first capillary tube 4F (diameter 0,70 mm, length 2800 mm) connected with the dehydrating strainer 3, a first electrovalve with a removable coil 5F (like that on fig.1), inserted into the first capillary tube 4F which is appropriately interrupted, a first evaporator 6F connected with the capillary tube 4F, a second capillary tube 4C (diameter 0,70 mm, length 3200 mm) connected with the dehydrating strainer 3, a second electrovalve with removable coil 5C, just as on figure 1, inserted into the second capillary tube 4C, appropriately interrupted, a second evaporator 6C, the inlet of which is connected with the outlet of the first evaporator 6F and the second capillary tube 4C, and a return flue 7 connecting the outlet of the second evaporator 6C with the input of the compressor 1.]

The functioning of the refrigerating assembly is carried out by a thermostatic circuit which does not appear on figure and is as follows: when both cells require cold, the compressor 1 starts to function, the electrovalve 5F remains open, the electrovalve 5C is closed. In this way the refrigerating fluid can circulate in both evaporators 6F and 6C and is cooling both cells.

When only one cell (that for frozen food) needs cold, compressor 1 is always in operation, while the electrovalve 5F is closed and the electrovalve 6F is open. In this way no refrigerating fluid is circulating in the evaporator 6F and the fresh food cell is not cooled, while the circulation of refrigerating fluid

BAD ORIGINAL

0061104

in the evaporator 6C cools the cell containing frozen food. Immediately after the stopping of the compressor 1, the thermostatic circuit opens both electrovalves 5F and 5C and allows a quick re-balancing of the pressures of refrigerating fluid, thus avoiding the degrading of the evaporators 6F and 6C.

In a variant, said thermostatic circuit can open the first electrovalve 5F and close the second one 5C; in this way the re-balancing of the pressures of the refrigerating fluid is not occurring very rapidly, but the whole of the outer heat is scattered on the evaporator of the cell for fresh food 6F, which is not worsening the operation because it finds itself in a phase of defrosting.

In this way, as can be noted, it was possible to obtain an essentially independent functioning of the two cells used for cooling purposes and the drawbacks connected with the degrading of the evaporators were avoided.

As can be noted from the description of the functioning, the electrovalve forming the subject of the present invention, may replace with the same performance an electrovalve of the known two-ways type, while two of the same electrovalves connected as per figure 2 may replace a three-ways electrovalve of a known type. It may even be added that this arrangement is advantageous as against the three-ways electrovalve because the latter can have only two positions (way A open and way B closed and way A closed and way B open, which can be indicated by symbols 01 and 10).

BAD ORIGINAL

The two electrovalves 5F and 5C connected as shown 00611042
allow four combinations viz. : 5F closed-5C closed, 5F closed-
5C open, 5F open-5C closed, 5F open-5C open which can be indica-
ted as 00,01,10,11 and through which one can obtain a performance
flexibility which is not obtainable with a three-ways electrovalve
In a non appearing variant for the refrigerating circuit of
the figure 2, the capillary tube may be wanting in the relevant
electrovalve (4C being the tube and 5C the electrovalve) so that
there remains only the capillary tube 4F, with an appropriate size
and in which electrovalve 5F is inserted (its type being the same
of that appearing on figure 3): the regulation in this case is
of the "analogue" kind.

When both cells 6F and 6C are to be cooled, the electrovalve 5F
finds itself in the maximum opening conditions and the flow of
refrigerating fluid is at a maximum level with an efficiency
able to cool both cells.

When the fresh food cell (in connection with evaporator 6C)
does not need any cooling, but this is the case of the frozen
food cell (connected with evaporator 6F) one uses the electro-
valve 5F, in the way already described in reference to fig.3,
in order to reduce the refrigerating fluid flow to a desired
level, so that on the inlet of the evaporator 6C there remains
essentially a saturated steam, practically deprived of any cooling
power. In this way it is possible to cool the frozen food cell
and not the fresh food one, thus obtaining an essentially inde-
pendent functioning of the two cooling cells.

0061104

in. above specification shows clearly the advantages presented by the contrivance in respect of a refrigerating assembly, and the same can be said of the regulation system for the refrigerating fluid according to the present invention. Such advantages are evidenced by the fact that it is possible to use particularly cheap components for both "analogue" and "digital" regulations of the refrigerating fluid flows, that it is possible to replace the coil 16 of said contrivance without causing any damage to the circuit of the refrigerating fluid, that both cells can practically be regulated independantly for cooling purposes, that drawbacks connected with degrading of evaporators are eliminated, that the electrovalves have essentially the same performance of other known types which are more costly and finally that the functioning causes little noise.

