April 1, 1958 J. F. BLACK ET AL 2,828,516

LADLE FOR CASTING METAL

Filed Feb. 8, 1955 2 Sheets-Sheet 1

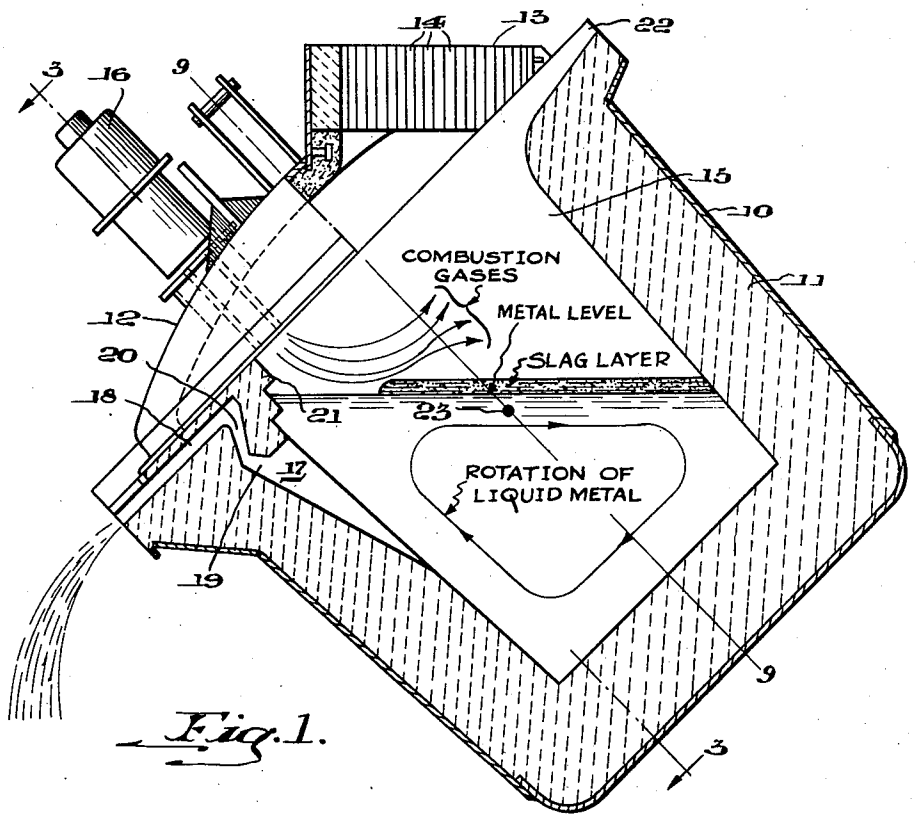

Fig. 1.

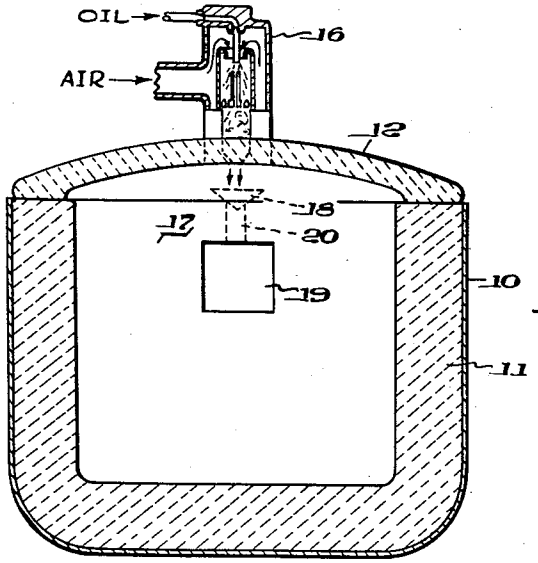

Fig. 2.

