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FURNACE WITH SECTIONAL RADIANT TUBE

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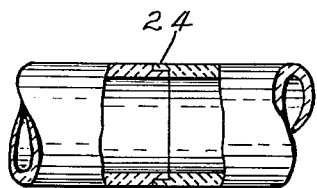
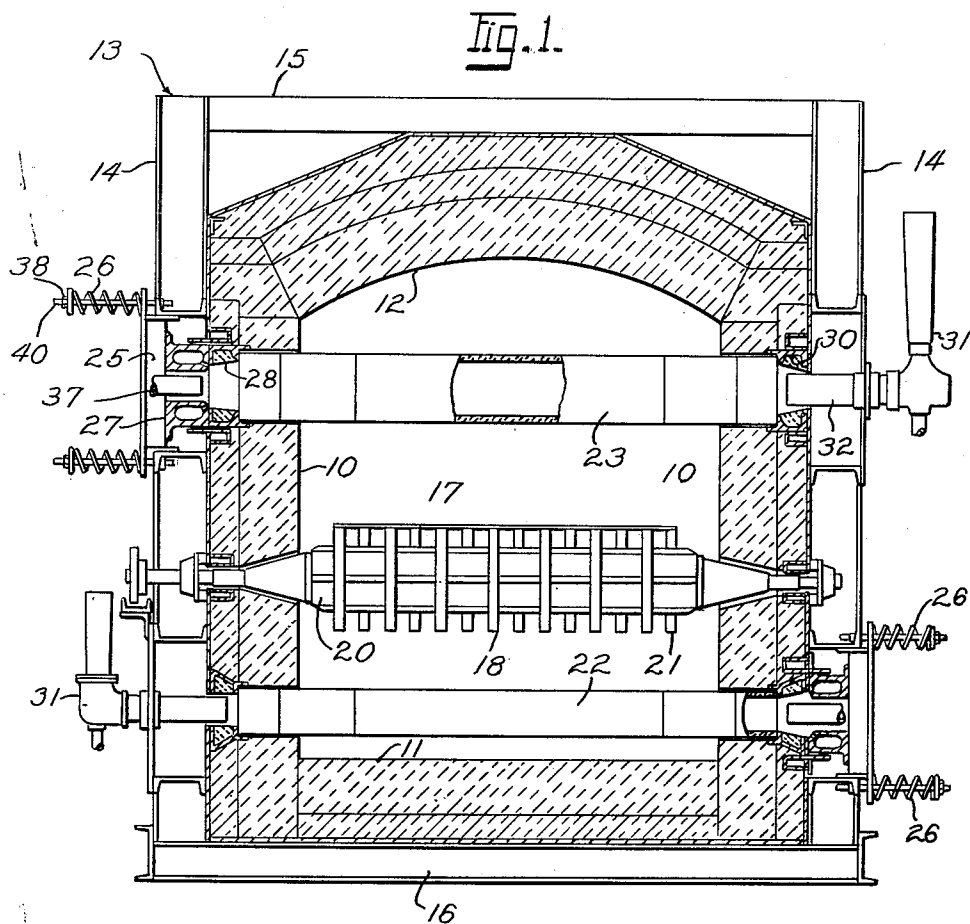


Fig. 2.

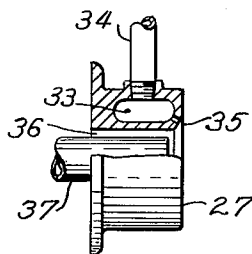


Fig. 3.

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FURNACE WITH SECTIONAL RADIANT TUBE

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7 Claims. (Cl. 158—1)

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This invention relates to a fuel fired radiant tube for use in a furnace chamber and more particularly to a radiant tube which is comprised of refractory tubular sections arranged in end to end relation between the side walls of a furnace chamber. The usual way of preventing a sectional refractory tube from collapsing at the joints is to provide a supporting means beneath each joint, the supporting means usually taking the form of roof supported hangers or floor supported piers depending on the location of the tube. Upon the heating and cooling of the furnace, the relative expansion of such joint supporting means places stress on the tube at said joints tending to open the tube at the joints and thereby to shorten the effective life of the tube. Moreover in addition to being ill adapted to support a sectional tube at the joints between the sections, roof supported hangers are relatively expensive to install and maintain. The present invention has for its object to provide for the support of a sectional radiant tube in a manner not requiring the use of any kind of supporting means intermediate the ends of the tube.

