United States Patent

[11] 3,630,480

[72] Inventor **Shingo Inouye**
Kettering, Ohio

[21] Appl. No. **67,449**
[22] Filed **Aug. 27, 1970**
[45] Patented **Dec. 28, 1971**
[73] Assignee **The United States of America as represented by the Secretary of the Air Force**

[54] **MOLD ASSEMBLY FOR CASTING INGOTS**
5 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **249/106,** 164/335, 249/108
[51] **Int. Cl.** **B22d 7/10**
[50] **Field of Search** 249/106, 108, 201, 197; 164/335, 337; 13/33

[56] **References Cited**

UNITED STATES PATENTS

1,235,166	7/1917	Stewart et al.	249/197 X
1,789,883	1/1931	Roth	249/197
1,921,729	8/1933	Charman	249/201

FOREIGN PATENTS

1,074,828	2/1960	Germany	164/337

Primary Examiner—Robert D. Baldwin
Attorneys—Harry A. Herbert, Jr. and Cedric H. Kuhn

ABSTRACT: In a mold assembly there is provided an improved hot top comprising a plurality of wedge-shaped fire bricks or refractories which, when positioned and held together, form a refractory body having a frustum-shaped opening therein. An asbestos cloth lines the opening and extends outwardly therefrom, resting on the fire brick surfaces around the upper and lower ends of the opening. The hot top is positioned on an open mold so that the cavity in the mold and the lower and larger end of the hot top opening communicate with one another, and the asbestos cloth extending outwardly from the lower end of the hot top opening rests on an asbestos ribbon or tape covering the upper mold surface adjacent its cavity and extending a short distance into the cavity. A tundish is also provided that is positioned on the hot top. The tundish comprises a metal container having its interior surface covered with a continuous layer of a ceramic material and its outer surface covered with an electrical insulating material. Heating means in the form of resistance wire is wound around the insulating material and connected to a source of electric current. A refractory cement covers the insulating material and the resistance wire. When the tundish is in position, a bottom opening formed therein communicates with the smaller end of the opening in the hot top.