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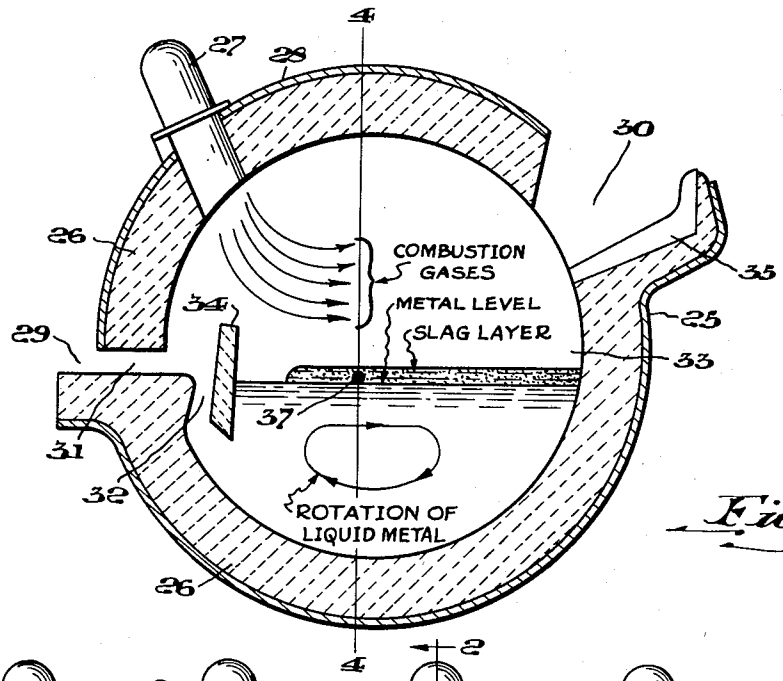

Fig. 4.

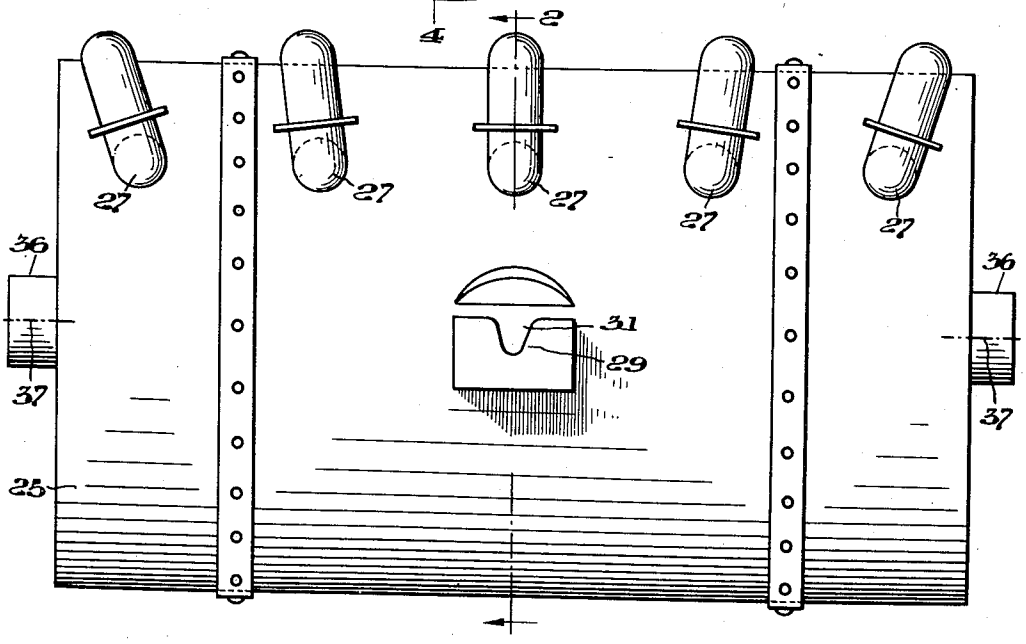

Fig. 3.

