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(54) **INFRARED RADIATING PANEL**

INFRAROTSTRAHLUNGSTAFEL

PANNEAU A RAYONNEMENT INFRAROUGE

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(56) References cited:
US-A- 3 240 915 **US-A- 6 160 957**

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Description

[0001] The present invention relates to an infrared radiating panel.

[0002] Infrared radiating panels are previously known and have among others been supplied by Kanthal AB, Sweden.

[0003] The construction of such panels is in principle such that an electrically resistor wire is arranged on a wall of ceramic fibre material. The resistor wire is connected to a power source such that the wire is heated to a high temperature, for example 1,500 - 1,600 °C. The resistor wire emits infrared radiation at this temperature.

[0004] One major problem is that the lifetime of the resistor wire is not sufficiently long relative to the desire lifetime. For example, a long lifetime is required in the paper industry, in which it would be possible to use infrared radiating panels in order to dry paper and paper pulp, due to the continuous operation of the manufacturing processes. It is a desire from the paper industry, for example, that the lifetime be 16,000 hours. Known panels, having a known resistor element, marketed by Kanthal AB under the name "Kanthal Super 1800" have a lifetime of 6,000 hours.

[0005] Electrical resistor elements of molybdenum silicide type have been known for many years. Their principle use is in so called high-temperature applications, by which ovens that operate at temperatures up to about 1,700 °C are primarily denoted.

[0006] The resistor element Kanthal Super 1900 is described in the Swedish patent 458 646. The material is a homogenous material with the molecular formula $Mo_xW_{1-x}S1_2$.

[0007] SiO_2 grows on the surface of the heating element at a parabolic rate of growth, which is the same irrespective of the cross-sectional dimension of the heating element, when the element is exposed to oxygen at high temperature. The layer can have a thickness of 0.1 to 0.2 mm after a few hundred hours of operation at 1,850 °C. This layer of glass will solidify when the temperature is reduced down towards room temperature and it will subject the basic material of the heating element to tensile forces due to the fact that the coefficient of thermal expansion of the basic material is significantly different from that of the glaze. The coefficient of thermal expansion of the glaze is $0.5x10^{-6}$, while the coefficient of thermal expansion of the basic material is $7\text{-}8x10\text{-}^{6}$.

[0008] It is obvious that the tensile forces increase with increasing thickness of the glaze layer. Breakage of the basic material arises when the tensile forces exceed the durability of the basic material, something that occurs when the glaze has grown such that it exceeds a certain critical thickness.

[0009] The glaze constitutes a greater fraction of the cross-sectional area of a thin element relative to that of the basic material than is the case for a thick element. This means that the critical thickness of the glaze is reached after a shorter period of operation for a thin element than for a thick element, at the same temperature of operation and with the same operating conditions.

[0010] It has been believed that the phenomenon described above is the dominating factor for determining the lifetime of an infrared radiating panel.

[0011] An infrared radiating panel is described in the Swedish patent 508 779, alias US-A-6,160,957 that has a significantly longer lifetime than known panels when using the same resistor wire.

[0012] According to the patent just mentioned, there is presented an infrared radiating panel comprising a wall of a ceramic fibre material on which an electrically resistor element is arranged, where the resistor element is attached by staples to the wall. According to the patent, the resistor element is arranged at a distance from the surface of the said wall. The complete jacket surface of the elements is allowed to radiate freely in that the resistor element is located at a distance from the wall, which increases the lifetime of the element.

[0013] The present invention increases further the lifetime of an infrared radiating panel.

[0014] Thus, the present invention relates to an infrared radiating panel comprising a wall of a ceramic fibre material to which an electrically resistor element is attached and which element comprises several shanks evenly distributed over the surface of the wall and which element is arranged to be,connected to a power source such that it can be heated to a high temperature such that the resistor element emits infrared radiation, where the resistor element is attached to the wall by staples and where the resistor element is arranged at a distance from the surface of the said wall, where a sheet of glass is arranged parallel to the resistor element and separated from it, in that a space is formed between the sheet of glass and the surface of the wall, and where a fan arrangement is arranged to force air through the said space from an inlet opening at one edge of the panel to an outlet opening at the opposite edge of the panel and it is characterised in that ventilation holes for air supply pass through the wall and open out into the said space.