For a consideration of what I consider to be novel and my invention attention is directed to the following specification and the claims appended thereto.

The present invention is based on the realization that by the application of compressive stress it is possible to make long spans of multiple sections safely support their own weight. Some refractory materials, such as bonded silicon carbide, are available for use at high temperatures but which cannot economically be formed into the sizes or shapes required for special applications such as radiant tubes, and have great compressive strength but little if any dependable tensile strength. The present invention makes use of such material to form a sectional radiant tube the sections of which are held together by compressive force.

In a lintel type of structure with vertical supports at the extreme ends and gravity forces acting along the entire structure, there is a couple formed by the force applied at a vertical support and the equal force of gravity applied at the location of the resultant of those gravity forces. The magnitude, or moment, of the couple so formed is equal to the product of the said resultant force and the distance between it and the supporting force. There will also be an equal and opposite couple formed at the other end of the lintel structure. If the lintel were cut at the center point, both sides would move, both turn-

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ing and downward. It is the application of equal and opposite couples that maintains a static, or motionless, structure.

At the center of the uncut lintel structure, there must be internal forces to oppose the externally applied couples, and these internal forces are supplied by the strength of the materials, with part of the forces in tension and part of the forces in compression. If an overall axial compressive force is applied to the lintel structure in addition to the couples already present, the compressive forces may be increased and the tensile forces reduced to zero, or even changed to small compressive forces without destroying the internal couple already present.

The present invention is based on applying sufficient compressive forces to such a structure to eliminate all tensile stress in the structure. It is then possible to use an unbonded joint and allow the couple formed by the compressive forces to support the joint.

There is required, of course, a certain sheer strength in the material and at the joints, but this strength is present in materials of the class described, and the forces of friction will supply the required shear strength at the joints. As a precaution, however, it is preferred to provide a shear surface at the joints such as an offset, cone, or spherical ball joint, the offset joint being illustrated in Fig. 2.

When utilizing compressive stresses and the couple of forces at the joints for support there is no longer need for individual support of the joints of the tubes, and in fact such supports constitute a hazard by their tendency to expand and move the joints out of alignment, with the result of leakage at the joints and danger of collapse of the tubes. The improved radiant tube provided by the present invention has special utility in furnaces such as the catenary strip heating furnace which requires no conveyor within the furnace, and furnaces with internally cooled metal conveyors which are operated at very high temperatures, or in processes such as the gas pickling process, where the furnace atmosphere or temperature is such that materials used for radiant tube hanger or pier supports cannot withstand furnace conditions and non metallic sectional radiant tubes are especially well suited to such conditions.

The principle of preventing propagation of hair line cracks and maintaining gas tight retorts in non-metallic materials is disclosed in the patent to C. E. Hawke, 2,067,085, but the support of a structure by the use of compressive stress over

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predetermined and arranged parting lines, eliminating the necessity of external supports at such parting lines or joints, is not disclosed therein. The use of springs or hydraulic means to apply the stress allows room for expansion to take care of thermal expansion and permanent growth, and maintains the required dynamic balance. This makes possible longer spans without individual joint supports.

In the drawing—

Fig. 1 is vertical cross sectional view of a disc type sheet annealing furnace embodying the invention.

Fig. 2 is a fragmentary sectional view of a portion of the radiant tube at one of its joints.

Fig. 3 is a somewhat enlarged view of the burner head shown in Fig. 1.

The furnace with which the improved radiant tube has special utility comprises a horizontally elongated furnace chamber defined by side walls 10, a floor 11 and a roof 12, all within a metal frame work 13 comprising upright side beams 14, top cross beams 15 and bottom cross beams 16. The work to be heated, namely, sheet metal plates 17, is advanced through the furnace on a disk type roller hearth, the disks being indicated at 18 and being mounted on power driven shafts 20 whose ends extend through the side walls 10 of the furnace chamber. The disks or adjacent shafts are in staggered relation as indicated by reference numeral 21.

