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### (54) TRANSCRITICAL REFRIGERATION DISPLAY UNIT

Schaukasten mit transkritischer Kühlung

Vitrine à réfrigération transcritique

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## Description

**[0001]** The subject of the present invention is a display unit comprising at least one compressor, at least one fluid/gas heat exchanger for cooling the compressed gas, at least one evaporator, at least one expansion device and conduits connecting the afore-mentioned components with each other to form a "transcritical" refrigeration circuit, especially a carbon dioxide refrigeration circuit. The term "transcritical" refrigeration circuit refers to a refrigeration circuit which can be operated in a subcritical as well as a super- or transcritical mode.

**[0002]** The term "display unit" shall include all kind of display units, especially cabinets, multideck cabinets, roll-in cabinets, counters et cetera. Display units as mentioned before are well known to a skilled person.

**[0003]** EP-A-0 908 688 discloses display units as described above as well as a refrigeration plant, by which one or more display units are connected via their fluid/gas heat exchangers to a refrigeration cycle. The heat given up from the transcritical refrigeration circuit of each display unit via its fluid/gas heat exchanger is discharged to the refrigeration cycle. Within the refrigeration cycle a fluid such as water is circulating; an anti-freeze-agent may be added to the circulating fluid if required. These kinds of refrigeration cycles are designed in a way that their pressures do not exceed 25 bar.

**[0004]** WO 95/08087 A discloses a refrigerated merchandiser which has a removable refrigeration unit mounted in the base thereof. The refrigeration unit is supported on guide rails which in the installed position operatively support the refrigeration unit in position. When moved to a position allowing the refrigeration unit to be removed, the guide rails allow the refrigeration unit to be moved out from the cabinet for maintenance or replacement. Special leverage achieved through moving the guide rails from one position to the other lifts the refrigeration unit into the correct position. Once positioned, the refrigeration unit delivers air flows to enhance the efficient operation of the refrigerated merchandiser with the filtered air flow to the merchandiser being drawn from underneath the merchandiser and the warm air being delivered up over the outside front of the access doors.

**[0005]** Within transcritical refrigeration circuits of display units pressures of 90 bar and more occur. For that reason all components and conduits mentioned above have to be able to withstand these high pressures. Nevertheless, neither the owner and service persons of supermarkets nor their customers are interested in being confronted with such high pressures. Additionally each leak in a component or conduit can result in bigger problems as any gas escaping from a leaking high pressure conduit or component can result in serious injuries of service persons and customers.

**[0006]** The main object of the present invention is to provide a display unit, which avoids the above-discussed problem regarding the high pressures within a transcritical refrigeration circuit, especially within a carbon dioxide

refrigeration circuit.

**[0007]** A further object of the present invention is to provide a display unit, which in case of any fault of one of the above-mentioned components enables an easy and quick replacement of a non-operating component by an operating component. This replacement of a non-operating component should be manageable even by a person not skilled in the art.

**[0008]** Furthermore, it is an object of the present invention to provide an assembly of the above-mentioned components and conduits, which can be (pre)manufactured and which only has to be integrated into the display unit at the display unit's production site or in the supermarket.

**[0009]** In accordance with an embodiment of the present invention, this problem and these objects are achieved by a display unit as claimed in claim 1.

**[0010]** The innovative concept upon which the present invention is based is that at least the compressor and the fluid/gas heat exchanger are arranged within a compartment, which can be removable from the display unit.

**[0011]** The compartment should be designed so as to be stable enough to at least substantially reduce the effect of any breach or leakage of any of the components comprising the refrigerant under pressure. Various materials can be used for the compartment, for example metal sheet, plastic material, etc. It is also possible to use different material in combination, for example a hard shell together with a dampening material. It is particularly possible to provide the hard shell at the outside and the dampening material at the inner side thereof. It is also possible to provide the compartment with a venting means, like an opening, a discharge valve, etc. in order to allow venting of the refrigerant after a failure of the refrigeration circuit.

**[0012]** It is possible to removably attach the compartment to a support structure within the display unit, for example a frame, etc. of the display unit. The compartment can comprise an attachment means, like an attachment flange, for attaching the compartment to the support structure. It might be sufficient to have the compartment rest on the support structure, it is also possible to additionally secure the compartment removably thereto, for example by means of a nut and bolt fastener. A positioning means can be provided with the support structure and/or with the compartment in order to ensure a precise positioning of the compartment in the installed condition. The positioning means can have a conical shape or can be V-shaped in order to allow for easy inserting as well as precise positioning.

