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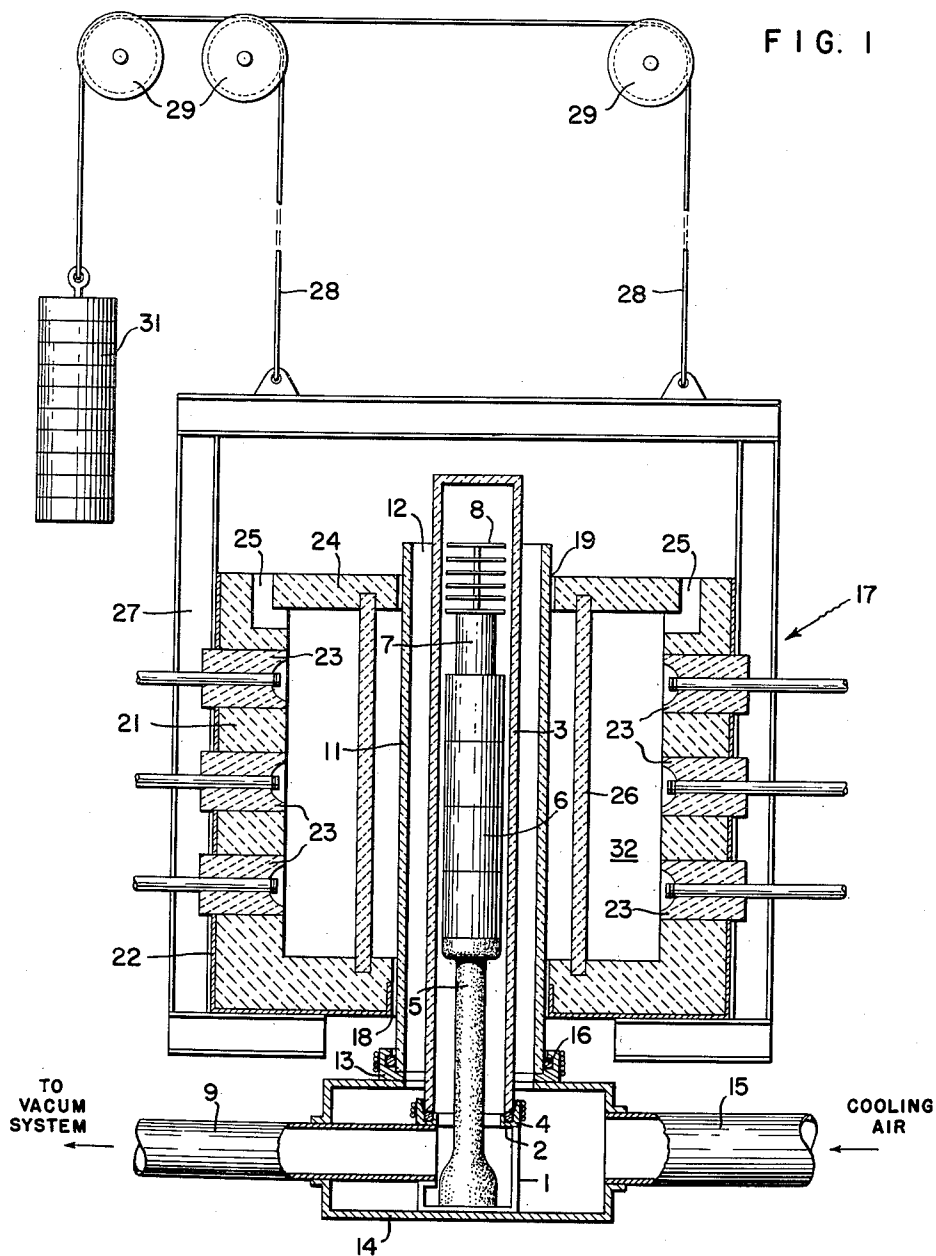
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VACUUM FURNACE

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2 Sheets-Sheet 1

FIG. 1



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VACUUM FURNACE

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4 Claims. (Cl. 263—42)

The present invention relates to heat treatment furnaces, and more particularly to a furnace used for heat treating metals and other materials in a vacuum.

Frequently it is desirable or necessary to heat treat metals in such a manner that the resulting product has a bright surface. This is often accomplished by heating the metal in a non-oxidizing atmosphere. In other cases, however, it is necessary for the heating to take place in a vacuum. The vacuum furnaces that are presently available are cumbersome pieces of equipment that are difficult to seal, and which are generally heated electrically. Because of the sealing problems it has been impractical in most cases to heat a furnace of this type with oil or gas as a fuel.

It is an object of the present invention to provide a vacuum furnace in which the work is heated directly by radiation.

It is a further object of the invention to provide a transparent container in which the work to be heated is placed and which container can be evacuated, with a furnace surrounding the container to supply heat thereto.

In practicing the invention the work is placed in a chamber of fused quartz or similar material that is evacuated. Surrounding and spaced from this chamber is a tube of the same material which is open at both ends so that cooling air can be forced between the two. A furnace surrounds the tube to direct radiant heat inwardly through the tube and chamber wall to heat the work contained therein.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a section view of the invention adapted for use in batch heating, and

FIG. 2 is a section view of the invention adapted for the continuous heating of wire, strip and the like.