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LADLE FOR CASTING METAL

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Application February 8, 1955, Serial No. 486,840

11 Claims. (Cl. 22—83)

This invention relates to ladles for casting metal and more particularly for continuous metal casting.

It is an object of this invention to provide a ladle for molten metal, such as molten iron or molten steel, which ladle has a burner in a position to discharge hot combustion gases in a manner to force or push back from the pouring spout the slag that is collecting on the surface of molten metal and to impart a stirring motion to the molten metal to prevent stratification during pouring.

Another object of this invention is to provide a ladle for molten metal having a burner moveable along with said ladle and in a position to discharge hot combustion gases into the ladle to provide heat replacement for whatever heat is lost.

A further object is to provide a ladle for the continuous casting of metal such as for example steel, which ladle has a burner moveable along with a vessel in a position to discharge hot combustion gases into the vessel, which gases will form a neutral blanket over the molten metal preventing oxidation and loss of alloying agent such as silicon.

Additional objects and advantages will be apparent as the invention is hereinafter described in more detail.

Broadly the novel ladle of this invention comprises a vessel having a tiltable center axis and a fixed axis of rotation normal thereto, such vessel being provided with an inner lining of refractory material, a pouring spout and a burner set intermediatae the spout and the tiltable center axis of the vessel, the burner being moveable along with the vessel and adapted to discharge hot combustion gases into the vessel along the surface of the molten metal contained therein to force slag away from the pouring spout and to aid in maintaining the heat of the metal while in the vessel.

In the drawings:

Figure 1 is a vertical cross sectional view through a preferred ladle of the instant invention.

Figure 2 is a transverse sectional view taken substantially on line 3—3 of Figure 1.

Figure 3 is an end elevation view of a modification of the ladle of this invention.

Figure 4 is a transverse sectional view taken substantially on line 2—2 of Figure 3.

With reference now to Figure 1 which illustrates a preferred embodiment of this invention, an open-top vessel 10, which is advantageously a ferrous metal vessel, is lined with a refractory material 11 such as fire and insulating brick and is provided with a ladle cover 12 attached to the top portion thereof. The drawing shows the ladle tilted at an angle of approximately 45° for pouring the molten metal therefrom. The ladle cover 12 is provided advantageously with a combustion gas chimney or outlet 13 which is lined with refractory material 14, such as fire brick, to permit the combustion gases to escape from the interior or chamber portion 15 of the ladle. A burner 16 such as, for example, a high heat oil burner, which is shown in greater detail in Figure 2 of the drawings, is attached to the ladle cover 12 and intersects this ladle cover to discharge hot combustion gases (as indicated by arrows in Figure 1) in a manner such that these gases contact or strike the surface of the molten metal close to the pouring spout, which is indicated generally at 17, to force the slag away from the spout. However if it is desired not to employ a ladle cover, the burner 16 can be suspended above the open-top vessel 10 by means of a trolley, or positioned above the open-top vessel by means of suitable braces or supports attached to the vessel, such as a spider, so as to be positioned above the vessel to discharge hot combustion gases in a direction to contact the surface of the molten metal close to the pouring spout to force the slag away from the pouring spout as is hereinbefore described. The pouring spout 17 consists of an outlet spout portion 18 located beneath the ladle cover, an upwardly-extending inlet spout portion 19 communicating with the interior or chamber portion 15 of the ladle, and an intermediate spout portion 20 extending upwardly and inwardly from the inlet spout portion and interconnecting the inlet spout portion with an inner part of the outlet spout portion.

As is shown in Figure 2 of the drawings, the outlet spout portion is advantageously V-shaped and the inlet spout portion and the intermediate spout portions are advantageously square shaped in cross section. However the outlet spout portion, intermediate spout portion and inlet spout portion could be of a circular shape or square shape in cross section, or of other suitable shapes.

