

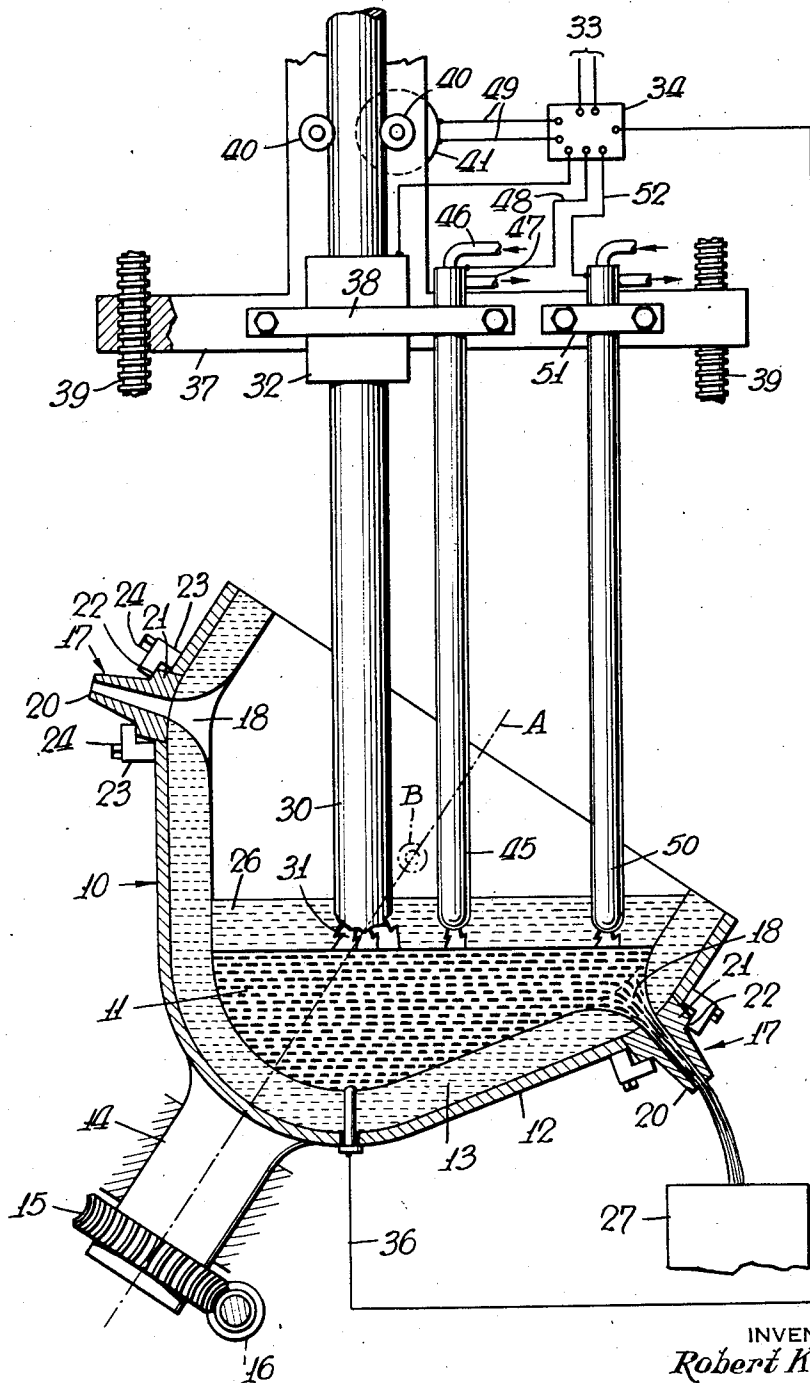
Aug. 20, 1946.

