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[54] **ARRANGEMENT FOR MAINTAINING A VENTILATED ZONE WITHIN A PART OF A ROOM PARTITIONED BY AN AIR CURTAIN**

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[52] **U.S. Cl.** ..... **98/36,** 128/1 R

[51] **Int. Cl.** **F24f 13/06**

[58] **Field of Search** ..... 98/36, 32, 33 R; 55/DIG. 29; 128/1 R

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[57] **ABSTRACT**

The invention relates to an arrangement for maintaining a ventilated zone within a part of a room, e.g. an operating room, partitioned by an air curtain or screen. In addition to a device for supplying ventilating air inside the partioned part of the room, there are outer air inlets provided in the part of the room outside of the air curtain, said outer inlets being designed to supply air to the room in replacement for the air sucked from outside said curtain into same.

3 Claims, 2 Drawing Figures

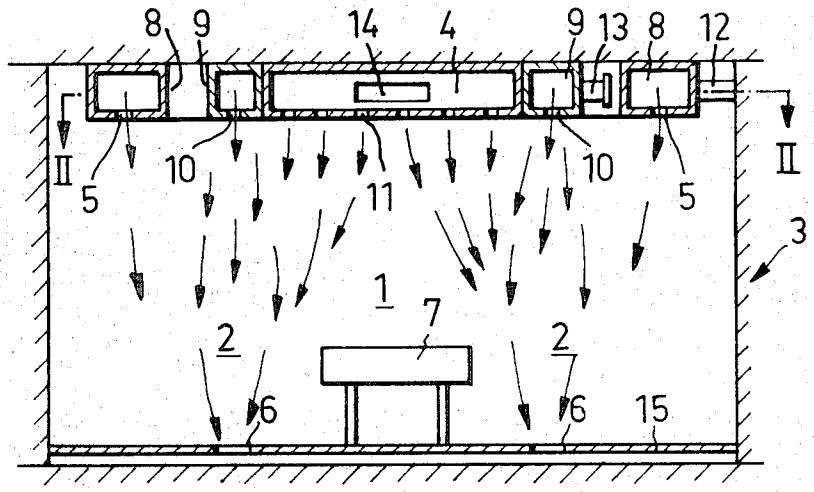


FIG.1

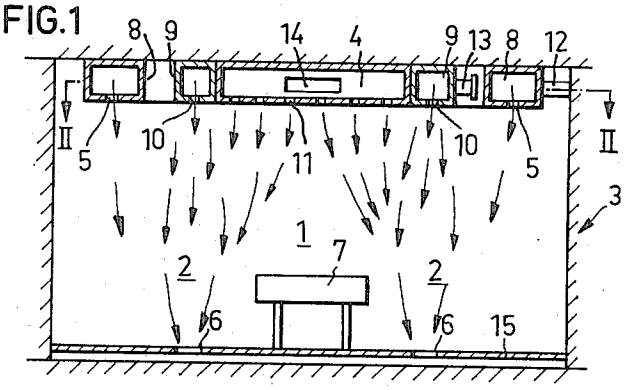
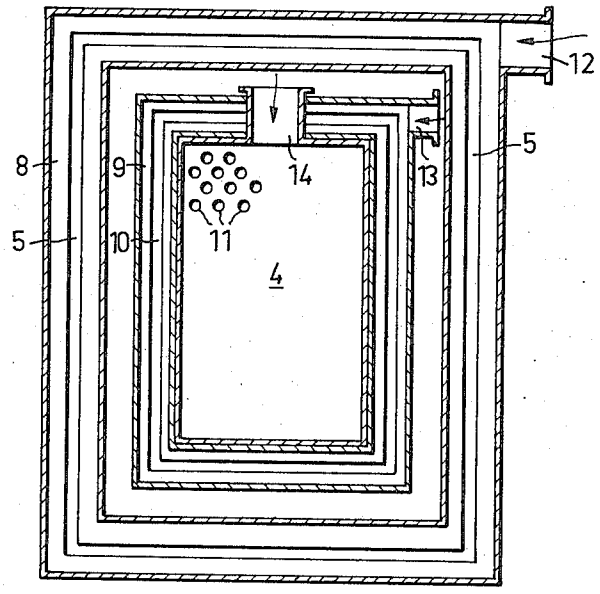


FIG.2



ARRANGEMENT FOR MAINTAINING A VENTILATED ZONE WITHIN A PART OF A ROOM PARTITIONED BY AN AIR CURTAIN

The present invention relates to an arrangement for maintaining a ventilated zone within a part of a room partitioned by an air curtain or screen.

In rooms where high demands are made on the purity of the air, it has become increasingly common to install arrangements maintaining a zone with ventilated air in a greater or lesser part of the room. The need for such rooms with purified zones is particularly great in hospitals, but also exists in special industries, e.g. where precision instruments such as gyroscopes are made.

