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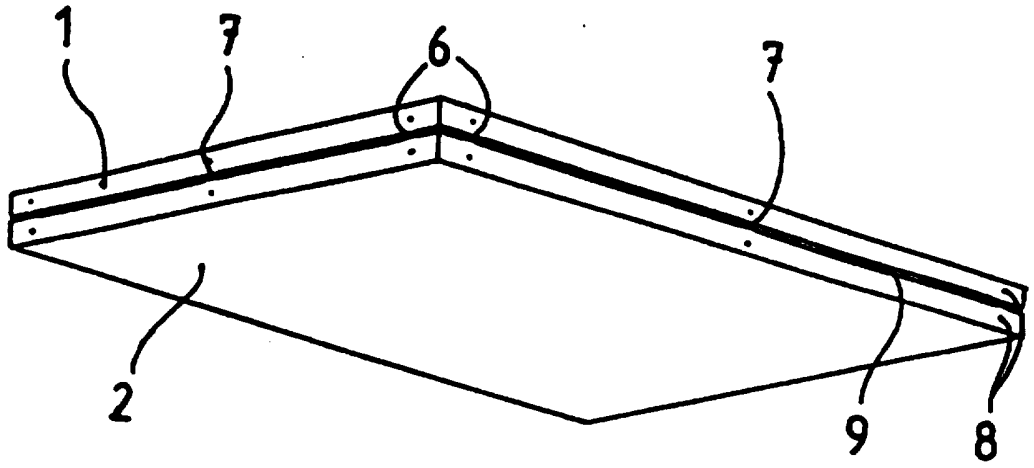
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(57) Abstract

Electric heater for ceilings which emits radiant heat, comprising a radiant plate (2) having heating elements and radiating in a downward direction, and a top part (1) for mounting the radiant plate and connecting the heating elements, wherein the radiant plate (2) is mounted on the top part (1) by means of a number of elastic/flexible brackets, possibly rotatably attached to the top part (1) and the radiant plate (2).

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Ceiling mounted electrical heater

The present invention relates to a heater based on a hot radiant plate which radiates heat, and comprising a heating element which produces and distributes heat across the radiant plate, a thermal insulation layer which also supports the radiant plate and ensures good heat contact between the heating element and the radiant plate, a cold plate where the electrical and mechanical fastening means are mounted, and fastening means between the hot plate and the cold plate which, with minimal heat contact, ensure free horizontal movement between the two plates while keeping them locked together about a center point.

A radiant panel heater is in principle based on heating a plate to a desired temperature so that heat waves are emitted to the surroundings as direct radiation from the plate. As a rule it is desirable to direct the heat waves in particular directions, for example downward from a ceiling heater, this being achieved by thermal insulation in other directions or by shielding against radiation in those directions where it is unwanted.

Electric radiant heaters for ceilings are previously known, comprising a relatively elongate radiant heating element consisting of an extruded aluminum profile which is heated to about 300^{o}C. The radiant heat profile is mounted in a steel box and insulation is placed on the top side so that there is a significant temperature difference between the radiating plate and the surface of the radiant element facing other directions.

Because of the various types of requirements set for such electric radiant heaters for ceilings, the design thereof involves considerable difficulties, inter alia, caused by uneven thermal expansion of the materials contained in the structure, an expansion which may lead to undesirable sounds,

torsion and deformations. Furthermore, in the previously known examples there is considerable heat contact and thereby heat transfer to those parts of the heater which shall not emit radiant heat, this heat thus being unavailable for heating those areas which are meant to be heated. It is only the radiant heat energy emitted in the desired direction that can be regarded as effective energy; all other radiated energy is to be considered a heat loss.

A ceiling heater is always highly visible in a room and should therefore be as discreet in its design and selection of materials as possible so as not to become a disturbing element in the ceiling, this being particularly important in buildings such as churches, for example. It may often be desirable to design the ceiling heater as a part of the ceiling, a task rendered difficult with the existing structures which are fixedly locked to one or more aluminum profiles positioned side by side in a steel box.

For space heating it is generally these types of heaters that are used:

Wall radiators, the main purpose of which is to heat the air in the room. These are well suited to low-ceilinged rooms used for extended periods of time. This type of heating is not suited to high-ceilinged rooms because a great deal of air circulation will occur in the room, at the same time as the hot air will accumulate on top, next to the ceiling.

