United States Patent [19]

Saccomano et al.

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[45] **Apr. 3, 1973**

[54] MOLTEN METAL REACTOR VESSEL

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Related U.S. Application Data

[62] Division of Ser. No. 850,358, Aug. 15, 1969.

[52] **U.S. Cl.** .....**266/36 P**, 266/41

[51] **Int. Cl.**.....**C21c 5/48**

[58] **Field of Search**.....266/36 P, 36 H, 39, 41, 35, 266/15, 38

[56] **References Cited**

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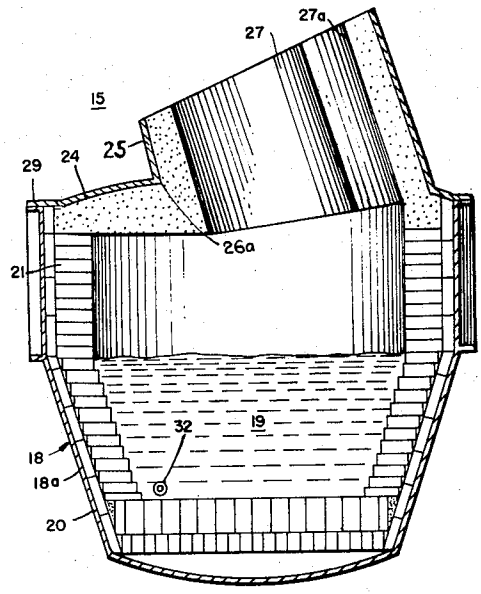
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[57] **ABSTRACT**

There is provided an improved reactor for the refining of molten metals, including an improved reaction vessel generally circular in cross section for holding a charge of molten metal, and having a lower side wall portion of the container sloping inwardly. A cover is provided on the container having edge areas projecting abruptly inwardly and having an elongated pouring spout radially inwardly of the edge areas. The reaction vessel is provided with an improved tuyere formed generally of concentric tubes of constant cross section so that the cross section of the tuyere remains constant as the tuyere erodes away with the erosion of the inner lining during successive heats of refined metal.