It is obvious that numerous variations are possible as far as the regulation system of the refrigerating fluid is concerned; e.g. a different way of opening and closing the electrovalves or the shape and/or the materials used for the coating or the partition or the ferromagnetic core of said electrovalves, without leaving the basic principles included in the area of the invention .


BAD ORIGINAL

CLAIMS

1. - Contrivance for the regulation of the refrigerating fluid flow in an apparatus for the production of cold or heat, characterized by the fact that it comprizes relatively simple means obtainable at reasonable costs for the regulation of said flow, said means including an electromagnetic valve put inside a capillary tube (13) forming part of the refrigerating fluid circuit, said valve including a movable element (19) for the regulation of said flow, the position of which is controlled by an electric pulse or signal reaching a coil (16) of said valve and by the pressure of the fluid inside the capillary tube (13).
2. - Contrivance according to the claim 1, characterized by the fact that said means energized by said electrical control pulse, allow a precise and continuous adjustment of the position of said movable element (10) and thus of said flow.
3. - Contrivance according to claim 1, characterized by the fact that said means, energized by said electrical control pulse allow a regulation for two limit positions of said movable element (19) and thus for limit values of opening and closing of said flow.
4. - Contrivance according one of the preceding claims, characterized by the fact that said electromagnetic valve comprizes a container (11) the ends of which are connected with two terminals (13', 15) of said capillary tube (13), said container (11) having inside it said mobile element (19) comprizing a core displaceable through said coil (16), this core having a terminal

(20) closing in total or in part an orifice (18, 18') ; putting in communication the two ends (13', 15) of the capillary tube.

5. - Contrivance according to claim 4, characterized by the fact that said orifice (18') is made in a partition (17) as a central hole having the shape of a truncated cone, this partition being present in the above mentioned container (11) while the terminal (20) of said core (19) is made of nylon.

6. - Contrivance according to claim 4, characterized by the fact that said orifice (18) is obtained as a cylindrical hole made centrally in a partition (17) inserted inside the container (11).

7 - Contrivance according to one of the claims from 4 to 6, characterized by the fact that said coil (16) is arranged around said container (11) and around at least one portion of said capillary tube (13) bent alongside said container, to allow an easy replacement of said coil (16) without interrupting the refrigerating fluid circuit.

8 - Contrivance according to one of the preceding claims, characterized by the fact that said mobile element (19) is in conditions to move vertically and said valve is connected with the a/m capillary tube (13), so that in absence of a control pulse reaching the coil , said mobile element (19) is subject to the action of the fluid flow, which against its weight keeps open said valve, whilst a control signal to said coil determines a reduction of the flow passing through the valve.

9. - Contrivance according to one of the claims from 1 to 7, characterized by the fact that said mobile element (19) can

0061104

move vertically and said valve is connected with said capillary tube (13) so that, in absence of a control pulse reaching the coil, said movable element (19) is subject to its weight and to the action of the fluid flow, so that said valve remains closed, whilst a control pulse reaching the coil determines an opening of said valve.

10. - Regulation system of the refrigerating flow in a refrigerating assembly comprizing at least two cooling cells at different temperatures, each of which is cooled by an evaporator through which the refrigerating fluid is flowing, one of them being meant for fresh food and the other for frozen ones, a compressor for compressing the refrigerating fluid, a condenser for condensing the refrigerating fluid arriving from the compressor and a system of capillary tubes for conveying the refrigerating fluid to the evaporators, characterized by the fact that it can warrant an essentially independent functioning of the two cooling cells by using a first (5F) and a second (5C) electrovalve inserted into the circuit of the refrigerating fluid, interrupting appropriately a first (4F) and a second capillary tube (4C) forming part of a network of tubes and being controlled separately.

11. - System of regulation of the refrigerating fluid flow in a refrigerating assembly according to claim (10) characterized by the fact that the inlet of said capillary tubes (4F, 4C) is connected with the outlet of said condenser, whilst the outlet of the first capillary tube (4F) is connected with the inlet of

the evaporator (6F) linked with the frozen food cell and with the outlet of the second capillary tube (4C), whilst the outlet of the evaporator (6C) linked with the cell of the frozen food is connected with a return flue or duct (7).

