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[54] **SUPPORTING PLATE FOR OBJECTS TO BE
 SUBJECTED TO A THERMAL TREATMENT**
 12 Claims, 15 Drawing Figs.

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 34/237
 [51] Int. Cl. F27d 5/00
 [50] Field of Search 263/47 R,
 47 A; 34/237; 25/153

[56]

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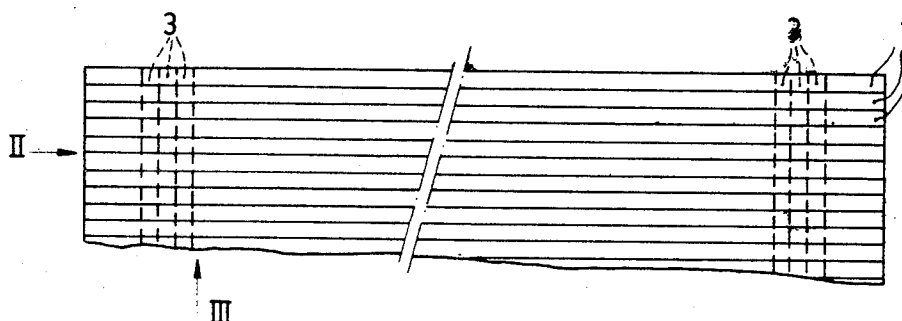
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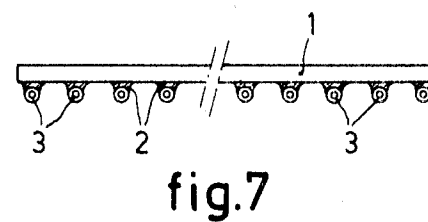
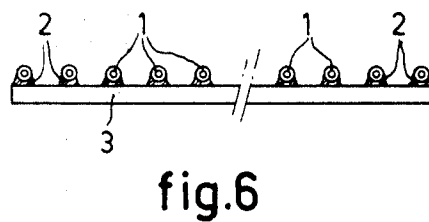
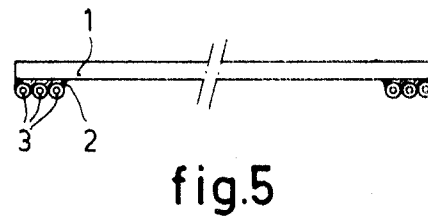
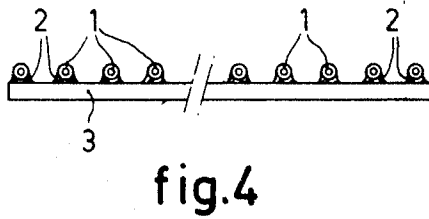
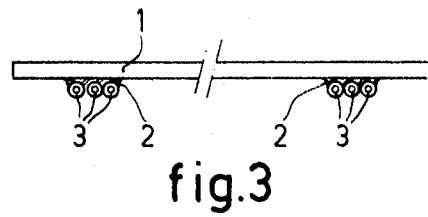
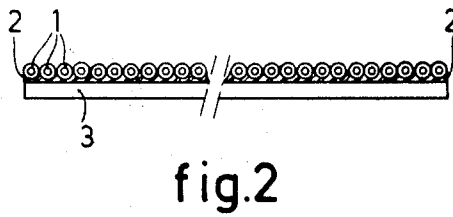
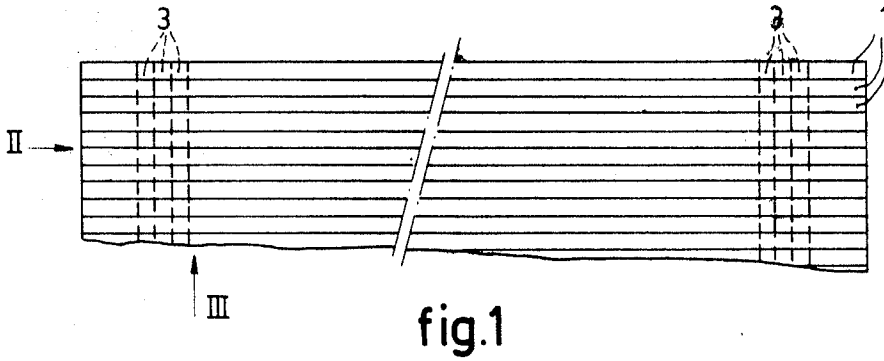
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ABSTRACT: A supporting plate for objects to be subjected to a thermal treatment in a furnace, said plate being formed by substantially parallel thin supporting tubes or bars of ceramic material interconnected by transverse connecting elements.