2 Claims, 5 Drawing Figures



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SHEET 1 OF 2

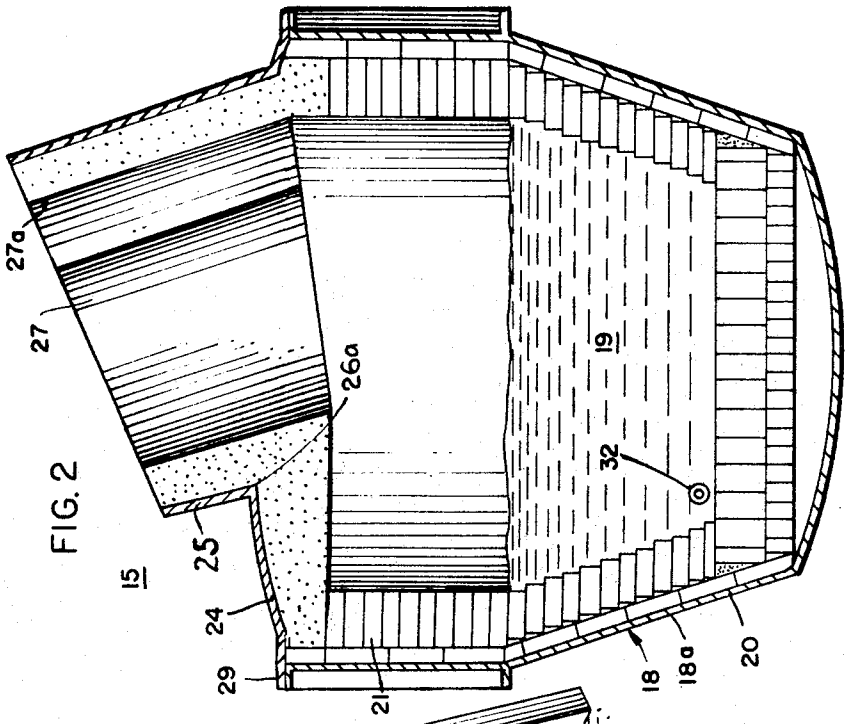


FIG. 2

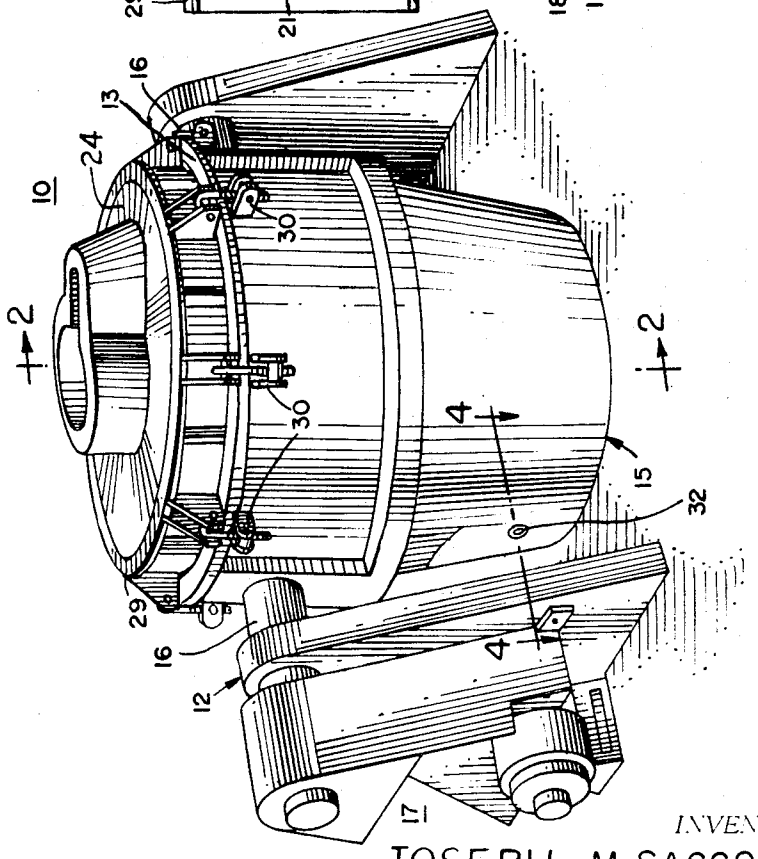


FIG. 1

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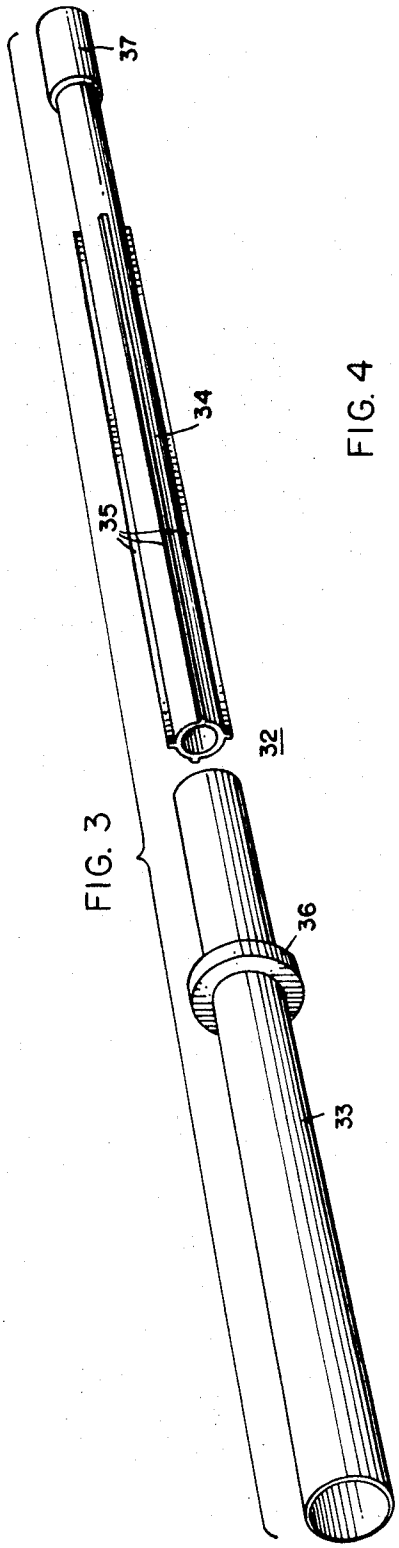