Ceiling heat and floor heat, both of which are a low-temperature radiant heat having a surface temperature 5-25^{o}C above the air temperature. Here the purpose is to give a low temperature radiant heat to the whole room from the heating elements built into the ceiling or floor. The weakness of the system is that it has a great deal of thermo-technical inertia, and that it does not concentrate the heat in those

areas of the room where it is wanted. The effect delivered is about 150 watt/m^2.

Reflector heaters, which have incandescent heating elements of 600–800°C. These are heaters which have high heat output in relation to size. They emit a short-wave heat radiation which after an extended period of time may often feel uncomfortable. The reflector is easily soiled, preventing the heat waves from being reflected down into the room and resulting in the heater changing character by approaching a convector heater, the heat thereby remaining on top right next to the ceiling.

Medium-temperature radiant panel heaters, which may be ceiling heater cassettes, either free-hanging or built into dropped ceiling systems, and having a radiant plate temperature in the range of 50-100°C above air temperature. For higher temperatures (up to 330°C) the radiant plate is commonly an extruded aluminum profile having the heating element positioned in a track in the aluminum profile which is mounted in an outer housing, so that the heat expansion in the longitudinal direction can occur as unobstructed as possible (Norwegian Patent Application No. 873830). These heaters have little thermo-technical inertia, function equally well if they become soiled, and are particularly well suited to high-ceilinged rooms which have poor thermal insulation in the walls and are not in continuous use. They provide a comfortable long-wave radiant heat which can be concentrated over those areas in the room where heating is desired, and they do not produce much air circulation in the room. These are heaters yielding an effect of 500-5000 watt/m^2.

The present invention describes a principle whereby both the top part and the radiant plate are made of plate-shaped material, have approximately the same shape and size, have unity of design for all heaters irrespective of the tempera-

ture of the radiant plate, and it thus covers all types and sizes of medium temperature radiant panel heaters for ceilings.

A radiant panel heater consists in principle of a hot plate emitting radiant heat, a heating element supplying the hot plate with an even heat across the entire surface, a heat insulation which prevents the heat from spreading to the cold plate which frames the heater and to which the ceiling fastening brackets and the electrical coupling box are attached.

The main problems in making such a heater are as follows: to make a hot plate having as even a temperature as possible across the whole plate, because it is that point on the plate which has the highest temperature which determines how much radiant heat it is possible to obtain from a given surface, due attention being paid to the maximum temperature sustainable by the radiant plate. This is of great importance for production costs.

If the hot plate has an uneven temperature, it will also produce uneven thermal expansion, leading to the possible deformation or twisting of the hot plate and the results this will have on appearance and, in particular, on the heat contact between the heating element and the radiant plate. This problem increases with the increase in temperature of the radiant plate, particularly because the rigidity of the material in the radiant plate is then often greatly reduced.

During the heating the entire hot plate will expand in all directions, and this expansion must be allowed to proceed without hindrance.

The heating element must conduct heat well in the horizontal direction, have good heat contact with the radiant plate and in conjunction therewith provide an even temperature across

the entire radiant surface. The expansion of the heating element is often different from that of the radiant plate, so that the heating element must be capable of moving freely in relation to the radiant plate at the same time as it is pressed down against it.

The insulation shall primarily provide a desired thermal insulation between the hot part of the heater and the cold part thereof, but it shall also support the radiant plate against mechanical stress, and press the heating element against the radiant plate.

The different parts of the heater must be connected in such a manner that there is as little heat contact as possible between the hot plate and the cold plate without free horizontal movement being prevented.

In order to be competitive in the market such a heater structure must be practical and inexpensive in production and be capable of being made in different sizes and shapes adapted to particular purposes. It should be capable of being made in a unified and discreet design, having a surface which in character and color can be adapted to the rest of the ceiling. In terms of production technique, it is an advantage that all heaters are produced on the same principle, so that many of the same technical solutions and components can be used in all types and sizes of heaters.

On the basis of the above, there are, according to the invention, provided solutions which are further disclosed in the patent claims.

