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(54) METHOD OF REDISTRIBUTING HEAT WITHIN A ROOM

(71) I, SIEGFRIED VINZ, a German citizen, of Neuwiesenrebenstr. 44, D-7505 Ettlingen, Federal Republic of Germany, do hereby declare the invention for which I pray that a Patent may be granted to me and the method by which it is to be performed to be particularly described in and by the following statement:-

The invention relates to a method and apparatus for redistributing heat within a room for operating a heating system for a dwelling, working or assembly room; with heat pumps adapted to obtain the heat from an available heat medium on their expansion side (cold side) and to deliver such heat on their compression side (hot side) to the medium which is to be heated.

The theoretical principles and practical effects of heating systems with heat pumps as heat generating means are generally known from the technical literature; practical embodiments have been taken up only very recently although very good experience has been available for a few embodiments which have already been installed for several decades. A powerful impetus, has evidently been required to give fresh encouragement to development in this field and this has been supplied by the increasing cost of primary energy.

Heating systems with heat pumps are generally operated by low grade heat being obtained from a medium with a large heat reserve, for example a large waterway, groundwater or soil, said heat is then transformed by means of the heat pump into a high grade heat and the high grade heat thus obtained is delivered to a medium to be heated, for example water or air. Under average conditions, it is possible for a very substantial part of the heat required for heating to be obtained from the relevant heat storage medium, i.e. for such heat to be obtained quasi-free of cost. Systems of this kind, which can be used for example for heating dwelling rooms or hot water, have hitherto generally been operated on the principle of obtaining inexpensive heat energy, as already described. The heat has hitherto always been given up to room heating systems by convective heat exchange with the room air through heat exchangers constructed in the manner of radiators or convectors of central heating systems.

It is well known that human beings feel radiated heat to be substantially more pleasant than the conventional heated room air. The physiological feeling of comfort from radiated heat is stimulated to a much greater extent, even at low air temperatures, than in the opposite case of heat absorption from environmental air at high temperature. Medical considerations therefore frequently demand the development of heating systems which transfer a greater proportion of sensible heat by radiation. However, apart from known electric heat radiators such a requirement can be achieved only with difficulty in actual practice.

Proceeding from this situation, it is an object of the invention to propose a method of redistributing heat within a room or for operating a heating system for a dwelling, working or assembly room with at least one heat pump as a heat generating means which obtains heat on an expansion side thereof from an available heat medium and delivers said heat on a compression side thereof to a medium which is to be heated. According to one aspect of the present invention this problem is solved by heat being obtained directly or indirectly through an intermediate medium accompanied by a reduction in the temperature from air contained within a room and delivering the heat to radiation members which radiate the heat and are disposed at the boundary surfaces of a room. Heat extracted from the air of a room

will be re-emitted by radiation members located in the same said room. According to another aspect of the present invention there is provided a method of redistributing heat within a room, comprising the steps of: removing heat exclusively from air contained with the room with a heat pump and delivering the heat back to the room by one or more radiation members disposed adjacent boundary surfaces of the room; circulating the air contained within the room by means of channels provided between the radiation members and the boundary surfaces.

It is obvious that in performing the method according to the invention the room is not heated to any great extent in the intrinsic sense but that the existing heat content is continuously converted from air heat into radiated heat, which is felt to be more pleasant, the heat content being slightly increased by the electric energy used for operating the heat pump; the heat which is constantly lost outside the system can be replaced by conventional heating devices based, for example, on heat convection. To perform the method according to the invention there is provided apparatus including at least one heat pump, at least one primary heat exchanger for transmitting heat obtained from the air of the room to be heated to the expansion side (cold side) of the heat pump, and situated in the room which is to be heated and at least one heat exchanger constructed as a surface heat radiator disposed adjacent boundary surfaces of the room for receiving heat from a compression side (hot side) of the heat pump and for delivering such heat substantially in the form of heat radiation to the room. By using surface heat radiators, that is to say radiators with a large surface area, the entire system can be operated at relatively low temperatures, a feature which also assists in conveying a feeling of comfort.

One simple embodiment of the invention provides that the primary heat exchangers associated with the heat pump on the expansion side (cold side) and on the compression side (hot side), the pump side of which heat exchangers carry the direct heat pump medium flow, are provided respectively as means for exchanging heat with the room air and means for radiating to the room.