A dam 21 is located or disposed between the intermediate spout portion 20 and the receptacle portion 15 of the ladle. As shown the dam extends downwardly from the top of the vessel and defines in part the intermediate spout portion 20 of the pouring spout. However this dam could be a separate element, i. e., a dam that did not aid is defining the intermediate spout portion or any part of the pouring spout 17 and was not integral with the top peripheral portion of the vessel. Further this dam 21 could be an upwardly-extending element, as long as it is disposed between the intermediate spout portion and the interior of the ladle as described so as to prevent slag on the surface of the molten metal from flowing out through the pouring spout when the ladle is tilted for pouring. The vessel 10 is advantageously provided with a slag outlet 22 in the top rim of the vessel for removal of the gangue or slag from the vessel. The axis of rotation of the vessel 10 is indicated at 23 and the vertical center axis is indicated by line 9—9.

In the operation of the preferred ladle of this invention, molten metal such as molten steel is poured into the open top vessel 10 which is lined with fire and insulating brick 11 and preheated preferably to about 2400° F. with suitable ladle heating means, the ladle cover 12 having first been removed. The ladle cover 12 is then positioned on the top portion of the vessel 10 and attached thereto in the conventional manner. If desired the ladle cover 12 can be attached to the vessel during the charging operation and the molten metal charged to the ladle through the combustion gas chimney or outlet 13.

The charged ladle is then transported to an automatic tilting cradle (not shown) where the ladle is tilted for pouring. The ladle is tilted at an angle which will allow the surface of the molten metal to flow upwardly and behind the dam or lip 21, which dam or lip will then prevent the slag layer, which floats on the surface of the molten steel, from flowing out through the pour-

ing spout 17. As the molten metal is poured from the vessel 10 and the amount of molten metal in the vessel decreases, the ladle is tilted at an increasingly greater angle so as to always keep the surface of the molten metal behind the downwardly-extending lip 21 as shown in Figure 1, thereby preventing the gangue or slag which floats on the surface of the molten metal from flowing out the pouring spout.

The burner 16, which is attached to and intersects the ladle cover 12 in the preferred ladle, is ignited advantageously immediately after the molten metal has been charged to the ladle. The burner discharges hot combustion gases into the interior of the ladle, which gases contact or strike the surface of the molten metal as shown close to the pouring spout 17 at a velocity sufficient to force or push the slag back from the inlet spout portion 18 of the pouring spout.

One type of burner which is eminently adapted for use in this invention and which is disclosed generally in vertical cross section in Figure 2 of the drawings is a high heat, high velocity oil burner manufactured by the Thermal Research and Engineering Corporation of Conshohocken, Pennsylvania. In this particular burner, the exit velocity of the combustion gases, i. e., the velocity of the combustion gases as they leave the burner, generally ranges from approximately 300–500 feet/second although velocities exceeding 1000 feet/second can be obtained, if desired. The flame temperature of this burner usually exceeds 3000° F. However, it is to be emphasized that this invention is not limited to the use of any one specific type of burner such as a high heat, high velocity oil burner. Any burner, for example a gas burner, can be employed in this invention which will emit or discharge combustion gases at a temperature advantageously to maintain the metal at the temperature desired for casting and at a velocity sufficient to push or force the gangue or slag back from the inlet spout portion 18 of the pouring spout 17.

The hot combustion gases produced by the burner 16 not only obviate the need of a holding furnace and other auxiliary equipment and force or hold back the slag from the pouring spout but also create a stirring action in the metal as shown in Figure 1 when the ladle is tipped for pouring. This stirring action improves the homogeneity of the molten steel, maintains an even temperature throughout the metal in the ladle, and assists in moving the slag or gangue back from the pouring spout. The waste combustion products then pass out from the receptacle portion 15 of the ladle through a combustion gas outlet 13.