In the following, the invention shall be explained in more details, with reference to the drawings, wherein:

FIG. 1 is a perspective view of a radiant panel heater having a top part 1, a radiant plate 2,

resilient and rotatable brackets 6, resilient and non-rotatable brackets 7, and a spacing (9) between the cold top part and the hot radiant plate;

FIG. 2 is a top view of the radiant panel heater, having the top part 1, drawn with a solid line, and the radiant plate 2 in a hot condition, drawn with a dotted line, and having arrows showing that the radiant plate 2, which in a cold condition has the same size as the top part 1, in a hot condition has expanded in all directions from a center point between lines A-A and B-B;

FIG. 3 is a section of a radiant panel heater parallel to lines A-A and B-B where the radiant plate 2 is in a cold condition; and

FIG. 4 is a section of a radiant panel heater parallel to lines A-A and B-B, where the radiant plate is in a hot condition and have thereby expanded in all directions from the center of the heater.

In the following it will be described how the invention makes it possible to produce a heater having the properties described in the stated objectives.

FIG. 1 shows a radiant panel heater, consisting of a cold top part 1, which contains fastening means for being mounted to the ceiling or wall, has space for electrical connections, is mechanically stable and provides the prefinished heater with sufficient strength to withstand the external and internal stresses to which it will be exposed, and a bottom radiant plate 2, which is separated from the top part 1 by a spacing 9, which may have a width of 2-8 mm depending upon the temperature difference between the two plates. This

spacing minimizes the heat transfer between the hot part and the cold part of the heater.

Furthermore, FIG. 1 shows how the two parts are fastened together by fastening brackets 6 at all points of extremity, by fastening brackets 7 in the middle of each side and by screws 8 which fasten the fastening brackets to the top part 1 and the radiant plate 2, respectively.

FIG. 2 shows, from above, a radiant panel heater where the top part and the radiant plate in a cold condition have been drawn with a solid line, and where the radiant plate in a hot conditions has been drawn with a dotted line. The arrows show how the hot radiant plate has expanded in all directions, thereby revealing the necessity of having the fastenings between the cold top part 1 and the hot radiant plate 2 capable of accommodating this extension in length in such a manner that the finished heater does not create noise, become deformed or become damaged in other ways.

FIG. 3 shows a section of the heater parallel to A-A or B-B in FIG. 2, where the radiant plate is in a cold condition. FIG. 4 shows the same section, but with the radiant plate in a hot condition.

The top part 1 is preferably made of a plate-shaped material of high rigidity, the surface treatment of which has the lowest possible emission coefficient, and which, in conjunction with this plate having optimal thermal insulation against the hot radiant plate, radiates as little heat as possible.

The radiant plate 2 has approximately the same size and shape as the top part 1 and is preferably made of a plate-shaped material which has high rigidity at those temperatures to which the plate is exposed, which has a surface treatment providing the highest possible emission coeffici-

ent, and which, in conjunction with this plate having optimal thermal insulation against the cold plate 1, radiates as much heat as possible.

Both the top part 1 and the radiant plate 2 have an upturned flange 1.1 and 2.1 around, preferably, all side edges, which serves as reinforcement and also as attachement base for the fastening brackets 6 and 7 which keep the two parts together. The lateral flanges may either be of equal height, so that the spacing 9 is in the middle of the side edge, or different, so that the spacing is closer to the radiant plate or to the top part. Furthermore, the spacing may be of different width depending upon the temperature difference between the top part and the radiant plate or upon possible design requirements.

The top part 1 and the radiant plate 2 are attached to each other by means of fastening brackets 6 at all corners or at a plurality of positions along the sides if the heater is elongate and such placement is necessary to prevent deformation of the heater because of the heat expansion of the radiant plate.

The heat expansion is accommodated by the fastening brackets 6 in that they in one plane can rotate about the fastening screw 8.1 and 8.2 and that they at right angles to the rotating plane are resilient in the middle section of the fastening bracket 6.1, as apparent from FIGS. 3 and 4. The radiant plate 2 achieves thereby unobstructed thermal expansion in all directions in the horizontal plane, but is locked in the vertical plane and is therefore incapable of twisting.

In order to ensure that the thermal expansion is equal on both sides of the heater and the radiant plate 2 will return to its original position in relation to the top part 1, the fastening brackets 7, which keep the top part 1 and the

radiant plate 2 together in the middle of all long sides, are fastened to the top part 1 in such a manner that they are resilient but not rotatable about the fastening screw 8, either in that the fastening bracket 7 is of such a length that it is locked against the top part, that it possibly has two fastening screws on one side or that it is glued to the top part 1. The thermal expansion will in this manner be locked about the central axes A-A and B-B in FIG. 2.