12. - System of regulation of the flow of the refrigerating fluid in a refrigerating assembly according to the claim 11, characterized by the fact that when both cooling cells are to be cooled, said first electrovalve (5F) is opened whilst the second electrovalve (5C) is closed so that the refrigerating fluid is in conditions of circulating inside both evaporators (6F and 6C) cooling the relevant cells, and by the fact that when it is desired to cool the frozen food cell only, said first electrovalve (5F) is closed, whilst said second electrovalve (5C) is opened, so that the refrigerating fluid can circulate in the evaporator (6C) only connected with the frozen food cell.

13. - System of regulation of the refrigerating fluid flow in a refrigerating assembly according to claim 11, characterized by the fact that after the stopping of said compressor (1) both electrovalves (5F and 5C) are opened in order to allow a quick re-balancing of the pressures inside the refrigerating fluid.

14. - System of regulation of the refrigerating fluid flow in a refrigerating assembly according to claim 11, characterized by the fact that after the stopping of said compressor (1) the first electrovalve (5F) is opened, whilst the second electrovalve (5C) is closed, so that during the re-balancing of the

pressures inside the refrigerating fluid the active heat proceeds from the condenser (2) is dissipated on the frozen food cell only helping it in its defrosting process, such cell bearing the number (6F).

5 15. - System of regulation of the refrigerating fluid flow in a refrigerating assembly according to one of the claims from 10 to 14, characterized by the fact that said electrovalves (5F and 5C) belong to a device according to claim 9.

10 16. - System of regulation of the refrigerating fluid flow including at least two cooling cells at different temperatures, each of them being cooled by an evaporator through which flows the refrigerating fluid, one of them being meant for fresh food and the other for frozen foods, a compressor for compressing the refrigerating fluid, a condenser for condensing the refrigerating fluid arriving from the compressor and a network
15 of capillary tubes for conveying the refrigerating fluid from the condenser to the evaporators, characterized by the fact that it warrants an essentially independent functioning of the two cooling cells by using an electrovalve (5F) inserted into the
20 refrigerating fluid circuit with an appropriate interruption of said capillary tube (4F).

17. - System of regulation of the refrigerating fluid flow in a refrigerating assembly according to the claim 16, characterized by the fact that said electrovalve (5F) belongs to a device
25 mentioned under claim 8.

18. - System of regulation of the refrigerating fluid flow in

0061104

a refrigerating assembly comprizing at least two cooling cells at different temperatures, each of which is cooled through an evaporator leaving passage to the refrigerating fluid , one of such cells being meant for fresh food and the other for frozen ones, a compressor for compressing the refrigerating fluid, a condenser for the condensation of the refrigerating fluid arriving from the compressor, and a system of capillary tubes for conveying the refrigerating fluid from the condenser to the evaporators, characterized by the fact that it ensures an essentially independent functioning of the two cells for cooling food by using at least one electrovalve belonging to a device according to one of the claims from 1 to 9 inserted into the refrigerating fluid circuit and interrupting appropriately said capillary tube.