For plants with a larger output and for more complicated space conditions it is on the other hand recommended that a secondary heat medium circuit, more particularly operated with water as heat medium, is associated with each of the primary heat exchangers associated with the heat pump respectively on the expansion side and on the compression side, that the secondary circuit on the expansion side absorbs room air heat through at least one secondary heat exchanger and supplies such heat to the primary heat exchanger and that the secondary circuit on the compression side receives the heat from the primary heat exchanger and radiates said heat *via* the secondary heat exchangers, constructed as at least one surface heat radiator, into the room which is to be heated. A plant perfected in this manner is shown to be advantageous if particularly large surfaces, situated in several planes, are to be provided with heat radiators or if heat to be obtained from the room air from several places which are separated from each other. Depending on the given conditions, a secondary circuit can be associated either only with a primary heat exchanger on the expansion side or only with a primary heat exchanger on the compression side or it can be associated with both heat exchangers.

One advantageous further embodiment of the invention provides that the surface heat radiators are disposed at a short distance from the boundary surfaces of the rooms (walls, ceiling, floor) so as to leave an air gap and seal strips for forming air guide ducts are disposed at specified places between the boundary surfaces and the surface heat radiators. These steps open numerous additional possibilities.

For example, the heat exchangers which are on the cold side can be disposed in the air gap between the boundary surfaces and the surface heat radiators and can be advantageously situated in ventilating shafts or they can be associated with an air pump for supplying the air. This arrangement not only offers the advantage of allowing the mechanical apparatus to remain concealed, but the air gap itself acts as a ventilating shaft and ensures that a powerful heat exchange takes place. It is also desirable for the purpose of an architecturally advantageous arrangement of the room to arrange not only the heat exchangers which are on the cold side but also the entire heat pump system in the air gap between the boundary surfaces and the heat radiators.

In a preferred embodiment, the heat radiators arranged in this manner are provided with several or a large number of ducts, extending from the external surface to the internal surface, to permit an exchange of air from the room to the air gap between the boundary surfaces and the surface heat radiators or *vice versa*.

It appears advantageous to provide the external surfaces of the surface heat radiators nearest to the boundary surfaces of the room with thermal insulation to prevent a substantial part of the heat supplied to the heat radiators being dissipated to the air which is situated in the air gap

between the heat radiators and the boundary surfaces.

Embodiments of apparatus according to the invention, will now be described, by way of example only by reference to the strictly diagrammatic basic sketches in the accompanying drawings, in which:

Figure 1 is a simple embodiment of a heating system with a heat pump;

Figure 2 is an embodiment of a heating system;

Figure 3 shows a greatly simplified plan view of a dwelling room with an associated heating system.

In the apparatus according to Figure 1, a primary, absorptive, heat exchanger 4 (cold side) and a primary, emissive heat exchanger 5 (hot side) associated with a heat pump 2, whose expansion part (cold part) is designated "K" and whose compression part (hot part) is designated "W", are used directly as heat exchangers for the room which is to be heated (in which the distribution of heat is to be controlled). In the illustrated embodiment, the heat exchanger 4 on the cold side comprises a pipe coil 41 through which the heat pump medium flows and which is surrounded by a jacket tube 40. Room air flows through the jacket tube under the action of an air pump 6 and gives up part of its sensible heat to the heat pump medium which was cooled due to the preceding expansion. The heat exchanger 5 for heating the room is constructed as an imperforate heat-radiating panel through the interior of which the heat pump medium flows.

Figure 2 shows a more sophisticated system. In this system, a secondary heat medium circuit, advantageously operated with water as heat medium but which can also be operated with other suitable liquids, associated with each primary heat exchanger 4 or 5. In this system a secondary, absorptive, heat exchanger 7 with a circulating pump 8 is associated with the primary heat exchanger 4 and a secondary emissive heat exchanger 9 with a circulating pump 10 is associated with the primary heat exchanger 5. As can readily be seen by reference to Figure 2, the functions of the primary heat exchangers 4,5 as regards room heating in this embodiment have been taken over by the secondary heat exchangers 7 and 9, by comparison with Figure 1. The last-mentioned heat exchangers effect heat exchange with the room that is to be heated by heat removal 7 or by radiation 9, the heat medium of the relevant secondary circuit functioning as exchange medium while the primary heat exchangers 4, 5 merely exchange heat between the medium of the heat pump and heat medium of the secondary circuit. By contrast to the simple embodiment illustrated in Figure 1, the arrangement according to Figure 2 offers important advantages. By selecting a suitable heat medium, for example water, the secondary circuits can be arranged for unpressurized operation and they can be constructed for supplying a plurality of secondary heat exchangers while the choice of their installation site and pipeline layout is substantially a matter of free choice.