FIG. 3

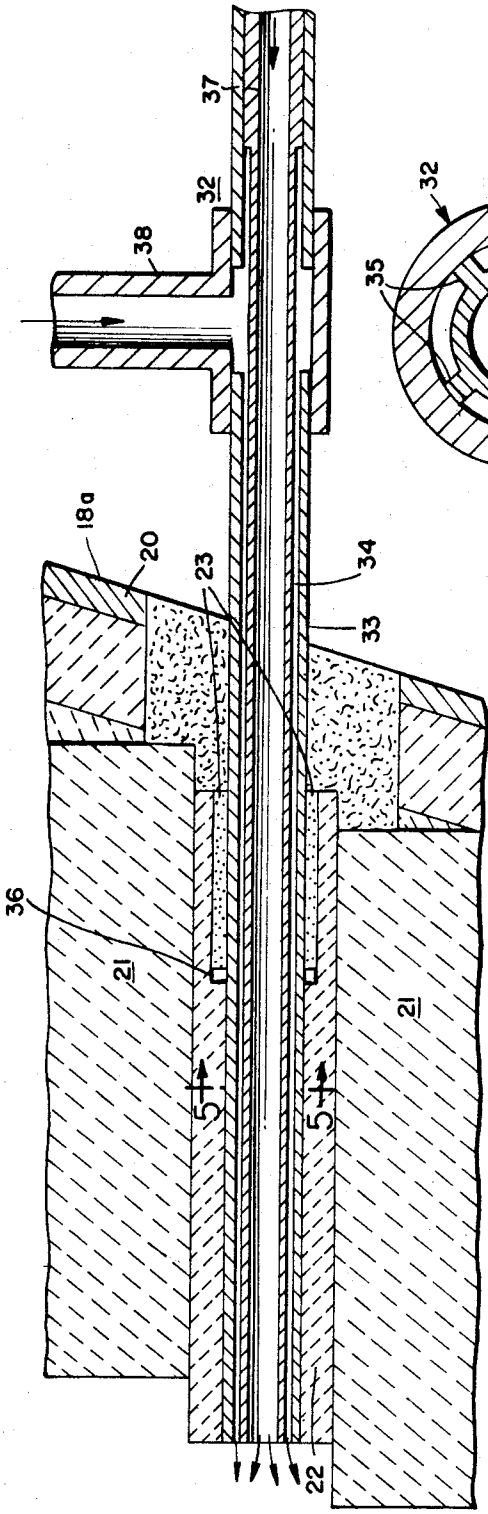


FIG. 4

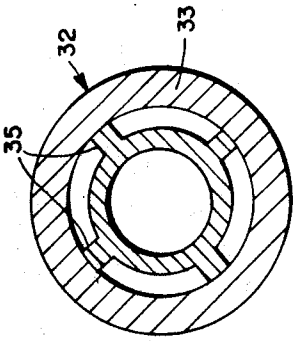


FIG. 5

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MOLTEN METAL REACTOR VESSEL

This application is a division of application Ser. No. 850,358, filed Aug. 15, 1969.

This application relates to an improved reactor, and more specifically to a reactor for the refining of molten metals such as stainless steel and the like. More specifically, the invention is directed to an improved reaction vessel for the refining of molten metals, and to an improved tuyere for blowing of fluid mixtures into the reaction vessel.

Heretofore, it has been the commercial practice in the refining of certain metals such as stainless steel to provide oxygen lancing in an electric furnace for the decarbonization of stainless steel melts which are relatively lean in chromium. The remaining necessary chrome is added to the mix after the decarbonization thereof. In order to obtain an analysis for the proper addition of chrome, it is necessary that the melt be removed from the furnace, analyzed, and charged back into the furnace to mix; and thereafter to adjust the chemical composition by the addition of chrome.

Thus, it is desirable to include in the furnace charge all of the chromium to be used, as chromium bearing scrap or charged chrome, and then decarbonized to the required carbon level with oxygen. Heretofore, such a procedure had been inefficient because of excessive chromium loss through oxidation. However, more recently, a process has been developed involving the simultaneous injection of argon and oxygen which permits decarbonization of melts in a reaction vessel containing the full optimum of chromium to low carbon levels with negligible chromium loss. The melt may contain essentially any desired amounts of carbon and silicon. Such a process uses the electric furnace for melting down scrap and alloy. The melted metal is then transferred to a reaction vessel for refining, and after refining, the molten metal is tapped into a teeming ladle.