The molten metal is poured from the ladle 10 through the pouring spout 17 which comprises an outlet spout portion 18 located beneath the ladle cover 12, an upwardly-extending inlet spout portion 19 communicating with the interior or chamber portion 15 of the vessel 10, and an intermediate spout portion 20 extending upwardly and inwardly from the inlet spout portion and interconnecting the inlet spout portion with the inner extremity of the outlet spout portion. It is advantageous that the intermediate spout portion 20 extend upwardly and inwardly as described, so as to prevent gangue or slag from flowing out of the ladle before the ladle can be tilted at an angle sufficient to raise the surface of the molten metal upwardly and behind the dam or lip 21. This type of spout is called a "semi tea pot" spout. The spout could also be of the full "tea pot" type, if desired.

After the molten metal has been poured from the ladle, the gangue or slag is advantageously poured out through a slag outlet 22. However, the hot slag could be poured out through the pouring spout 17, if desired.

As a modification or different embodiment of the ladle of this invention, which modification is exemplified by Figure 3 and in more detail by Figure 4, a cylindrical vessel 25, which is advantageously a ferrous metal vessel, is lined with a refractory material 26 such as fire and insulating brick. A plurality of burners 27 such as, for example, high heat oil burners are attached to and intersect the diametrical upper half portion 28 of the vessel which is the portion located above the pouring spout indicated generally at 29. These burners intersect this upper portion of the vessel to discharge hot combustion gases (as indicated by arrows in Figure 4) in a direction such that these gases contact or strike the surface of the molten metal close to the pouring spout at a velocity sufficient to force or push the slag or gangue away from the pouring spout.

Depending on the size of the vessel, one burner or a plurality of burners can be employed. A plurality of burners 27 are employed in the ladle disclosed in Figures 3 and 4 because of the large size of this ladle with its horizontal length (as taken along line 37—37 of Figure 3) greater than its diameter (as taken along line 2—2 of Figure 3). A burner or burners eminently suited for this embodiment is the foregoing high heat, high velocity burner manufactured by the Thermal Research and Engineering Corporation. However other burners, such as, for example, gas burners can be employed in this modification which will discharge combustion gases at a temperature advantageously to maintain the metal at a temperature for casting and at a velocity sufficient to force the slag back from the pouring spout 29.

The pouring spout 29 comprises an upper outlet spout portion 31 communicating with the exterior of the vessel and a downwardly extending spout portion 32 communicating at its lower part with the interior or chamber portion 33 of the vessel and interconnecting the upper outlet spout portion with the interior of the ladle. The upper outlet spout portion 31 is advantageously substantially V-shaped in cross section but could be of a circular or square shape, if desired.

A dam 34 is located or disposed between the downwardly extending spout portion 32 and the interior or chamber portion of the vessel. As disclosed the dam defines in part the downwardly extending spout portion 32 of the pouring spout. However this dam could be a separate element and would not have to aid in defining any part of the pouring spout.

The vessel 25 is provided with an orifice 30 which is lined with refractory material such as firebrick. In this embodiment this orifice can serve two purposes, viz., to serve as an inlet for charging the steel to the vessel and to serve as an outlet for permitting the waste products of combustion to escape from the interior of the vessel.

As shown the vessel 25 is advantageously provided with a slag lip or outlet 35 for permitting the gangue or slag to be removed from the ladle after the molten metal has been removed. However the hot slag could be removed through the pouring spout 29, if desired. As disclosed in Figure 3, the vessel 25 is advantageously provided with pivot members 36 attached to the exterior of the vessel for permitting the ladle to be tilted for pouring. However if desired, these tilting members could be omitted and the ladle tilted in a suitable tilting apparatus. The axis of rotation of the vessel 25 is located at 37 and the vertical center axis is indicated by line 4—4.

The operation of this embodiment of the invention is substantially identical to the hereinbefore-described operation of the preferred embodiment. The effect of the hot combustion gases on the molten steel in the vessel is also the same as in the preferred embodiment.

It is to be understood that this invention is not limited to a ladle of any one specific shape. For example, the vessel could be rectangular in shape, drum-shaped, square in shape, round in shape, etc.