Figure 3 shows a plan view of a basic diagram of a room heating system in which surface heat radiators, which cover substantial parts of the wall surfaces, are situated at a short distance from boundary walls 11 of a room 12 which is to be heated. As shown in Figure 2, these heat radiators have ducts extending from one to the other of their walls and permit the exchange of air from the interior of the room to the air gap 13 which remains between the boundary walls and the system of heat radiators. In the interests of simplifying the drawing, this Figure shows only a simplified heat pump heating system according to Figure 1; in a system having this embodiment, it will however be far more advantageous to provide a heating system according to Figure 2. The heat exchanger 4 or 7 for obtaining heat from the room air is disposed in the air gap 13, for reasons of space as well as for reasons of heat technology or for aerodynamic reasons; this is because the air gap itself acts as a ventilating shaft so that the heat exchanger 4 or 7 on the cold side does not require sheathing to produce a ventilating action but can be freely suspended in the air gap as a simple pipe coil 41. To assist the ventilating action resulting from heat convection, it is possible for seal strip of plastics material to be mounted at the places provided to this end between the boundary walls and the system of heat radiators so that the air gap is subdivided by the said seal strips into rising and/or horizontal ducts.

WHAT I CLAIM IS:

1. A method of redistributing heat within a room by employing at least one heat pump which is adapted to obtain heat on an expansion side from a supply of heat and to deliver such heat on its compression side to a medium to be heated, comprising the steps of: removing heat exclusively from air contained within the room with said heat pump and delivering the heat back to the room by one or more radiation members disposed adjacent boundary surfaces of the room; circulating the air contained within the room by means of channels provided between the radiation members and the boundary surfaces.

2. A method according to claim 1, characterised in that the heat is removed directly by the heat pump from said air and is delivered directly to said radiation members.

3. A method according to claim 1, characterised in that the heat is removed indirectly from the said air and is delivered indirectly to said one or more radiation members.

4. A method according to claim 3, characterised in that the secondary heat medium carriers are employed to effect said indirect removing and delivering of heat.

5. A method according to claim 4, wherein water is employed as a heat carrier medium of the secondary circuit.

6. A method of redistributing heat within a room substantially as hereinbefore described with reference to Figure 1, Figure 2 or Figure 3 of the accompanying drawings.

7. A method for operating a heating system for a dwelling, working or assembly room having at least one heat pump as a means for transferring heat from a supply of heat and adapted to obtain heat from an available heat supply on its expansion side (cold side) and to deliver such heat on its compression side (hot side) to a medium to be heated, characterised in that the heat is obtained directly or indirectly through an intermediate medium accompanied by a temperature reduction from air contained within a room and is delivered by one or more radiating members disposed adjacent boundary surfaces of the room.

8. A method of operating a heating system according to claim 7, characterised in that one or more radiating members are disposed in distribution over boundary surfaces of the room in such a manner that a symmetric radiation arises.

9. Apparatus for performing the method of claim 1 or claim 7, having at least one heat pump and characterised in that at least one primary heat exchanger, for transmitting heat obtained from the air of the room to the expansion side (cold side) of the heat pump, is situated in the room which is to be heated and that at least one primary heat exchanger constructed as a surface heat radiator, is disposed adjacent a boundary surface of the room for receiving heat from the compression side (hot side) of the heat pump and for delivering such heat substantially in the form of heat radiation to the said room.

10. Apparatus according to claim 9, characterised in that the said primary heat exchangers associated with the heat pump on the expansion side and on the compression side, the pump side of which carries the direct heat pump medium flow, are provided respectively as means for exchanging heat with the room air and means for radiating to the room.

11. Apparatus according to claim 10, characterised in that a secondary heat medium circuit, is associated with each of the primary heat exchangers and the secondary circuit on the expansion side of the heat pump is arranged to absorb heat from the room air through heat exchangers and to supply the heat to the primary heat exchanger on the expansion side of the heat pump, and the secondary circuit on the compression side of the heat pump is arranged to receive the heat from the primary heat exchanger and to radiate said heat *via* heat exchangers, constructed as surface heat radiators, into the room.