[0015] The invention is described in more detail below, partially in association with an embodiment of the invention shown in the attached drawings, where

- Figure 1 shows an infrared radiating panel directly from the front
- Figure 2 shows the panel in a section along the line A - A in Figure 1.

[0016] An infrared radiating panel is shown in Figures 1 and 2 comprising a wall 1 of a ceramic fibre material on which an electrical resistor element 2 is arranged. The surface 6 of the wall acts as a reflector. The ceramic fibre material may be of the aluminium silicate type with about 50% Al_2O_3. The resistor element is arranged to be connected by conductors 3, 4 to a source of power in order to be heated to a high temperature such that the resistance wire emits infrared radiation. The resistor wire is

fixed by staples 5 to the wall 1.

[0017] The resistor element is arranged at a distance from the surface 6 of the said wall 1.

[0018] The ceramic wall is surrounded along its side edges at least partially by a frame 17. The frame is open on the side of the panel where the elements 2 are located, but it is equipped with inwardly protruding sections 18, 19, 20, 21 for the support of a sheet of glass 22.

[0019] A current of air is led, according to the invention, as is indicated by the arrows 23, 24, 25, in the space 26 between the surface 6 of the wall and the said sheet of glass 22. The air is led in the space 26 along a channel, not shown, located to the right of the panel in Figure 1, to which a conventional fan, not shown, is attached. The air exits from the panel to the left in Figure 1.

[0020] According to the invention, a number of air-holes 29 for input air are located along a line that runs perpendicular to the current of air passing over the element 2. The air-holes 29 are evenly distributed along the width of the panel. Furthermore, the air-holes are located closer to the outlet opening than to the inlet opening for the current of air over the elements. The air flows through the air-holes upwards from the paper in Figure 1.

[0021] The flowing air 23 is continuously warmed as it flows towards the left in Figure 1. This air is cooled by the additional air that arrives through the air-holes 29, which ensures that the part of the element to the left in Figure 1 is cooled such that the element as a unit acquires a more even temperature. The air-holes are fed by a fan and channels, not shown in the drawings, from the rear 30 of the wall. The air-holes may have a diameter of 3 - 8 mm, when the radiative area of the panel is approximately 200 X 150 mm.

[0022] This air flow cools the element to a certain degree, but it ensures that the element temperature is more even than it is in conventional infrared radiating panels, and thus that a more even emission of heat is achieved. Furthermore, the air flow ensures that condensation from the elements onto the surface of the sheet of glass that faces the element is avoided.

[0023] Furthermore, the occurrence of what are known as "hot spots" is avoided to a greater degree than previously. Hot spots are points at which the temperature can become higher than the maximum allowed temperature for the element, with element failure as a result.

[0024] The more even temperature of the element and the avoidance of hot spots ensures that the lifetime of the element increases. This increase can be achieved despite it being possible to increase the temperature of the element compared to known infrared radiating panels.

[0025] According to a highly preferred embodiment, rods 8 - 13 of ceramic material are located separated from each other and between the said surface 6 of the wall 1 and the resistor element 2.

[0026] The various shanks of the resistor element 2 are fixed to the said wall 1 by means of staples 5 in the form of an "S", which are in contact with the respective shank and which are fixed in a hole in the wall 1, as shown in Figure 2. In that the S-shaped staples are in contact with only one side of a shank, the area that emits radiation is increased, which ensures, among other effects, that hot spots are avoided, compared with a staple that is bent around the element.

[0027] The conductors 3, 4 are fixed by means of an attachment 14, 15, 16 to the wall 1. Furthermore, the resistor element is additionally attached by staples 27 at thicker sections 28 of the resistor element 2. The thicker sections are present such that they can support the long, straight sections of the resistor element, such that bending under the effect of its own weight, and lateral deformation, is avoided.

[0028] Thus the resistor element 2 is held in place between the staples 5 and the rods 8 - 13.

[0029] This design prevents the formation of hot spots.

[0030] It is preferred that the ceramic rods 8 - 13 consist of a ceramic tube through which a rod of the resistor element passes. This provides security against failure due to the breakage of a ceramic rod.

[0031] The ceramic rods may, however, be solid rods of a ceramic material.

[0032] According to a further preferred embodiment, the said staples 5, 27 also consist of a wire of a resistor element material, where tubes of ceramic material are located outside of the wires in at least that region of the staple 5 that is in contact with the resistor element 2. This prevents an electrical short circuit between the shanks of the element.