What is claimed is:

1. A ladle for casting metal comprising a vessel having a tiltable center axis and fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon,

a pouring spout, a refractory-lined orifice communicating the interior of the vessel with the exterior of the vessel, and a burner moveable along with the vessel, said burner and said orifice being both disposed in the upper portion of said vessel above said axis of rotation when said vessel is in a vertical position, and said burner being set intermediate said spout and said tiltable center axis to discharge hot combustion gases into the vessel in a direction along the surface of the molten metal and at a velocity sufficient to force the slag away from the pouring spout.

2. A ladle for casting metal comprising a vessel of greater horizontal length than width, said vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon, a pouring spout, a refractory-lined orifice communicating the interior of the vessel with the exterior of the vessel, and a plurality of burners attached to the vessel and intersecting it along its horizontal length in a region of said vessel above the normal level of the upper surface of the slag on molten metal therein, said pouring spout comprising an upper outlet spout portion communicating with the exterior of the vessel and a downwardly extending spout portion communicating at its lower part with the interior of the vessel and interconnecting the upper outlet spout portion with the interior of the ladle, a dam disposed between the pouring spout and the interior of the vessel to prevent the slag on the surface of the molten metal from flowing out through the pouring spout when the ladle is tilted for pouring, said burners and said orifice being both disposed in the upper portion of the vessel, and said burners being set intermediate said spout and said tiltable axis to discharge hot combustion gases into the vessel in a direction along the surface of said molten metal and at a velocity sufficient to force slag away from the pouring spout.

3. A ladle in accordance with claim 2 further characterized in that the refractory-lined orifice which communicates the interior of the vessel with the exterior of the vessel is an orifice in the periphery of the vessel on the side of the axis of rotation opposite the side at which the burners are disposed, said orifice comprising a radial extension beyond the periphery of the vessel terminating in an upwardly extending lip.

4. A ladle for casting metal comprising an open-top vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon; a pouring spout in the upper portion of the vessel; and a burner moveable along with the vessel; said pouring spout comprising an upper outlet spout portion communicating with the exterior of the vessel, a lower-upwardly extending inlet spout portion communicating with the interior of the vessel, and an intermediate spout portion extending upwardly and inwardly of the vessel from the inlet spout portion and interconnecting said inlet spout portion with an inner part of the outlet spout portion; said burner being set intermediate said spout and said tiltable axis to discharge hot combustion gases into the top of the vessel in a direction along the surface of the molten metal close to the pouring spout and at a velocity sufficient to force the slag away from the pouring spout.

5. A ladle for casting metal comprising an open-top vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refactory material and adapted to hold a mass of molten metal having a layer of molten slag thereon a pouring spout in the upper portion of the vessel; a ladle cover disposed over the top portion of said vessel and provided with a refractory-lined outlet for combustion products and a burner attached to said ladle

cover and intersecting it; said pouring spout comprising an upper outlet spout portion located beneath the ladle cover, a lower upwardly-extending inlet spout portion communicating with the interior of the vessel, and an intermediate spout portion extending upwardly and inwardly of the vessel from the inlet spout portion and interconnecting said inlet spout portion with an inner part of the outlet spout portion; said burner intersecting the ladle cover intermediate said spout and said tiltable center axis to discharge hot combustion gases into the vessel along the surface of the molten metal close to the pouring spout and at a velocity sufficient to force the slag away from the pouring spout.

6. A ladle for casting metal comprising an open top vessel having a tailtable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon; a pouring spout in the upper portion of the vessel; a ladle cover disposed over the top portion of said vessel and provided with a refractory-lined outlet for combustion products; a burner attached to said ladle cover and intersecting said ladle cover; said pouring spout comprising an upper outlet spout portion located beneath the ladle cover, a lower upwardly-extending inlet spout portion communicating with the interior of the vessel, and an intermediate spout portion extending upwardly and inwardly of the vessel from the inlet spout portion and interconnecting said inlet spout portion with an inner part of the outlet spout portion; a dam disposed between the intermediate spout portion and the interior of the ladle to prevent the slag on the surface of the molten metal from flowing out through the pouring spout when the ladle is tilted for pouring; said burner intersecting the ladle cover intermediate said spout and said tiltable center axis to discharge hot combustion gases adjacent said dam along the surface of the molten metal close to the pouring spout, thereby forcing the slag back from said pouring spout.

