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[54] **METHOD AND FURNACE FOR SINTERING**

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[51] **Int. Cl.**.....**F27b 21/00**

[58] **Field of Search**.....75/200, 211, 221, 223-225, 75/227; 266/2 R, 5 R, 5 E, 5 C, 5 T, 27, 24, 25, 20

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[57] **ABSTRACT**

A method and furnace are disclosed for continuous sintering powdered metal products. The furnace includes a high temperature heating zone through which the powdered metal products pass for sintering. The high temperature heating zone includes a thermally stable medium preferably alumina sand, in which the sintered product is carried through the furnace. The invention provides a sintering furnace which is capable of achieving and maintaining higher temperatures in continuous operation than previously possible for commercially operated furnaces.

4 Claims, 2 Drawing Figures

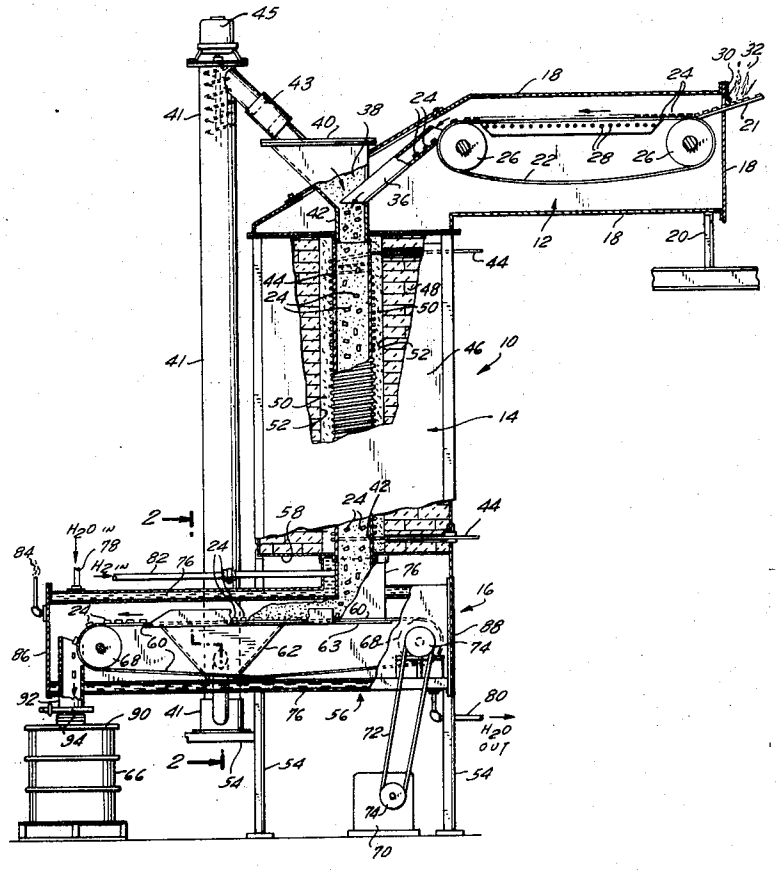


FIG. 1

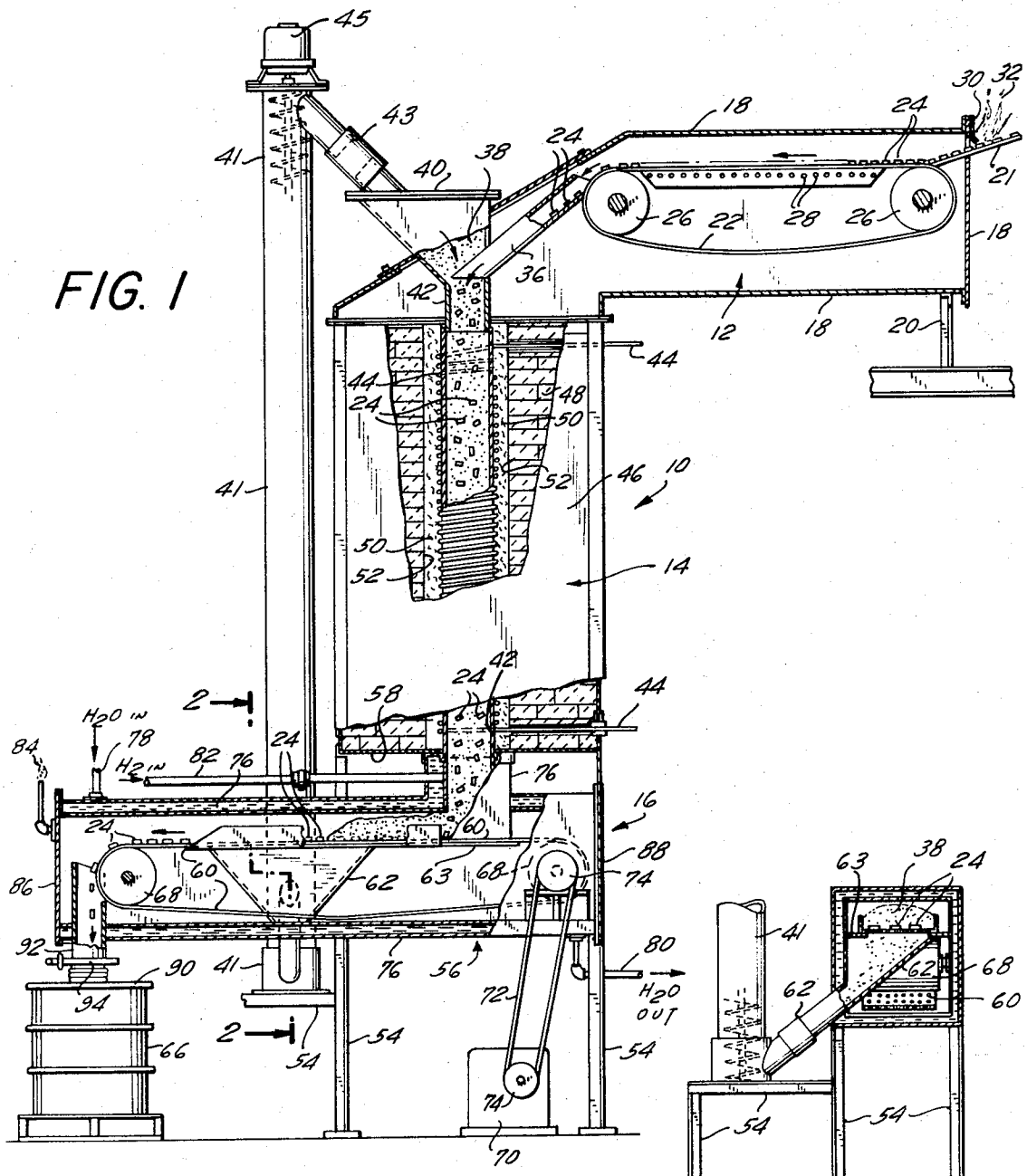


FIG. 2

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METHOD AND FURNACE FOR SINTERING

BACKGROUND OF THE INVENTION

Powdered metallurgy involves the pressing of powdered metal and the subsequent heating or sintering of the pressed metal to obtain an integral durable product. As a consequence of improved metallurgy and bonding techniques, the quality and strength of powdered metal products has been improved to a point where powdered metal parts are replacing machine parts such as drive gears which formerly required several machining operations. Through powdered metal technology it is possible in one step to produce a gear or other part directly from raw material.

After pressing, the powdered metal parts are introduced into a sintering furnace where the powdered metal parts are heated to improve quality and strength. According to present practice, conventional continuous sintering furnaces include a conventional horizontal conveyor for moving the powdered metal products through a high temperature zone. Because of the limitations in the conveyor design and materials, maximum temperatures are limited to approximately 2,150° Farenheit in presently used conventional sintering furnaces.

