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J. O. BETTERTON ET AL

2,054,922

VACUUM TREATMENT OF METALS

Filed Oct. 12, 1933

2 Sheets-Sheet 1

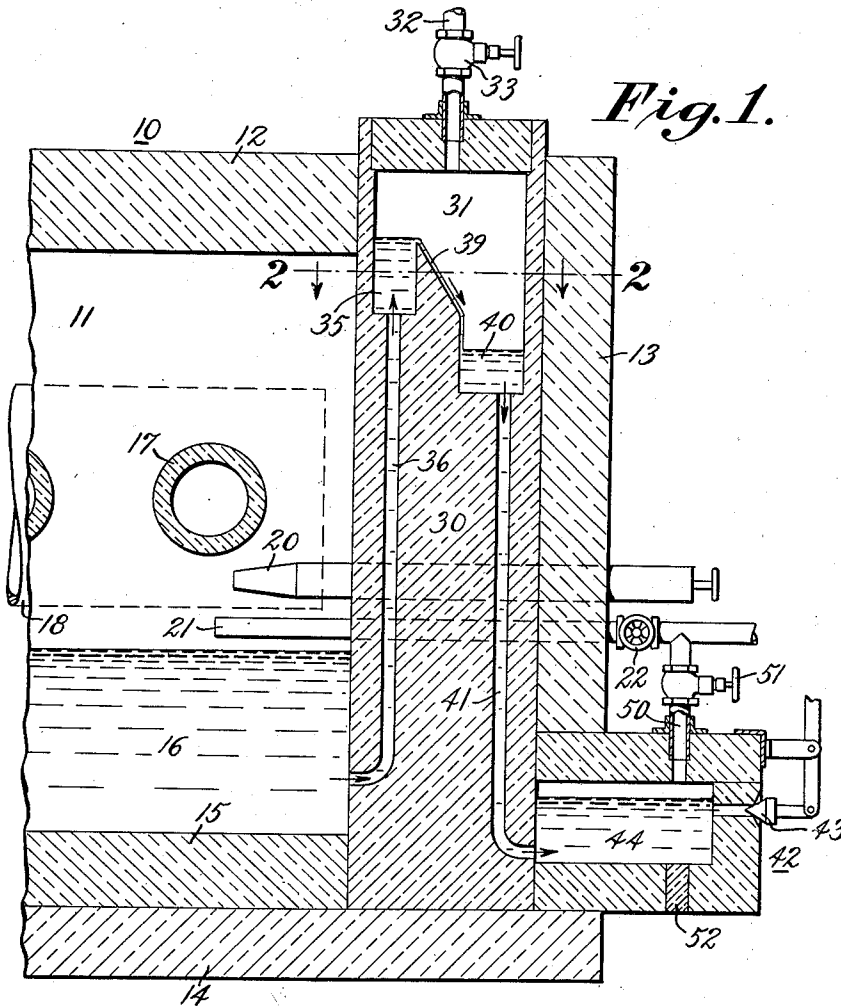


Fig. 1.

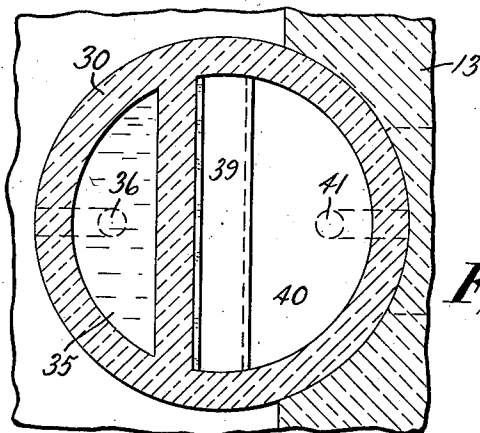


Fig. 2.

INVENTORS
Jesse O. Betterton
BY Albert J. Phillips
Justin & Phillips
ATTORNEYS

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Fig. 3.

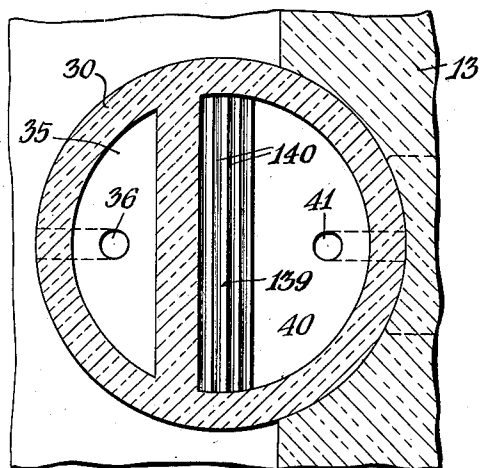


Fig. 3^a.

