

Description

The invention relates to a convector, i.e. an apparatus comprising a heat exchanger for heating or cooling the air present in a space to the conditioned, such as a living room or office.

There is a need for equipment for controlling the temperature of the ambient air in spaces, such as a living room or office, in such a manner that this temperature is kept substantially constant at a level that is experienced as pleasant by the persons present in that space. In cold seasons there is mainly a need for heating. In warm seasons there is mainly a need for cooling, in particular in office spaces where heat sources are already present, such as lighting and computers. Moreover, in particular in office spaces, there is a need for refreshing the air present.

The above involves, inter alia, the following problems. In the first place, the equipment should have sufficient capacity. If the capacity is sufficient, the desired result can perhaps be reached through installing several apparatus, but that is relatively expensive.

Further, the temperature in the space to be conditioned should be distributed as evenly as possible, but on the other hand, the displacement velocity of the air in the space should remain low, because strong airflows are experienced as unpleasant.

Conventional heating equipment comprises a heat exchanger, also referred to as radiator, which is disposed at floor level adjacent a wall or window of the room. The radiator is flown through by hot water, whereby the radiator surface becomes hot. Air contacting that hot surface is heated and rises, to flow along the ceiling into the space. Cooled air descends and flows along the floor towards the radiator. In this manner, an airflow (convection) is generated in the space in question, merely on the basis of differences in temperature.

The term 'radiator' indicates that the heat exchanger also generates heat radiation, which contributes to a pleasant feeling for the persons present. If the heat exchanger is concealed, for instance below floor level, it is referred to by the term 'convector'.

In a similar manner as described hereinabove, a heat exchanger may also provide for the cooling of air if the heat exchanger is flown through by a medium whose temperature is lower than that of the air, for instance cold water. In prior art literature, cooling heat exchangers are proposed wherein the airflow caused by that equipment is directed vertically upwards; examples thereof are Dutch patent 101.758 and Dutch patent application 72.11805. A common drawback of such apparatus is that they are not suitable for being mounted flat, or at least substantially flat, in the ceiling, while such mounting is in fact desired, in particular in respect of cooling equipment, for being able to effect an air circulation in the space by means of natural convection.

International patent publication WO94/24491

relates to a cooling convector to be mounted in the ceiling. This known cooling convector has inter alia the drawback that the outflowing air has an unstable flow pattern, which is not only disadvantageous for a good air circulation, but is moreover experienced as uncomfortable by the persons present in the space to be conditioned. Hence, an important object of the present invention is to provide a convector suitable for mounting in a ceiling, wherein the outflowing airflows horizontally along the ceiling in a stable flow pattern.

In particular, but not exclusively, the invention relates to a cooling convector to be installed in the ceiling of a space such as a living room or office, for cooling the air in that space, and will hence hereinafter be described for such a practical example. However, it is expressly noted that the invention is not limited to such use. More in particular, it is pointed out that whenever hereinbelow, by way of example, the cooling of air by means of a medium of lower temperature is mentioned, the invention likewise relates to the heating of air by means of a medium of higher temperature. It is further observed that the present invention is also applicable in situations where incorporation into the ceiling is not possible; in that case, the convector according to the present invention will be mounted against the ceiling.

Hereinafter, a heat exchanger generating an air circulation (convection) merely on the basis of differences in temperature will be designated by the term "free convector". A free convector for heating purposes is generally known. A free cooling convector is for instance described in international patent application PCT/SE94/00326, published as WO94/24491. Free convectors have as a drawback that the capacity thereof is relatively low, and that the temperature difference between inflowing and outflowing air must be fairly substantial in order to generate the air circulation. Further, free convectors do not provide the feed of fresh air.

For stimulating the airflow, it is known per se to provide the heat exchanger with a fan for drawing in air from the space and for blowing out heated/cooled air into that space. It is thus further provided that a heat exchanger intended for cooling can be disposed adjacent the floor and that a heat exchanger intended for heating can be disposed adjacent the ceiling. Such apparatus can then moreover be selectively used for both heating and cooling, but does not provide the feed of fresh air. A convector comprising a fan for forcing an airflow will hereinafter also be referred to by the term 'forced convector'.

Apparatus for feeding fresh air and for simultaneously establishing a flow of air present in the room along the convector have already been proposed as well. The fresh air is passed along the convector in such a manner that a pressure difference is created over the convector, whereby air is drawn in from the room. This mechanism is referred to as 'induction' and convectors operating according to this principle will hence hereinafter be referred to by the term 'induction convector'.

The invention in particular relates to an induction convector. Hereinbelow, the fresh air will also be referred to as 'primary air', and the air drawn in from the room will also be referred to as 'secondary air'.

It is a general object of the present invention to provide an improved induction convector for ceiling-mounting.

It is a particular object of the present invention to provide an induction cooling convector having an improved cooling power, whereby is meant the amount of thermal energy that can be drawn per unit of time from a given quantity of air of a given temperature.

It is a further object of the present invention to provide an induction cooling convector having an improved induction factor, i.e. the ratio between the quantity of secondary air and the quantity of primary air.

Another important object of the present invention is to configure an induction convector in such a manner that the outflowing airflows horizontally.

A further important object of the present invention is to provide a convector capable of creating a flow pattern that is selectively adjustable. It is preferred that in a relatively large space, several convectors can be mounted, and in that case it is desired that the flow patterns created by all those convectors cooperate constructively and do not hinder one another.

