March 12, 1940. G. MARS 2,193,034

APPARATUS FOR TREATING MATERIALS UNDER REDUCED PRESSURE

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Fig. 1

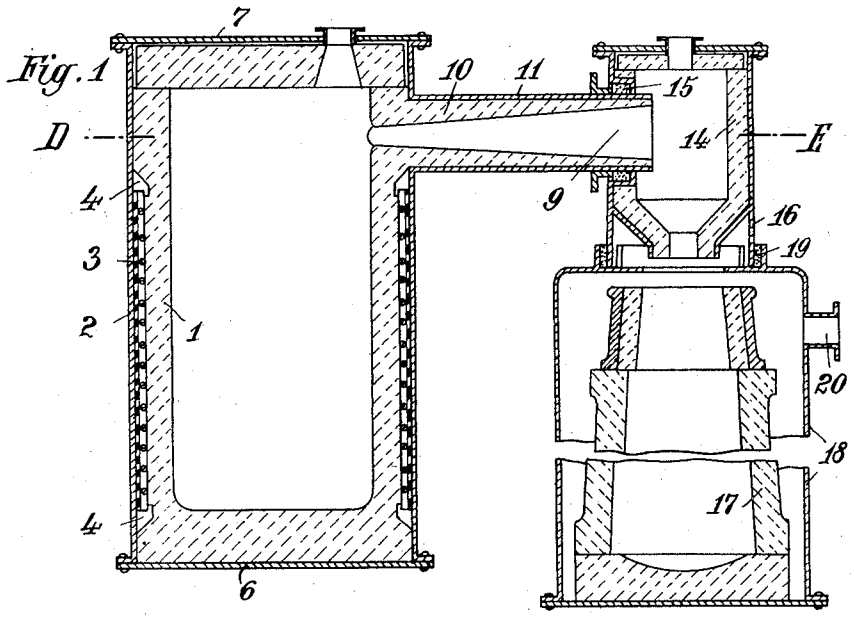


Fig. 2

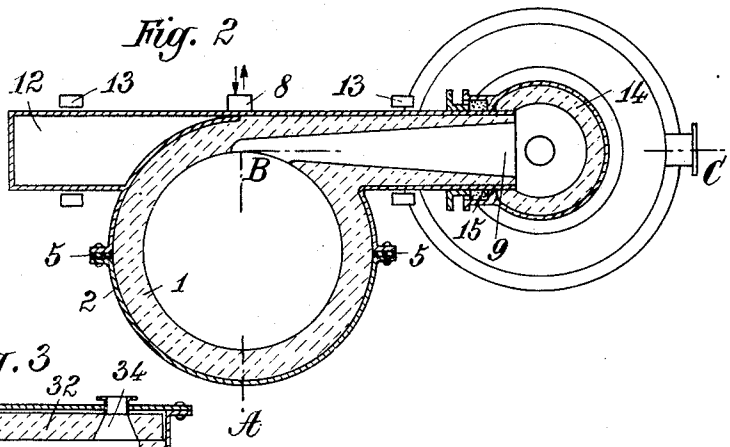
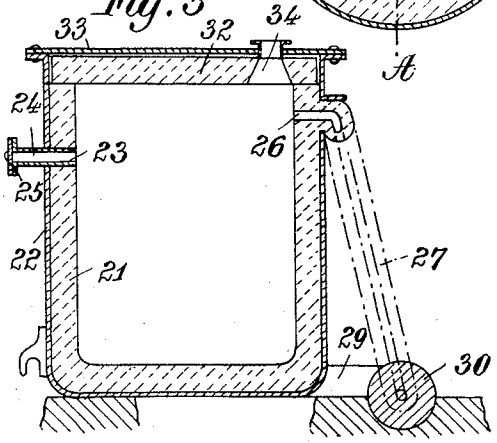


