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(54) Heat radiation tube.

(57) The invention is for heat radiation tubes for furnaces and the like heating devices, mainly for industrial processes.

Heating can be obtained by electrical heating elements or by combustion for example of gas. The radiation tube is a circular tube having end walls, flanges etc. as required.

Thereby that a radation tube according to the invention is a seam-less tube made from iron-chromium-aluminium essential advantages are obtained in respect of oxide spalling which is greatly reduced and shape strength at high temperatures of use. Preferably the tubes are made by extrusion whereby conditions are chosen to give a rough surface with grooves and ridges which further improves the adhesion of the oxide layer.

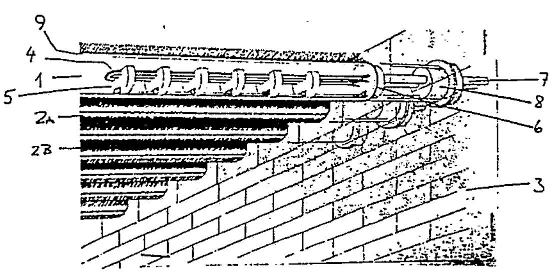

Fig 1

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Description

HEAT RADIATION TUBE

The present invention is for a heat radiation tube for furnaces and the like heating purposes. The source of heat can be electrical resistance elements or a burner using for example gas. Furnaces primarily means furnaces for heat treatment in industrial processes.

Heat radiation tubes are mainly used in furnaces where the furnace atmosphere does not allow direct heat. This can be due to that the atmosphere is harmful to the elements which are being used for electrical heating or a wish to control the atmosphere in the furnace whereby combustion gases are not allowed therein. Other reasons for the use of radiation tubes instead of direct heating where such should be possible might be for example that one wants to repair or exchange the heat source while the furnace is being used. It will then be easier to do this in a separate space, e.g. inside the radiation tube, than in the furnace chamber itself.

A heat radiation tube may comprise a cylindrical tube. A bottom is mounted in one end of the tube. In the other end of the tube there is as a rule a flange for mounting in the furnace wall. The tube can also have other arrangements, protrusions, etc. for mounting in the furnace as well as distance pieces and the like. Mainly when heating is obtained by combustion there may in the tube be inserts forming flow channels for the combustion gases. There are also U-shaped radiation tubes.

Radiation tubes have hitherto mainly been used by furnace temperatures up to about 1100°C. The tubes are often made from an alloy mainly comprising nickel, chromium and iron. The alloy composition is for example 40-60 weight % nickel, 15-20 % chrom and 25-45 % iron. These radiation tubes, however, have certain drawbacks which are of great importance in most application. On the surfaces of the tubes the outside as well as the inside oxide layers are formed which are spalled off when they have reached a certain thickness, which varies due to conditions in each application. Hereby the oxide layers do not give protection against continuing attacks on the tubes. Downfalling oxide flakes may cause problems if they get into contact with the products which are present inside the furnaces. However, the greatest problems are caused by the oxide flakes inside the tubes. If these are holding electrical elements for the heating the flakes may cause short-circuiting between separate elements and between separate parts of one element which brings with it an immediate interruption of the function of the element or a considerably decreased life of the element. When an element is exchanged, which means that element and element support is pulled out from the radiation tube and after repair or exchange again is pushed into it,the supports may function as scrapes and bring about heaps of oxides in most cases in the far end of the tube which may cause difficulties by the repair work and function deficiencies.

Hitherto used radiation tubes do not have satisfactory mechanical properties by high temperatures of use. Due to their own weight and the internal load the tubes tend to sag. In order to compensate for this the tubes have to be turned 180° at regular intervals. This can in most cases be made in connection with normal maintenance or repair but it is still an important drawback and a factor which limits the possibilities of use.

The object of the present invention is to avoid the above-mentioned drawbacks of hitherto known radiation tubes and to make possible a higher temperature of use than has hitherto been possible. This mainly refers to a higher constant temperature by continuous use. The invention also makes it possible to have longer intervals between stops for maintenance works. The much reduced or totally eliminated sagging of the tubes means much for reliable function of the radiation tubes as well as easier maintenance.

Radiation tubes according to the invention are intended for use in furnaces and the like heating purposes and are characterized therein that the tube is made from an alloy of FeCrAl-type whereby a cylindrical part is a seamless tube. These radiation tubes have important advantages compared to conventional tubes made by casting or welding of plates from nickel chromium or iron-nickel-chromium-alloys. Radiation tubes according to the invention can be used at temperatures up to 1250-1300°C.