These and other aspects, characteristics and advantages of the present invention will be clarified by the following description of preferred embodiments of a cooling convector according to the invention, with reference to the accompanying drawings, wherein:

Fig. 1 schematically shows a known free cooling convector;

Fig. 2 schematically shows a known induction cooling convector;

Fig. 3A shows a schematic cross section of an induction cooling convector according to the present invention;

Fig. 3B shows a schematic cross section taken on the line A-A of a portion of the induction cooling convector of Fig. 3A;

Fig. 4 shows a schematic cross section, comparable with Fig. 3A, of another embodiment of an induction cooling convector according to the present invention;

Fig. 5 shows a table of properties of an embodiment of the convector according to the present invention;

Fig. 6 schematically illustrates some flow patterns; and

Fig. 7 illustrates a variant of the embodiment of the convector according to the present invention illustrated in Fig. 4.

Fig. 1 illustrates a cooling convector generally designated by reference numeral 1, such as for instance described in international patent application PCT/SE94/00326, published as WO94/24491. This

cooling convector 1 is intended to be installed in the ceiling 2 of a space 3 to be conditioned, and comprises a substantially closed housing 4 having an outlet opening 5 and an inlet opening 6. Within the housing 4, a cooling unit 7 is present above the outlet opening 5. Air contacting the cooling unit 7 cools down and thus becomes heavier than the other air, as a result of which the cooled air 8 flows outside through the outlet opening 5. Through the inlet opening 6, new air 9 flows in, to reach the cooling unit 7. In this manner, an airflow 8 is established in the space 3 to be conditioned, while the air 8 leaving the cooling convector 1 has a lower temperature than the air 9 entering the cooling convector. Within the purview of the present invention, such cooling convector is described as a free cooling convector, because the mechanism driving the flow of the air through the cooling convector is merely based on natural flow caused by differences in temperature.

The cooling power of a free cooling convector 1 is fairly small.

Further, the convector described in the above-cited publication WO94/24491 has the drawback that the outflowing air has a great vertical flow component.

Another major drawback of the convector described in the above-cited publication WO94/24491 is that it is not possible that the opening 6 acts as outlet and that the opening 5 acts as inlet. More in particular, it is not possible that this convector simultaneously generates oppositely directed flows.

Fig. 2 schematically illustrates the principle of a forced cooling convector 10, which principle is also known per se from the above-cited publication WO94/24491 and will hence be discussed only summarily. In Fig. 2, parts identical to or comparable with those in Fig. 1 are designated by identical reference numerals. The forced cooling convector 10 comprises a primary air duct 11, through which fresh air is drawn /blown in by means of a motor which, for simplicity's sake, is not shown. The primary air duct 11 has a blow-out opening 12 arranged adjacent the outlet opening 5 of the cooling unit 4, for blowing out primary air 13 in such a manner that a secondary airflow 14 is induced through the cooling unit 4. The induced or secondary airflow through the cooling unit 4 is stronger than the airflow of a free convector, and when the forced cooling convector 10 is suitably dimensioned, the induction factor, i.e. the ratio between the secondary airflow 14 and the primary airflow 13, can be greater than 1.

This known forced convector likewise has the drawback that it is not possible to have the outlet and the inlet change functions. It is true that the publication describes an embodiment wherein both left-flow and right-flow air is generated, but this embodiment can in fact be regarded as a double version wherein the two halves are oppositely mounted together, and the secondary air is not fed horizontally but vertically, at the center of the convector.

Another major drawback of the convectors

described in the above-cited publication WO94/24491 is that the airflow in the convector must move through a strongly curved path and, in doing so, must undergo a directional change of virtually 180°. In addition, these convectors have the drawback that the cooling unit is disposed within the flow path and hence constitutes a resistance to the airflow.

The invention provides a forced cooling convector having an improved cooling power, wherein a relatively high induction factor to the order of 5 or more can be realized without great problems. According to a first important aspect of the present invention, a convector has a plurality of elongated, horizontally directed ducts having substantially closed walls, and the primary air is blown through those ducts longitudinally. The principle of such forced cooling convector will be explained with reference to Figs. 3A and 3B.

Fig. 3A shows a schematic cross section of a forced cooling convector 30 according to the present invention, while Fig. 3B shows a schematic cross section taken on the line A-A of a portion of the forced cooling convector 30. The cooling convector 30 is suitable for being mounted in a ceiling 2, as shown, in such a manner that no part whatsoever of the convector 30 projects below the plane of the ceiling 2. The cooling convector 30 comprises a number of longitudinal, horizontal airflow ducts 31, enclosed by substantially entirely closed side-walls 32. In this connection, the expression "substantially closed" is understood to mean that possible small openings in the sidewalls 32 are allowed, provided that they hardly, if at all, influence the flow of the air in the ducts 31. The sidewalls 32 are made from a material of good heat conduction, such as for instance copper, aluminum or steel. The sidewalls 32 can be defined by hollow airflow conducting pipes 32, disposed side by side and parallel to one another. In the example shown, those pipes 32 have a substantially square cross section, and are arranged with their sidewalls against one another. The pipes may also have a different contour and need not be in contact with one another. The longitudinal airflow ducts 31 can for instance also be defined by a profiled plate, having for instance a sinusoidal or toothed cross section, to be sandwiched between two flat plates.

The longitudinal airflow ducts 31 will typically have the same cross section throughout their lengths; however, this is not essential for the proper operation of the convector.

The longitudinal airflow ducts 31 will typically be linear; however, the longitudinal airflow ducts 31 may also be curved.