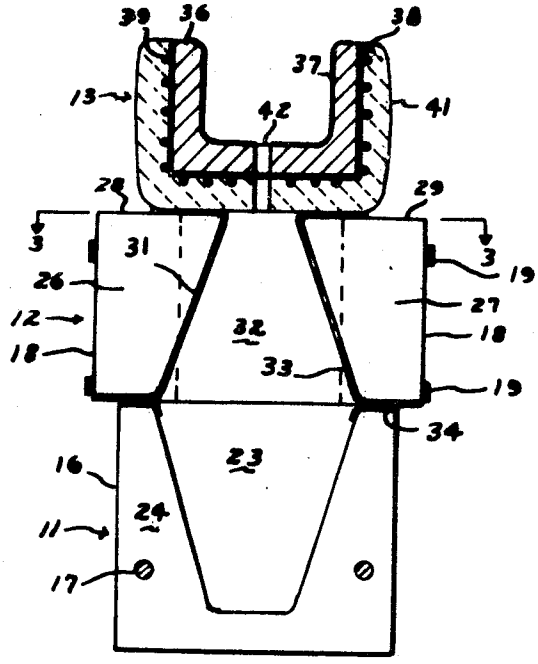


Fig-1

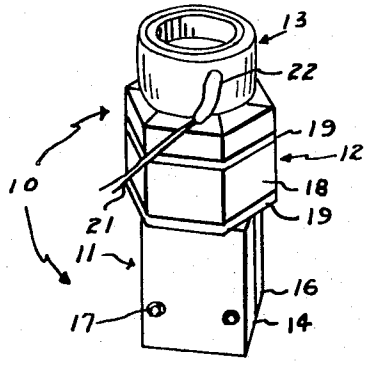


Fig-2

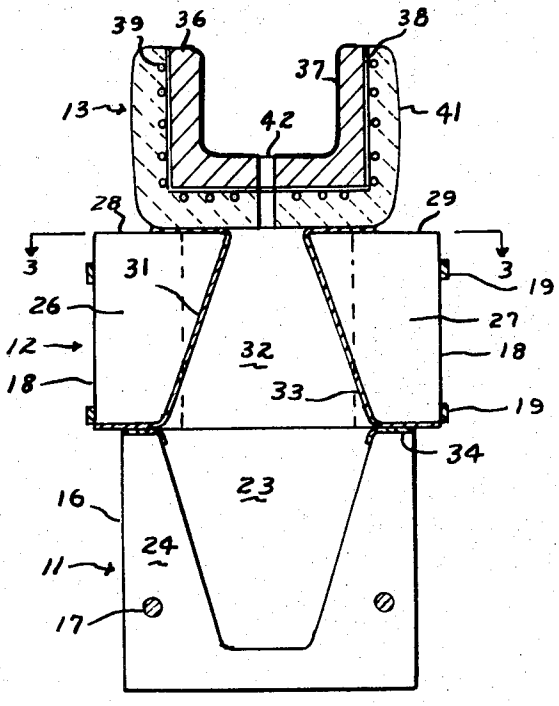


Fig-3

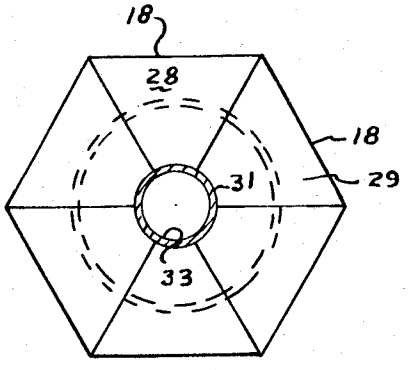


Fig-4

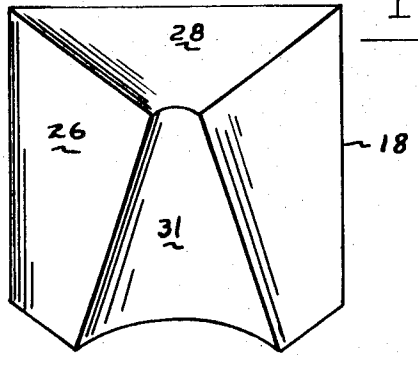
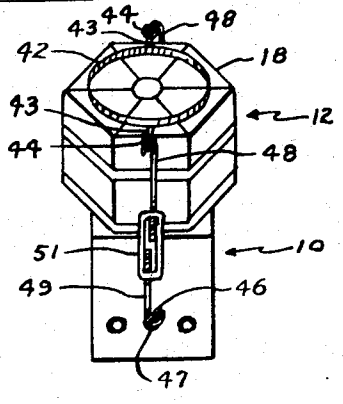


Fig-5



INVENTORS
SHINGO INOUYE
BY Harry A. Herbert, Jr.
and
Cedric H. Kuhn
ATTORNEYS

MOLD ASSEMBLY FOR CASTING INGOTS

FIELD OF THE INVENTION

This invention relates to a mold assembly comprising a mold, a hot top and a tundish. In one respect it relates to a reusable hot top. In another aspect it relates to a tundish whose temperature can be controlled.

BACKGROUND OF THE INVENTION

A mold assembly generally comprises a mold, a hot top and tundish or pouring basin, positioned one on top of another in the order named. In casting ingots it is important that the temperature or the molten metal be controlled as it passes through the tundish. It is particularly important to eliminate any possibility of the metal solidifying in the tundish.

A variety of hot tops having diverse structures are described in the literature. In general, hot tops are usually classified as reusable and nonreusable types. The reusable type generally comprises a metal casing lined with a coated refractory material. The nonreusable type is usually formed from fire clay. In the reusable type the refractory material is often in the form on a one-piece structure having a circular or square cross section or the refractory material may be in the form of slabs or arcuate segments which are cemented together. Because of their rigid structure, such hot tops are frequently difficult to remove from the solidified ingot. And in the process of removal, this difficulty may result in damages to the refractory material so that replacement of repair is necessary.

OBJECTS OF THE INVENTION

It is an object of this invention, therefore, to provide an improved mold assembly.

Another object of the invention is to provide a mold assembly that is particularly useful in casting ingots of nonferrous metals. Yet another object of the invention is to provide a tundish which incorporates means to control the temperature of molten metal that passes therethrough.

