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APPARATUS FOR SINTERING POWDERED METALS

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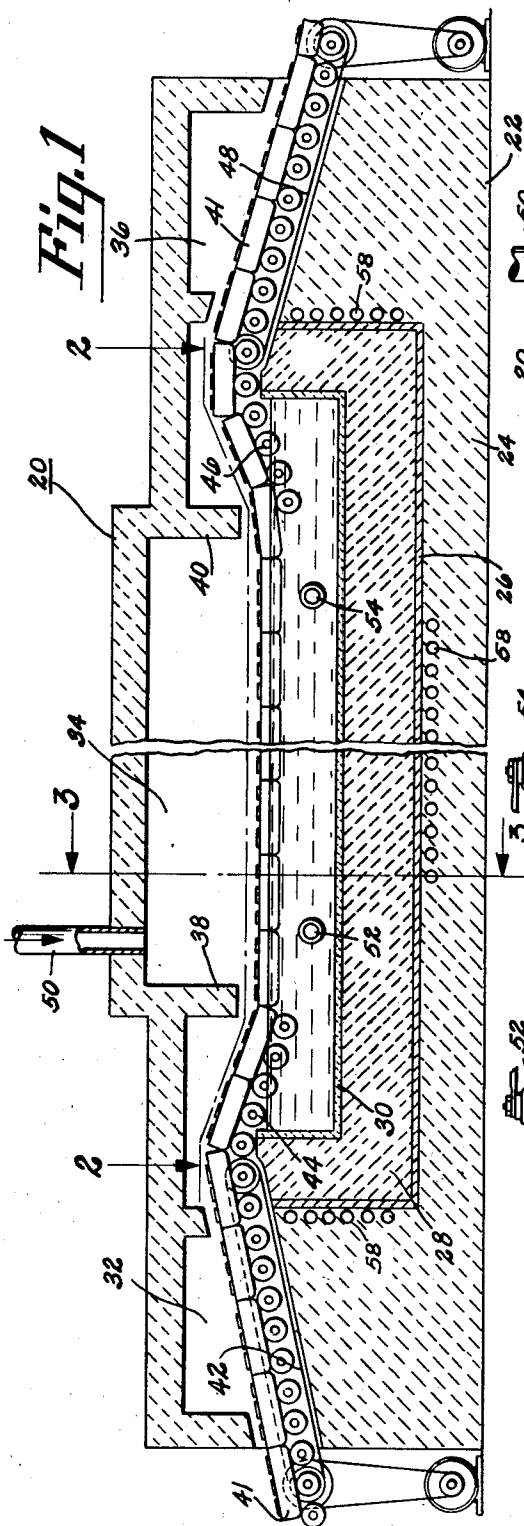


Fig. 1

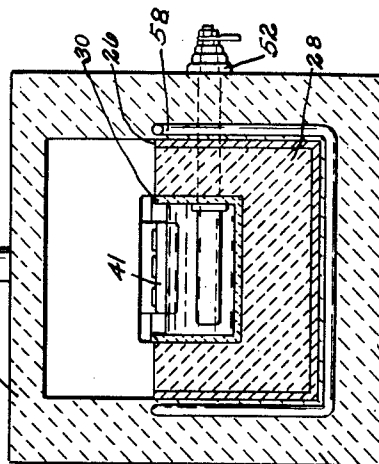


Fig. 3

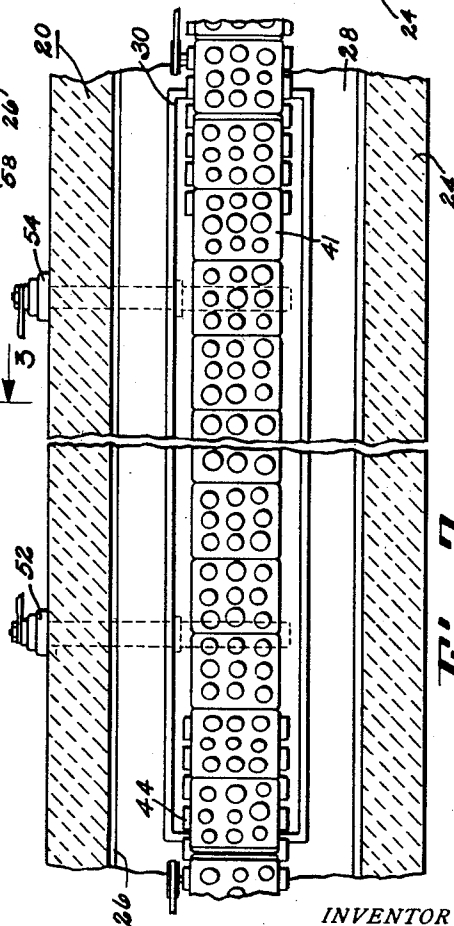


Fig. 2

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APPARATUS FOR SINTERING POWDERED METALS

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4 Claims. (Cl. 13—23)

This invention relates to apparatus for sintering powdered metals and is particularly concerned with apparatus wherein the sintering is accomplished by heat obtained from molten metal.