At high temperatures FeCrAl-alloys at oxidizing conditions form a stable and adhering layer of aluminium oxide on the surface of the material. This oxide is also more heat resistant and resistant against chemical attacks than the layers which are formed on nickel-chromium-alloys. This is particularly obvious in sulphur containing environments, where rapid and severe attacks are obtained on nickel-chromium materials. If the oxide layer is undamaged the FeCrAl-alloys are better also in carburating atmosphere. In many applications it is therefore important to pre-oxidize the radiation tubes according to the invention. This shall be done also if the intended temperature of use is below 1100°C. Suitable pre-oxidation is for example heat treatment in air at 1100°C for at least 8 hours. The FeCrAl-alloy may also contain minor amounts of other alloying components such as yttrium, titanium and zirkonium in amounts up to 0.2 weight % of each. These additives influence the oxide layers as well as the structure and properties of the material.

The cylindrical tube which is a main part of the radiation tube is seam-less and preferably made by extrusion. The slab which is used for the extrusion is made in a well-known way be casting or by power metallurgy. The shearing speed and other conditions by extrusion are choosen to give the tubes a striped surface which means that all of the outer surface of the tubes is rough with axially extending irregular grooves and ridges, the size of which is chosen to optimize the properties of the oxide layer, mainly its strength and elasticity, in order to avoid oxide spalling by high temperatures and changing temperature.

Below the invention will be further described with reference to the accompanying figures.

Fig. 1 shows electrically heated radiation tubes inside a furnace. One of the radiation tubes is shown with part of the tube cut away in order to show the element.

Fig. 2 shows a cross section through a radiation tube which is heated by combustion of gas.

Fig. 3 shows the surface of the cylindrical tube of a radiation tube.

Fig. 4 shows a cross section of the cylindrical tube.

Fig. 1 shows several radiation tubes (1, 2A, 2B) which have been mounted into a furnace, whereof a brick wall (3) is shown. The radiation tubes have a sheath which is a cylindrical tube (9) made from FeCrAl material. FeCrAl material means iron-chromium-aluminium-alloys as described above. At the outer end of the tube is a wall (not shown) from the same material. Into the wall (3) of the furnace is opened a hole which corresponds to the tube and wherein the end of the tube is supported. For the not shown end of the tube there is a corresponding support, for example a shelf or an opening in the furnace wall. The distance between the walls of the furnace can be up to 2 meters and the radiation tube is hanging unsupported therein between. Inside the tube there is an electrical resistance element (4) which in the example shown is made from $MoSi_2$ of the kind which is marketed under the trademark KANTHAL SUPER. The element is resting on a ceramic support (5). The terminal parts (7) of the element pass through two plugs (6, 8), which separate the hot atmosphere of the radiation tube from the surroundings and support the terminal parts.

The radiation tube shown in Fig. 2 is intended to be heated by an indicated gas burner (14). The combustion gases from the burner flow firstly through the insert (12), make a turn at the wall (10) and flow back along the radiation tube (9). The latter has a flange (11) for mounting to the furnace wall in a conventional way. Supports (13) are welded to the insert.

The radiation tubes shown in figures 1 and 2 have dimensions chosen with respect to the furnace wherein they are to be used. For example, the length of the tube may be 1800 mm, its external diameter 200 mm and wall thickness 8 mm.

Figures 3 and 4 show the appearance of a radiation tube according to the invention. Figure 3 is a photograph of the surface of the tube and figure 4 shows a cross section of the same surface of the tube at about 50 times magnification. The striped appearance of the surface is shown in the pictures. These crystal stripes are obtained by the use of a sufficient high shearing speed at the extrusion process and can be essential for the properties of the oxide layer.

Claims

1) Radiation for furnaces and the like heating purposes, **characterized in** that the tube is made from a FeCrAl alloy, whereby its cylindrical part is a seam-less tube.

2) Radiation tube according to claim 1, **characterized in** that the tube is extruded.

3) Radiation tube according to any of the preceding claims, **characterized in** that the surface of the tube is rough having along the tube extending irregular grooves and ridges.

4) Radiation tube according to any of the preceding claims, **characterized in** that its outer surface by pre-oxidation has been covered with an oxide layer comprising mainly aluminum oxide.

5) Method of the production of tubes of alloys of FeCrAl type, **characterized in** that the tubes are obtained by extrusion.

6) Method according to claim 5, **characterized in** that the extrusion is made at such a shearing speed that the surface of the tube is rough having along the tube extending grooves and ridges.