In hospitals, the demand for a high degree of purity is particularly great in the operating room, especially at and around the operating table. It is desirable to maintain a pure, ventilated zone about the operating table to reduce as much as possible the risk of exposing the patient being operated on to infections caused by bacteria carried to the patient via particles present in the air in the operating room.

In this context, it is previously known to use an arrangement which produces an air curtain or screen of flowing air that separates the zone from the rest of the room, at the same time as ventilating air is supplied within the partitioned zone.

An arrangement of this general type is described in e.g. Swedish patent No. 213,277.

Even if the above mentioned, and similar types of arrangements have been quite effective in preventing airborne particles found in the air outside of the air curtain from being admitted into the ventilated zone inside the air curtain, it has been shown that the known arrangements cannot satisfactorily prevent the carrying of airborne particles in the opposite direction — i.e. from the space inside the air curtain to the space outside the air curtain. On first thought, it may appear to be of minor importance to prevent this reversed air flow since it does not result in increased risk of infection for the patient on the operating table. This is probably the reason why the problem has not yet met with deserved attention.

However, if one considers that leakage of airborne particles from within the air curtain implies a significant risk of infection for hospital personnel working outside the air curtain when the patient on the operating table constitutes a source of infection, the problem with the reversed air flow comes into new light. This reversed air flow can also result in bacteria being transferred from a patient in the operating room to another patient in an adjacent room. This infection situation often seems to arise in hospitals, especially where epidemic and infections diseases are being treated.

The problem on which the present invention is based is to provide an arrangement of the type mentioned in the introduction which not only prevents air flow and the transport of particles in through the air curtain to the ventilated zone, but also equally effectively prevents air flow in the opposite direction.

According to the invention, this problem is solved in an exceedingly effective manner whereby, in addition to having a device for supplying in a known way ventilating air within the partitioned part of the room, there are outer air inlets provided in the part of the room outside the air curtain. These outer air inlets are designed to convey air to the room in replacement for the air

which is sucked from outside the air curtain into same.

Thus, with regard to the air flow, the essential difference between the arrangement according to the present invention and previously known arrangements is that the latter arrangements merely controlled and determined the supply of air required to produce the air curtain (the curtain air) and the ventilating air supplied inside the air seal, whereas the arrangement according to the invention also controls and determines the air supply in the area outside the air curtain.

With this outer air supply, it will be possible to maintain an air curtain having double sealing or blocking action — i.e. an air curtain which not only prevents flow leakage in through it but also prevents flow leakage in the opposite direction, out through the air curtain.

It has been shown that optimum double sealing action is obtained if the outer air inlets are designed to aggregately supply an amount of air per unit of time, which is equal to the amount of ventilating air supplied per unit of time in the part of the room within the air curtain.

With previously known arrangements which lacked special means for supplying the outer replacement air, the sucking in of air to the air curtain's outer portions resulted in a certain partial vacuum occurring outside of said air curtain. This partial vacuum subsequently contributed in turn to a transverse compensation flow out through the air curtain — i.e. the undesired leakage.

In order to well define the air curtain and keep it stationary to the greatest possible degree, suitably placed air exhausting devices are required in the room in question. When the arrangement produces an air curtain which separates all or a greater part of the room in question, it may be preferable to provide an exhausting device at the bottom of the room, e.g. by having adjustable outlet valves at the foot of the room's walls near the floor. Such an exhausting device is known from the above mentioned Swedish patent.

When the air curtain partitions off only a ventilated zone within a part of a room, e.g. a zone around an operating table, it has been shown to be particularly advantageous to design the air exhausting device with air exhaust openings in the floor instead of along the foot of the walls in the room.

According to the invention the arrangement is then characterized by providing the room, preferably at the floor, with exhaust openings adapted to suck out an amount of air per unit of time which is at least equal to the amount of ventilating air supplied per unit of time, increased by the amounts of curtain air supplied and outer replacement air.

Additional characteristics of the invention will be described below with reference to the embodiment illustrated schematically on the enclosed drawing where

FIG. 1 shows a vertical section through a room equipped with an arrangmment that maintains a ventilated zone through partitioning by means of an air curtain.

FIG. 2 shows a horizontal section through the air supply means included in FIG. 1 on the line II—II thereof.