**[0013]** Display means, like instruments, a screen, etc., for displaying an operational condition and/or operating means, like knobs, etc. can be provided on the compartment's outer side in order to adjust cooling output, correct temperature, etc. A powerline with a plug may lead out of the compartment. Similarly, signal lines can be provided. Quick couplings can be provided in order to fluidly couple components within the compartment with exterior

components, conduits, etc. Accordingly, the compartment can easily be replaced by merely decoupling the quick couplings and unplugging the powerline.

**[0014]** For cooling the fluid/heat exchanger, it is possible to provide a "back cooling" to the compartment or directly to the fluid/gas heat exchanger. Such back cooling can be provided by means of a "low pressure" cooling circuit, e.g. with another refrigerant and even with air or water. The respective conduits can be connected to the compartment with a quick release coupling, for example.

**[0015]** In accordance with an embodiment additional or all of the above-mentioned components forming the transcritical refrigeration circuit are arranged within said compartment.

**[0016]** In case of any leak in one of the above-mentioned components or conduits the compartment will function as a buffer for the escaping gas. For that reason no direct disturbance or harm to service persons and customers should occur.

**[0017]** In case of any fault of one of the above-mentioned components the component does not have to be repaired within the display unit or replaced from the display unit, which normally takes for at least 30 minutes. During this period the display unit is out of order. According to the innovative concept the whole compartment can be removed and replaced by another compartment, housing operating components. The time for replacing the compartment takes about 10 minutes or less. The repair of the non-operating component can then be realized without any time pressure and stress.

**[0018]** According to a further embodiment of the present invention the compartment is preferably arranged below the show room or storing compartment of the display unit.

**[0019]** This arrangement enables an easy and quick replacement of the compartment.

**[0020]** Further characteristics and advantages of the invention will become clearer from the following detailed description of preferred embodiments thereof, described by way of nonlimiting examples with reference to the attached drawings, in which:

Figures 1 and 3 are schematic lateral cross-sections of preferred embodiments

Figure 2 is a schematic perspective view of the same preferred embodiment as shown in figure 1

**[0021]** In figures 1 and 2 a multideck cabinet C is shown. Below the show room or storing compartment S a compartment 1 is arranged. Within that compartment 1 a compressor 2, a fluid/gas heat exchanger 3 for cooling the compressed gas and conduits - not shown in figures 1 to 3 - are arranged. Outside of the compartment 1 an evaporator 4 and an expansion device - not shown in figures 1 to 3 - are arranged; the afore-mentioned components are connected with each other to form a transcritical refrigeration circuit, especially a carbon dioxide refrigeration circuit, as e. g. described in the above-men-

tioned EP-A-0 908 688.

**[0022]** The aforementioned expansion device is preferably designed as an expansion valve, while the compressor 2 is preferably designed as a frequency controlled compressor.

**[0023]** According to a further embodiment of the present invention the amount of the medium, circulating in the transcritical refrigeration circuit does not exceed 1000 g.

**[0024]** As can be seen from figure 3 (cooling) air 6 is forced by the ventilating fans 5,5' to flow through the evaporator 4, wherein the air is cooled against the evaporating refrigerant of the transcritical refrigeration circuit, and via the backflow-channel 7 to the show room or storing compartment S of the multideck cabinet C. This flow of the circulating cooling air is already known to a skilled person.

**[0025]** The ventilating fans 5,5' are especially frequency controlled ventilating fans. This enables an optimal adaptation of the power of the ventilating fans 5,5' to the required cooling capacity.

**[0026]** According to the embodiment shown in figure 3 all aforementioned components forming the transcritical refrigeration circuit are arranged within a compartment 1, that can be removed as a whole from the multideck cabinet C.

**[0027]** Not shown in figures 1 to 3 is the at least one quick coupling, by which the fluid/gas heat exchanger 3 can be connected easily and quickly to a refrigeration cycle or plant.

**[0028]** If the compartment 1 has to be removed or replaced by an other compartment only the connection to the power source, which is at least necessary for the compressor(s) and the fan(s), and the quick coupling have to be separated.

