Free Convection Personalized Ventilation (FCPV)

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Free Convection Personalized Ventilation (FCPV)

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The idea is a device which can **supply air directly to the breathing zone** of a person.

I will start by describing some of the background and the state of the art:

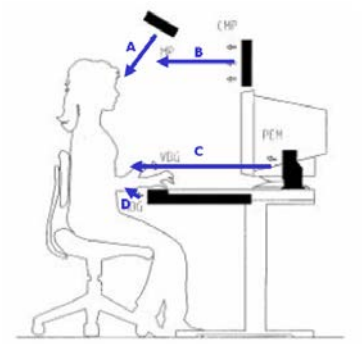
Normally we supply fresh air to a room with a diffuser, and this air is distributed in the room according to different principles as: mixing ventilation, displacement ventilation etc. That means we have to supply a very large amount of air to the whole room, although a person in the room totally only need a small amount of air. It is usual to supply 1-5 times the volume of the room per hour, but a person only need (in his/her inhalation) about 0.6 m^3 per hour. Therefore, if people have a rather fixed position during the work, there is a possibility to supply air more directly to the breathing zone, **and therefore to supply a much smaller amount.**

Another feature by supplying the air directly to the breathing zone is to ensure that the air has not been contaminated by other persons or by other components in the room or surroundings. **This will minimize e.g. cross infection and passive smoking.**

To explain the work made until now and how it works we have to look at the boundary layer which is surrounding all people, seated or standing.

A person emits heat to the surroundings. A person has a surface temperature which is higher than the surrounding temperature. The air close to the person's surface is heated and it will rise due to the gravity effect. Surrounding air is entrained into this boundary layer flow, which rises all around the person. This flow is about 180 m^3/h at head height. It is seen from the figure that the air which the person will inhale is taken from the boundary layer. This air has been entrained in the boundary layer below head height.

State of the art



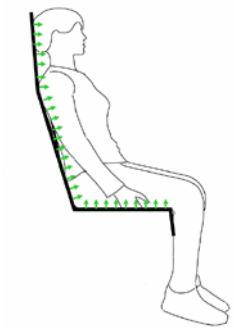
The figure shows different known principles in “Personalized Ventilation”. (A) shows a panel which supplies a jet of air to the breathing zone. (B) shows the same principle. (C) and (D) are principles where air is supplied to the boundary layer of a person, and the air is then transported into the boundary layer up to the breathing zone. All the designs are based on a supply jet, which also means **a supply of momentum flow**. The problem with all the cases is that the jets will entrain air from the surroundings and, therefore, reduce the amount of fresh air which will reach the breathing zone. Also the distance in the boundary layer from (D) to the breathing zone will entrain some contaminated air from the room.

The free convection boundary layer around the body, does to some extent protect the body from other flows. It is therefore necessary to have a certain velocity in the jet so it can penetrate the boundary layer. This velocity will be expirenced as an uncomfortable draught.

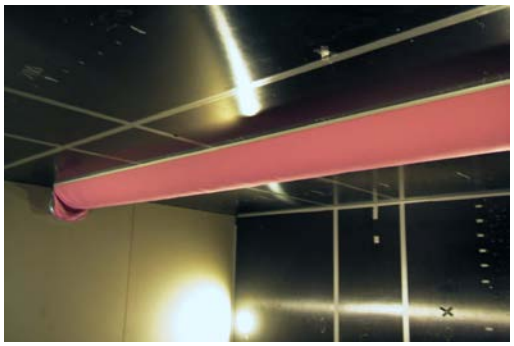
The present idea does not use jets and a high momentum to supply the fresh air in the breathing zone. The air is simply **supplied in the boundary layer of the person**, and the boundary layer will transport the air to the breathing zone. The problem with entrainment is minimized in this case, especially when the source of clean air is located in the boundary layer close to the breathing zone.

The present idea is based on all situations where the head or the body is in **natural contact with surfaces as chairs, beds, pillows, clothing, etc,** and those surfaces are designed also to be a supply opening of fresh air.

The first suggestion for a design is to place the supply in the chair and use the fabric as a diffuser, as shown in the following figure. This could be a typical application in aircraft cabins and offices

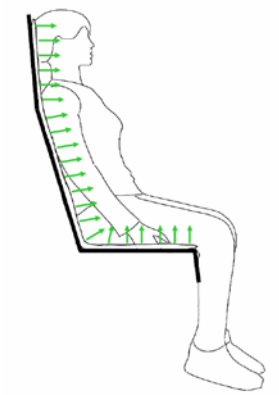


The openings could be formed as bands in the chair or parts, especially in the upper part close to the face regions. The use of textile as supply openings is known in room air diffusion, see the figure.