A plate heating element 3 having a heating element 4 is in direct contact with the radiant plate 2. The plate heating element 3 is made of tempered pure aluminum, which conducts heat better and is more easily shaped that alloy aluminum. The plate heating element is heated by the heating element 4 which for low temperatures may be silicon insulated heating cable and for higher temperatures tube elements or bead insulated heating coils, and which is arranged in a sinuous fashion at a desired distance from the center and attached to the plate heating element by lugs 3.1. By varying the center distance and thickness of the material in the plate heating element and thereby the ability to conduct heat in the horizontal direction, the desired heat distribution can be obtained.

The plate heating element 3 lies flatly and loosely against the radiant plate 2, is capable of moving freely in all directions in the horizontal plane, and is pressed down toward the radiant plate 2 by the thermal insulation 5. The thermal insulation 5, which preferably is of rigid ceramic fibers, covers the entire space between the top part 1 and the plate heating element 3, prevents the heat from the plate heating element 3 to be transmitted to the top part 1, presses the plate heating element 3 down toward the radiant plate 2 and provides a mechanical support of the radiant plate 2 at the same time as the whole structure becomes mechanically stable.

Patent Claims

1.

Electric heater for ceilings which emits radiant heat, comprising a radiant plate (2) having heating elements and radiating in a downward direction, and a top part (1) for mounting the radiant plate and connecting the heating elements,

c h a r a c t e r i z e d i n that the radiant plate (2) is mounted on the top part (1) by means of a number of elastic/flexible brackets, possibly rotatably attached to the top part (1) and the radiant plate (2).

2.

Electric ceiling heater for radiant heat, comprising a radiant plate (2), the radiation of which is directed downward, and a top part (1) for the mounting of and the electrical connection of the heating elements,

c h a r a c t e r i z e d i n that they on all sides are separated by a spacing which may be 2-8 mm, depending upon the temperature difference between the radiant plate and the top part.

3.

Heater according to claim 1,

c h a r a c t e r i z e d i n that the top part (1) and the radiant plate (2) are attached to each other at all corners by means of resilient and rotatable fastening brackets (6).

4.

Heater according to claims 1 and 2,

c h a r a c t e r i z e d i n that the top part (1) and the bottom part (2) are fastened together in the middle of all sides by a fastening bracket (7) which is resilient but not rotatable in the lateral direction.

5.
Heater according to claims 1, 2 and 3,
c h a r a c t e r i z e d i n that there between the radiant plate (2), having a plate heating element (3) placed above it, and the top part (1) is a ceramic insulation (5) of high rigidity which occupies the whole space between the two plates and simultaneously provides mechanical support for the radiant plate (2).

6,
Heater according to claim 4,
c h a r a c t e r i z e d i n that the ceramic insulation (5) between the top part (1) and the plate heating element (3) presses the plate heating element (3) down against the radiant plate (2) so that optimal heat contact is achieved.

7.
Heater according to claims 1 and 2,
c h a r a c t e r i z e d i n that the fastening brackets (6) and (7) are of a poor heat conducting material and that they have a hole (6.1) and (7.1) in their middle section.

8
Heater according to claims 1, 2 and 6,
c h a r a c t e r i z e d i n that the fastening brackets (6) and (7) have a middle section bending inward inside the heater so that the middle section of the fastening brackets does not prevent the radiant plate (2) from moving.

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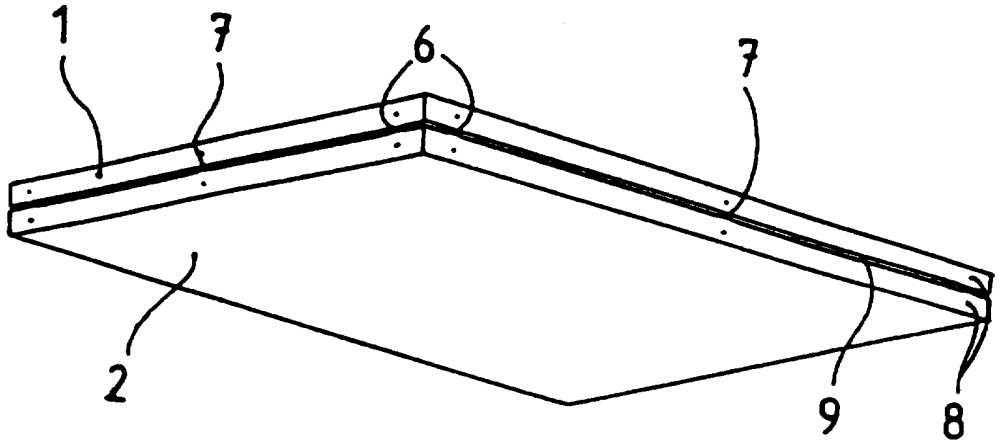