A bottom row of radiant tubes is indicated at 22 and an upper row of the same at 23. The tubes of the bottom row have a somewhat smaller cross sectional area than the upper tubes but otherwise the tubes are the same and therefore a detailed description of one will suffice for all.

Each radiant tube is comprised of tubular sections, arranged end to end with offset joints 24 (see Fig. 2) to assist in assembly and alignment of the sections. In Fig. 1 the tube is shown as comprised of five tubular sections with the middle section substantially longer than the end sections. The tube extends across the furnace chamber and is maintained in compression between its ends by means comprising a spring pressed member 25, the spring being indicated at 26. The member 25 presses against an annular burner head 27 which in turn presses against an annular metal spacer 28 which in turn abuts the adjacent end of the radiant tube. At its opposite end the tube abuts an annular fixture 30 which is backed by the adjacent parts of the metal frame work 13. Products of combustion are exhausted from the radiant tube by an eductor 31 which connects with the discharge end of the tube by a tubular extension 32 whose inner end projects into the annular fixture 30.

The burner head 27 has an annular gas supply chamber 33 to which fuel gas is delivered by a supply pipe 34, the gas issuing from said chamber 33 through a ring of gas discharge ports 35 which are inclined to discharge towards a point near the front end of the radiant tube. The central aperture 36 in the burner head constitutes an inlet for the admission of atmospheric air for supporting combustion of the fuel issuing from the burner head ports 35. The eductor 31 produces enough partial vacuum in the radiant tube to induce air at atmospheric pressure to flow through the said central aperture 36. The fuel thus issuing from the ports 35 may be ignited by flame from a premix pilot burner 37 which projects into said aperture 36 from a support not shown.

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The springs 26 are held in adjusted compression by means of adjusting nuts 38 on the outer ends of rods 40 whose inner ends are anchored to the metal frame work 13. The springs 26 are maintained under such degree of compression that the radiant tube will not collapse at the joints of its tubular sections.

From the foregoing description it will now be seen that the present invention provides a radiant tube assembly that is well adapted for its intended purpose.

What I claim as new is:

1. A furnace comprising structure defining a furnace chamber, a horizontally extending tubular heating element disposed in said chamber, support means attached to said structure for vertically supporting said element at the ends thereof, said element comprising tubular sections in abutting end to end relation, and means for maintaining said sections in axial alignment consisting of means supported on said structure for maintaining said element under compressive stress sufficient to produce compressive forces across the adjoining faces of the abutting ends of the tubular sections, thereby vertically supporting the entire element in the furnace chamber between support means.

2. In a furnace having a chamber to be heated, in combination, a radiant tube in said chamber defined by an assembly of tubular sections in end to end relation, means carried by said furnace for maintaining said tube under sufficient longitudinal compression to maintain axial alignment of said sections, and structure defining two vertical supports for supporting said tube.

3. In a furnace according to claim 2, the combination which comprises wall means defining a furnace chamber between said supports through which said tube is adapted to extend whereby to supply heat to said furnace chamber.

4. In a furnace according to claim 2, the combination which comprises a gas supply head at one end of said tube for feeding fuel therinto for combustion therein and exhaust means at the other end of said tube for producing a draft through said tube, said head and draft means being supported on said supports.

5. In a furnace according to claim 2, the combination which comprises an annular head at one end of said tube for feeding fuel therinto for combustion therein, and means carried by one of said supports for applying longitudinal compression to said assembly through said head.

6. In a furnace according to claim 2, the combination which comprises means carried by one of said supports for applying longitudinal compression to said assembly, an annular fixture carried by the other of said supports for receiving thrust from said assembly, and means carried by said other support for producing draft through said tube.

7. In a furnace, in combination, structure defining two laterally spaced supports, a radiant tube adapted to extend between said supports, the said tube being defined by an assembly of tubular sections in end to end relation and being supported only at its ends, and means carried by said structure for maintaining said assembly under longitudinal compression sufficient to maintain said sections in axial alignment.

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