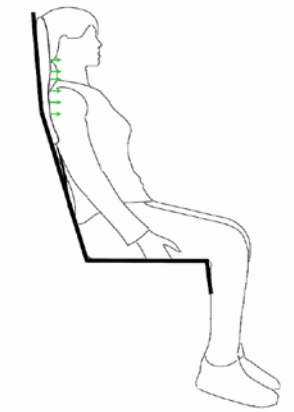
The chair could also be covered with a snap on blanket with the supply textile. **The blanket could be washed from time to time**. (Textile channels and textile supply openings are cleaned by washing in a washing machine).

Snap lock blanket with supply of fresh air:

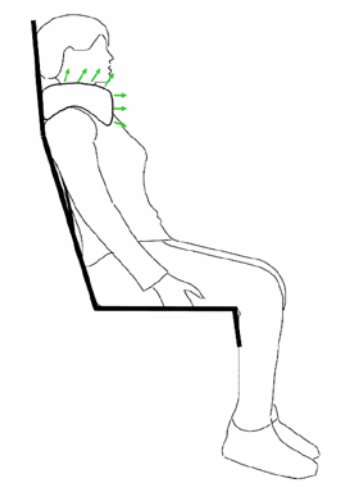


A number of designs are shown below, which could especially be used in aircrafts, but some of them will also be applicable for offices, cars, trains etc.

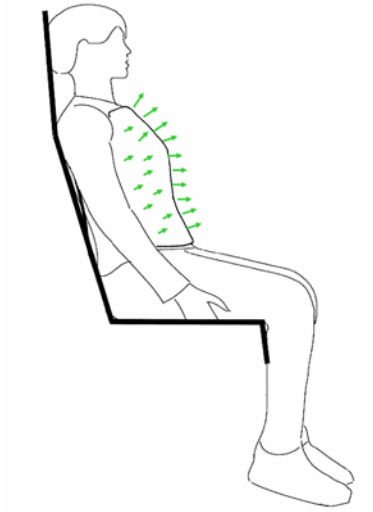
Pillow:
A pillow with supply openings made from fabric. The air diffuses into the boundary layer of the person.



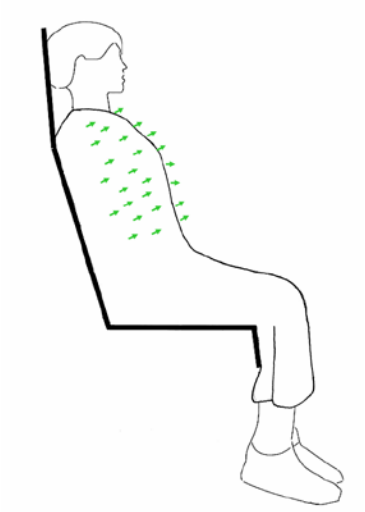
Head rest:
A combined head rest and a fresh air diffuser.



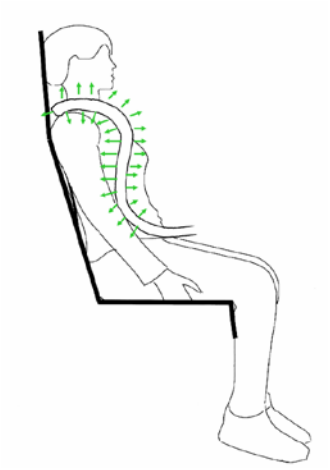
Waistcoat:
A special waistcoat that supplies fresh air through the outer surface.



Blanket:
A special blanket supplying air through the outward side. This is for aircraft application, but it can also be used in other situations involving transportation and/or rest.

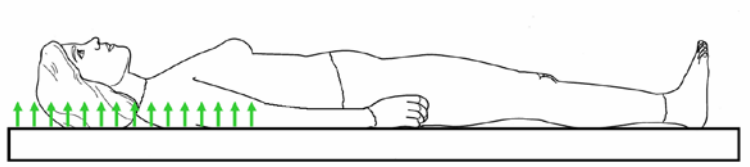


Flexible diffuser:
This flexible diffuser can also serve as a sort of pillow which the user can adjust for e. g. a good position for reading, sleeping, resting etc.