FIG. 1

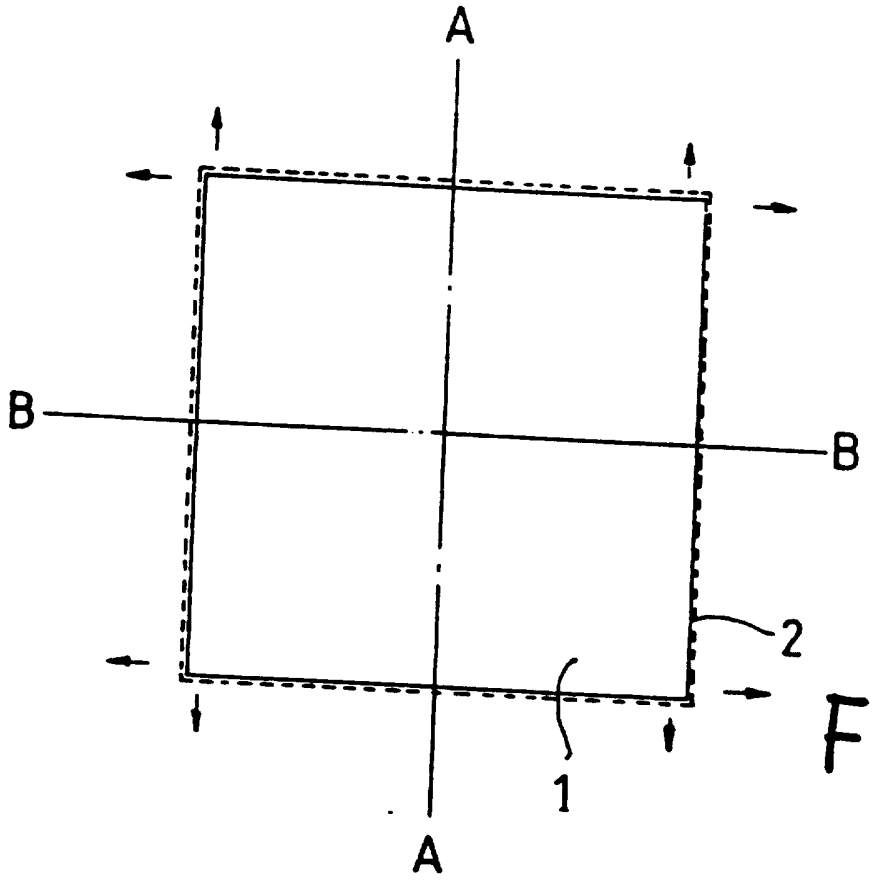


FIG. 2.

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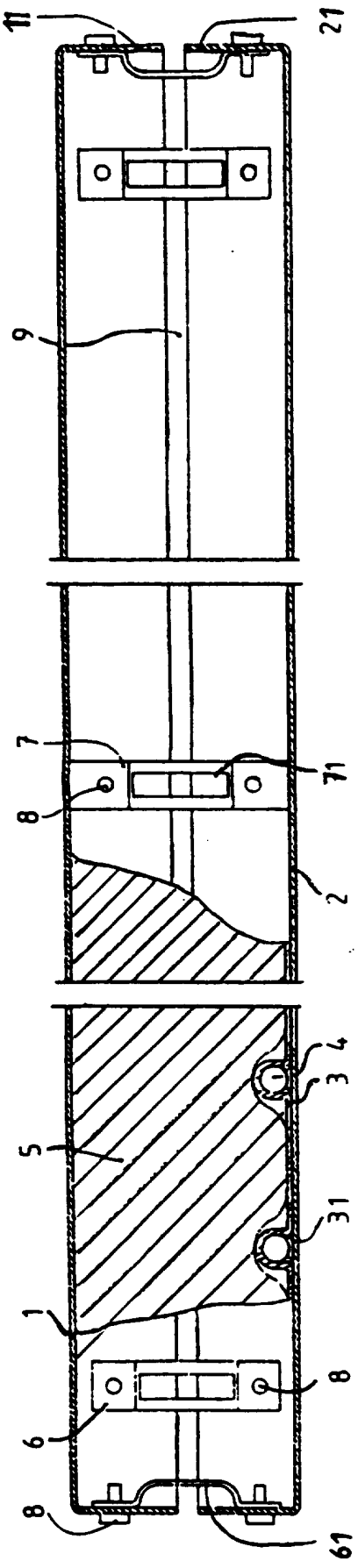