SUMMARY OF THE INVENTION

The present invention provides a sintering method and a preferred furnace for carrying out the method.

The sintering method relates to sintering the pressed powdered metal parts in a thermally stable carrying medium. In carrying out the method, the metal parts are preheated to about one-half the final sintering temperature and are then mixed or distributed through the carrying medium for sintering at an elevated temperature. The carrying medium preferably is alumina sand and after sintering the metal parts are removed while the alumina sand may be reused. Of course other suitable carrying medium may be used.

The present invention also provides a high temperature sintering furnace which makes possible and sintering of powdered metal products on a continuous commercial basis at temperatures considerably in excess of those presently possible with existing conventional continuous sintering furnaces. The furnace according to the present invention, includes a preheating zone where the pressed powdered metal products are initially heated. Thereafter, the metal products are introduced into a high temperature zone. The powdered metal products are carried through the high temperature zone in a thermally stable free flowing medium which preferably is alumina sand. The high temperature furnace is advantageously arranged vertically to receive the powdered metal products mixed with the alumina sand. The alumina and the powdered metal products pass through the high temperature zone and receive heat from a suitable source for the purpose of sintering the powdered metal products. The alumina functions as a conveying medium for carrying the powdered metal products through the high temperature furnace.

Flow of the carrying medium and the powdered metal products is controlled by a take-off conveyor located at the bottom of the vertical high temperature furnace. That is to say, the rate of flow of medium through the furnace is effectively controlled by the rate at which the take-off conveyor removes the carrying medium and sintered product at the bottom of the vertical furnace.