Fig. 3



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Fig. 4

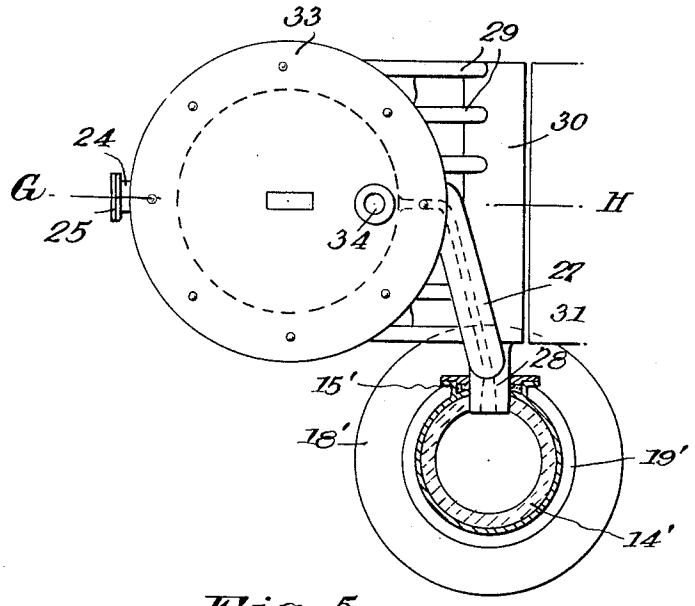
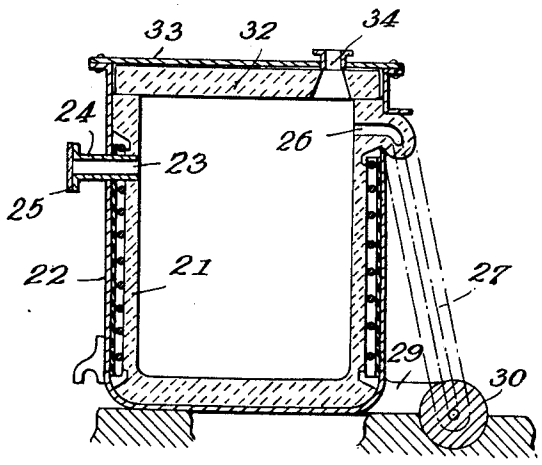


Fig. 5



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APPARATUS FOR TREATING MATERIALS UNDER REDUCED PRESSURE

Georg Mars, Csepel at Budapest, Hungary

Application May 4, 1937, Serial No. 140,727
In Hungary May 8, 1936

7 Claims. (Cl. 266—38)

This invention relates to an apparatus for treating, in particular for melting and casting, substances which can be melted and cast in a chamber from which air has been wholly or partly evacuated or has been charged with an inert, neutral or reducing gas under low pressure. The apparatus for melting and casting fusible materials in a chamber from which the air has been evacuated which have previously been proposed are bulky and cannot be easily supervised. In the previously proposed apparatus the melting apparatus and the casting apparatus were arranged in an air-tight chamber filled with neutral gases within which the furnace could be moved by means actuated from the outside in such a manner that the melted charge could be poured into the mould. It has also been proposed to employ an apparatus consisting of a melting furnace and a mould combined air-tightly and rigidly with and at right angles to the furnace and to mount the apparatus so that it can be tilted. An apparatus of this nature is difficult to construct if the furnace is large and also has disadvantages from a technical point of view.

By means of the present invention the desired result is obtained in a simple manner. According to the invention, a melting apparatus which is provided with a vacuum jacket and can be rotated is connected vacuum-tightly with a casting apparatus which is also provided with a vacuum jacket but is stationary, the connection being effected by means of a stuffing box which connects the tubular pouring channel of the melting apparatus with the pouring funnel of the casting apparatus. Instead of the melting apparatus a pan or ladle or the like which may or may not be provided with means for heating it may be employed.

The melting apparatus can be of any desired construction. It may consist of a melting crucible and a pouring channel both of which are enclosed by vacuum jackets which are connected together vacuum-tightly. The crucible can be of any desired shape and, for example, in the case of substances which melt at a low temperature, may be heated from the outside, for example by oil firing or by electrical resistance heating. In the case of substances which melt at a high temperature, for example difficultly fusible metals, a coreless induction furnace is most suitable.