**[0029]** More and more, display units as described above are built as modules having the same dimensions, e. g. a length of 1250 mm. These modules are connected to each other in case a display unit having a length of  $x \cdot 1250$  mm (wherein  $x = 1, 2, 3, \dots$ ) is required.

**[0030]** According to a further embodiment of the present invention each module has its own compartment 1.

## Claims

1. Display unit comprising a compressor (2), a fluid/gas heat exchanger (3) for cooling the compressed gas, an evaporator (4), an expansion device and high pressure conduits connecting the aforementioned components with each other to form a transcritical refrigeration circuit, wherein at least the compressor (2) and the fluid/gas heat exchanger (3) are arranged within a compartment (1); wherein the compartment is supported by a support structure within the display unit; wherein the compartment (1) is designed to be stable

enough to at least substantially reduce the effect of any breach of any of the components comprising the transcritical refrigerant under pressure; wherein a low pressure cooling circuit is provided for back-cooling the fluid/gas heat exchanger (3) of the high pressure transcritical refrigeration circuit; and wherein the compartment (1) has a hard shell at its outside and a damping material at its inner side and is configured to serve as a buffer for escaping gas.

2. Display unit according to Claim 1, in which all components forming the transcritical refrigeration circuit are arranged within said compartment (1).
3. Display unit according to Claim 1 or Claim 2, in which said compartment (1) is arranged below the show room or storing compartment (S) of the display unit (C).
4. Display unit according to one or more of the preceding claims, in which the amount of the medium circulating in the transcritical refrigeration circuit, does not exceed 1000 g.
5. Display unit according to one or more of the preceding claims, in which the expansion device is an expansion valve.
6. Display unit according to one or more of the preceding claims, in which the compressor (2) is a frequency controlled compressor.
7. Display unit according to one or more of the preceding claims, in which the display unit comprises at least one quick-coupling, by which the fluid/gas heat exchanger (3) is connected to a refrigeration cycle or plant.
8. Display unit according to one or more of the preceding claims, wherein the transcritical refrigeration unit is a carbon dioxide refrigeration circuit.
9. Display unit according to one or more of the preceding claims, wherein the compartment is removable from the display unit (C).

#### Patentansprüche

1. Präsentationseinheit, aufweisend einen Verdichter (2), einen Fluid/Gas-Wärmetauscher (3) zum Kühlen des verdichteten Gases, einen Verdampfer (4), eine Expansionsvorrichtung sowie Hochdruckleitungen, die die vorgenannten Komponenten miteinander verbinden, um einen transkritischen Kühlkreislauf zu bilden, wobei zumindest der Verdichter (2) und der Fluid/Gas-Wärmetauscher (3) innerhalb eines

Raums (1) angeordnet sind; wobei der Raum durch eine Halterungskonstruktion innerhalb der Präsentationseinheit gehalten ist; wobei der Raum (1) stabil genug ausgebildet ist, um den Effekt von jeglichem Bruch jeglicher Komponenten, die das transkritische Kältemittel unter Druck aufweisen, zumindest im Wesentlichen zu vermindern; wobei ein Niederdruck-Kühlkreislauf zum Zurückkühlen des Fluid/Gas-Wärmetauschers (3) des transkritischen Hochdruck-Kühlkreislaufs vorgesehen ist; und wobei der Raum (1) an seiner Außenseite einen harten Mantel und an seiner Innenseite ein Dämpfungsmaterial aufweist und dazu ausgebildet ist, als Puffer für entweichendes Gas zu dienen.

2. Präsentationseinheit nach Anspruch 1, wobei alle Komponenten, die den transkritischen Kühlkreislauf bilden, innerhalb des Raums (1) angeordnet sind.
3. Präsentationseinheit nach Anspruch 1 oder Anspruch 2, wobei der Raum (1) unterhalb des Präsentationsraums oder Aufnahme Raums (S) der Präsentationseinheit (C) angeordnet ist.
4. Präsentationseinheit nach einem oder mehreren der vorausgehenden Ansprüche, wobei die Menge des in dem transkritischen Kühlkreislauf zirkulierenden Mediums 1000 g nicht übersteigt.
5. Präsentationseinheit nach einem oder mehreren der vorausgehenden Ansprüche, wobei die Expansionsvorrichtung ein Expansionsventil ist.
6. Präsentationseinheit nach einem oder mehreren der vorausgehenden Ansprüche, wobei der Verdichter (2) ein frequenzgesteuerter Verdichter ist.
7. Präsentationseinheit nach einem oder mehreren der vorausgehenden Ansprüche, wobei die Präsentationseinheit mindestens eine Schnellkupplung aufweist, durch die der Fluid/Gas-Wärmetauscher (3) mit einem Kältezyklus oder einer Kälteanlage verbunden wird.
8. Präsentationseinheit nach einem oder mehreren der vorausgehenden Ansprüche, wobei die transkritische Kühleinheit ein Kohlendioxid-Kühlkreislauf ist.
9. Präsentationseinheit nach einem oder mehreren der vorausgehenden Ansprüche,