[0033] According to one preferred embodiment, the surface of the ceramic rods and the ceramic surface of the staples are of a material with a high content of Al_2O_3. The material preferably consists of about 99% Al_2O_3 and about 1% SiO_2. It has namely turned out to be the case that adhesion between the glaze and the supporting ceramic material is much lower when material with a high level of aluminium oxide is used, compared with the adhesion when the level is lower.

[0034] According to one highly preferred embodiment, the resistor element 2 is constituted by a homogenous silicide material containing molybdenum and tungsten, with the molecular formula $Mo_xW_{1-x}Si_2$, where x lies between 0.5 and 0.75, and where from 10% to 40% of the total weight is replaced by at least one of the compounds molybdenum boride or tungsten boride, and where the said compounds are present in the form of particles in the silicide material.

[0035] This material has shown that it can withstand higher temperatures and give rise to a lower quantity of glaze than previous elements. By using the recently mentioned resistor element, problems with element breakage due to the adhesion of glaze to the structure are reduced, while the efficiency at the same time increases with the increasing temperature.

[0036] A panel of one embodiment has been described above. It is, however, clear for one skilled in the art that the present invention can be used in all sorts of infrared

radiating panels, irrespective of the design of the panel and irrespective of the folding pattern of the element.

[0037] Thus, the present invention is not to be considered to be limited to the embodiments described above. The invention can be varied within the scope of the attached claims.

Claims

1. Infrared radiating panel comprising a wall (1) of a ceramic fibre material to which an electrically resistor element (2) is attached and which element comprises several shanks evenly distributed over the surface of the wall (1) and which element is arranged to be connected to a power source such that it can be heated to a high temperature such that the resistor element emits infrared radiation, where the resistor element is attached to the wall by staples (5, 27) and where the resistor element (2) is arranged at a distance from the surface (6) of the said wall (1), **characterised in that** a sheet of glass (22) is arranged parallel to the resistor element and separated from it, **in that** a space (26) is formed between the sheet of glass (22) and the surface (6) of the wall where the element is located, and where a fan arrangement is arranged to force air through the said space from an inlet opening at one edge of the panel to an outlet opening at the opposite edge of the panel and **in that** ventilation holes (29) for air supply pass through the wall (1) and open out into the said space (26) and **in that** the ventilation holes are placed closer to the outlet opening than to the inlet opening for the said air flow over the element.

2. Infrared radiating panel according to claim 1, **characterised in that** the said staples (5, 27) consist of a wire of resistor element material, and **in that** tubes of ceramic material are located outside of the wire in at least that part of the staple that comes into contact with the resistor element (2).

3. Infrared radiating panel according to claim 1 or 2, **characterised in that** the free ends of the said staples (5) have a curved section that makes contact with only one side of the wire of the resistor element.

4. Infrared radiating panel according to claim 3, **characterised in that** the said staples (5) have the shape of an "S", whereby the end that, faces away from the resistor element is bent such that it in this way can be fixed in a hole in the said wall (1) of ceramic material.

5. Infrared radiating panel according to any one of the preceding claims, **characterised in that** the resistor element (2) is constituted by a homogenous silicide material containing molybdenum and tungsten with the molecular formula $Mo_xW_{1-x}Si_2$, where x lies between 0.5 and 0.75, and where 10% to 40% of the total weight has been replaced by at least one of the compounds molybdenum boride and tungsten boride, and **in that** the said compounds are present in the silicide material in the form of particles.

Patentansprüche

1. Infrarot strahlendes Paneel mit einer Wand (1) aus einem keramischen Fasermaterial, an der ein elektrisches Heizelement (2) angebracht ist, wobei das Element mehrere gleichmäßig über die Oberfläche der Wand (1) verteilte Schäfte aufweist, und wobei das Element derart angeordnet ist, dass es mit einer Energiequelle verbindbar ist, sodass es auf eine derart hohe Temperatur heizbar ist, dass das Heizelement infrarote Strahlung emittiert, wobei das Heizelement an der Wandung mittels Klammervorrichtungen (5, 27) befestigt ist, und wobei das Heizelement (2) in einem Abstand von der Oberfläche (6) der Wand (1) angeordnet ist, **dadurch gekennzeichnet, dass** eine Glasplatte (22) parallel und beabstandet von dem Heizelement angeordnet ist, dass ein Raum (26) zwischen der Glassplatte (22) und der Oberfläche (6) der Wand ausgebildet ist, wo das Element angeordnet ist und wo eine Ventilatoranordnung platziert ist, um Luft durch den Raum von einer Einlassöffnung an einer Kante des Paneels zu einer Auslassöffnung an der gegenüber liegenden Kante des Paneels zu drücken, und dass sich Ventilationslöcher (29) für eine Luftzufuhr durch die Wand (1) erstrecken und sich in den Raum (26) öffnen, und dass die Ventilationslöcher näher an der Auslassöffnung als an der Einlassöffnung für den Luftstrom über das Element angeordnet sind.