The forced cooling convector 30 further comprises heat transfer means 40 disposed so as to be in heat-exchanging contact with the pipes 32 on the outside of the pipes 32, i.e. outside the airflow ducts 31. Thus, the heat transfer members 40 form no obstruction to the airflow in the pipes 32.

In the embodiment shown, the heat transfer mem-

bers 40 comprise heat pipes 41 made from a material of good heat conduction, such as for instance copper, aluminum or steel, which heat pipes 41 are attached to the air pipes 32. In the example shown, the heat pipes 41 are directed perpendicularly relative to the air pipes 32, and are attached to the top sides of the air pipes 32, but the air pipes 32 may also be provided with heat pipes 41 at their bottom sides. It is also possible that the air pipes 32 are provided with heat pipes 41 at their top sides as well as their bottom sides. It is also possible that air pipes 32 are attached to the top sides as well to the bottom sides of the heat pipes 41. It is also possible that the heat pipes 41 are directed parallel to the air pipes 32, while the heat pipes 41 may for instance be arranged in the same plane as the air pipes 32, for instance for reducing the total height of the convector.

The heat pipes 41 serve for conducting a heat transfer medium 42, which in a simple embodiment may advantageously be water. The temperature of the heat transfer medium 42 may be lower than the temperature of the air in the space 3 so as to cool that air, while it is preferred that the temperature of the heat transfer medium 42 be not less than 15° in order to prevent condensation of humid ambient air. However, the temperature of the heat transfer medium 42 may also be higher than the temperature of the air in the space 3 so as to heat that air.

It is also possible that heat transfer medium 42 flows around the air pipes 32 directly.

The forced cooling convector 30 further comprises means 50 for blowing primary air 13 into the airflow ducts 32. The air blow-in means 50 comprise blow nozzles 51 communicating with a main air feed duct 52 of the convector, through which fresh air 53 is fed from outside the space 3. The feed of this fresh air 53 is for instance effected by a fan driven by a motor, such as is known per se and is therefore not shown, for simplicity's sake. It suffices to observe that this fan with motor may form part of the convector 30, but may also be externally provided.

The blow nozzles 51 are suitable for blowing out the fresh air 53 in the form of a jet of primary air 13. The blow nozzles 51 have a slight passage for imparting a high velocity to the primary air 13 leaving the blow nozzles 51. As the construction of the blow nozzles 51 does not constitute a subject of the present invention, while blow nozzles capable of blowing out a jet of a desired dimension are known per se and such known nozzles are applicable in the realization of the present invention, the construction of the blow nozzles 51 will not be further discussed. It suffices to remark that a skilled person knows how a blow nozzle for blowing out a jet of desired dimensions should be designed.

In the embodiment shown, the convector 30 comprises an air chamber 54 defined by a top wall 55, sidewalls 56 and a bottom wall 57. The main air feed duct 52 debouches into an opening in the top wall 55 and is preferably, and as illustrated, centrally positioned rela-

tive to that top wall 55. The heat pipes 41 are located above the bottom wall 57, i.e. within the air chamber 54. The pipes 32 are located below the bottom wall 57, i.e. outside the air chamber 54.

In particular cases, it may be desired or even necessary that the convector 30 project entirely or partially below the plane of the ceiling 2, for instance when the available space above the ceiling 2 is limited. However, the convector 30 is suitable for incorporation, in such a manner that not a single part of the convector 30 projects below the plane of the ceiling 2. More in particular, the pipes 32 are then located above the level of that ceiling 2. To guide the flow of air in a suitable manner, in such a way that the outflowing air follows the ceiling 2 horizontally, an inclined airflow guide face 59 is disposed opposite the outflow end 35 of the flow ducts 31, which guide face includes with the horizontal an angle α that is preferably less than 60° , more preferably less than 45° , and most preferably about 30° . In vertical sense, the airflow guide face 59 extends from the top side of the pipes 32 down to the bottom side of the ceiling 2; preferably, and as shown in Fig. 3A, the bottom side of the pipes 32 is flush with the bottom side of the ceiling 2. Further, there is preferably a distance of about 1 cm between the outlet end 35 of the pipes 32 and the beginning of the airflow guide face 59.

Opposite the inflow end 35 of the flow ducts 31 there is likewise disposed an inclined airflow guide face 59', which includes with the horizontal an angle β which is preferably less than 60° , more preferably less than 45° , and most preferably about 30° . Preferably, α and β are equal. Preferably, the arrangement of the faces 59 and 59' is mirror-symmetrical.

The bottom wall 57 of the air chamber 54 may be entirely flat, and the airflow guide faces 59 and 59' may be attached to the bottom of that bottom wall 57. In the embodiment shown, which is preferred, the airflow guide faces 59 and 59' form part of the bottom wall 57, and that bottom wall 57 further comprises a centrally disposed, substantially flat bottom wall portion 58 supporting the heat pipes 41 and the air pipes 32. The flat bottom wall portion 58 extends beyond the ends 35, 36 of the air pipes 32, with the overhang preferably being about 1 cm. From the lateral edges of the flat bottom wall portion 58, inclined bottom wall portions 59 extend down to the lower edge of the sidewalls 56, while, if necessary, a horizontal bottom wall portion 60 may further be provided between the inclined bottom wall portion and the sidewall, flush with or lower than the bottom side of the pipes 32, which horizontal bottom wall portion 60 is aligned with the level of the ceiling 2.

The structural variant shown offers as a particular advantage that it can be manufactured in a particularly simple manner.