A further object of the invention is to provide a reusable hot top which can be readily removed from the solidified metal ingot.

Still another object of the invention is to provide a hot top which can be easily assembled.

A still further object of the invention is to provide a hot top which can be repaired with a minimum of difficulty.

Other and further objects and advantages of the invention will become apparent to those skilled in the art upon consideration of the accompanying disclosure and the drawing in which:

FIG. 1 is a perspective view of the mold assembly of this invention;

FIG. 2 is a vertical cross-sectional view of the mold assembly;

FIG. 3 is a plan view of the hot top of the mold assembly taken along line 3—3 of FIG. 2;

FIG. 4 is a perspective view of an individual refractory of the hot top; and

FIG. 5 is a perspective view of the hot top and mold, illustrating another embodiment of the invention.

SUMMARY OF THE INVENTION

The present invention resides in a mold assembly which includes an improved tundish and hot top. Broadly speaking, the mold assembly comprises a mold, a hot top positioned on the mold, and a tundish positioned on the hot top, the hot top comprising a plurality of wedge-shaped refractories, each having an inner edge that slopes outwardly so that when the refractories are positioned and held together with their sides abutting one another a refractory body is formed having a frustum-shaped opening therethrough. The tundish comprises a metal container, a heat-resistant material lining the interior of the container, an electrical-insulating material covering the exterior of the container, heating means adjacent the insulating material, refractory cement covering the insulating material and heating means, and an opening formed in the bottom of the container and extending through the insulating material and refractory cement.

PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to FIG. 1 of the drawing, mold assembly **10** is shown in a perspective view. The mold assembly, as illustrated, is composed of mold **11**, hot top **12** and tundish **13**. These elements of the assembly are positioned one upon the other in the order named. As depicted, mold **11** consists of two identical sections **14** and **16** which are held in contact with one another by suitable holding means, such as bolt and nut set **17**. Two such sets are employed with the illustrated mold, each bolt passing through the solid side portions of the mold sections. The mold sections can be fabricated, as by casting or machining, from any suitable material capable of withstanding the temperature to which they are to be subjected. When molding ingots of a nonferrous metal, such as aluminum, cast iron molds have been found to be satisfactory.

Hot top **12** is composed of a plurality of wedge-shaped refractory bricks **18**. As shown, six bricks are utilized so that upon placement of the bricks with their sidewalls in contact with one another a refractory body in the shape of a hexagon is formed. The bricks are not cemented together but are merely held together by means of a suitable holding means, such as metal, e.g., steel, straps **19**. While the straps encircle the bricks and maintain their vertical, inner surfaces in a tight contiguous relationship, there is a small amount of flexibility as between individual bricks. Thus, the refractory body is not a rigid structure as would be the case if the bricks were cemented or bonded together. Because of the structure of the hot top which permits a certain degree of movement as between its individual components, removal of the hot top from the solidified ingot is greatly facilitated, thereby minimizing possible damage to the refractories. Furthermore, should there be any damage, repair of the hot top can be readily and inexpensively accomplished by replacement of one or more of the bricks. While the hot top has been described as being composed of six refractory bricks, which is the preferred number, it is to be understood that the hot top can be formed from a smaller or larger number of bricks. Also, the number of straps used as the means for holding the bricks together can be varied.

Tundish **13** resting on the hot top is substantially in the shape of a cylindrical container with an open top. Electrical leads **21** connected to a source of alternating current (not shown) are further connected to an electrical heating element. The electrical heating element is not shown in FIG. **1**, being embedded in refractory cement which forms the outer surface of the tundish. A portion of electrical leads **21** adjacent the tundish is also covered with refractory cement **22** to protect their insulation from the heating coming from the molten metal as it is poured into the tundish.

An understanding of the interior structure of the mold assembly can be obtained by referring to FIG. **2**. In this figure as well as in the other figures, identical reference numerals have been used to identify the same elements. Mold **11** is depicted as having a cavity **23** which is the shape of an inverted conical frustum. In other words, the sides of the cavity slope inwardly so that the diameter of its base is smaller than that of its opening. The inner surface **24** of section **16** of the mold is shown in this figure.