12. Apparatus according to claim 11, characterised in that one or both secondary circuits utilises water as a heat carrier.

13. Apparatus according to any of claims 9 to 12, characterised in that the surface heat radiators are disposed at a short distance from the boundary surfaces of the room so as to leave an air gap and that seal strips for forming air guide ducts are disposed at specific places between the boundary surfaces and the said surface heat radiators.

14. Apparatus according to any of claims 9 to 13, characterised in that external surfaces of the surface heat radiators nearest to the boundary surfaces of the room are thermally insulated.

15. Apparatus according to claim 13, characterised in that the surface heat radiators are provided with ducts which permit an air exchange between the room and the air gap between the boundary surfaces and the surface heat radiators or *vice versa*.

16. Apparatus according to claim 13, characterised in that the heat exchangers on the expansion side are disposed in the air gap between the boundary surfaces and the surface heat radiators and that they are situated in ventilating shafts or that they are associated with an air pump for supplying the room air.

17. Apparatus according to claim 13, characterised in that the entire apparatus for the heat circuit except for said heat pump and surface heat radiators is situated in the air gap between the boundary surfaces and the surface heat radiators at the outside of the surface heat radiators and that the apparatus is isolated from air in the air gap.

18. Apparatus for performing the method of claim 1 or claim 7, substantially as hereinbefore described with reference to Figure 1, Figure 2, or Figure 3 of the accompanying drawings.

Agents for the Applicants,
STANLEY, POPPLEWELL, FRANCIS & ROSS,
Chartered Patent Agents,
1, Dyers' Buildings,
Holborn,
London, EC1.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

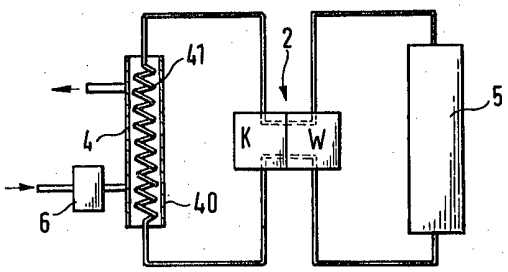

Fig.1

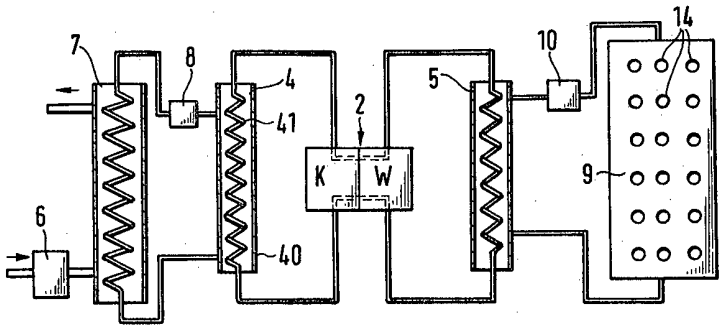

Fig.2

1591724 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

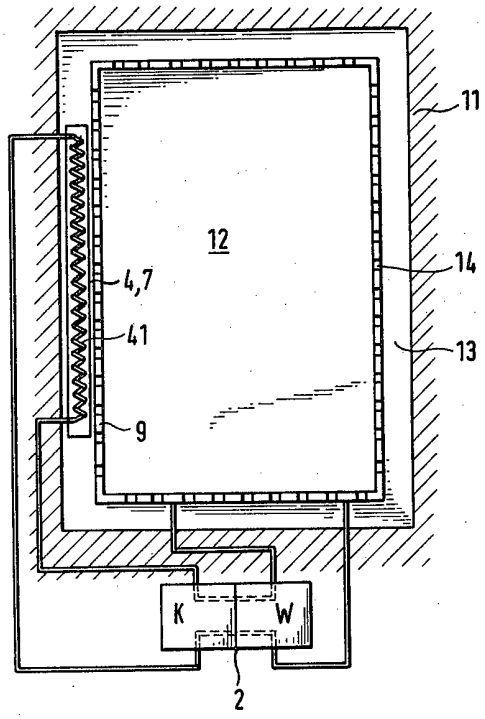

Fig.3