In an experiment, a cooling convector was built wherein the pipes 32 had a square contour, having a width and height of 19 mm internally, a wall thickness of 2 mm, and a length of 48 cm. The heat pipes 41 were

formed from a standard copper water feed pipe having an internal diameter of 10 mm and a wall thickness of 1 mm. The mutual distance between the pipes 41 was 6 cm center-to-center. The convector comprised 64 square pipes 32 disposed against each other, so that the total length of the heat pipes was 160 cm. Testing took place at an air temperature of 25°C and a water temperature of $15\text{--}17^\circ\text{C}$. The quantity of primary air blown in by the air feed was $55\text{ m}^3/\text{h}$, and the temperature of the primary air was 16°C . Each air pipe 32 comprised a nozzle 51. In an experiment, the passage of the nozzles 51 was varied. Fig. 5 shows a table of results, wherein the results relating to the induction capacity have been measured and the results relating to the heat transfer have been calculated by means of a model. A particularly favorable result was obtained with a passage of 4 mm, at which a blow-in velocity of 15 m/s was reached and an induction factor of 5.45. In this embodiment, the calculated cooling power was about 516 W.

The air blow nozzles 51 are oriented so that the jet of primary air 13 caused thereby is directed substantially parallel to the flow duct in the air pipes 32. In the structural variant illustrated in Fig. 3A-B, the nozzles 51 are provided in a wall portion of the pipes 32, in this case in the top wall thereof. Surprisingly, it has been found that the distance d from the nozzle 51 to the end of the pipe 32 influences the induction factor. That induction factor, as function of the distance d , proved to exhibit a peak at a distance of about 10 cm. It is suspected that the optimum value of this distance d is generally about 5 times the height of the air pipes 32.

Fig. 4 illustrates a convector 70 that is substantially identical to the convector 30 of Figs. 3A-B, except that the blow nozzles 51 provided in the walls of the pipes 32 have been replaced by blow nozzles 71 arranged before the inlet 36 of the air pipes 32. The blow nozzles 71 can then be provided in the above-mentioned inclined wall portions 59 of the air chamber 54, as shown. In this context, by the expression "before" is meant:

- (1) that there is a horizontal distance A between the outflow end of a nozzle 71 and the inflow end 36 of the corresponding pipe 32, which distance A is greater than zero, preferably at least twice as great as the diameter of the outflow opening of the nozzle 71, and most preferably approximately equal to the diameter of the corresponding pipe 32; and
- (2) that this distance A is sufficiently great for secondary air 14 to enter, along the nozzle 71, the inlet 36 of the corresponding pipe 32.

This embodiment 70 offers the major advantage that the nozzles 71 are easily accessible from below, also when the convector 70 has already been incorporated into a ceiling 2, without requiring additional provisions. Preferably, the nozzles 71 are designed as removable inserts provided in corresponding openings in those inclined wall portions 59. It is then easily possi-

ble to remove those nozzles 71 for cleaning, or to change them for nozzles having a different passage.

In an important preferred embodiment of the present invention, the construction of the pipes 32 and the inclined guide faces 59, 59' is symmetrical. In that case, the construction can also be used for flow in opposite direction, i.e. the end 35 is then an inlet end, and the end 36 is then an outflow end. Hence, the actual direction of flow in the pipes 32 is therefore adjustable by choosing the position and/or orientation of the nozzles 51, 71. That choice may be a fixed choice, but is preferably flexible, in the sense that a user can change the position and/or orientation of the nozzles 51, 71 selectively and per duct 31. In the embodiment shown in Fig. 3A, this is readily possible if the nozzles 51 can be reached from below, through the pipes 32, and for instance be rotated about a vertical axis by means of a screw driver. In such a structural variant, the nozzles 51 are preferably arranged at half the length of the pipes 32.

In a preferred structural variant of the embodiment shown in Fig. 4, the two inclined wall portions 59, 59' are provided with outlet openings 72, provided in line with the pipes 32, for mounting nozzles 71, while there are further provided closing plugs 73 for closing such outlet openings 72, as is also illustrated in Fig. 4. In such a preferred embodiment, it is readily possible to select the flow direction through the air pipes 32 by providing a nozzle 71 in an outlet opening 72 in one inclined wall portion 59' and providing a closing plug 73 in the outlet opening 72 corresponding therewith in the opposite inclined wall portion 59, or the other way round.

Both the convector 30 of Fig. 3 and the convector 70 of Fig. 4 can then readily be designed for outflow on the right-hand side at end 35 (all nozzles 51 directed to the right or all nozzles 71 arranged on the left-hand side respectively), or outflow on the left-hand side at end 36 (all nozzles 51 directed to the left or all nozzles 71 arranged on the right-hand side respectively); see Figs. 6A and 6B, which are schematic top plan views of the convector 30 and 70 respectively, to illustrate the generated flow patterns of the outflowing air, indicated by arrows. Generally, such convector will be used when an asymmetrical airflow is desired, for instance when the convector is installed near a wall of the space 3.

Moreover, the convector 30, 70 according to the present invention can then readily be designed for symmetrical airflow, with outflow taking place both on the right-hand side and on the left-hand side, for instance by alternately positioning the nozzles 71 to the left and right in successive pipes 32, while the closing plugs 73 are fitted to the right and left respectively in successive pipes 32; see Fig. 6C. Such convector will generally be used when the convector is installed more centrally in the space 3. An additional advantage of such symmetrical outflow is that a portion of the combined primary and secondary air flowing from a pipe 32 will be entrained by the primary air that is blown into an adjacent pipe 32,

which portion hence passes through a pipe 32 twice and can thus be cooled down further.