wobei der Raum von der Präsentationseinheit (C) lösbar ist.

## Revendications

1. Vitrine comprenant un compresseur (2), un échangeur thermique fluide/gaz (3) pour refroidir le gaz comprimé, un évaporateur (4), un dispositif d'expansion et des conduits de pression élevée reliant les composants susmentionnés l'un à l'autre pour former un circuit de réfrigération transcritique, dans lequel au moins le compresseur (2) et l'échangeur thermique fluide/gaz (3) sont disposés dans un compartiment (1) ; dans lequel le compartiment est supporté par une structure de support dans la vitrine ; dans lequel le compartiment (1) est conçu pour être stable suffisamment pour au moins réduire essentiellement l'effet de toute brèche d'un quelconque des composants comprenant le réfrigérant transcritique sous pression ; dans lequel un circuit de refroidissement basse pression est fourni pour refroidir l'échangeur thermique fluide/gaz (3) du circuit de réfrigération transcritique haute pression ; et dans lequel le compartiment (1) a une coque dure de son côté extérieur et un matériau d'amortissement de son côté intérieur et est configuré pour servir en tant que tampon pour un gaz d'échappement. 5 10 15 20 25 30
2. Vitrine selon la revendication 1, dans lequel tous les composants formant le circuit de réfrigération transcritique sont disposés dans ledit compartiment (1). 35
3. Vitrine selon la revendication 1 ou la revendication 2, dans lequel ledit compartiment (1) est disposé en dessous du compartiment d'exposition ou de stockage (S) de la vitrine (C). 40
4. Vitrine selon une ou plusieurs des revendications précédentes, dans lequel la quantité du milieu circulant dans le circuit de réfrigération transcritique ne dépasse pas 1000 g. 45
5. Vitrine selon une ou plusieurs des revendications précédentes, dans lequel le dispositif d'expansion est une valve d'expansion.
6. Vitrine selon une ou plusieurs des revendications précédentes, dans lequel le compresseur (2) est un compresseur commandé en fréquence. 50
7. Vitrine selon une ou plusieurs des revendications précédentes, dans lequel la vitrine comprend au moins un couplage rapide, par lequel l'échangeur thermique fluide/gaz (3) est raccordé à un cycle ou installation de réfrigération. 55
8. Vitrine selon une ou plusieurs des revendications précédentes, dans lequel l'unité de réfrigération transcritique est un circuit de réfrigération de dioxyde de carbone.
9. Vitrine selon une ou plusieurs des revendications précédentes, dans lequel le compartiment est amovible à partir de la vitrine (C).