R. K. HOPKINS

2,406,147

APPARATUS FOR PRODUCING METAL

Filed May 9, 1944



INVENTOR
Robert K. Hopkins
BY *Virgil F. Davies*
ATTORNEY

44-74

UNITED STATES PATENT OFFICE

2,406,147

APPARATUS FOR PRODUCING METAL

Robert K. Hopkins, New York, N. Y., assignor to
The M. W. Kellogg Company, New York, N. Y.,
a corporation of Delaware

Application May 9, 1944, Serial No. 534,828

4 Claims. (Cl. 13—10)

1

The present invention relates to improvements in the construction of vessels for holding molten metal, and more particularly to improvements in the construction of metallurgical vessels of the type having discharge orifices. In its broader aspects, the term "metallurgical vessels" is intended to apply to any vessel adapted to hold molten metal. In accordance with certain aspects of the invention, such a vessel may, for example, consist of a furnace crucible in which metal is produced, refined or otherwise metallurgically treated, or may consist merely of a receptacle for transferring molten metal from a furnace to a mold.

In the usual metallurgical vessel, such as the conventional crucible furnace having a discharge orifice through which the molten metal is streamed, if the orifice should become fouled, eroded or otherwise impaired for use, pouring must be stopped, and the metallurgical processes being carried out interrupted until the orifice structure has been repaired or replaced.

One object of the present invention is to provide a new and improved metallurgical vessel constructed to permit continuous pouring of metal therefrom and continuous operation of any metallurgical process which may be progressing in said vessel, even though its pouring orifice structure should be impaired beyond utility.

In carrying out certain features of the present invention, the metallurgical vessel in the form of a cup-shaped crucible is mounted on an inclined axis and is provided with at least two duplicate orifice structures or devices interspaced around said vessel, and arranged in a plane substantially at right angles to said axis. The vessel is rotatable about this axis, and when said vessel is in pouring position with respect to one of the orifice structures, the other orifice structure is disposed above the horizontal level of the fluid in said vessel and out of pouring position. When the lower active orifice structure requires to be replaced or repaired, the vessel is rotated about its inclined axis, to move said orifice structure out of pouring position and the upper inactive orifice structure into pouring position. This transition from one orifice structure to the other can be quickly effected with minimum of pouring interruption. While the damaged orifice structure is in elevated inactive position, it can be repaired or replaced without interfering with the pouring through the other orifice structure. By rotating the vessel into a position intermediate of the extreme pouring positions of the two orifice structures, it is possible to raise both of said structures above the level of the liquid in the vessel, and thereby com-

2

pletely shut off flow of liquid from said vessel. In this manner, an easy and effective expedient is provided for controlling flow of the molten metal from the vessel without the use of valves or stoppers.

As another feature of the present invention, means for producing and/or heating the metal in the vessel are arranged and constructed to continue their operation without interruption irrespective of the rotative position of said vessel.

Various other objects, features and advantages of the invention will be apparent from the following particular description, and from an inspection of the accompanying drawing, which shows somewhat diagrammatically partly in vertical section and partly in side elevation an apparatus embodying the features of the present invention.

Referring to the drawing, the apparatus of the present invention comprises a metallurgical vessel 10 adapted to contain molten metal 11, such as ferrous metal, and shown specifically as a cup-shaped crucible furnace of circular cross-section. This vessel 10 is shown comprising an outer metal shell 12 with an inner refractory lining 13, but as far as certain aspects of the invention are concerned, said vessel may be made entirely of metal such as copper, and may be provided with a jacket to permit liquid cooling of the vessel.

As a feature of the present invention, the vessel 10 is tilted along an inclined axis A, and is mounted for rotary discharge emplacement. For that purpose, the vessel 10 is fixed at its bottom end to an inclined shaft 14 which extends along the axis A, and which is suitably journaled. Any suitable means may be provided for rotating the shaft 14. In the specific form shown, a worm wheel 15 fixed to the shaft 14 meshes with a worm 16 driven by a hand crank or by a motor (not shown).

The vessel 10 is provided with a plurality of equally spaced duplicate discharge orifice structures or devices 17, two being shown disposed on diametrically opposite sides of said vessel, and extending in a plane substantially at right angles to the axis A. Each of these orifice structures 17 comprises a tapering opening 18 in the wall of the vessel 10, and a nozzle or spout 20 of suitable heat-resistant material, seated against the refractory lining 13 with its aperture in registry with the wall opening 18. This spout 20 is desirably removably mounted to permit its easy replacement. For that purpose, the spout 20 has a base section 21 affording a shoulder 22 which is clampingly engaged at its diametrically opposite sides by a pair of metal holding dogs 23, secured to the shell 12 of the vessel 10 by

studs 24. By loosening studs 24, the dogs 23 may be swung out of holding engagement with the spout 20, and said spout removed for replacement, for repair or for cleaning.