In practice, an alternating leftward/rightward flow will preferably be set so that the separate airflows have a width of about 25 cm. This can be realized by using in each case a suitable number of juxtaposed ducts in one direction, and a suitable number of juxtaposed ducts in the other direction.

Other patterns for the outflowing air are also readily settable in the convector 70 according to the present invention. As an example, a pattern is mentioned wherein in the successive pipes 32, the flow in one pipe is always directed to one side and, subsequently, the flow in two adjacent pipes is directed to the other side, which can be described as left-right-right-left-right-right, etc. (Fig. 6D), so that the quantity of outflowing air at one side is half the quantity of outflowing air at the other side, which can for instance be used when the convector is installed near a window, with the flow towards the window being half the flow away from the window, into the space.

It is also possible that in one half of the convector the flow is leftwards and in the other half the flow is rightwards (Fig. 6E). Such variant has, like the variant of for instance Fig. 6C, the advantage that two or more cooling convectors can successively be provided, wherein the flow patterns created do not disturb one another and yet virtually compensate each other as a net result, as is also illustrated in Fig. 6E, which is important for the user's feeling of comfort.

Any other patterns can also be selected (see Fig. 6F). In this regard, it is an advantage that the flow directions in the different air conduction pipes can be set independently of one another, entirely according to the user's wishes, and that this setting can always be changed in a simple manner, also when the convector is installed in a ceiling, by removing or fitting nozzles or closing plugs.

Of course, it is also possible that the nozzles are not adjustably mounted, so that the set flow patterns are fixed.

Fig. 7 illustrates a variant of the embodiment of Fig. 4, wherein the water pipes 41 are located below the air pipes 32. Provided below the water pipes 41 is a cover plate 81, and the ends of the cover plate 81 are connected, by means of inclined faces 82, 82' which are preferably directed parallel to the inclined faces 59, 59', to the ends 35, 36 of the air pipes 32. This variant has the aesthetic advantage that the end faces of the air pipes 32 are more concealed, viz. partially covered by the overhanging cover plate 81.

It will be readily understood by anyone skilled in the art that the protective scope of the present invention as defined by the claims is not limited to the embodiments shown in the drawings and discussed, but that it is possible to change or modify the embodiments shown of the convector according to the invention within the framework of the inventive scope. For instance, it is pos-

sible that the nozzles 51 are positioned in a sidewall of the air pipes 32, with the pipes 32 then being spaced apart by a certain distance, or that the nozzles 51 are positioned in the bottom wall of the air pipes 32, with the air chamber 54 then extending around the pipes 32.

It is also possible that the inlet 36 of the air conduction pipes 32 communicates with the hollow space above the ceiling 2 rather than with the chamber 3, so as to draw in the secondary air from above the ceiling 2.

It is also for instance possible that the main air feed duct 52 communicates with the chamber 3 or with the hollow space above the ceiling 2, so as to draw in the primary air from the chamber 3.

It is also for instance possible that the convector 30 shown in Fig. 3A is settable for several patterns in that adjacent the two ends of the pipes openings are provided for fitting nozzles or closing plugs, in which case the top cover of the convector may be detachable for positioning nozzles or closing plugs.

It is also for instance possible that the walls of the pipes 32 are provided with longitudinal ribs so as to enlarge the surface area thereof.

If it is desired that the convector according to the present invention can be used both for heating and for cooling, the temperature of the medium in the heat pipes 41 can selectively chosen to be high or low, but it is also possible that two sets of heat pipes 41 are provided, one set being intended for hot medium and the other set being intended for cold medium.

Claims

1. An induction convector for heating or cooling air, suitable for assembly in or to a ceiling (2) of a space (3) to be conditioned, comprising:

- a plurality of elongated, horizontally directed flow ducts (31) enclosed by substantially entirely closed sidewalls (32);
- heat transfer members (40) which are disposed outside the flow ducts (31) and which are disposed so as to be in heat-exchanging contact with the sidewalls (32) of the flow ducts (31);
- air blow-in means (50) for blowing primary air (13) into the flow ducts (31) according to the flow direction of said flow ducts (31), the air blow-in means (50) comprising blow nozzles (51; 71) communicating with a main air feed duct (52);
- two airflow guide faces (59, 59') inclined before the inlet and outlet ends of the flow ducts (31), the angle (α , β) between an airflow guide face (59, 59') and the horizontal being less than 60°, more preferably less than 45°, and most preferably about 30°.

2. An apparatus according to claim 1, wherein the blow nozzles (71) are arranged before the inflow

opening (36) of the air pipes (32).

3. An apparatus according to claim 2, wherein the blow nozzles (71) are mounted in said airflow guide face (59, 59').

4. An apparatus according to any one of claims 1-3, wherein an air chamber (54) is provided, an inlet of which is connected to the main air feed duct (52), said air chamber (54) comprising wall portions (59) in which outlet openings (72) of the air chamber (54) are provided, said outlet openings (72) being provided opposite to and being aligned with the two ends (35, 36) of the air pipes (32), and wherein there are further provided blow nozzles (71) and closing plugs (73) that can selectively be fitted in an outlet opening (72).

5. An apparatus according to claim 1 or 2, wherein the blow nozzles (51) are mounted in a sidewall (32) of the ducts (31).

6. An apparatus according to claim 5, wherein the blow nozzles (51) are provided at a distance (d) of about 10 cm from the outflow end of the air pipes (32).