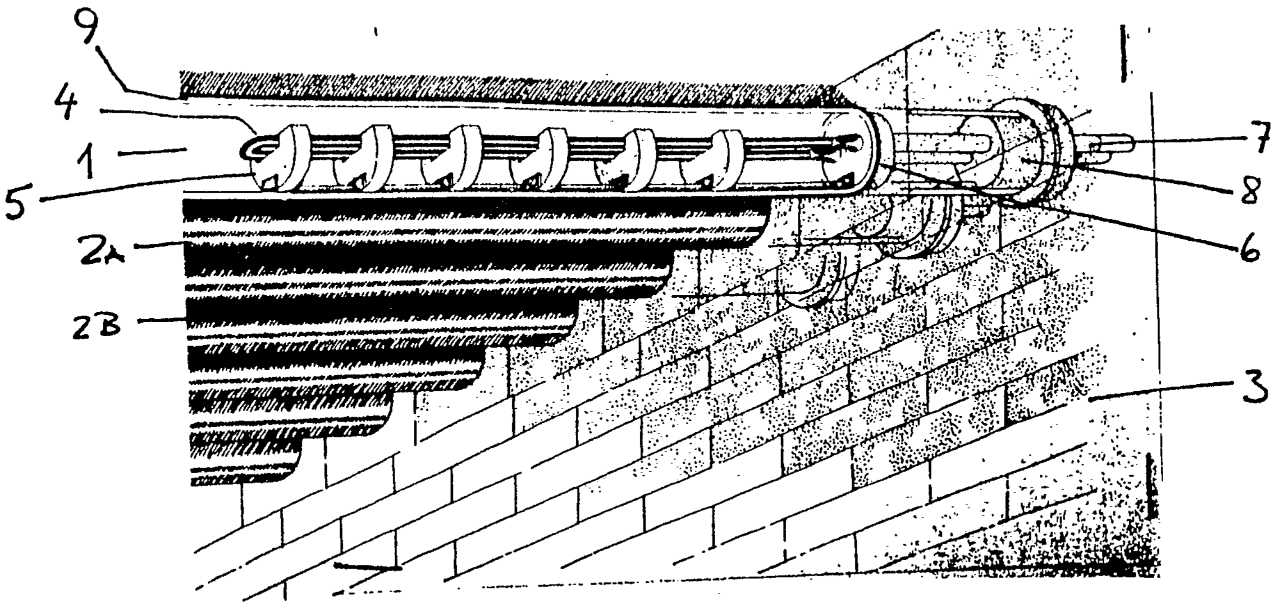


FIG 1

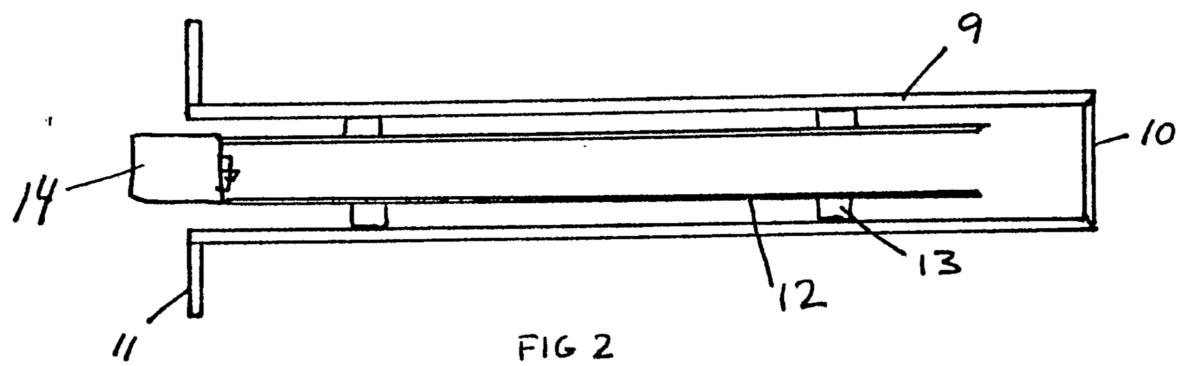