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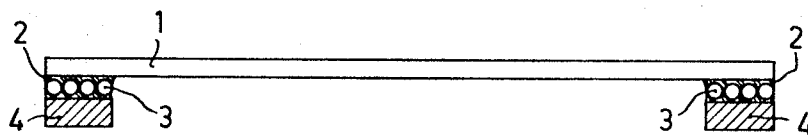


fig.8

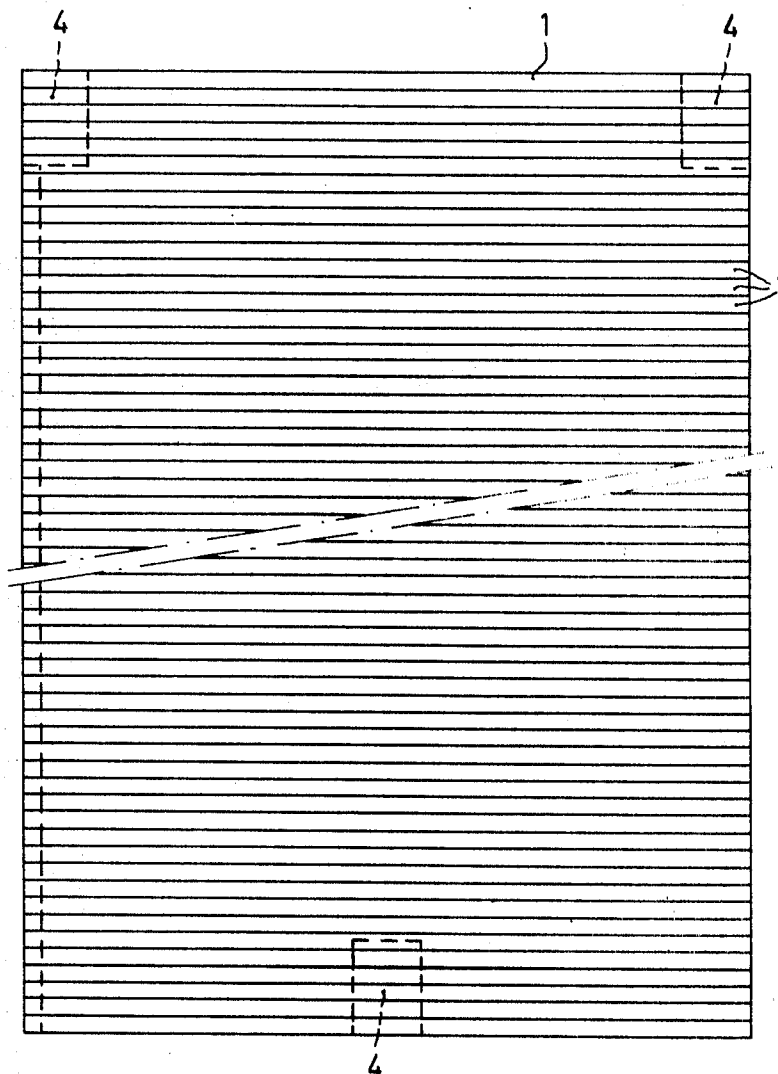


fig.9

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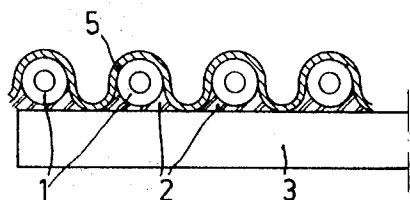