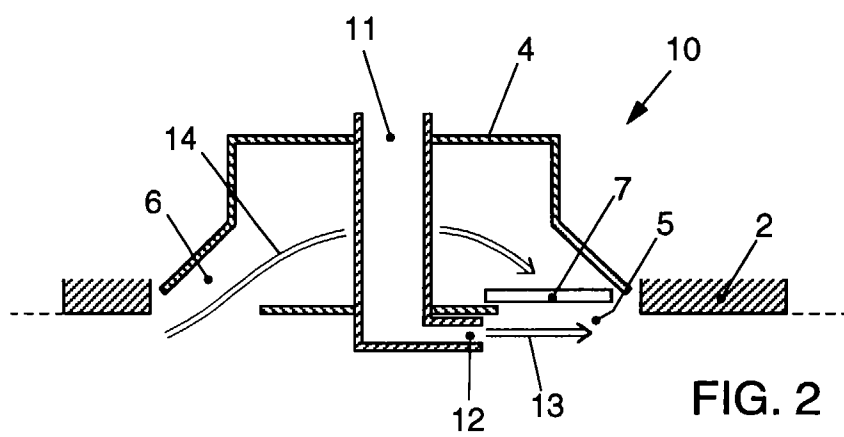
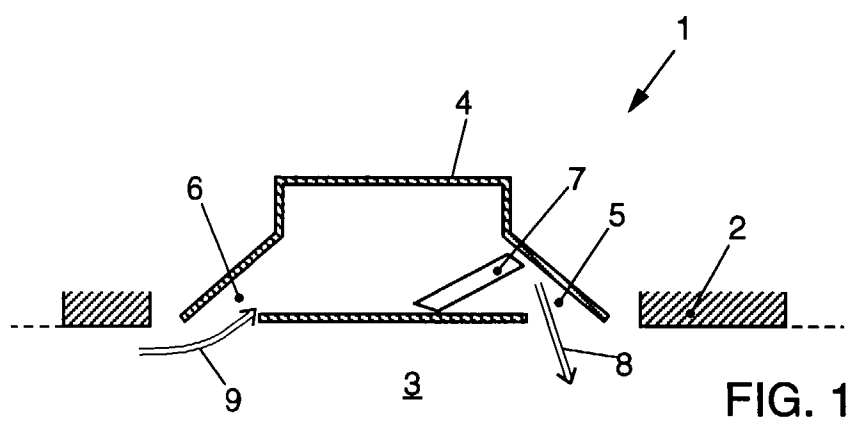
8. An apparatus according to claim 5, wherein the blow nozzles (51) are provided at half the length of the ducts (31).

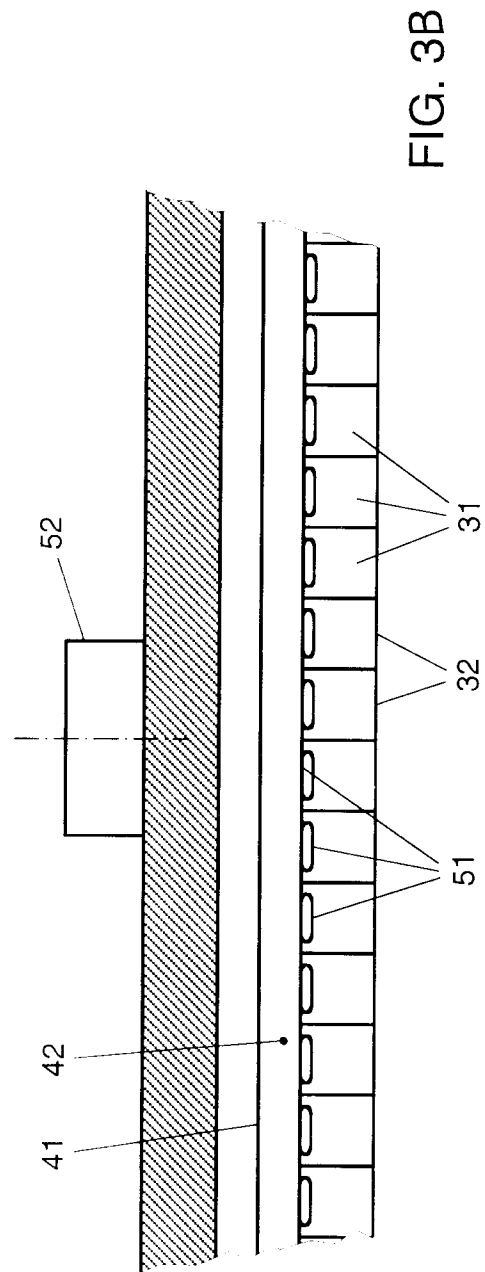
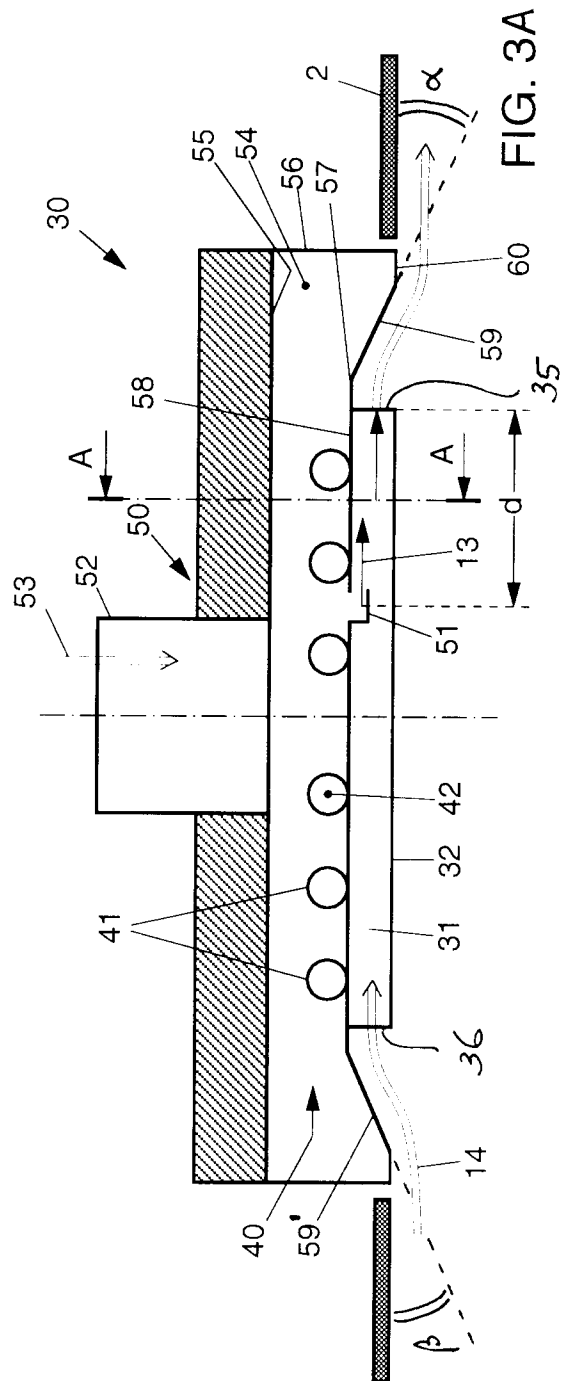
9. An apparatus according to claim 8, wherein the blow nozzles (51) are rotatable about a vertical axis.