The pouring channel which is connected to the upper part of the crucible is of tubular form and acts as the axis about which the melting apparatus is tilted. Apart from this, its shape depends on the height relatively to the outlet opening in the crucible for the molten material and on the radial distance from the axis of the furnace at which the outflow of the contents of the crucible from the pouring channel into the casting apparatus is to take place. When the height of the inlet and outlet ends of the pouring channel is approximately the same, the pouring channel may consist of a straight channel which is made in one piece and is arranged tangentially of the furnace. When the inlet and outlet ends of the pouring channel are situated at different heights, it consists firstly of a part which passes at any desired angle through the wall of the furnace and then continues in the form of at least one part with leads at a suitable angle to the plane in which the outlet opening is situated and consists finally of a part, which forms the axis about which the melting apparatus is tilted, and is disposed horizontally in the plane in which the outflow takes place and tangentially of the furnace. The head necessary for the material to flow out of this horizontal part of the pouring channel is obtained by suitably shaping the refractory lining.

The casting apparatus in all cases consists preferably of a casting funnel and a mould or moulds. If only one mould is used without a separate casting funnel, then the upper part of the mould can act as the casting funnel.

A pan or ladle is not usually utilised with the method of operation which is carried out with the apparatus described. If the material has been previously liquefied in a melting furnace in which the material to be melted is directly heated by means of combustion gases and is to be subsequently subjected to vacuum treatment for removing the gases dissolved in the melted material, a pan or ladle, which may or may not be capable of being heated, may be employed. The pan or ladle must, however, be provided with a vacuum-tight jacket, cover and pouring channel as in the case of the furnace described.

The evacuation treatment, for example of steel in an induction furnace supplied with electric current, takes place considerably more quickly owing to the eddy effects set up in the molten material by the induction currents than the removal of gas from steel which has been previously liquefied in a Siemens-Martin furnace and superheated but is no longer heated in the pan or ladle. The volatilization of the gases from the liquid steel, which takes place very rapidly under the action of a sufficiently high vacuum, also effects a rapid diminution of the gas content of the steel in the unheated pan, the more so because,

owing to the escaping gases, a certain amount of eddy effect is produced in the pan.

The apparatus which has been described can be constructed in many different ways. Three forms of apparatus will be hereinafter described by way of example, of which one form comprises a coreless induction furnace having a pouring channel made in one piece, and another an unheated pan or ladle with a pouring channel made in several parts, while a third form includes both the induction furnace and the multi-part channel. All forms of the apparatus illustrated are for use in the removal of gases from steel.

When coreless induction furnaces are employed, the crucible and the induction coil which surrounds it are equipped with a vacuum-tight jacket to which a jacket which encloses the pouring channel vacuum-tightly is connected.

In order to reduce the current losses in the jacket, it is made of a material of high electrical resistance, for example of sheet metal which is as thin as possible or of a non-conducting substance, for example artificial slate. The induction coil is preferably directly in contact with the wall of the furnace or indirectly through a layer of interposed insulating material, in which case the induction coil is preferably held between bracket-like supports arranged on the inside of the furnace jacket in order to avoid vibration due to the action of the current. The furnace jacket, when constructed of sheet metal, is subdivided by the interposition of insulating material in order to reduce current losses.

Three forms of a melting and casting apparatus in accordance with the invention are illustrated by way of example in the accompanying drawing, in which:

Figure 1 is a cross-section through the first form of apparatus on the line A—B—C of Figure 2, and

Figure 2 is a horizontal section on the line D—E of Figure 1;

Figure 3 is a part sectional elevation of the second form of apparatus, and

Figure 4 is a plan view of an apparatus according to Figure 3 and also Figure 5, the casting apparatus being shown partly in section and broken away.

Figure 5 is a vertical sectional view of a pan or ladle similar to that of Figures 3 and 4 except that it is provided with an electric induction heating coil.