fig.10

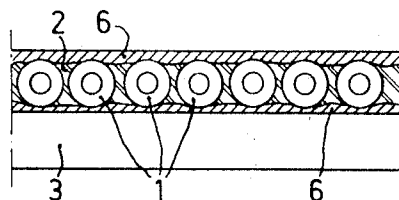


fig.11

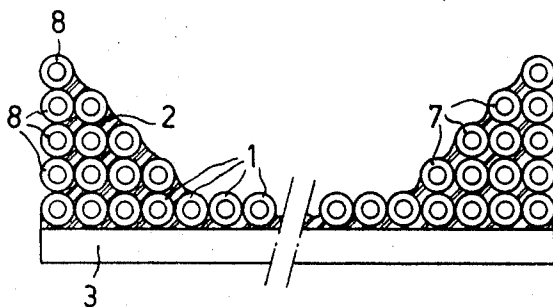


fig.12

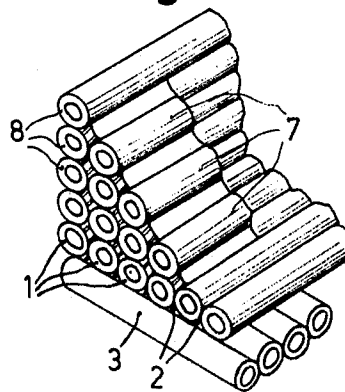


fig.13

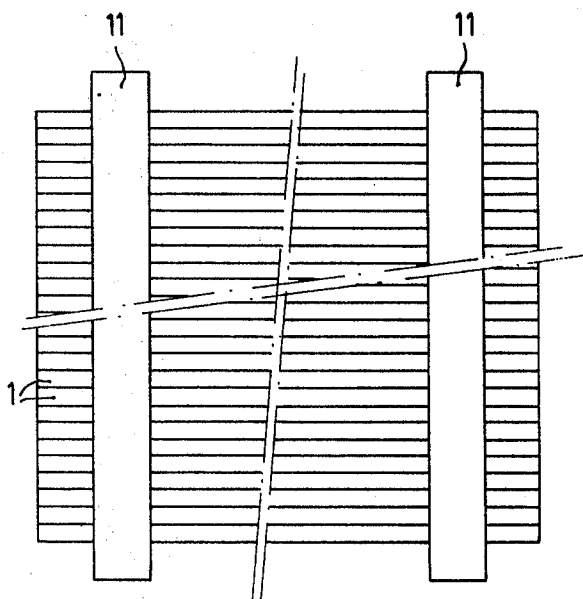


fig.14

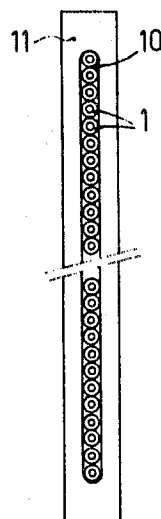


fig.15

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SUPPORTING PLATE FOR OBJECTS TO BE SUBJECTED TO A THERMAL TREATMENT

The invention relates to a plate for supporting objects being subjected to a thermal treatment in a furnace. More specifically, the invention is concerned with such a plate having members of ceramic material.

In furnaces for the thermal treatment of materials, for example for sintering ferrites, it is common practice to pass the material on a ceramic tile across the furnace. These tiles are thick and especially when a number of tiles are arranged one above the other at a given distance from each other, they occupy a comparatively large portion of the furnace channel. The amount of space within the furnace for the objects to be treated is therefore low, which adversely affects the cost price of the objects. Moreover, the thermal capacity of these thick tiles is high so that much of the supplied heat is not economically used and temperature changes, if desired, can only be brought about slowly. Reduction of the conventional thickness of the tiles has not achieved the desired success. The heat stresses occurring in the thinner tiles are great, particularly at high, variable temperature and give rise to rupture of the tiles.