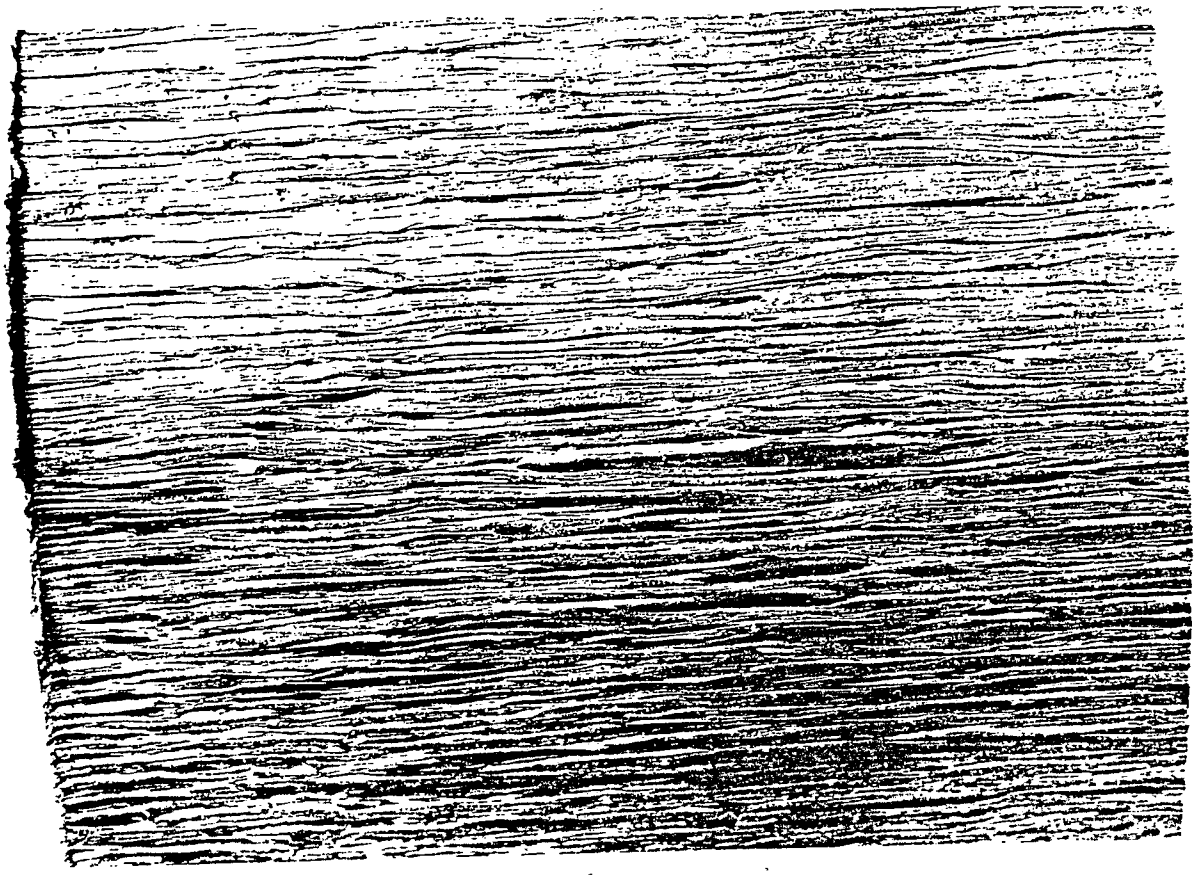
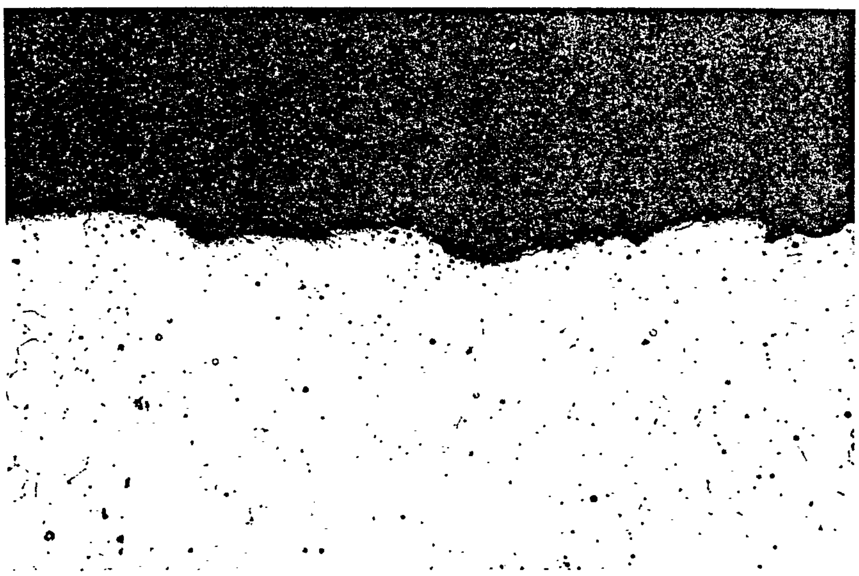


FIG 2



Figur 3



Figur 4