Referring to Figures 1 and 2 of the drawing, the crucible 1 which is made of refractory material is enclosed vacuum-tightly by a jacket 2 which is made of a material of high electrical resistance, for example sheet metal which is as thin and therefore as poorly conducting as possible or of a non-metallic material, for example artificial slate. An induction coil 3 is fitted inside the jacket 2, namely between bracket-like supports 4 on the wall of the furnace, a layer of insulating material being interposed if necessary. In order to minimize the induction current losses, the jacket 2 is divided into two parts by slits 5. The parts of the jacket which form the bottom and cover consist of separate pieces 6 and 7. An electrically insulating packing is interposed between the various parts of the jacket in the separating slits. The leads for the supply of current to the coil pass through stuffing box 8 in the jacket. The pouring channel 9, which in this form of construction is made in one piece and leads tangentially outwards from the upper part of the furnace, is formed by the refractory material 10 and widens conically outwards and is provided with a vacuum-tight jacket 11 which is connected vacuum-tightly with the jacket 2 of the furnace. The pouring channel 9 and a bearing member 12 on the furnace which is co-axial with the channel 9 act as the means whereby the furnace is supported in the bearings 13 in which it can be turned.

The casting apparatus consists of the casting funnel 14 which is enclosed by a vacuum-tight jacket and is provided with a stuffing box 15 by means of which the pouring channel 9 is vacuum-tightly connected to it. The casting apparatus also has a vacuum hood 18 which encloses the mould 17, a stuffing box 19, which makes a tight connection with a ring 16 of the jacket enclosing the casting funnel and a pipe connection 20.

In operation, after the cover has been removed, the charge to be melted is placed in the furnace, the cover is then replaced, the current is connected to the induction coil 3 until the charge melts under the action of the current. In order to subject the molten material to vacuum treatment or to the action of neutral gases, the interior of the apparatus is evacuated or filled with the desired gas through the inlet 20. After this, the crucible is turned about the pouring channel as axis until the channel is at the lowest point. The molten material then flows through the pouring channel 9 into the casting funnel 14 and thence into the mould or moulds 17 without coming into contact with air.

The apparatus illustrated in Figures 3 and 4 which comprises an unheated ladle or pan for treating, in an air-tight chamber, liquid materials or materials which have been previously liquefied, will now be described.

The pan or ladle 21 which is made of refractory material is enclosed air-tightly by the jacket 22 and is provided in its upper part with a slag passage 23 which leads radially outwards from the interior of the pan and can be extended by means of the flanged connection 24, the outside of which is connected vacuum-tightly to the jacket of the pan and can be closed vacuum-tightly by the cover 25.

The pouring channel of the pan consists firstly of the radial port 26 in the lining of the pan. An inclined pipe 27 which has a refractory lining and runs obliquely downwards and forwards is connected to the port 26 and is also connected vacuum-tightly to the jacket of the pan. The pipe 27 opens into the outlet 28 which is also tubular in form and is provided with a refractory lining, but is horizontal and perpendicular to the axis of the pan. The axis of the outlet 28 is the axis about which the pan is tilted. The outlet 28 of the pouring channel leads to a casting apparatus shown only partly in Figure 4 as having a hood 18', a casting funnel 14', stuffing boxes 15' and 19', and as being otherwise similar to the apparatus 14—20 illustrated in Figures 1 and 2.

In order to take the weight when the pan is tipped, the jacket 22 is connected at its lower end by struts 29 with the pin or pivot 30 which is horizontal and perpendicular to the axis of the pan and is supported in the bearing 31. The central axis of the pivot 30 coincides with the central axis of the outlet 28 of the pouring channel which forms the axis of rotation of the pan.

The end of the outlet 28 which faces the pivot 30 is rigidly connected to the pivot.

The pan can be closed vacuum-tightly by means of a removable cover 32 having a jacket 33 and sight hole 34. The evacuation of the contents of the pan is effected in the same manner as in the apparatus according to Figure 1. If the pan, together with its contents which are under vacuum is turned clockwise about the pivot 30, the contents of the pan rise on the side on which the pouring channel is fitted and, on turning it further through an angle of 90°, they flow through the radial port 26 and then through the pipe 27 which leads obliquely forwards and downwards to the outlet 28 and from there into the casting apparatus 14—20, illustrated in Figure 4, without coming into contact with air in the course of their passage.

The form of pan or ladle shown in Figure 5 is similar to that of Figures 3 and 4 except that it is provided with an induction heating coil 3' similar to that of Figure 1. The pan is in this case also provided with means connecting it air-tightly and rotatably with a casting apparatus not shown but similar to that of the other embodiments herein illustrated.