In FIG. **2**, one of the vertical surfaces **26** and **27** of each of two refractory bricks **18** of the hot top is shown. The other vertical surfaces of the two bricks as well as those of the other bricks are identical in shape, An indication of the configuration of top surfaces **28** and **29** of the two bricks can be obtained by referring to FIG. **3**. Because the hot top comprises six bricks, their top surfaces are each in the shape of an equilateral triangle whose vertex has been cut away. Also, as seen from FIG. **3**, the bricks can be described as being wedge

shaped. A better appreciation of the configuration of an individual brick can be obtained by an examination of FIG. 4. In this figure, vertical sides 26, top surface 28 and inner surface 31 are shown.

The inner surface 31 of each refractory brick slopes outwardly from its upper surface. The slope begins at a line parallel to the outer brick surface and removed from the vertex of the upper triangular surface. Thus, the inner side of each brick presents a flat surface, or preferably an arcuate surface, with diverging edges which extent outwardly. When the refractory wedge-shaped bricks are held in position as shown in FIG. 2, an opening 32 in the form of a frustum is formed in the refractory body. The surface of opening 32 is lined with asbestos cloth 33 which also covers at least a portion of the upper and lower surfaces of the hot top.

The bottom of opening 32 substantially coincides with the top of mold cavity 23. Asbestos tape or ribbon 34 covers the top surface of the mold and extends a short distance, e.g., from one-half to 2 inches, down into cavity 23. The two layers of asbestos separate the lower surface of the hot top from the top surface of the mold. The arrangement described serves as a seal and as protection to the refractories from the molten metal. The asbestos cloth or ribbon is usually applied when wet after which the hot top or mold is heated to an elevated temperature, e.g., to about 1,000° F., to remove any moisture. The asbestos cloth or ribbon then adheres to the surface to which it has been applied.

Tundish 13 comprises a substantially cylindrical container or basin 36 with its upper end being open. The container is preferably formed of a mild steel although any other suitable metal capable of withstanding the high temperatures of the molten metal can be used. The interior of container 36 is lined with a ceramic material 37 to provide a surface which prevents erosion and scaling of the interior of the container as well as welding of the molten metal to the container. It is usually preferred to utilize a lining of zirconia which can be readily flame sprayed on the interior surface of the container.

The sides and bottom container 13 are lined with an electrical insulating material 38. It is generally preferred to employ sheets of mica as the insulator. A heating means or element is provided that takes the form of a spirally wound resistance wire 39. The resistance wire, preferably made of Nichrome alloy, is connected to a source of alternating current by means of electrical leads 21 as described in conjunction with FIG. 1. The resistance wire and the mica sheets with which it is in contact are covered with a layer 41 of refractory cement.

Formed in the bottom of container 36 is an opening 42, generally of circular cross section, which extends through mica layer 38 and the layer 41 of refractory cement. The diameter of opening 42 is smaller that that of the upper end of opening 32 in hot top 12. The bottom of the tundish rests on the asbestos cloth covering on the upper surface of the hot top so that molten metal poured into the tundish flows downwardly through opening 42 into opening 32 and thence into cavity 23 of mold 11. The diameter of opening 42 is sized so as to obtain a desired pouring rate. Thus, it is possible to control the rate at which the molten metal is charged to the mold cavity.

When filling the mold cavity with molten metal, sufficient metal is supplied to ensure that the cavity is completely filled. In order that this may be accomplished, an amount of metal is supplied so that the top surface of the metal extends a short distance into the hot top. While the weight of the hot top together with that of the tundish is usually sufficient to maintain the hot top in position on the mold, there may in some cases be a tendency for the rising molten metal to cause the hot top to float out of contact with the mold. In one embodiment of the invention as illustrated in FIG. 5, means are provided for maintaining the lower surface of the hot top in contact with the upper surface of the mold.