After take-off the alumina medium is separated from the sintered product and maybe reused again in the furnace. The sintered product is conveyed to a convenient collecting station where it is allowed to cool.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a continuous sintering furnace capable of achieving higher sintering temperatures than presently possible with conventional continuous furnaces.

Other and further objects of the present invention will become apparent upon an understanding of the following description of the preferred embodiment, or will become apparent to one skilled in the art upon employment of the invention in practice.

DESCRIPTION OF THE DRAWINGS

A preferred embodiment has been chosen for the purpose of illustrating and describing the principles of the invention and is illustrated in the accompanying drawing wherein:

FIG. 1 is a side elevation view illustrating the vertical sintering furnace of the present invention; and

FIG. 2 is a section view taken along line 2—2 of FIG. 1.

Referring now to the drawing, particularly to FIG. 1, the sintering furnace **10** comprises a preheat section **12**, a vertically disposed high temperature furnace **14**, and a take-off and separating section **16**.

The preheat section **12** comprises an enclosed casing **18** supported at one end upon the high temperature furnace **14** and at its other end by a suitable support member **20**. The preheat section includes an infeed chute **21** and a preheat conveyor **22** over which pressed metal products **24** are conveyed and heated prior to entering the high temperature furnace. The preheat conveyor is mounted over suitable end rolls **26** and preferably the conveyor surface **22** is a mesh type conveying belt. A series of heating elements **28** underlie the upper run of the conveyor for heating the pressed metal parts to a temperature of about 1,500° F. The heating elements are preferably electric resistance heaters.

Hydrogen is introduced into the furnace to provide a protective atmosphere during the sintering operation. An asbestos curtain **30** covers the entrance to the preheat section to prevent flash-back of the hydrogen. A suitable flame **32** is maintained outside the asbestos curtain to burn off any hydrogen which may escape through the opening in the preheat furnace.

The powdered metal products enter the preheat section on the infeed chute **21** and are deposited onto the preheat conveyor **22**. The preheat conveyor delivers the pressed products onto an output chute **36** which feeds into the high temperature furnace **14**.

The high temperature furnace **14** receives a mixture of the powdered metal parts **24** and a conveying medium **38** at a funnel **40** located at the top of the furnace. A vertical screw conveyor **41** delivers the conveying medium to the funnel **40** through a suitable chute **43**. A suitable motor **45** drives the screw conveyor.

The medium serves to separate the metal parts from each other and to convey them through the furnace for sintering. The medium is selected for its thermal stability and its ability to retain a free flowing character at the elevated temperatures. A fine mesh, for example between −50 and 100 mesh alumina sand is suitable for this purpose. Magnesium oxide in pebble grain form may also be used however it cannot withstand furnace temperatures as high as alumina sand can.

The mix of alumina medium and metal parts enters the high temperature furnace and passes through a central vertical tube **42** for sintering. A heating element **44**, preferably an electric resistance heater wound in a spiral around the central tube, heats the metal parts to a desired temperature, for instance, to a selected temperature between 1,500° F to 2,900° F in a continuous operation. The central vertical tube **42** is carried by a furnace casing **46** of suitable sheet steel. The interior of the casing is lined with refractory brick **48** for insulation. Loose insulation **50** may be used in the space **52** immediately surrounding the tube.

If desired an electric induction heater may be used to heat the furnace in which case the alumina medium will act as an insulator. However, any suitable heating means may be used.

The high temperature furnace includes a lower support structure **54** which provides sufficient clearance to allow for take-off equipment **56** to be positioned under the furnace.

The vertical tube **42** passes through the bottom wall **58** of the furnace casing for delivering the conveying medium and the sintered product onto a take-off conveyor **60**.

Flow of the alumina conveying medium and sintered product through the furnace, is controlled by means of the take-off conveyor **60** located at the bottom of the vertical tube. The alumina and the sintered product move under the force of gravity and the rate of flow increases as the linear speed of the conveyor increases. The take-off conveyor which is preferably a mesh belt removes the medium and product **24**, carrying them over a funnel **62** which collects the alumina. The alumina is moved by the screw conveyor **41** to the top of the furnace for recycling.

The separation of the sintered product from the alumina is accomplished by using the porous mesh belt **60** through which the alumina falls into a funnel **62** at the input end of the screw conveyor **41**. The funnel **62** includes a flange plate **63** below the conveyor for confining the alumina while it is being moved to the funnel. The sintered product is removed from the take-off conveyor and delivered into a suitable receptacle **66**. The mesh belt conveyor is spaced by suitable end rolls **68** and is driven by a power unit **70** through a suitable belt **72** and sprocket arrangement **74**. The power unit may be controlled to vary the conveyor speed and hence the rate at which product and medium pass through the furnace.