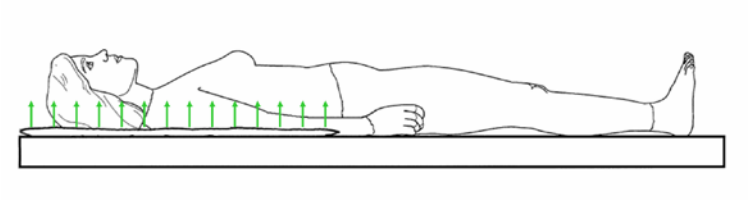


There will also be a number of designs which are relevant for use in a bed (vertical position) especially for minimizing cross infection in hospitals wards.

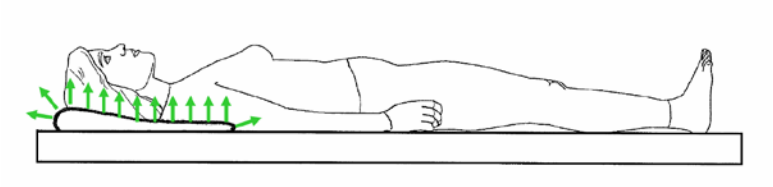
Bed with diffuser:
The whole bed or part of the bed/madras is using the fabric as a supply opening for fresh air. The air inside the boundary layer will be transported into the person's boundary layer, and supply air outside the boundary layer will be inhaled if it is within the breathing zone.



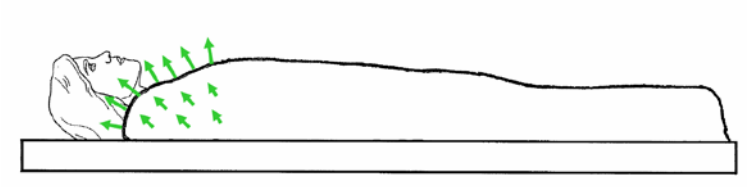
Bed with snap lock blanket:
The bed could also be covered with a **snap on blanket** with the supply textile. **The blanket could be washed from time to time**.



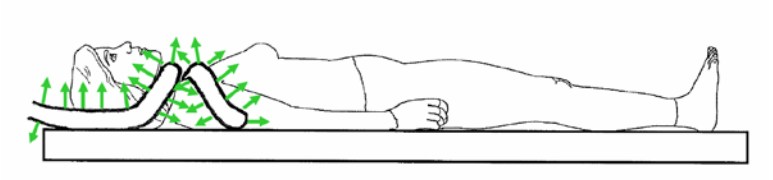
Bed/pillow with diffuser:
The pillow could be the fabric supply diffuser. This design will give a remarkable short way from fresh air supply to nose and moth. Especially if the persons want to use this knowledge.



Bed with supply blanket:
This design shows a special blanket with a supply opening (fabric) in the vicinity of the breathing zone similar to the design of the supply diffuser in a pillow.



Bed with flexible diffuser:
This flexible diffuser can also serve as a sort of pillow which the user can adjust for a good position for sleeping, resting etc.



The **Free Convection Personalized Ventilation (FCPV)** can also be used in some medical treatments. It can be used to supply oxygen to patients who suffer from **Chronic Obstructive Lung Illness.** (Perhaps the oxygen consumption is too high in this application compared to directly supply in the nose). **Sudden Infant Death Syndrome** is another case which could be controlled by directly supply of air, independent of the orientation of the baby; see the following sketch where part of the mattress or the whole mattress is covered with supply openings/textile.

All the versions of personalized ventilation may include an individual temperature control. In this way the device will both be **a fresh air supply** and also **a cooling/heating** device.

The temperature control can have three purposes. First it can be **adjusted for optimum thermal comfort for the user.**
Secondly, if the surroundings are in thermal comfort conditioning (air temperature, mean radiant temperature, air velocity, clothing etc.), then the supply air can have a lower temperature which means that **the user will experience an increased air quality**.
At last the air temperature can be adjusted to a temperature which is close to the temperature of the thermal boundary layer in the area where the supply air the boundary layer will merge. This will minimize the mixing and external entrainment and send the fresh air in the right direction towards the breathing zone. Especially when the supply air has to travel some distance in the boundary layer along the person.

The possibility of **having a temperature control which is personalized** is an additional positive feature. This will give the user a feeling of control of his/her environment.