In FIG. 5 there is depicted only the mold 11 and hot top 12. Means for maintaining these two elements in contact with one another comprises a metal ring member 42 positioned on the top surface of the hot top. The ring member has a diameter such that the tundish can be positioned in the ring. Attached to opposite sides of the ring are rods 43, each of which has a small ring 44 formed at its end. Each of the mold sections has a similar rod 46 with ring 47 attached to its side. Each ring 44 is in substantially vertical alignment with and parallel to each ring 47. The outer ends of rods 48 are in the shape of a hook so as to engage rings 44 and 46 while their opposite ends are threaded so as to engage the opposite internal threads to turnbuckles 51. When turnbuckles 51 are turned in the proper direction, rods 48 and 49 are drawn together, thereby forcing ring 42 downwardly and concomitantly maintaining the bottom of the hot top in fixed contact with the top of the mold.

In forming an ingot, for example, of an alloy consisting of 95.5 weight percent aluminum and 4.5 weight percent copper, the molten alloy is poured into the tundish. The tundish has a ½-inch opening at its bottom and has been previously heated to a temperature of 1,350° F. The molten metal enters the opening in the tundish and flows downwardly therethrough into the mold cavity. Sufficient molten metal is poured into the tundish to completely fill the mold cavity and rise about 1 inch into the hot top. The molten metal solidifies in the mold from the bottom upwardly. After cooling, the ingot is removed from the mold. The removal is accomplished by removing the bolt and nut sets and separating the two mold sections. The portion of the ingot in the hot top is readily separated therefrom since the ingot can be moved laterally a small amount because of the flexible structure of the hot top. After assembling of the mold and positioning of the tundish, hot top and mold, the mold assembly is in readiness for the casting of another ingot.

As will be evident to those skilled in the art, various modifications of this invention can be made or followed in the light of the foregoing disclosure without departing from the spirit or scope of the invention.

I claim:

1. A mold assembly comprising, in combination, a mold having a cavity formed therein and open at its upper end surface; an asbestos ribbon covering said surface around said cavity and extending a short distance into said cavity; a hot top comprising a plurality of wedge-shaped refractories, each refractory having an inner, outwardly extending side, said refractories being positioned and held together in movable relationship with one another so as to form a refractory body having a frustum-shaped opening therein with upper and lower surfaces surrounding said opening; asbestos cloth lining said opening and extending outwardly therefrom so as to cover at least a portion of said upper and lower surfaces, said refractory body being positioned on said mold so that said opening and said cavity are in open communication with one another and so that said asbestos cloth lining said lower surface of said refractory body rests on said asbestos ribbon covering said surface around said mold cavity; and a tundish positioned on said hot top, said tundish comprising an open container having an interior with sidewalls and a bottom; a ceramic coating covering said interior of said container; an electrical insulating material covering the exterior of said container; an electrical heating element in contact with said electrical-insulating material; refractory cement covering said electrical-insulating material and said electrical heating element; and an opening formed in said bottom of said container and extending through said electrical-insulating material and said refractory cement, said opening communicating said interior of said container with said frustum-shaped opening in said refractory body, and said container opening having a smaller diameter than said frustum-shaped opening.

2. The mold assembly according to claim 1 in which said mold comprises two identical sections which are bolted together and said cavity is in the shape of an inverted conical frustum.

3. The mold assembly according to claim 1 in which said hot top comprises six refractories; and at least one metal strap encircles said refractories to hold them in position and form a hexagonal refractory body.

4. The mold assembly according to claim 1 in which said interior of said container is coated with zirconia; said electrical insulating material is formed of sheets of mica; and said heating element is a spirally wound resistance wire.

5. The mold assembly according to claim 1 in which an enlarged metal ring surrounds said tundish and rests on the upper surface of said hot top; a first pair of metal rods, each of which is attached to opposite sides of said ring and extends outwardly therefrom, the outer end of each rod having a small metal ring attached thereto, a second pair of metal rods, each attached to opposite exterior sides of said mold and extending outwardly therefrom, the outer end of each rod having a small metal ring attached thereto, the rings attached to said first pair of rods being substantially in vertical alignment with and parallel to corresponding rings attached to said second pair of rods; and two pairs of rod members; each rod having a hook at one end and threads at the opposite end, the individual rods of each pair being threaded into a turnbuckle with opposite internal threads and said hooks of each pair of rods being positioned in a pair of said vertically aligned rings.

* * * * *