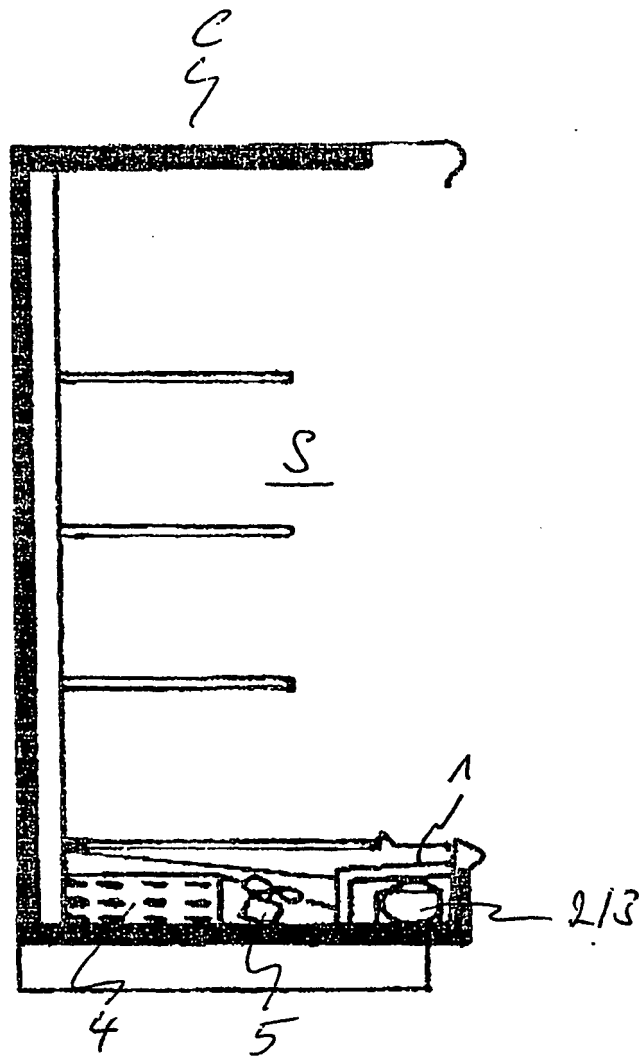


Fig. 1

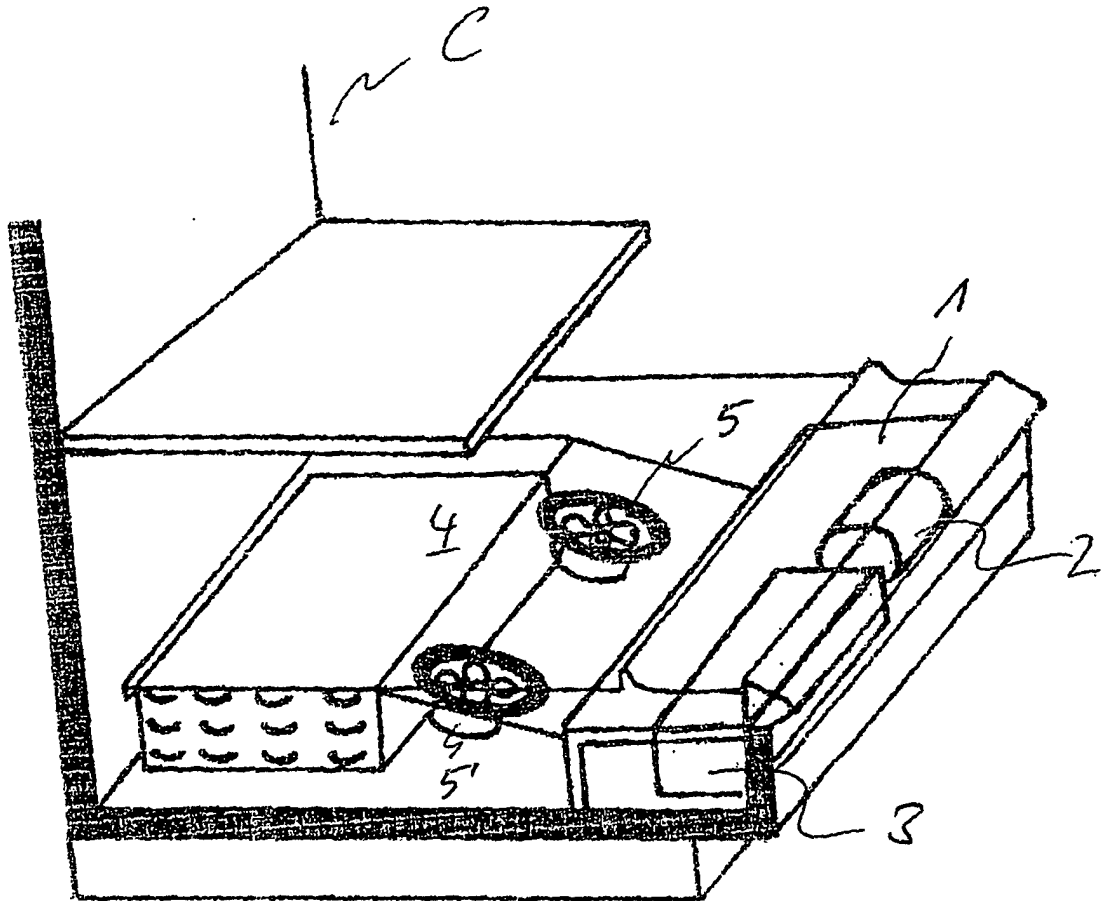


Fig. 2

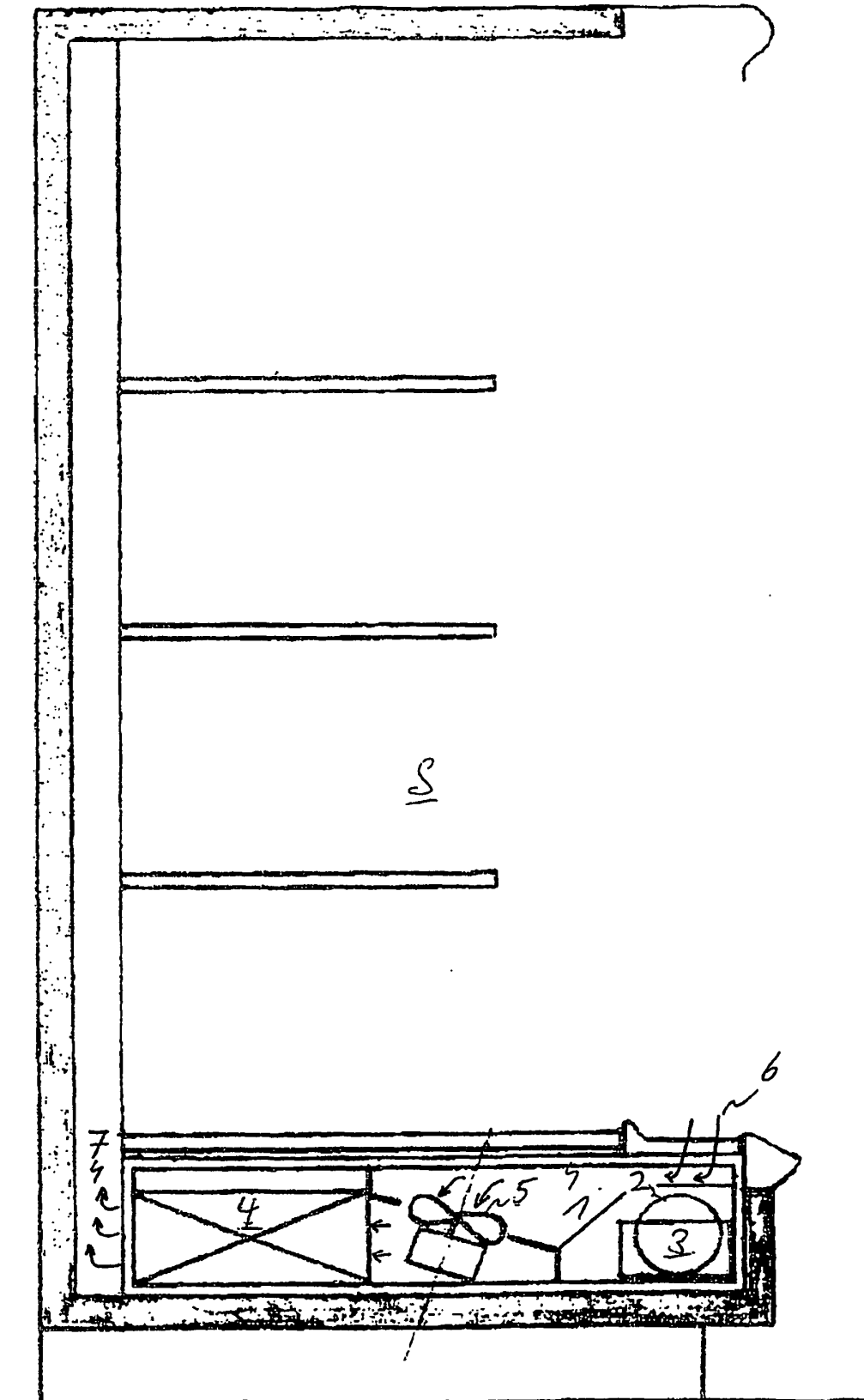


Fig. 3

**REFERENCES CITED IN THE DESCRIPTION**

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