10. An apparatus according to any one of the preceding claims, wherein the flow direction in some of the ducts (31) is oriented in a first direction, while the flow direction in other ducts (31) is oriented in an opposite direction.

11. An apparatus according to any one of the preceding claims, wherein the apparatus has a substantially symmetrical construction.

12. An apparatus according to any one of the preceding claims, wherein the elongated flow ducts (31) are defined by hollow airflow conduction pipes (32) having preferably a rectangular cross section, wherein the heat transfer members (40) comprise heat pipes (41), and wherein the heat pipes (41) are attached to the airflow conduction pipes (32), and are preferably directed perpendicularly thereto.





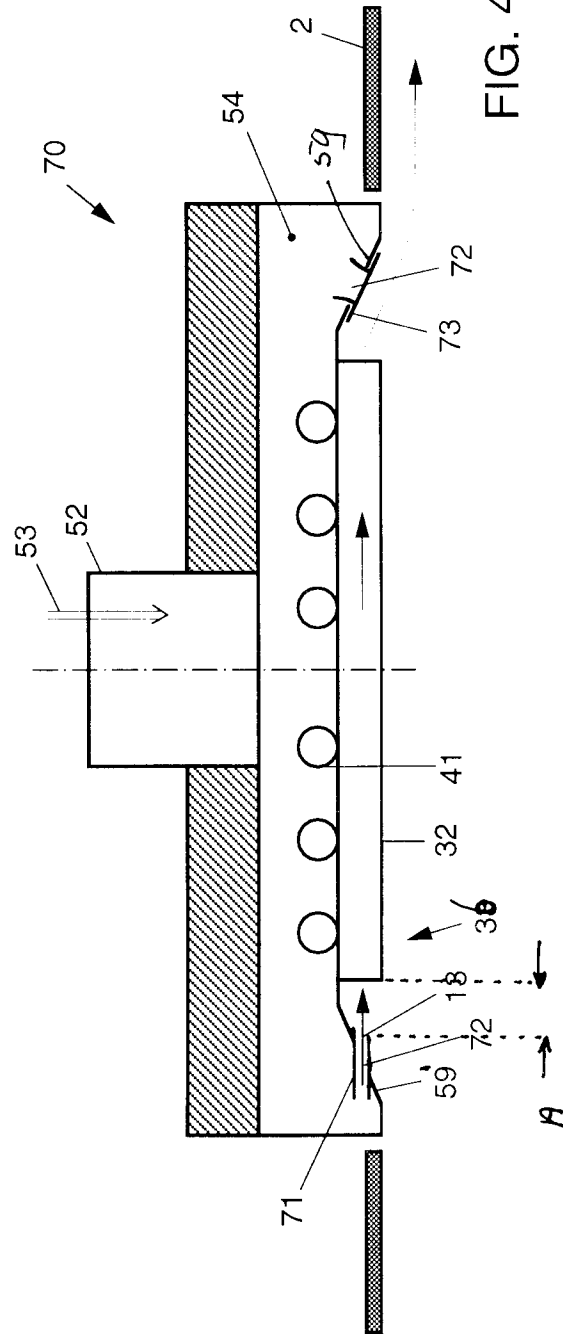


FIG. 4

Jet diameter	Blow-in velocity	Induction factor	Blow-out velocity	Output	Power
mm	m/s	times	m/s	-	W
0.003	26.7	7.00	3.67	0.91	599
0.0035	19.7	6.17	3.23	0.91	556
0.004	15	5.45	2.85	0.92	516
0.0045	11.9	4.79	2.51	0.93	479
0.005	9.63	4.19	2.19	0.93	443
0.0055	7.96	3.67	1.92	0.94	412