Referring to the drawings, there is shown in FIG. 1 a cylindrical base 1 having an open top and, surrounding the top, a shelf 2. A closed end tube 3 of fused quartz, high silica glass, or the like, which is transparent generally to light and always to infra red rays forms a vacuum chamber, and is mounted upon the shelf 2. A suitable vacuum seal 4 is provided between the lower end of the tube 3 and shelf 2 so that the interior of the tube which forms the vacuum chamber can be evacuated. A pedestal 5 for supporting work to be heated, which is shown herein as small coils 6, is placed upon the bottom of base 1 and extends upwardly into the chamber. On top of the coils of work there is a support 7 for a plurality of radiation reflectors 8 in the form of thin disks of a highly polished material which will reflect radiant heat. The base 1 is provided with a connection 9 in the form of a suitable duct to a vacuum pump so that the chamber 3, can be completely evacuated.

A cylindrical shield 11 in the form of a tube and of the same material as the tube 3 surrounds this tube and forms an annular space 12 between them. Tube 11 is

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supported by member 13 that in turn rests on top of an air box 14 which is connected by a supply duct 15 with a source of cooling air. A seal 16 is provided between support 13 and the lower end of tube 11 so that cooling air, which is forced through space 12, will not leak around the joint between the tube and its support. It is noted that the seals 4 and 16 may be water cooled if this is found to be necessary because of heat conducted through the tubes 3 and 11, respectively.

Radiant heat is directed inwardly toward the tube 11 by means of a furnace 17 that is annular in shape and which surrounds the tube; the furnace being provided with center openings 18 and 19 of a size only slightly larger than the tube 11. The furnace is built in accordance with ordinary furnace practice with a refractory material 21 having suitable high temperature and insulating qualities that is backed up by sheet metal work 22. A plurality of burners 23 are located in the walls of the furnace at various elevations and around the circumference thereof. These burners which may use oil or gas as a fuel are shown herein as being, and preferably are, of the radiant cup type in which the cup surfaces are heated to incandescence without flame extending noticeably into the furnace chamber. The top of the furnace is formed of a disk 24 of suitable refractory material that is provided with openings 25 through which products of combustion can be exhausted. The burners may heat tube 11 directly or a cylindrical muffle 26 may be placed between the burners and the tube 11 with the muffle being located in the furnace by suitable grooves formed in the floor of the furnace and the underside of top 24. It is noted that radiation shields 8 and the top of pedestal 5 are substantially aligned with the top and bottom of the furnace, respectively.

The furnace can be moved vertically from the position shown in which it surrounds the tubes 11 and 3, to a position above the tubes. For this purpose there is provided a steel frame 27 which supports the furnace for movement. This frame is moved by a pair of ropes 28 guided over pulleys 29 and attached to counterweights 31.

In the operation of the furnace, work to be heated is placed upon pedestal 5, the tube 3 is placed upon shelf 2 and the seal 4 adjusted. Thereafter a vacuum is applied through duct 9 to evacuate the interior of tube 3 and the material therein. Tube 11 is then placed in position in seal 16 and the furnace lowered to the position shown in the drawings. As the burners are fired the heat produced by the cup surfaces, as well as the hot products of combustion which fill space 32, heat the walls of the furnace as well as the muffle to incandescence. Radiant heat from these walls, or the muffle if one is used, is directed inwardly through tube 11 and tube 3 to the work contained within the latter. Thus, the work is heated directly by radiant heat without any contact with the atmosphere, products of combustion or other gases that may have some effect on the work at elevated temperatures. In order to prevent the tubes themselves from becoming overheated, cooling air is forced through space 12 to cool the tubes. Since radiant heat can travel through the tubes and the vacuum surrounding the work, the work can be heated to a temperature above that which the tubes are capable of standing.

With a furnace that will heat muffle 26 to a temperature in the neighborhood of 2000 F. to 2100 F. work can be heated without difficulty to above 1900 F. while the quartz tubes 3 and 11 are held at a safe temperature of 1500 F. A furnace like that disclosed herein is particularly valuable in heating of tantalum, for example, which

is a highly corrosion resistant material at ordinary temperatures, but will oxidize in air above 570 F. This material is annealed at a temperature of approximately 1920 F. which can be obtained in the present furnace without excessively heating the quartz tubes.

The embodiment of the invention disclosed in FIG. 2 is intended to be used for heating a continuous length of material which may be either in the form of a wire or a strip. The furnace in this form of the invention is similar to that described above in connection with FIG. 1. The arrangement of the vacuum chamber, however, is different.