An object of the invention is to provide apparatus for sintering powdered metals wherein powdered metals in the desired shape are floated on refractory blocks through a bath of molten metal whereby the heat radiated and conducted from the molten metal is sufficient to sinter the powdered metal together and wherein the rate of movement of the supporting refractory block through the molten metal is controlled to provide the desired period of sintering.

Another object of the invention is to provide apparatus for sintering powdered metal wherein objects formed from powdered metal and supported upon refractory blocks are floated through a bath of molten lead maintained at the desired sintering temperature.

A still further object of the invention is to provide an apparatus for sintering powdered metal which includes a bath of molten metal which metal is heated by means of its resistance through the use of electrodes placed therein and spaced a desired distance apart so that the resistance of the bath itself produces the heat required for maintaining the bath in a molten condition.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a cross sectional diagrammatic view of a sintering furnace embodying the invention herein described.

Fig. 2 is a view taken on line 2—2 of Fig. 1.

Fig. 3 is a view taken on line 3—3 of Fig. 1.

In the sintering of porous metal parts made from powdered metal, it has been conventional procedure to pass the parts through a furnace heated either electrically, or by gas, which is maintained at the desired sintering temperature wherein the powdered metal parts passed there-through are sintered together by heat radiated from the walls of the furnace. Furnaces of this type usually contain a continuous conveyor there-through and have a controlled atmosphere therein to prevent oxidation of the powdered metal and in some instances have a reducing atmosphere therein which reduces superficial oxide films on the powdered metal particles, thereby improving

the bonding of one particle to another. These furnaces also include an attached cooling chamber which is preferably watercooled and which likewise contains a controlled atmosphere therein whereby the particles are reduced in temperature after sintering to a point where atmospheric oxidation is not apparent.

The present invention is directed to another type of sintering furnace wherein higher temperatures may be maintained without encountering the usual difficulties apparent in conventional types of furnaces, that is to say in the conventional furnace the conveyor is usually fabricated from steel or the like and at temperatures above 2400° the links thereof tend to elongate due to softening of the metal. In the furnace comprising the present invention no driving metal parts are necessary within the high temperature zone of the furnace. It is further apparent, however, that this type of furnace may be used in the sintering of any type of metal powder whether a sintering temperature is extremely high or whether the sintering temperature is maintained in the conventional range used for the sintering of bronzes and the like.

Referring to the drawing, and particularly Fig. 1, a furnace 20 is shown which comprises a base portion 22 which supports a body of heat insulating material 24. This may be any refractory cement, or refractory blocks, or may be other refractory material in powdered form in which case the base 22 is preferably a steel enclosure. Supported by the refractory 24 is a steel tank 26 which has a body of refractory lining 28 therein. The lining 28 is preferably some higher refractory material such as aluminum oxide and includes an inner lining of similar material designated 30, which lining is preferably continuous and free from cracks.

The furnace 20 comprises three main zones, namely, a preheating zone 32, a high temperature zone 34 and a cooling zone 36. The high temperature zone 34 is separated from the preheating zone by means of a baffle 38 and is separated from the cooling zone by means of a baffle 40. At the ingress end of the furnace a driven conveyor 42 is provided which is preferably inclined slightly whereby material placed on the conveyor is conveyed upwardly to a point just prior to entrance into the high temperature zone whereby the incline is reversed and a plurality of rollers 44 are provided which are not driven. At the egress end of the high temperature chamber 34 similar rollers 46 are provided which are not driven and which are placed on an upward in-

cline to a point just past the high temperature zone whereupon the incline is reversed through the cooling zone and wherein a second conveyor 48 is provided.

The refractory material 28 and 30 forms a tank within the high temperature zone of the furnace which is filled with some relatively low melting point metal which has a relatively high boiling point, that is to say the metal melts well below the desired sintering temperature but should have a boiling point considerably above the desired sintering temperature. In most instances lead is a desirable metal since lead melts around 621.2° F. and boils at about 2948° F. Other metals may obviously be used such as antimony with a melting point of 1166° and a boiling point of 2975°, copper, which melts at 1981° and boils at 4190°, tin with a melting point of 449.4° and a boiling point of 4118°, or any other suitable metal. It is also apparent that alloys of the aforementioned metals may be used. In each case it is preferable to cover the surface of the bath with a refractory powder such as alumina, bentonite or other suitable material to prevent oxidation and fuming. In this respect it is also desirable to have a controlled atmosphere within the furnace which is supplied through the pipe 50 and which may be either non-oxidizing in nature, or reducing in nature in accordance with the desired effect. It is apparent that if the pressure of the atmosphere is maintained above atmospheric pressure in the high temperature zone, that the preheating zone and cooling zone will likewise be filled with controlled atmosphere due to outward leakage as occasioned by the pressure.