FIG. 3

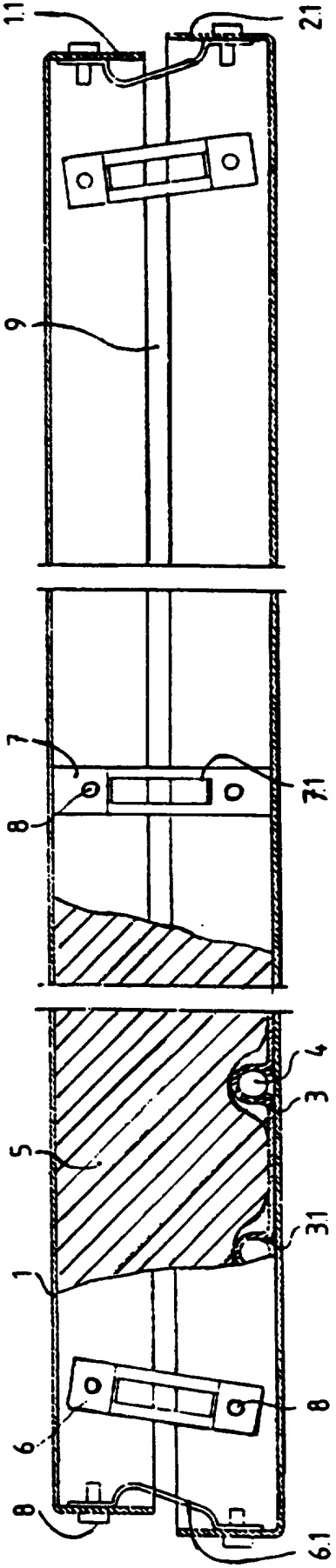


FIG. 4.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 96/00007

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F24D 13/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F24C, F24D, H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4677279 A (WESSELTOFT), 30 June 1987 (30.06.87), column 1, line 5 - column 4, line 14, figures 1-2, abstract	1-4
Y	column 1, line 5 - column 4, line 14, figures 1-2, abstract	5-8
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X	WO 8902565 A1 (PER WESSELTOFT), 23 March 1989 (23.03.89), page 3, line 4 - page 4, line 8, figures 1-3, abstract	1
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Y	FR 2437759 A1 (F.G.F. EQUIPEMENTS), 25 April 1980 (25.04.80), page 2, line 15 - line 38, figures 1,3	5-6,8
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
10 April 1996	12.04.96
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Roland Landström Telephone No. +46 8 782 25 00

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International application No.
PCT/NO 96/00007

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2525850 A (G. ANDERSEN), 17 October 1950 (17.10.50), column 4, line 33 - line 37, figure 12 --	7
A	DE 3914897 A (PRODUCTECH GMBH), 9 June 1993 (09.06.93), figures 1-9 --	1-8
A	US 3603764 A (HUGH MARTIN), 7 Sept 1971 (07.09.71), figures 1-2, abstract --	1-8
A	FR 2323105 A1 (CARLSSON LARS ERIK JAN), 1 April 1977 (01.04.77), page 3, line 23 - page 5, line 24, figures 1-6 -- --------	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

05/02/96

International application No.
PCT/NO 96/00007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4677279	30/06/87	NONE	
WO-A1- 8902565	23/03/89	NONE	
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US-A- 2525850	17/10/50	NONE	
DE-A- 3914897	09/06/93	NONE	
US-A- 3603764	07/09/71	NONE	
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