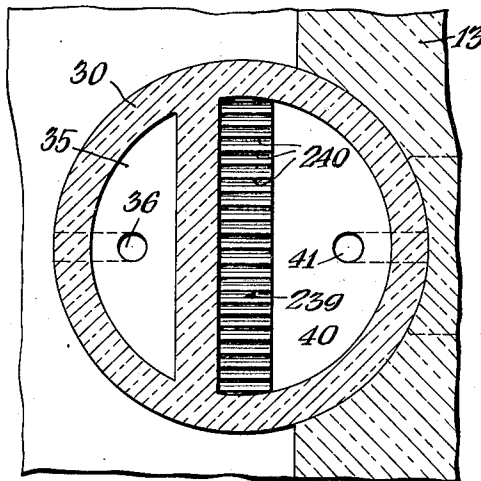


Fig. 4.

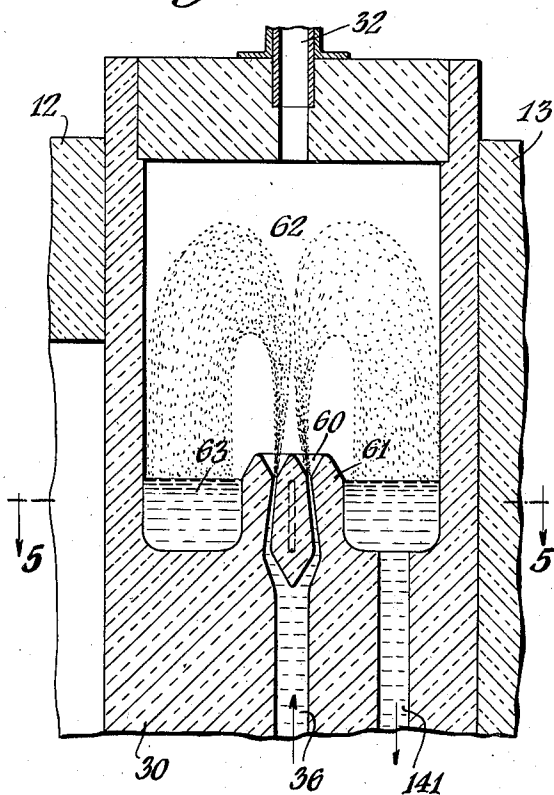
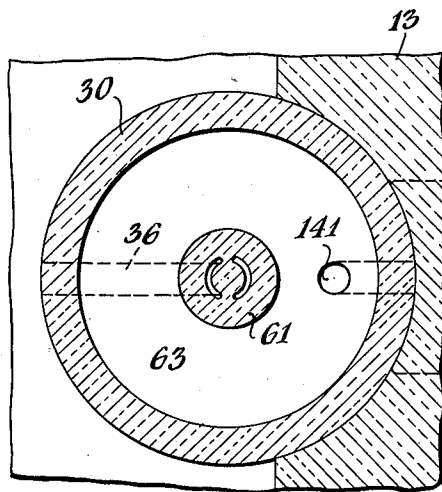


Fig. 5.



INVENTORS
Jesse O. Betterton
Albert J. Phillips
BY Austin & Dix
ATTORNEYS

UNITED STATES PATENT OFFICE

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VACUUM TREATMENT OF METALS

Jesse O. Betterton and Albert J. Phillips, Metuchen, N. J., assignors to American Smelting and Refining Company, New York, N. Y., a corporation of New Jersey

Application October 12, 1933, Serial No. 693,238

4 Claims. (Cl. 266—34)

This invention relates to the preparation of metals for casting and more particularly to the vacuum treatment of molten metals.

In certain instances, it has been found that by subjecting molten metals to a vacuum the characteristics of the casting are improved. For example, the casting may be made particularly free from gases and voids. The present invention, accordingly, provides an improved method and means for effecting this treatment which is simple, effective and economical and is an improvement on the invention described in the co-pending application of Jesse O. Betterton, Serial No. 675,149. The invention is particularly adapted to the treatment of non-ferrous metals, such as copper and aluminum, but it may also be applied to the treatment of other metals as will be apparent to a person skilled in the art.

In accordance with this invention, the metal is melted, preferably in a non-absorbable atmosphere, and on its way to a casting box is passed through a vacuum chamber in a form having a high ratio of surface area to volume so that substantially the entire mass of metal is directly exposed to the action of the vacuum. In certain embodiments of the invention, the metal is passed through a vacuum chamber in the form of a thin film or in the form of a fine spray.

The invention also consists of certain novel features hereinafter more fully set forth. Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 is a broken vertical section of a furnace constructed in accordance with the present invention,

Fig. 2 is a section taken on the line 2—2 of Fig. 1,

Fig. 3 is a similar section to Fig. 2 showing a modified form of vacuum chamber,

Fig. 3a is a similar section to Fig. 2 showing a further modified form of vacuum chamber,

Fig. 4 is a broken vertical section showing a further modified form of vacuum chamber, and Fig. 5 is a section taken on the line 5—5 of Fig. 4.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims

various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit.