FIG. 1 shows a vertical section through a room 3 which is provided with an arrangement according to the invention. The arrangement maintains a ventilated zone 1 within a part of the room 3 partitioned by an air

curtain 2. An operating table 7 is placed in the ventilated zone 1. The air supply means are arranged on the ceiling in the room and consist of three main parts; an outer, rectangular, air channel or duct 8 for supplying outer replacement air and, within said channel, an inner air channel or duct 9 which is similarly shaped and congruent with the outer channel and is responsible for supplying curtain air. Finally, within the inner channel is a box-shaped device 4 for supplying ventilating air within the air curtain 2. The bottoms of the channels 8 and 9 are provided with slotted air inlets 5 and 10 respectively and the bottom of the box-shaped device or box 4 is provided with a plurality of openings 11 for the ventilating air. Furthermore, the channels 8,9 and the box 4 are each provided with one or more ducts 12,13 and 14 respectively which are connected to an air supply stream (not shown in detail on the drawing). The operating table 7 is placed on the floor 15 which is provided with air exhaust openings 6. These openings 6 may consist of e.g. one row or several parallel rows of holes or slots which form a rectangular pattern in the floor 15. If there is an air curtain 2, as shown in FIG. 1, having essentially vertical sides, it is preferable to arrange the openings 6 directly under the slotted air inlets 10. However, if the air curtain diverges or converges towards the floor, the openings will be placed further out towards the room's walls, or respectively nearer the operating table 7.

In this context, it ought to be noted that the invention is in no way restricted to an arrangement having rectangularly extending air ducts 8 and 9. The ducts or channels may instead be shaped as the sides of a triangle, square or any other suitable polygon; they may also form a circle, an ellipse or have another closed shape. In the present case, the box 4 will have a shape which allows it to take up the space within the duct 9. It is clear here that the openings 6 are so placed in the floor 15 that, together with the air inlet 10 of the duct 9, they give the air curtain the desired shape.

Finally, it may be justifiable to elucidate the air flow of the arrangement with a mathematical example. Here $\dot{Q}$ is used to denote the time derivate (dQ/dt) of the amount of air Q — i.e. the air flow. We now assume for simplicity's sake that the channels 8 and 9 form the sides of a square — i.e. each consists of four equally long parts. Ventilating air $\dot{Q}_v$ is conveyed through the openings 11 in the bottom of the box 4. The curtain air $\dot{Q}_r$ is supplied to the inner air channel 9 via the duct 13 and is assumed to be equally distributed to the side parts of the channel — i.e. the amount of air blown out through the slotted air inlet 10 is one-fourth $\dot{Q}_r$ per side of said channel. In order to prevent cross flow (leakage) of air from the ventilated zone 1 through the air curtain 2 out to the surrounding part of the room 3, outer replacement air shall, according to the invention, be supplied to replace the air which has been sucked into the air curtain from the outside of same. Under the above noted conditions and according to the invention, this amount of air will hereby be $\dot{Q}_e = \dot{Q}_v$; i.e. equal to the amount of ventilating air supplied in the part of the room inside of the air curtain. If the replacement air $\dot{Q}_e$ is equally distributed to the side parts of the channel 8, the amount of air blown out through the slotted air inlet 5 will consequently be one-fourth $\dot{Q}_e$ per side of the channel. The ventilating air $\dot{Q}_v$ supplied within the air curtain 2 may be assumed to be distributed evenly over the inside of the air curtain — i.e. the air curtain, per side, will be supplied from within with one-fourth $\dot{Q}_v$. For each side part of the air curtain, a flow equilibrium will consequently occur between the amount of air coming in from within one-fourth $\dot{Q}_v$ and the amount of air coming from without one-fourth $\dot{Q}_e$ which, according to the above, is equal to one-fourth $\dot{Q}_v$, since $\dot{Q}_e = \dot{Q}_v$. Thus, to attain a stationary air curtain with double sealing action, it is necessary that the amount of air for each side part of the air curtain and sucked out through the openings 6 shall be $\dot{Q}_{out} = \frac{1}{4}\dot{Q}_v + \frac{1}{4}\dot{Q}_r + \frac{1}{4}\dot{Q}_e$ or, in other words, $\dot{Q}_{out} = \frac{1}{2}\dot{Q}_v + \frac{1}{4}\dot{Q}_r$.

What I claim is:

1. Arrangement for maintaining a ventilated zone in a part of a room partitioned by an air curtain, comprising in combination means establishing an air curtain in the room, a device for supplying ventilating air within said partitioned part, and outer air inlets in the part of the room outside of the air curtain, said outer inlets supplying air to said room to replace the air which is sucked from the outside of the air curtain into same, said means establishing an air curtain comprising air inlet means extending in a first closed horizontal path about the top of the room and spaced inwardly from the side walls of the room, and air exhaust openings beneath the last-named air inlet means and extending in a closed horizontal path about the floor of the room and spaced inwardly from the side walls of the room, said outer air inlets extending in a second closed path symmetrically about said first closed path.

2. Arrangement according to claim 1, the floor of the room being free from air exhaust openings outside said closed horizontal path about the floor.

3. Arrangement according to claim 2, said device and said outer air inlets being disposed at the top of the room.

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