Preferably, the entire take-off area **56** of the sintering furnace including the lower end of tube **42** is encased in a water-cooled jacket **76** to lower the temperature of the sintered product and to maintain the ambient temperature for operating personnel within tolerable limits. The water-cooled jacket is of suitable double wall construction and includes input and outlet pipes **78** and **80** for circulating cooling water through the cooling jacket.

It will be observed that hydrogen is introduced into the sintering furnace through an input pipe **82** located near the bottom of the vertical tube **42**. The hydrogen percolates through the alumina into the high temperature furnace and into the preheat furnace. A suitable burn-off flame **84** is maintained for consuming excess hydrogen and also to indicate the presence of the protective hydrogen atmosphere within the furnace. The take-off area **56** of the furnace is enclosed to maintain hydrogen within the furnace. The water jacket is provided with end walls **86** and **88** for this purpose. The receptacle **66** includes a cover **90** connected to an outlet tube **92** for further enclosing the furnace. A suitable valve **94** closes tube **92** when removing the receptacle **66** to prevent hydrogen loss.

In operation and in carrying out the method of the invention the green pressed products **24** are introduced into the preheat area **12** of the sintering furnace and are heated to a selected temperature between 1,000° to 1,500° F in a protective hydrogen atmosphere. The preheated product is conveyed to the input end of the high temperature zone **14**. At this point the alumina **38** is mixed with the green pressed products **24** and to provide the medium by which the green pressed product is moved through the sintering furnace **14**. The green pressed products are distributed through the medium out of contact with each other for proper sintering action.

Hydrogen is introduced into the lower end of the furnace and percolates through the mixture to provide the necessary protective atmosphere in which sintering occurs. Suitable arrangements are made at the preheat and take-off areas to consume whatever hydrogen escapes from the furnace.

The rate of flow through the furnace is controlled by a mesh-type belt take-off conveyor **60** which carries the alumina and sintered product away from the bottom end of the sintering furnace. In other words, by increasing the linear speed of the conveyor a greater volume of alumina and sintered product flow by gravity through the vertical shaft. Alumina which is of very fine consistency, preferably approximately 100 mesh, falls through the mesh take-off conveyor into a suitable funnel **62** and thereafter is returned by a screw conveyor **41** to the input end of the furnace **40**. The sintered product is dropped off the take-off conveyor into a suitable collecting barrel **66**.

By using this arrangement this invention provides the highly advantageous possibility of sintering at temperatures up to 2,900° F. The higher temperature produces sintered products of improved quality and strength. The high temperature is confined to the central core area of the high temperature furnace and more specifically to the heating coil and to the vertical tube **42** passing through the furnace. There are no moving parts such as are presently used in horizontal conveyor furnaces which are destroyed by the high temperatures which the present invention is able to operate at. Consequently, the life expectancy of the furnace components is greatly increased.

The vertical tube **42** in the high temperature zone may easily be removed for inspection or replacement, in virtue of the space **52** between the refractory brick

and the central vertical shaft. This space is filled with loose insulation.

What is claimed is:

1. A sintering furnace for pressed metal parts including a preheat section having an enclosed casing and a conveyor for receiving and moving parts through the enclosed casing, means for heating the pressed parts up to a temperature of about 1,500°F. on the conveyor, a high temperature section having an elongated conduit arranged with its inlet elevated with respect to the outlet to allow gravity flow through the conduit, a funnel fitted to the inlet of the conduit for receiving the parts from the preheat conveyor, means for delivering a carrying medium to the funnel so the parts are distributed in the medium upon entering the conduit, said medium being −50 to 100 mesh alumina sand, means for heating the parts in the conduit throughout more than half the entire length of said conduit up to approximately 2,900° F., said heating means being disposed about more than half the entire length of said conduit, said heating means being an electrical resistance heater wound in a spiral around said conduit, said heater being surrounded by insulating brick, a conveyor located beneath the outlet from the conduit to receive the discharge of the medium and parts, and means to vary the linear speed of the outlet conveyor to control the rate of gravity flow of the medium and parts through the conduit, said outlet conveyor being adapted to separate the medium from the parts, and means for cooling the parts on the outlet conveyor.

2. The furnace of claim 1 wherein the cooling means comprises a water-cooled jacket surrounding the outlet conveyor.

3. The furnace of claim 1 which further includes means for introducing a protective atmosphere into the furnace.

4. The furnace of claim 1 which further includes means for returning the medium to input end of the conduit.

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