The molten metal 11 in the vessel 10 is desirably maintained under a floating blanket of flux or slag 26 having the usual metallurgical function, such as that of refining the metal and/or conserving its heat. This flux 26 may be of any well-known composition suitable for performing this function.

During normal pouring operations, the metal 11 in the vessel 10 is maintained at a level above the lowermost position of either one of the discharge openings 13, as shown in the drawing. In this position of the discharge openings 13, the molten metal 11 will flow through the lowermost opening and through its spout 20 as shown, while the other opening 13 is in elevated position above the level of the slag 26. While the upper orifice structure 17 is inactive, it may be replaced, repaired or cleaned so that it can be made ready for immediate use. In the meantime, the metal 11 may be teeming through the lower active spout 20 into a suitable mold 27, such as an ingot mold.

In extreme pouring position of the vessel 10, the elevated inactive discharge opening 13 as well as a substantial portion of the refractory lining 12 around said opening is disposed above the slag 26. This permits the refractory lining 12 to be patched up around the elevated discharge opening 13, in case such repair work is required.

When it is necessary to clean, replace or repair the lower active orifice structure 17, the vessel 10 is rotated about its inclined axis A, so that this orifice structure is raised above the level of the slag 26 out of pouring position, while the other conditioned orifice structure 17 is lowered into pouring position. This rotary transition of the vessel 10 between the two extreme positions of the orifice structures 17 can be effected with minimum of pouring interruptions.

When it is desired to shut off the flow of metal, the vessel 10 is rotated in intermediate position between its two extreme pouring positions. In this intermediate position, the two orifice structures 17 will be disposed in horizontal alignment above the level of the slag 26 in approximate position B shown in dot and dash lines. In this manner, an easy and expeditious expedient is afforded for cutting off or turning on the metal flow without the use of valves or stoppers.

The vessel 10 desirably constitutes a furnace in which the metal is continuously produced as it is being discharged into a mold. As an additional feature of the present invention, the metal producing means is constructed and arranged to operate continuously without interruption, even while the vessel 10 is being rotated between its two extreme operating positions. This metal producing means desirably comprises one or more consumable electrodes 30, one being shown, containing at least some of the ingredients of the metal to be produced, and having its lower end submerged in the slag 26. Electrode 30 may be of the kind and character shown and described in my prior Patent No. 2,191,479, issued February 27, 1940. Current of sufficient intensity is discharged across this gap 31 to create a metal fusing zone in and around said gap. To create this metal fusing current discharge across the gap 31, the electrode 30 and the metal 11 are electrically connected in the same circuit. The

electrical connection to the electrode 30 may be established, as for example through a contact nozzle 32 connected to a suitable source 33 of electric current through a power feed and control unit 34, and embracing said electrode with a snug slide fit loose enough to permit the feeding of said electrode through said nozzle, but tight enough to maintain contact between said nozzle and said electrode. The electrical connection of the deposited metal 11 into the circuit of the contact nozzle 32 may be effected, as for example, through a lead 35 connected into the power feed and control unit 34.

The electrode 30 may be lowered into the vessel 10, or may be raised from said vessel by any suitable means. In the specific form shown, the electrode 30 is supported through a clamp 38 on a hoist 37 which may be elevationally moved through a pair of feed screws 39 adapted to be rotated in unison through a hand or motor unit (not shown).

The electrode 30 extends substantially vertically as shown, and is desirably arranged so that its lower end is approximately near or at the axis A. With this arrangement, the vessel 10 can be rotated without interfering with the metal producing operation of the electrode 30, and without substantially altering the position of the lower end of said electrode relative to the sides of the vessel.