Referring to the drawings more in detail and particularly to Figs. 1 and 2, the invention is shown as applied to a furnace 10 comprising side walls 11, roof 12 and an end wall 13. The furnace is also provided with a bottom 14 having a lining 15 of suitable refractory material upon which a bath 16 of molten metal is supported.

The furnace may be provided with a plurality of fire tubes 17 which may be supported by the side wall 11 in any suitable manner and may join with a suitable header 18. Each flue 17 may be provided with a burner (not shown) by which heat is supplied to the furnace. An auxiliary burner 20 may be mounted in the end wall 13 to assist in raising the temperature of the furnace, for example, in starting the melting operation. A pipe 21 may also be provided for supplying a chemically inert, non-absorbable gas to the furnace which may be controlled by suitable means, such as a valve 22.

It is to be understood that the various parts of the furnace outlined above are of standard construction and that only so much thereof has been described as is essential to a proper understanding of the present invention.

The vacuum treating device is shown as comprising a cylinder 30 which may be made of any suitable refractory material having sufficient heat conductivity to permit a uniform heat distribution to be maintained, for example, graphite, silicon carbide or other molded materials. The cylinder 30 is mounted within the end walls of the furnace in a position to receive heat therefrom, whereby the metal is prevented from freezing as it passes through the cylinder in the manner to be described.

The cylinder 30 is provided, preferably at its upper end, with a vacuum chamber 31 which communicates by pipe 32 controlled by valve 33 with a suitable source of vacuum (not shown). This vacuum chamber 31 includes a sump 35 which is adapted to receive metal through a passage 36 from the bath 16. The sump 35 is connected by an inclined surface 39 to a discharge sump 40 which communicates through a channel 41 with a casting box 42.

The casting box 42 may be provided with a control valve 43 situated above the level of the discharge end of the channel 41 so as to always maintain a suitable quantity of molten metal 44 within the casting box above said channel. Suit-

able means, such as a pipe 50 controlled by valve 51, may be provided for maintaining a suitable atmosphere within said casting box. The casting box may be provided with a tap hole 52 to permit the box to be drained when it is to be taken out of operation.

In the operation of the above described apparatus, the metal to be melted is supplied to the furnace 10 in any convenient manner and is suitably heated by said furnace while a chemically inert, non-absorbable atmosphere is maintained therein. The pressure is then reduced within the vacuum chamber 31 by applying suction to pipe 32 and a vacuum is produced in the chamber sufficient to raise the molten metal from the bath 16 through the channel 36 to the sump 35. The metal then fills the sump 35 until it flows over the inclined surface 39 into the sump 40 in the form of a continuously flowing thin film. The metal in the discharge sump 40 then flows through the channel 41 into the casting box 42.

It is to be noted that the elevation of the edge of inclined surface 39 above the molten metal within the furnace 10 bears a definite relation to the barometric height of the metal such that the metal will not flow over the surface 39 at a rate to fill the sump 40 beyond a predetermined point and thus will not cut down the effective area of the surface 39 which is essential for rapid degasification action.

The elevation of the metal in the sump 40 above the metal in the casting box 42 also bears a relation to the barometric height of the metal such that the level of the metal in the sump 40 is controlled by the level of the metal in the casting box 42 which is preferably maintained at atmospheric pressure. Consequently, by regulating the level of the metal within the casting box by means of the valve 43, the level of the metal within the sump 40 may be varied as desired. The casting box preferably has sufficient area to prevent substantial changes in the level of the metal contained therein in response to intermittent operation of the valve 43 during casting. It is obvious that the metal may be cast directly from the box 42 or may be applied to any suitable casting device.

By maintaining a thin film of metal over the inclined surface 39, a large surface area is provided so that substantially all parts of the metal are directly exposed to the vacuum within chamber 31. The removal of the gases from the metal is thus facilitated and a more efficient and rapid operation may be effected. It is obvious that the thickness of the film may be controlled by the rate at which the metal is applied to the sump 35 and by the effective width of the inclined surface. The velocity of the metal over said surface is determined both by the area thereof and by the slope of the surface in respect to the horizontal. It is contemplated that the apparatus will be so operated that a continuously moving film is maintained on a surface 39 throughout the melting and casting operation.

In the form of the invention illustrated in Fig. 3, the inclined surface 139 corresponds to the surface 39 of Figs. 1 and 2 and is fluted to provide a plurality of depressions 140 over which the film of metal passes in a film of varying thickness. The apparatus is otherwise identical with that described above. It is obvious that the contour of surface 139 may be varied in any suitable manner so as to increase the area of the film and to reduce the thickness thereof at points intermediate the depressions 140 whereby the entire

mass is more intimately exposed to the vacuum within the chamber 31.