Difficulties have been experienced in carrying out such a process. First, the life of the refractory lining in the reaction vessel has been very short; secondly, the tuyeres used for blowing in the reaction oxygen and argon have been unsatisfactory; and thirdly, the turbulence caused by reaction gases creates a splash control problem and oversizing of the vessel is necessary to contain the metal being refined. Thus, it would be desirable in the commercial carrying out of the improved argon-oxygen refining system of stainless steels to provide a reaction vessel and tuyeres for the vessel so that the splash or turbulence was confined to a smaller space. Moreover, since the vessel must be frequently rebuilt, it would be desirable if: (1) the vessel were removable from its support so that another vessel could be supplied by the furnace during the down or rebuilt time and thereby permit continuous operation; and (2) with a splash control feature, the vessel size would be reduced and less refractory would be required for rebuilding.

Accordingly, it is an object of the present invention to provide a new and improved reactor which overcomes the above mentioned difficulties.

It is an object of the present invention to provide an improved reaction vessel for the refining of molten metals.

It is a further object of the present invention to provide an improved reaction vessel for the refining of molten metals which may be removed from its supporting structure during the rebuilding or reconstruction thereof.

It is also an object of the present invention to provide an improved reaction vessel for the refining of molten metals which confines the splash or turbulence caused by the reaction gases injected into the molten metal to a small space.

Yet another object of the present invention is the provision of an improved tuyere for a reaction vessel.

Another object of the present invention is the provision of an improved tuyere for a reaction vessel which has a life approximate to that of the vessel lining.

In accordance with these and other objects, there is provided an improved reactor for the refining of molten metals, and particularly for the refining of stainless steel by an argon-oxygen decarbonization process wherein the reactor includes a readily replaceable reaction vessel carried by a vessel support structure. The vessel support structure is pivotally mounted on trunnion means to a frame, and drive means are provided for rotating the support structure for charging and tapping the vessel. Thus, the reaction vessel may readily be removed from the supporting structure for rebuilding or reconstruction of the vessel lining.

In accordance with one feature of the present invention the improved reaction vessel includes a lower wall portion sloping inwardly, with tuyeres positioned in the inwardly sloping portion thereof. The vessel is designed to be charged with molten metal to a level above the lower sloping portion. The sloping portion provides for moving the tuyeres in toward the center of the vessel so that the mixing of the argon-oxygen gases occurs closer to the center of the heat, the boiling action resulting therefrom taking place away from the side walls of the vessel and minimizing erosion thereof. In addition, the sloping bottom increases the depth of metal in the vessel and thereby increases the time that the argon-oxygen mixture passes through the molten metal.

In accordance with another feature of the present invention, the tuyeres are each formed of concentric tubes having a uniform cross section so that they are consumable with the vessel lining and last the life of the lining without a change in the characteristics of the tuyeres. Moreover, advantageously, the tuyeres provide for straight flow of the gaseous mixture, thereby preventing erosion and diverting the stream of gas mixture into the molten metal.

For a better understanding of the invention, reference may be had to the accompanying drawings wherein:

FIG. 1 is an exploded perspective view of the improved reactor;

FIG. 2 is a cross-sectional elevational view of the reaction vessel;

FIG. 3 is a fragmentary exploded perspective view of an improved tuyere;

FIG. 4 is a longitudinal sectional view of an improved tuyere; and

FIG. 5 is a cross sectional view of the improved tuyere, taken along line 5—5 of FIG. 4.

Referring now to the drawings, there is illustrated generally a reactor cam having a frame 12 including a

vessel support ring 13, and a readily replaceable reaction vessel 15 according to the present invention. The support ring 13 is typically mounted on the frame 12 by suitable trunnions 16 and a reversible drive assembly 17 is provided for tilting the reaction vessel 15 from an upright position to a tapping position.

Referring now to the reaction vessel 15, the reaction vessel 15 includes a normally vertical container 18, illustrated as generally circular in cross section, and adapted for holding a charge of molten metal 19. The container 18 is formed of an outer shell 20 of steel or other suitable material, and inner layers of refractory material 21 of chrome-magnesite brick composition or other suitable material. The lower wall portion 18a of the container 18 slopes inwardly, and in the illustrated embodiment is generally frusto-conical in section.

The reaction vessel also includes a cover 24 on the container 18 having an outer shell 25 of metal or other suitable material, and an inner layer 26 of refractory material. The inner layer 26 has edge areas projecting abruptly inwardly, as at 26*a* thus preventing splashing of the molten metal during boiling and the like from escaping from the vessel and permitting a larger charge of molten metal 19 within the reaction vessel 15. The cover 24 further includes an elongated pouring spout 27 positioned generally radially inwardly of the edge areas to provide for charging, sampling, holding, or tapping of the molten metal. Advantageously the spout 27 is generally key-shaped, having a projecting edge portion 27*a* aligning generally with an edge portion of the container 18 thereby permitting complete tapping of the reaction vessel 15.