The object of the invention is to provide a supporting plate having a very thin thickness and nevertheless having such a rigidity that rupture does not occur at high and/or varying temperatures. This is achieved by constructing the supporting plate of substantially parallel supporting tubes or bars of ceramic material, interconnected by transverse connecting elements.

These supporting plates may have a very small thickness. When ceramic tubes of an outer diameter of 2.5 mm. or 3.5 mm. are used, the maximum overall thickness of the supporting plate is only 5 mm. or 7 mm. respectively. A number of these supporting plates may be stacked with spacers therebetween, the objects to be heat treated being disposed on each supporting plate. The lowermost plate bears, may be supplied with holders, and supported on a sliding tile, which serves to pass the assembly through the furnace. The amount of space available within the furnace for the objects to be treated is thus materially enhanced. The supporting plate in accordance with the invention has a greater resistance to temperature variations than a solid plate of the same ceramic material. It has been found that rupture due to stresses at temperature variations does not occur. It has furthermore been found that no deflections of the supporting plates loaded with objects occur even at high temperatures, so that they may be employed many times.

In an advantageous embodiment of the invention the parallel supporting tubes or bars are interconnected at two areas by at least one transverse connecting tube or bar, fastened by means of a temperature-resistant cement to the supporting tubes or bars. This embodiment, in which, for example, a few connecting bars may be located at the two ends of the supporting tubes or bars or else at a given distance from said ends, gives very satisfactory results in practice. The connecting tubes or bars are preferably located on the bottom side of the supporting plate in order to obtain high loadability. If the support has to be suitable for alternate use on both sides, each of the two sides of the plate may be connected at least at two areas by connecting tubes or bars.

In a further embodiment of the invention the parallel supporting tubes or bars are interconnected by means of beams of ceramic material, in which a slot or an elongated hole is provided, in which the supporting tubes or bars may be fastened by means of a temperature-resistant cement. This embodiment has the advantage that the supporting plate can be easily manufactured, since the supporting tubes or bars are simply held together by the beams.

In a further embodiment of the invention the supporting tubes or bars are separate from each other with the exception of the junctions with the connecting elements. The supporting tubes or bars cannot exert forces one on the other so that the

risk of rupture due to thermal stress, even at very high temperatures, is negligible. In order to support elongated objects of uniform cross section the supporting tubes or bars are preferably arranged at such a distance from each other that the objects bear on two tubes or bars, whilst they are supported throughout their length.

In order to obtain a very rigid supporting plate, which is capable of avoiding deflections or sag under a fairly heavy load, the supporting tubes or bars of a further embodiment of the invention are practically in contact with each other and interconnected throughout their length with the aid of a temperature-resistant cement.

In a further embodiment of the invention the supporting tubes or bars are interconnected by connecting tubes or bars arranged at regular intervals throughout the length of the supporting tubes or bars. This embodiment provides a high loadability of the plate.

According to the invention it is advantageous to provide beneath a number of connecting tubes or bars supporting blocks of ceramic material which are fastened to the connecting tubes or bars by means of a temperature-resistant cement. These supporting plates can be stacked up in a simple manner. In this case three-point disposition is preferable.

According to the invention for the thermal treatment of small loose bulk objects the support is provided at least on the two longitudinal sides with an upright collar formed by interconnected ceramic tubes or bars similar to the supporting tubes or bars.

According to the invention the supporting tubes or bars are made of a material containing at least 95 percent of Al_2O_3 . The resultant supporting plate is extremely suitable for use at high temperatures for example, at $1,400^\circ\text{C}$. The supporting plate has a great rigidity and a high resistance to temperature variations.