I claim:

1. An apparatus for treating fluid materials under sub-atmospheric pressure comprising, a container for the material to be treated having an air-tight, enclosing jacket, a second container for receiving the material from the first-mentioned container, said second container also having an air-tight jacket, a conduit for transferring the material from the first container to the second container, said conduit being air-tightly and fixedly connected to the upper portion of the jacket of the first-mentioned container, said conduit being rotatably connected with the second container, and a stuffing box for air-tightly sealing the rotatable connection of said conduit with the air-tight jacket of the second container, whereby the first container may be rotated about the axis of the rotatable connection of the conduit with the second container to transfer the material to said second container through said conduit.

2. An apparatus for treating fluid materials under sub-atmospheric pressure comprising, a container for the material to be treated having an air-tight, enclosing jacket, a second container for receiving the material from the first-mentioned container, said second container also having an air-tight jacket, a conduit for transferring the material from the first container to the second container, said conduit being air-tightly and fixedly connected to the upper portion of the jacket of the first-mentioned container, said conduit being rotatably connected with the second container, and a stuffing box fitted in the wall of the air-tight jacket of said second container for air-tightly sealing the rotatable connection of said conduit with the air-tight jacket of the second container, whereby the first container may be rotated about the axis of the rotatable connection of the conduit with the second container to transfer the material to said second container through said conduit.

3. An apparatus for treating and casting materials under reduced pressure comprising a melting furnace, a pouring conduit connected near the upper end of the melting furnace, an air-tight jacket enclosing said melting furnace and pouring conduit, a casting funnel, a mould below said casting funnel, an air-tight jacket enclosing said mould and casting funnel, a stuffing box through which one end of the pouring conduit enters the casting funnel air-tightly and in which the conduit can rotate, and a connection through which air can be evacuated from the space inside said jackets.

4. An apparatus for treating and casting materials under reduced pressure comprising a melting furnace, a tubular pouring conduit connected near the upper end of the melting furnace, an air-tight jacket enclosing said melting furnace and pouring conduit, a bearing member on said furnace arranged co-axially with said pouring conduit, bearings supporting said bearing member and pouring conduit, a casting funnel, a mould below said casting funnel, an air-tight jacket enclosing said casting funnel and mould, a stuffing box through which one end of the pouring conduit enters the casting funnel air-tightly, whereby by turning the furnace around the pouring conduit as an axis the liquid will flow from the furnace into the mould.

5. An apparatus for treating and casting materials under reduced pressure to remove gases therefrom, comprising an air-tight container for the liquid to be treated, a pouring conduit connected to said container and extending from near the top of the container downwardly and outwardly therefrom and ending in a horizontal outlet disposed substantially tangentially to the container, a second container for receiving liquid material from the pouring conduit, an air-tight jacket enclosing said second container, a stuffing box fitted air-tightly in the jacket through which the said horizontal outlet extends and in which it is air-tightly but rotatably held.

6. An apparatus for treating and casting materials under reduced pressure to remove gases therefrom, comprising a container for the liquid to be treated, a pouring conduit extending from near the top of the container downwardly and outwardly therefrom and ending in a horizontal outlet disposed substantially tangentially to the container, an air-tight jacket enclosing said container, a horizontal bearing member coaxial with said outlet, supports connecting said bearing member to said jacket, a bearing in which said bearing member is carried, a second container for receiving liquid material from the pouring conduit, an air-tight jacket enclosing said second container, and a stuffing box fitted air-tightly in said latter jacket through which the said horizontal outlet extends and in which it is air-tightly but rotatably received.

7. An apparatus for treating and casting materials under reduced pressure for removing gases therefrom, comprising an air-tight coreless induction furnace container for the liquid to be treated, a pouring conduit connected with said container and extending from near the top of the container downwardly and outwardly therefrom and ending in a horizontal outlet disposed substantially tangentially to the container, a second container for receiving liquid material from the pouring conduit, an air-tight jacket enclosing said second container, a stuffing box fitted air-tightly in said jacket and through which the said horizontal outlet extends and is air-tightly but rotatably held.

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