In the form of the invention illustrated in Fig. 3a the inclined surface 239 corresponds to the surfaces 39 and 139 of Figs. 2 and 3. The surface is provided with a plurality of shallow grooves or channels 240 which conduct the molten metal downwardly to the sump 40 in the form of numerous small streams with a large surface area exposed to the action of the vacuum. Instead of being parallel to the line of flow or at right angles thereto as respectively shown by 149 and 139, various other designs or modifications thereof may be effected in order to expose as large an area of surface as possible to the purifying action of the vacuum.

In the form of the invention illustrated in Figs. 4 and 5, the furnace and associated parts are similar in construction with those above described. In this form of the invention, however, the channel 36 terminates in a nozzle 60 which may be of any desired form adapted to produce a fine spray or mist as the molten metal is passed therethrough. The nozzle 60 may be formed in a boss 61 located preferably at the center of the vacuum chamber 62 and surrounded by a circular sump 63. The metal from the sump 63 is discharged through a channel 141 similar to the channel 41 above described.

In this form of the invention, the elevation of the nozzle 60 may be somewhat less than the barometric height of the metal in the channel 36 so that the metal will be forced through the nozzle under positive pressure. If the metal contains a considerable amount of dissolved gas, the nozzle may be in the form of a simple jet opening inasmuch as the accompanying gases in the metal may serve to atomize the stream without the use of a special nozzle construction. The nozzle may be formed of graphite or of a special hard pressed carbon or of a molded baked refractory material or the like.

The metal level in the sump 63 may be regulated by means of the metal level in the casting box 42 in the manner described in connection with the apparatus shown in Fig. 1. The regulation should be such that the metal within the sump 63 never reaches the nozzle 60 to interfere with the operation thereof.

In the operation of this form of the invention, practically the entire mass of metal is exposed to the action of the vacuum inasmuch as the fine spray of mist presents a maximum surface area and prevents any substantial amount of gas from remaining occluded within the metal. It has been found that metal thus treated produces castings having superior characteristics, particularly when the metal is melted and cast in a non-absorbable atmosphere.

While certain specific terms have been used for convenience in describing the present invention, it is to be understood that the invention is not to be limited thereby. For example, the term "vacuum" has been employed in describing the chamber 31 and the operation of the apparatus. It is to be understood, however, that the degree of vacuum may be varied as required in each particular instance without departing from the spirit of the invention. It is also to be understood that the furnace 10 and the casting box 42 and the associated apparatus may be operated at substantially atmospheric pressure and preferably in the presence of a non-oxidizing, non-absorbable gas in a manner more fully described in the co-pending application above referred to.

Although certain preferred embodiments of the invention have been shown for purposes of illustration, it is to be understood that the invention is not to be limited thereto but is only to be limited in accordance with the following claims when interpreted in view of the prior art.

What is claimed is:

1. In combination, a melting furnace and a vacuum treating chamber associated therewith comprising a body member mounted within the influence of the heat of said furnace, said chamber having a lower inclined surface elevated a substantial distance above the level of the metal in said furnace, means to remove said metal from said furnace and to pass the same in a thin film over said surface, means to receive the metal from said surface and means to discharge the metal thus received.

2. In combination with a metal melting furnace and a casting box, vacuum treating means comprising a body member interposed in said furnace and having a vacuum chamber, a sump within said chamber and positioned above the level of the metal in said furnace and connected thereto by means of a channel, the elevation of the sump bearing a relation to the barometric height of the metal such that the metal from said bath is raised into said sump by the vacuum within said vacuum chamber, and an inclined surface associated with said chamber and adapted to receive metal overflowing from said sump in the form of a thin film.

3. In combination with a metal melting furnace and a casting box, vacuum treating means comprising a body member interposed in said furnace and having a vacuum chamber, a sump positioned in said chamber above the level of the metal in said furnace and connected thereto by means of a channel, the elevation of the sump bearing a relation to the barometric height of the metal such that the metal from said bath is raised into said sump by the vacuum within said vacuum chamber, an inclined surface associated with said chamber and adapted to receive metal overflowing from said sump in the form of a thin film, and a second sump adapted to receive metal from said surface and communicating with said casting box, the elevation of said second sump above said casting box having such relation to the barometric height of the metal that the metal in said second sump is maintained at an elevation below said inclined surface.

4. An apparatus for treating molten metals comprising a body member forming a vacuum chamber, said chamber having an inclined fluted surface comprising spaced depressions, and means for causing the metal to pass over said surface across said depressions in a film the thickness of which is reduced between said depressions.

JESSE O. BETTERTON.
ALBERT J. PHILLIPS.