In an advantageous embodiment of the invention the supporting tubes or bars are coated with a ceramic layer. The objects will bear on the coating, for example, of zirconium oxide, which prevents a chemical reaction between the objects and the supporting tubes. This coating may form a thin film around the supporting tubes or bars and this is preferably applied when the tubes or bars are located at a given distance from each other. When the supporting tubes or bars are in contact with each other, the coating may be provided both on the upper side and on the lower side of the support in order to avoid warping of the plate due to heat stresses.

The invention will be described more fully with reference to a number of embodiments illustrated in the drawing.

FIGS. 1, 2 and 3 are a plan view and lateral views respectively of a first supporting plate embodying the invention.

FIGS. 4 and 5 are two elevations of a supporting plate in which a few connecting tubes are fastened to the ends of the supporting tubes.

FIGS. 6 and 7 are two elevations of the supporting plate, in which the connecting tubes are arranged at regular intervals throughout the length of the supporting tubes.

FIGS. 8 and 9 show on a reduced scale a side elevation and a plan view respectively of a supporting plate to which spacers are secured.

FIG. 10 shows on an enlarged scale part of a supporting plate in which the supporting tubes are coated with ceramic layer.

FIG. 11 shows on an enlarged scale part of a supporting plate in which the ceramic coating is applied to the upper and lower sides of the supporting tubes.

FIGS. 12 and 13 are an elevation and partly a perspective view of a supporting plate provided on its longitudinal sides with an upright collar, and

FIGS. 14 and 15 are two elevations of a support in which the connecting elements are formed by ceramic beams having a slot.

FIGS. 1, 2 and 3 show a first embodiment of the supporting plate in which parallel supporting tubes 1 are interconnected by a temperature-resistant cement 2, and united by a number

of connecting tubes 3. In a proved embodiment both the supporting tubes 1 and the connecting tubes 3 were made of sintered material known under the name of Alundum; in said advantageous embodiment the material contained 99 percent of Al_2O_3 . The cement was formed by a mixture of silica and alumina. The tubes had an outer diameter of 2.5 mm. and an inner diameter of 0.9 mm. The length of the supporting plate was 280 mm. and the width was 130 mm. The resultant supporting plate had a very small thickness, a high rigidity and a high resistance to temperature variations and may be used at temperatures up to at least 1,400° C. The upper side of this supporting plate is completely available for holding objects to be subjected to a thermal treatment in a furnace, for example for sintering ferrites. It will be obvious that in this embodiment and in the embodiments to be described hereinafter tubes of a different ceramic material may be used in accordance with the desired strength, the resistance to temperature variations and the maximum temperature of the treatment. Also the cement may consist of a different material. For example, the connection may be established by means of platinum applied to the form of a metallizing paste to the junctions. Instead of tubes bars may be employed; the cross section of the tubes or bars need not be circular. Also the thickness of the tubes or bars may have a different value; for example, the outer diameter may be 3.5 mm. in accordance with the desired loadability. In order to obtain maximum space utilization of the furnace the tubes or bars used will, of course, have a minimum thickness.

The supporting tubes of the supporting plate shown in FIG. 1 are practically in contact with each other and are interconnected throughout their length by the temperature-resistant cement 3. Thus a rigid assembly is obtained.

FIGS. 4 and 5 show a supporting plate whose supporting tubes 1 are separated from each other by a given distance. The tubes are interconnected to form a supporting plate by means of connecting tubes 3 located at both ends of the supporting tubes 1 and fastened to the supporting tubes by means of a temperature-resistant cement 3. In such an embodiment the supporting tubes cannot affect each other by stresses at high temperatures so that the resistance to temperature variations of such a supporting plate is particularly high.

FIGS. 6 and 7 show an embodiment of the supporting plate in which the connecting tubes 3 extend at equal intervals beneath the supporting tubes. The resultant supporting plate has a high loadability.