I prefer to heat the metal bath by means of its own resistance and in this connection a pair of spaced contacts or electrodes 52 and 54 are provided so as to normally be below the surface of the bath of molten metal. The electrodes 52 and 54 are preferably made from high melting point metals of a refractory nature and are preferably tantalum covered, to prevent disintegration thereof at the temperatures encountered. Electrodes 52 and 54 are connected to a suitable current source and maintain the bath through automatic controls at any desired temperature.

Articles to be sintered are preferably placed on blocks of refractory material 41. One of such materials is known under the trade name of "Corhart" and these blocks of refractory are then placed upon the conveyor 42 whereupon they are moved toward the high temperature zone. As they pass from the conveyor 42 they roll down rollers 44 into the bath of molten metal and float therein. Additional blocks coming up the conveyor push the floating blocks through the bath and up the rollers 46 until they reach the conveyor 48 whereupon they are removed from the furnace. By choosing proper driving speeds for the conveyor 42, it is possible to regulate the period of sintering.

It should be noted that the metal used for the bath must have a specific gravity greater than the gravity of the blocks to be passed there-through to insure that the blocks will float thereon. In this instance certain metals having high specific gravity are preferable, although any desirable metal may be used if suitable refractory blocks are obtained so as to insure a differential in gravity sufficient to cause the blocks to float.

The powdered metal articles which are in the unsintered condition may be placed on the blocks and due to reflected and conducted heat, they are sintered while floating through the molten

bath of metal. The baffles 38 and 40 maintain the controlled atmosphere in the high temperature portion of the furnace and it is for this reason that the ingress and egress to the furnace are at an incline, since such construction permits a partial seal of the high temperature zone.

Steam coils 58 are provided externally of the tank 26 so that if any leak occurs through the refractory linings 28 and 30 and through the tank 26, such molten metal will contact the coils 58 and increase the temperature thereof which may be noted on a suitable control thermometer placed exteriorly of the furnace. Thus, if the temperature within the coils 58 is markedly increased, it is reasonable to assume that a leak in the lining of the molten metal containing tank has occurred. In this instance, the molten metal leaking through will reach the second refractory lining 24 and solidify, thereby self-sealing the tank. However, it is desirable to know if any leaks have occurred so that repairs may be carried out at convenient intervals. It is for this reason that the coils 58 are provided.

The use of a furnace of the type described provides a uniform temperature control within the high temperature zone of the furnace and likewise permits the use of relatively high sintering temperatures, for example, on the order of 2500° F. and above which sintering temperatures are difficult to obtain in the usual roller hearth, or conveyor type gas fired, or electrically heated furnaces. Furthermore, a furnace of this type is relatively inexpensive to build and maintenance costs on the same are relatively low, since the only heating elements provided are the tantalum covered contacts 52 and 54. Due to the fact that the metal of the bath is a relatively large body, temperature changes therein are slow and, therefore, the temperature within the furnace is maintained substantially constant which is highly desirable in sintering procedures.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A sintering furnace comprising, in combination, a tunnel-like structure divided into three compartments, conveyor means in the first compartment adapted to convey blocks of refractory through the compartment and into the second mentioned compartment, a tank of molten metal disposed in the second compartment adapted to receive said blocks from said conveyor whereupon the blocks float on the surface of the molten metal, and a second conveyor disposed in the third compartment and adapted to remove the blocks from said molten metal and discharge them from the furnace.

2. A sintering furnace comprising in combination, a tunnel like structure, conveyor means extending part way only into the furnace at the ingress and egress ends thereof, an intermediate portion separating said conveying means and adapted to act as a container for molten metallic material, whereby articles introduced into the furnace on the ingress end conveyor means are delivered into the molten material in the intermediate portion and are pushed there-through by subsequent articles being introduced into the furnace, said articles after passing through the intermediate portion being removed from the molten material by the egress end con-

veyor means and ejected from the furnace, and spaced electrical connections in said immediate portion and adapted to be connected only by said metallic material whereby the resistance of the material itself raises the temperature thereof when current is passed from one said connection to the other.

3. A sintering furnace comprising in combination, a furnace consisting of three zones, conveyor means in the first zone adapted to convey material from said first zone into the second zone, means for containing molten metallic material in said second zone whereby articles conveyed on said conveyor means are introduced into said molten material, and conveyor means in the third zone adapted to remove articles from said molten material and convey them outwardly from the second zone into said third zone said articles being passed through the second zone entirely by the pushing action of the subsequent articles being fed thereto by the conveyor means in the first zone.

4. A sintering furnace for close temperature control and comprising in combination, a tunnel like structure divided into three compartments, a roller conveyor in the first compartment and extending part-way into the second compartment, a second roller conveyor in the third compartment extending part-way into the second compartment, a heat resisting vat in said second compartment adapted to contain molten lead, or the like, said conveyor in the first compartment being adapted to convey blocks which support articles to be sintered from the first compartment into said molten bath whereby the blocks float on the surface of the bath and are pushed throughout by subsequent blocks being conveyed therein, said blocks being picked up by said conveyor in the third compartment after they have traversed the bath and removed from the bath and discharged from the furnace.

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