As the molten metal is continuously being discharged from the vessel 10 at a certain rate through one of the orifice structures 17, metal is continuously being produced in said vessel at substantially the same rate. As the electrode is consumed, it is fed lengthwise into the metal fusing zone at a rate controlled to maintain the level of the molten metal 11 in the vessel 10 substantially constant. This controlled movement of the electrode 30 may be effected in any suitable manner, as for example through a pair of feed rolls 40 mounted on the hoist 37 and disposed on opposite sides of the electrode 30 in frictional engagement therewith. At least one of these feed wheels 40 is driven from a motor 41, while the other wheel may be positively driven from said motor or may be merely an idler serving as a guide for the electrode 30. The electrode 30 may be formed continuously and progressively from skelp as it is being fusibly fed into the vessel 10.

To control the feeding movement of the electrode 30, there is desirably provided a non-consumable pilot electrode 45, disposed alongside of said electrode, and having its lower end submerged in the slag 26. This pilot electrode 45, disposed alongside of said electrode, and having its lower end submerged in the slag 26. This pilot electrode 45, which is supported on the hoist 37, as for example by the clamp 38, may be made of high heat conductive metal such as copper, and may be formed with chambers through which a cooling liquid is circulated by means of inlet and outlet connections 46 and 47. Pilot electrode 45 is connected by a lead 48 to the control unit 34, and controls the feed movement of the electrode 30, as for example, by the voltage drop across the gap separating said pilot electrode from the metal 11 in the vessel 10. The electrode feed motor 41 is connected to the control unit 34 by the leads 48, and when the pilot electrode gap changes in length from a predetermined value, this control unit 34 in response to this change operates said feed motor correspondingly, and thereby causes the electrode 30 to be fed at a rate necessary to maintain the level of the metal

5

11 substantially constant. The details of the control unit 34 and the manner in which it controls the feed of the electrode 30 are not per se part of the present invention, and since they are well-known in the art, they are not herein described with any particularity.

In order to maintain the metal 11 near and around the actual discharge opening 18 sufficiently fluid to flow freely, there is desirably provided a non-consumable upright electrode 50 submerged at its lower end in the slag 26, and disposed directly about this opening. This heating electrode 50 may be of hollow copper construction chambered for the circulation of a cooling medium therethrough, as in the case of the pilot electrode 45, and is supported on the hoist 37, as for example a clamp 51. A lead 52 connects the heating electrode 50 to the power feed and control unit 34. By maintaining a current discharge across the gap separating the electrode 50 from the metal 11, freezing of the metal in the active discharge opening 18 is prevented, and free flow therethrough continuously maintained. The current discharge from or to this electrode 50 can be controlled automatically by the temperature of the metal near or at the active discharge opening 18.

It should be noted that the three electrodes 30, 45, and 50 are so supported and positioned as to maintain their relative position with respect to the sides of the vessel 10, irrespective of the rotative position of said vessel, and that the heating electrode 50 will remain directly above either one of the discharge openings 13 in either extreme relative position of said vessel.

As many changes can be made in the above apparatus, and many apparently widely different embodiments of this invention can be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In combination, a metallurgical vessel hav-

6

ing two duplicate discharge openings, a heating electrode in said vessel, and means for rotating said vessel to bring either one of said openings into pouring position below said electrode while moving the other opening out of pouring position.

2. A metallurgical vessel supported for rotation about an inclined axis, and having two discharge openings diametrically opposed with respect to said axis whereby one of said openings will be in pouring position below the level of the molten metal in said vessel, while the other discharge opening will be above the top level of the fluid in said vessel.

3. In combination, a metallurgical vessel supported for rotation about an inclined axis, and having two discharge openings substantially in a plane transverse to said axis, said openings being arranged whereby one of said openings will be in pouring position below the level of the molten metal in said vessel, while the other discharge opening will be above the top level of the molten content of said vessel, and a heating electrode in said vessel above one of said openings in its pouring position.

4. In combination, a crucible furnace supported for rotation about an inclined axis, and having two discharge openings diametrically opposed with respect to said axis, whereby one of said openings will be in pouring position below the level of the molten metal in said furnace, while the other discharge opening will be above the top level of the molten content of said furnace, orifice devices removably connected to said furnace adjacent to and in registry with said openings respectively, whereby said devices may be removed for repair or replacement while their corresponding discharging openings are out of pouring position, electrode means for continuously producing metal in said furnace while metal is being discharged therefrom through one of said openings, and a heating electrode in said furnace above one of said openings in its pouring position.

ROBERT K. HOPKINS.