BAD ORIGINAL

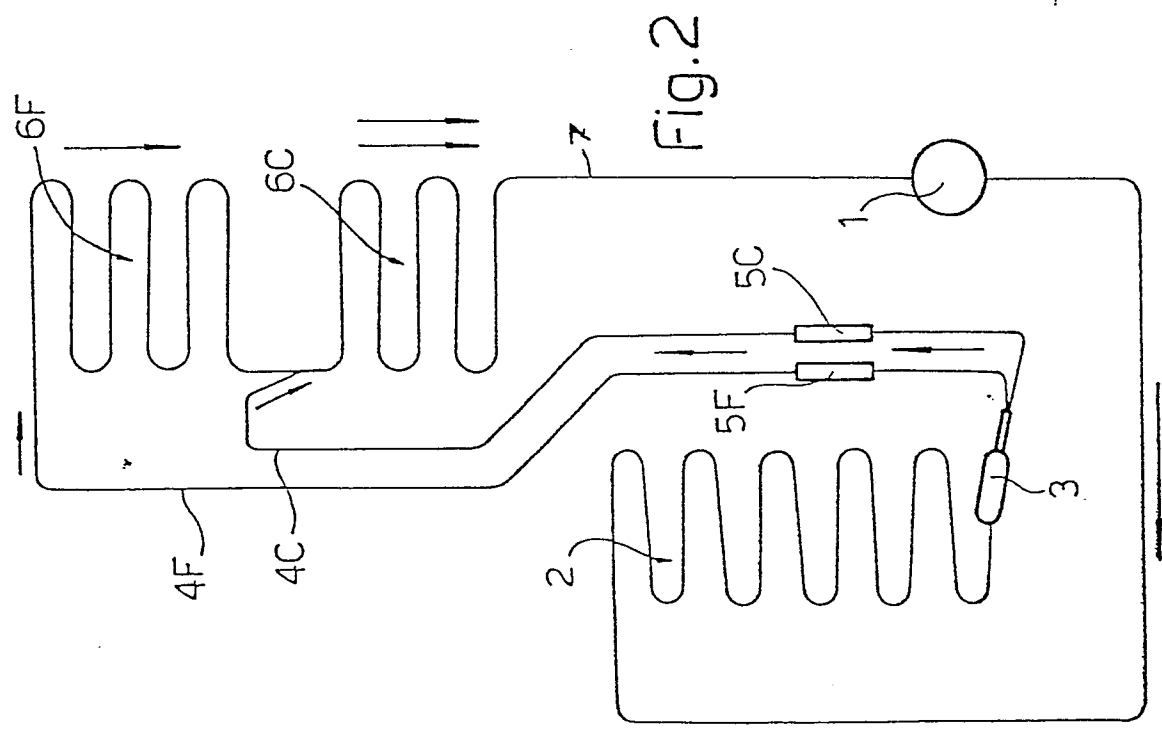


Fig. 2

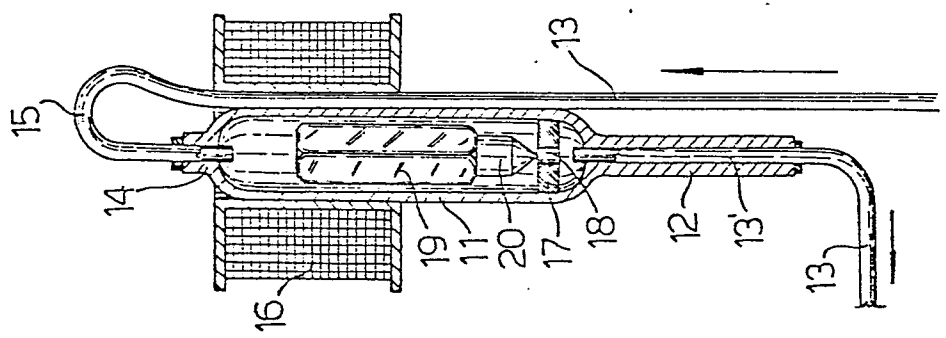


Fig. 1

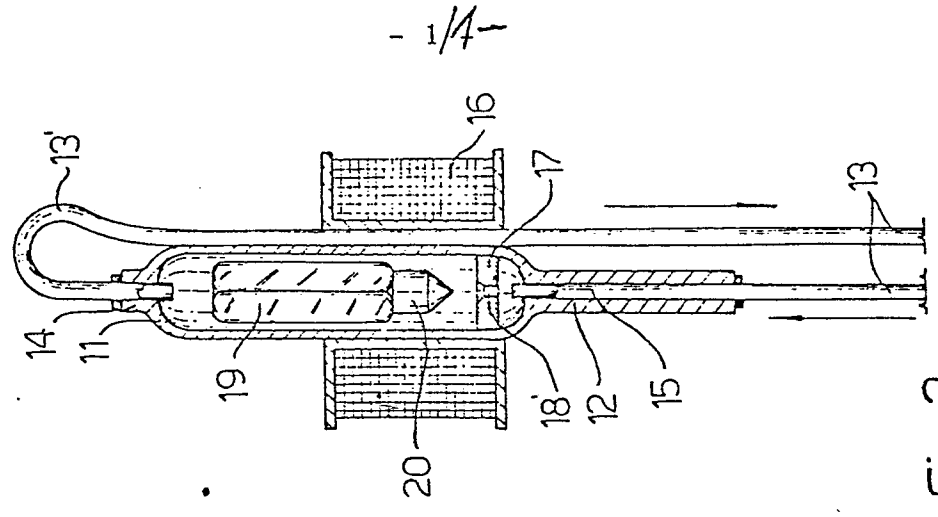


Fig. 3