Table 1: the properties of the cooling convector

Water 15-17 °C
 Air temperature 25 °C
 Primary air quantity 55 m³/h

Fig. 5

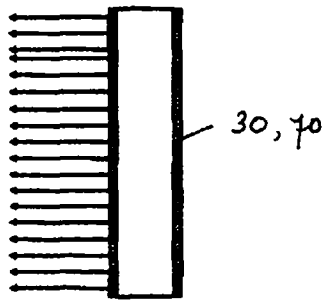


FIG. 6A



FIG. 6B

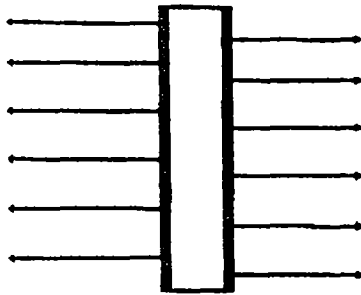


FIG. 6C

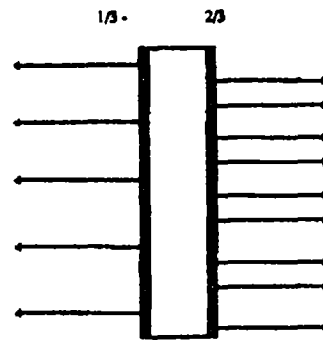


FIG. 6D

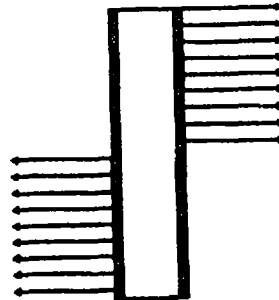
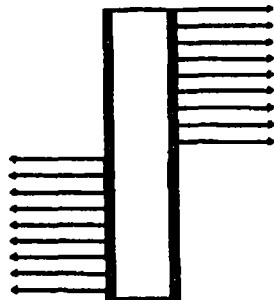


FIG. 6E

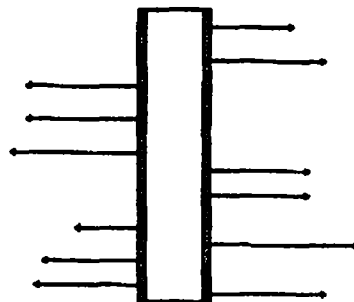


FIG. 6F

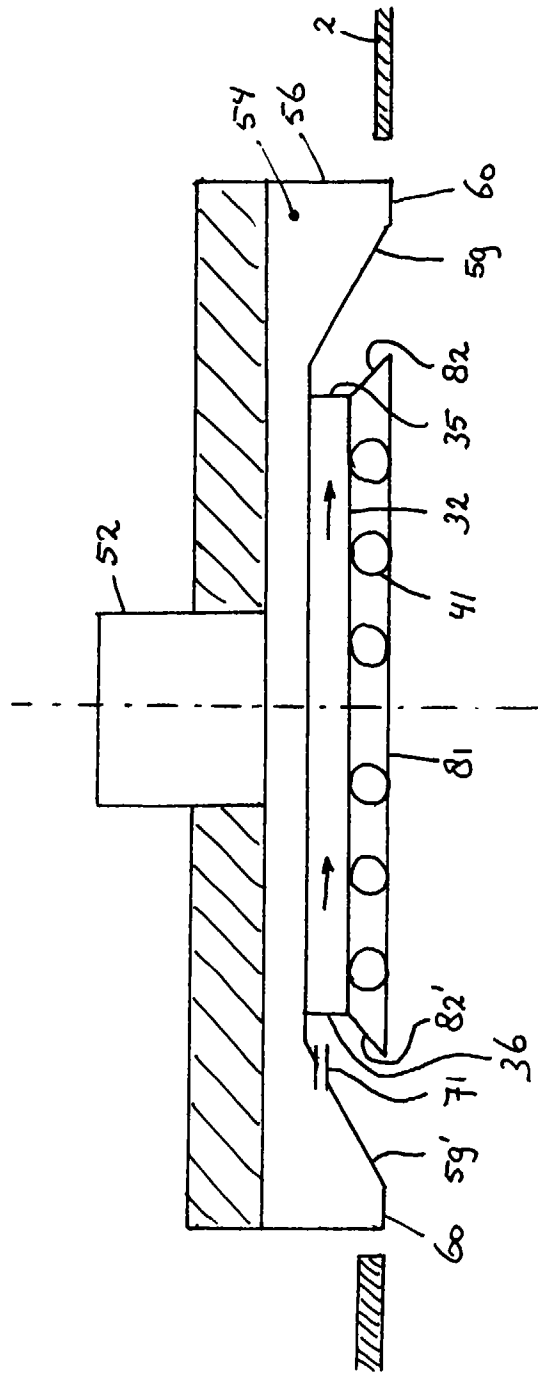


FIG. 7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 2827

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	US 2 758 822 A (KARL SAUTER) 14 August 1956 * column 2, line 29 - column 5, line 17; figures *	1-3,12	F24F1/01 F28D1/02
D,Y	WO 94 24491 A (FAREX AB ;SANDBAKKEN MORTEN) 27 October 1994 * the whole document *	1-3,12	
A	NL 7 211 805 A (ROX LUFTECHNISCHE GERÄTEBAU) 2 March 1973 * page 4, line 29 - page 6, line 4; figures *	1-12	
A	DE 30 44 080 A (SCHMIDT REUTER) 9 September 1982 * page 13, line 25 - page 14, line 26; figure 4 *	1-12	
A	WO 88 10402 A (MOSZKOWSKI STEFAN JACEK) 29 December 1988 * page 3, line 23 - page 7, line 6; figures *	1-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F24F F28D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		8 January 1998	Van Dooren, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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