2. infrarot strahlendes Paneel nach Anspruch 1, **dadurch gekennzeichnet, dass** die Klammervorrichtungen (5, 27) aus einem Draht des Heizelementmaterials bestehen, und dass Röhren aus einem keramischen Material außerhalb des Drahtes an zumindest dem Teil der Klammervorrichtung angeordnet sind, der in Kontakt mit dem Heizelement (2) kommt.

3. Infrarot strahlendes Paneel nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die freien Enden der Klammervorrichtungen (5) einen gekrümmten Bereich aufweisen, der nur eine Seite des Heizelementdrahts berührt.

4. Infrarot strahlendes Paneel nach Anspruch 3, **dadurch gekennzeichnet, dass** die Klammervorrichtungen (5) die Form eines "S" aufweisen, wobei das von dem Heizelement abgewandte Ende derart gebogen ist, dass es auf diese Art in einem Loch in der

Wand (1) aus dem keramischen Material fixierbar ist.

5. Infrarot strahlendes Paneel nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Heizelement (2) aus einem homogenen Silizidmaterial besteht, das Molybdän und Wolfram gemäß der molekularen Formel $Mo_xW_{1-x}Si_2$ aufweist, wobei x zwischen 0,5 und 0,75 liegt, aufweist, und wobei 10% bis 40% des Gesamtgewichts durch zumindest eine der Verbindungen Molybdänborid und Wolframborid ersetzt sind, und dass die Verbindungen in dem Silizidmaterial in Form von Partikeln vorhanden sind.

Revendications

1. Panneau à rayonnement infrarouge composé d'un panneau (1) en fibres céramiques, à laquelle est fixé un élément de résistance électrique (2), cet élément étant formé de plusieurs tiges réparties régulièrement à la surface du panneau (1), et
cet élément est destiné à être relié à une alimentation électrique pour chauffer à température élevée, de façon à émettre un rayonnement infrarouge,
l'élément résistant étant fixé à la paroi par des agrafes (5, 27), et
l'élément résistant (2) est écarté de la surface (6) du panneau (1),
caractérisé en ce qu'
une plaque de verre (22) est installée parallèlement à l'élément résistant, à distance de celui-ci, et
un intervalle (26) est formé entre la plaque de verre (22) et la surface (6) du panneau recevant l'élément résistant, et
un dispositif de ventilation force de l'air à travers l'espace entre une ouverture d'entrée dans un bord du panneau et une ouverture de sortie dans le bord opposé du panneau, et
des trous de ventilation (29) permettent le passage d'air d'alimentation à travers le panneau (1) en débouchant dans l'espace (26), et
les orifices de ventilation sont situés plus près de l'ouverture de sortie que de l'ouverture d'entrée de la veine d'air passant sur l'élément résistant.

2. Panneau à rayonnement infrarouge selon la revendication 1,
caractérisé en ce que
les agrafes (5, 27) sont formées en fil de la même matière que celle de l'élément résistant et des tubes en matière céramique sont placés sur le côté extérieur du fil, au moins dans les parties de l'agrafe venant en contact avec l'élément résistant (2).

3. Panneau à rayonnement infrarouge selon les revendications 1 ou 2,
caractérisé en ce que
les extrémités libres des agrafes (5) ont une section courbe qui vient en contact seulement avec un côté du fil de l'élément résistant.

4. Panneau à rayonnement infrarouge selon la revendication 3,
caractérisé en ce que
les agrafes (5) ont une forme de S, l'extrémité non tournée vers l'élément résistant étant recourbée de façon à pouvoir être fixée dans un trou réalisé dans le panneau (1) de matière céramique.