As shown herein, the vacuum chamber consists of a tube 33 of fused quartz or other similar material which is supported at its lower end upon a lower seal support 34, and is closed at its upper end with an upper seal support 35. The lower end of tube 33 is received in a vacuum seal 36 formed around the upper edge of support 34, which support is provided with a duct 37 leading to a suitable vacuum pump. In the lower portion of this support there is provided a multiple vacuum seal 38 provided with outlets 39 leading to the vacuum system. A support 41 rests on the upper one of vacuum seals 38, and is provided at its upper end with a plurality of perpendicularly extending radiation shields 42 that may be thin, shiny metallic discs. The upper support 35 has vacuum seal 43 which receives the upper end of tube 33. This member also has a multiple vacuum seal 44, the chambers of which are connected by suitable passages 45 with the vacuum system. The lower compartment has attached to it a support 46 for a series of radiation shields 47. It is noted that the radiation shields 42 and 47 are located substantially in line with the lower and upper ends of the furnace chamber, respectively. Seals 38 and 44 are of a type which will permit the work to move through them without losing the vacuum between them.

An air box 48 surrounds the lower support 34 with the box being provided on its upper surface with a pressure tight seal 49 that receives the lower end of a cylinder 51 of fused quartz or similar material. Cylinder 51 surrounds and is spaced from cylinder 33 to form an annular air space 52 through which cooling air can be blown in order to keep the quartz, of which the tubes are formed, at a suitable temperature. A duct 50 from a suitable blowing apparatus supplies the cooling air to air box 48.

The material to be heated, which is designated herein at 53, passes over guide pulleys 54 and 55, respectively, to be guided in a vertical path through seals 44 and 38 in order to guide the work through the heating zone between shields 47 and 42. It will be noted that the upper guide pulley 54 must be above the height that will be reached by the cross piece of frame 27 when the furnace is in its elevated position.

In the operation of the embodiment of the invention with the furnace in the elevated position, the work to be heated is threaded through the vacuum chamber and the seals at each end thereof. Chamber 33 is then evacuated and the work started. At this time the heated furnace is moved down into a position shown in the drawing. When in this position, radiant heat is produced in the manner described above and is transmitted from muffle 26 through the tubes 51 and 33 to the work thereby heating the work to the desired temperature. Since heating of this type is a time-temperature proposition, the speed with which the work will be moved through vacuum chamber 33 will depend upon the temperature that work is to reach as it is moving between shields 47 and 42. The work is cooled below a temperature at which it will be affected by the atmosphere during its travel between shields 42 and the lower seal 38.

From the above description it will be seen that I have provided apparatus in which either a fixed furnace charge or a continuous length of work may be heated in a vacuum.

The heat used to raise the temperature of the work is radiant heat. With this arrangement a means is provided to protect material surrounding the heating chamber while permitting heat to be directed against the work.

The present invention has been described as being used for heating various materials in a vacuum, and is especially designed for that purpose. It will be apparent, however, that the furnace chambers 3 and 33 could be filled with some desired neutral or treating atmosphere after they have been evacuated, if it is so desired.

While in accordance with the provision of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. Vacuum heating apparatus including a hollow base in fixed position, the interior of which is adapted to be placed in communication with a source of reduced pressure, said base being provided with an opening therein, a work support in said base and extending through said opening, a hollow member of material transparent to radiant heat, said member having an opening therein, means to attach said member to said base with the openings therein in communication and with said member surrounding both said support and work adapted to be placed thereon, an elongated shield of material transparent to radiant heat surrounding and spaced from said member, means to connect one end of said shield to a source of cooling fluid, the other end of said shield being open whereby cooling fluid may be circulated around said member, a furnace surrounding that portion of said shield and member in which work is adapted to be located on said support, means to heat said furnace to supply radiant heat through said shield and member to heat work located within said member, and means to move said furnace from a position surrounding said shield to a position beyond one end thereof.

2. Vacuum heating apparatus comprising a work supporting element, a tubular member made of material transparent to radiant heat having one end open, means to hold said member over said element including a base and a pressure tight connection between said member and base, means to connect said base to a source of reduced pressure, an elongated shield made of material transparent to radiant heat and open at both ends surrounding said member and spaced therefrom, means to connect one end of said shield to a source of cooling air under pressure whereby air may be circulated through the space between said shield and member, an annular furnace surrounding said shield and having a wall facing said shield, means to heat said wall to incandescence whereby radiant heat can travel through said shield and member to work within the latter, and means to move said furnace axially from a position surrounding said shield to a position beyond one end thereof.

3. Heating apparatus including in combination an annular muffle, structure forming a furnace chamber around said muffle including burners to heat said muffle to incandescence, a heating chamber made of material transparent to radiant heat concentric with and surrounded by said muffle, means to support said chamber in a fixed position including means forming a passage and means forming a pressure tight connection between the interior of said chamber and said passage, means to apply a vacuum to said means to support, and through said passage and said connection, to said chamber, an annular shield made of material transparent to radiant heat be-

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tween said muffle and chamber and spaced from the latter, supporting means for said shield to hold said shield in a fixed position surrounding said chamber, means to supply cooling air to flow through the space between said chamber and shield, means to hold work to be heated in said chamber in a location between the ends of said muffle, and a radiation shield in said chamber between an end of said chamber and the location between the ends of the furnace in which work is adapted to be held to be heated.

4. The combination of claim 3 including means to mount said furnace for movement from a position in which it surrounds said shield to a position removed from said shield whereby access may be had to said shield and the member surrounded thereby.

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