7. A ladle for casting metal comprising an open-top vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon; a pouring spout in the upper portion of the vessel; a ladle cover disposed over the top portion of said vessel and provided with a refractory-lined outlet for combustion products and a burner attached to said ladle cover and intersecting it; said pouring spout comprising an upper outlet spout portion located beneath the ladle cover, a lower upwardly-extending inlet spout portion communicating with the interior of the vessel, and an intermediate spout portion extending upwardly and inwardly of the vessel from the inlet spout portion and interconnecting said inlet spout portion with an inner part of the outlet spout portion; a dam disposed between the intermediate spout portion and the interior of the ladle to prevent the slag on the surface of the molten metal from flowing out through the pouring spout when the ladle is tilted for pouring; said burner intersecting the ladle cover intermediate said spout and said tiltable axis to discharge hot combustion gases adjacent said dam and along the surface of the molten metal close to the pouring spout and thereby forcing the slag back from said pouring spout.

8. A ladle for steel casting comprising an open-top vessel having a tiltable center axis of rotation and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten steel having a layer of molten slag thereon, a pouring spout in the upper portion of the vessel, a slag outlet in the top rim of the vessel for removal of the slag; a ladle cover disposed over the top portion of the vessel and provided with a refractory-lined outlet for combustion products and a burner

attached to said ladle cover and intersecting it; said pouring spout comprising an upper outlet spout portion located beneath the ladle cover, a lower upwardly-extending inlet spout portion communicating with the interior of the vessel, and an intermediate spout portion extending upwardly and inwardly of the vessel from the inlet spout portion and interconnecting said inlet spout portion with an inner part of the outlet spout portion; a downwardly-extending lip disposed between the intermediate spout portion and the interior of the ladle to dam the slag on the surface of the molten metal from flowing out through the pouring spout when the ladle is tilted for pouring; said burner intersecting the ladle cover intermediate said spout and said tiltable center axis to discharge hot combustion gases adjacent said lip and along the surface of the molten metal close to the pouring spout and thereby forcing the slag back from said pouring spout.

9. A ladle for casting metal comprising a vessel of greater horizontal length than width, said vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon, a pouring spout, a refractory-lined orifice communicating the interior of the vessel with the exterior of the vessel, and a plurality of burners attached to the vessel and intersecting it along its horizontal length in a region of said vessel above the normal level of the upper surface of the slag on molten metal therein, said burners and said orifice being both disposed in the upper portion of the vessel, and said burners being set intermediate said spout and said vertical center axis to discharge hot combustion gases into the vessel in a direction along the surface of the molten metal contained therein and at a velocity sufficient to force slag away from the pouring spout.

10. A ladle for casting metal comprising a vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of molten slag thereon, a pouring spout, and a burner moveable along with the vessel, said burner being set intermediate said spout and said tiltable center axis to discharge hot combustion gases into the vessel in a direction along the surface of the molten metal and at a velocity sufficient to force the slag away from the pouring spout.

11. A ladle for casting metal comprising a vessel having a tiltable center axis and a fixed axis of rotation normal thereto, said vessel being provided with an inner lining of refractory material and adapted to hold a mass of molten metal having a layer of slag thereon, a pouring spout, a ladle cover disposed over said vessel at a level above an inlet to said pouring spout, and a burner attached to said ladle cover and intersecting it, said burner intersecting the ladle cover intermediate said spout and said tiltable axis to discharge hot combustion gases into the vessel along the surface of the molten metal and at a velocity sufficient to force the slag away from the pouring spout.

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