In the supporting plate shown in FIGS. 8 and 9 ceramic supports 4 are fastened by means of temperature-resistant cement 2 to the connecting bars 3 so that the supporting tubes, the connecting tubes and the supports are integral with each other. Supporting plates of this structure can be easily stacked up for being passed through a furnace; such a stack is a stable assembly.

FIG. 10 shows part of a supporting plate whose supporting tubes 1 are coated with a layer 5, for example, of zirconium oxide. The objects to be treated bear on the layer 5, which prevents a chemical reaction between the objects and the supporting tubes.

In the embodiment shown in FIG. 11, in which part of the supporting plate is shown, the supporting tubes 1 are practically in contact with each other and interconnected by means of a temperature-resistant cement. On the upper side and on the lower side of the plate a ceramic coating 6 is provided. Thus warping of the supporting plate is avoided, whilst the plate may be employed alternately on both sides.

FIG. 12 shows a supporting plate provided at both its longitudinal sides with an upright collar. This upright collar is formed by tubes 8 similar to the supporting tubes 1. At some places connections 7 are established between the supporting plate and the collar, which connections may be formed by

short lengths of tube, as will be seen from FIG. 13. Such a supporting plate is particularly suitable for the thermal treatment of bulk objects.

FIGS. 14 and 15 finally show a supporting plate in which the supporting tubes 1 are interconnected by being taken through slots 10 in ceramic beams 11. The supporting tubes may be fastened in the slots to the beams 11, if desired, by means of a temperature-resistant cement. They may furthermore be interconnected throughout their length by means of a temperature-resistant cement.

It will be obvious that the embodiments described above are only examples of the supporting plate in accordance with the invention and that within the scope of the invention other variants may be designed.

We claim:

1. A supporting plate for supporting thereon objects to be subjected to heat treatment comprising a plurality of thin tubes spaced-apart in parallel relationship the upper surface thereof forming the supporting surface, a plurality of transverse connecting elements secured to each of said thin tubes by means of a heat resistant cement thereby interconnecting said parallel spaced thin supporting tubes to form a rigidly constructed supporting plate capable of withstanding temperature variations and usable in temperatures up to at least 1,400°C.

2. The supporting plate according to claim 1 wherein said transverse connecting elements comprises thin tubes of sintered material and are secured to the undersurface of said supporting tubes at at least two spaced-apart locations.

3. The supporting tube according to claim 2 wherein said heat-resistant cement comprises a mixture of silica and alumina.

4. The supporting plate according to claim 2 wherein said heat-resistant cement comprises a metallized paste formed of platinum.

5. The supporting plate according to claim 2 wherein each of said supporting tubes is attached to the supporting tube adjacent thereto by said heat-resistant cement.

6. The supporting plate according to claim 2 wherein said transverse connecting elements are secured to the undersurface of said supporting tubes and are spaced-apart at regular intervals thereacross.

7. The supporting plate according to claim 2 wherein said transverse connecting elements are secured to the undersurface of said supporting tubes and are located at the opposite ends of said supporting tubes.

8. The supporting plate according to claim 7 further comprising a support block of ceramic material secured to the undersurface of said transverse connecting elements by means of said heat-resistant cement so as to provide a means for stacking said supporting plates one on the other.

9. The supporting plate according to claim 1 wherein said supporting tubes are formed of a material containing at least 95 percent of Al_2O_3 .

10. The supporting plate according to claim 1 wherein said transverse connecting elements comprise beams of ceramic material have a single elongated slot extending longitudinally therethrough for receiving all of said supporting tubes in said single slot.

11. The supporting plate according to claim 2 further comprising a plurality of supporting tubes secured together by said heat-resistant cement and stacked to form upright collars along the longitudinal sides of said supporting plate for supporting bulk objects to be heat treated.

12. The supporting plate according to claim 2 further comprising a layer of ceramic material coated over the supporting surface of said support tubes.