5. Panneau à rayonnement infrarouge selon l'une quelconque des revendications précédentes,
caractérisé en ce que
l'élément résistant (2) est en un siliciure homogène contenant du molybdène et du tungstène selon la composition moléculaire suivante : $Mo_xW_{1-x}Si_2$,
composition dans laquelle x est compris entre 0,5 et 0,75 et 10 % à 40 % du poids total est remplacé par au moins l'un des composants suivants : borure de molybdène et borure de tungstène, et
les composants sont présents dans le siliciure à l'état de particules.

Fig.1

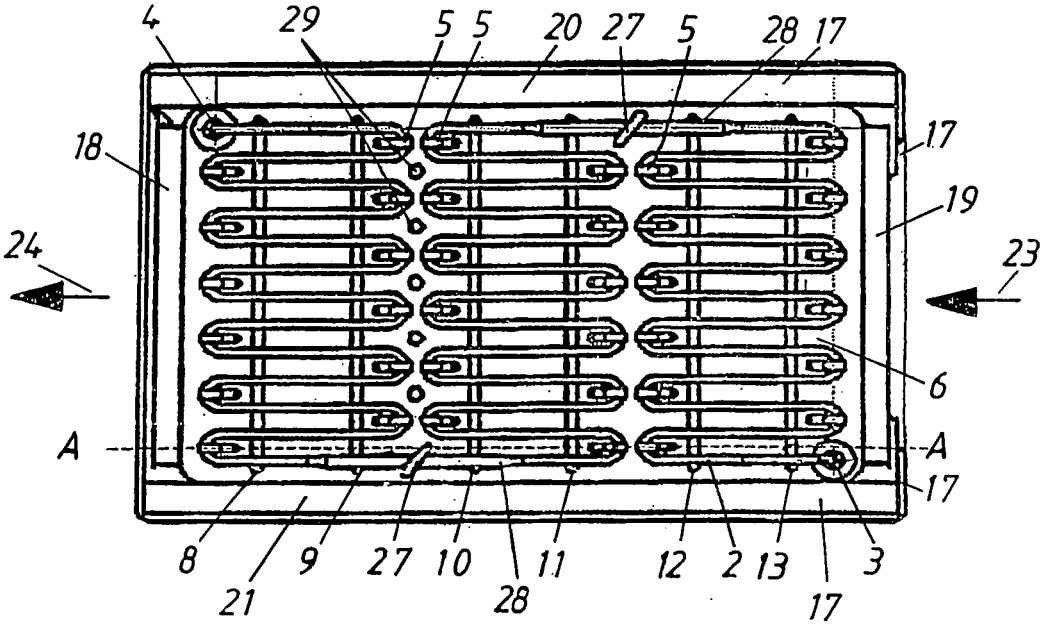
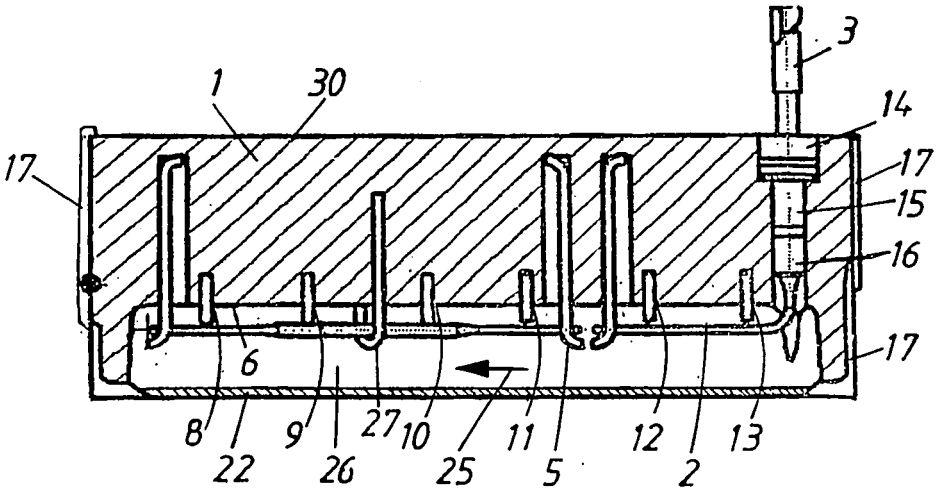

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Fig.2


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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- SE 458646 **[0006]**
- SE 508779 **[0011]**
- US 6160957 A **[0011]**