For supporting the reaction vessel 15 without the support ring 13, the container 18 is provided with outwardly extending support feet 29 which rests on the upper surface of the support ring 13. Hold-down clamps 30 secured to the support ring 13 hook over the support feet 29 to secure the reaction vessel 15 to the support ring 13.

To provide for blowing in suitable reaction or refining fluids, such as a mixture of argon and oxygen, there is provided a suitable number of tuyeres 32, here shown as 2 in number and positioned at about 90° to each other on the side of the trunnions 16 which would be away from the pouring side of the reaction vessel 15 during tapping and the like. Each of the tuyeres 32 extends through the inwardly sloping lower wall portion of the reaction vessel 15 in contact with the heat of molten metal during refining thereof. Thus, the tuyeres 32, which are subjected to the high temperature of molten metal, will erode with the erosion of the refractory lining 21 in this area. Moreover, each of the tuyeres 32 includes an outer tube 33 and a concentric inner tube 34. The tuyeres 32 extend through the side wall of the reaction vessel 15, an inner portion thereof extending the thickness of the refractory layer 21. Throughout this layer the inner tube 34 is provided with a plurality of ribs 35 which serve to maintain the concentric spacing of the inner and outer tubes 34 and 33, and further serve to direct a longitudinal flow of fluids from the chamber between the tubes.

For positioning the tuyeres 32 within the side wall, the outer tube 33 is provided with an annular flange or washer 36 which is secured with refractory mortar 23 inside the countersunk portion of the refractory shape 22. The refractory shape 22 is of the same material composition and shape as the refractory lining 21. A suitable fitting 37 provides for connection of the inner tube 34 to a suitable source of fluid, and an additional fitting assembly 38 provides for connection of the generally annular chamber formed between the inner and outer tubes to a source of pressurized fluid.

From the above detailed description, the operation of the improved reactor is believed clear. However, briefly, it will be understood that the reactor includes an improved reaction vessel, removably supported in a support ring 13 mounted on suitable trunnions. The reaction vessel 15 includes a spout 27 and may be tilted forwardly, as viewed in FIG. 1, for tapping, sampling, and the like. Advantageously, the reaction vessel 15 may be removed from the support ring 13 for necessary reconstruction upon deterioration of its lining, and a replacement vessel may be provided for continuing the operation. Advantageously, the cover to the container 18 is provided with abruptly, inwardly extending projections 26*a* which confine splash of the molten bath during the refining thereof.

The improved tuyeres 32 are spaced on the upper side of the reaction vessel 15 when the reaction vessel 15 is tipped for tapping so that the tuyeres are out of contact with the molten bath and deterioration thereof is minimized.

It will be understood that in a typical refining of the molten metal, suitable mixtures of refining and cooling fluids are supplied through the tuyeres 32. In the improved process of refining stainless steel, oxygen, argon or a mixture of argon-oxygen may be introduced through the inner tube 34, and commercially pure argon or another inert gas supplied through the chamber formed between the inner and outer tubes 34 and 33 to provide for cooling of the tuyeres and surrounding refractory. It is understood that the argon does not combine chemically with the molten metal, but may form a catalyst for the decarbonization of the metal.

The location of the tuyeres 32 in the inwardly sloping lower surface of the reaction vessel provides for the blowing of the reaction gases toward the center of the molten heat, and the direction of the gases toward the center of the heat minimizes erosion of the lining above the tuyeres.

It has been found that the cover configuration with the abruptly inwardly extending upper edges minimizes the buildup of solidified metal around the pouring spout, reduces maintenance of removing the buildup and extends the useful life of the reaction vessel.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An improved reaction vessel for the refining of molten metals and comprising:

a normally vertical container generally circular in cross section for holding a charge of molten metal, the lower wall portion of said container sloping inwardly, said container being formed of

an outer shell and

an inner lining of refractory material;

tuyere means extending through said lower wall portion of said container for supplying submerged injection of pressurized fluids into the interior of a heat of molten metal, said tuyere means compris-

ing an outer tube extending through the wall of said vessel, an inner tube concentrically aligned within said outer tube to form an annular chamber therebetween, and straight ribs extending from one tube to the other tube so as to provide a longitudinal flow of fluid from said annular chamber into said molten metal; and

cover means for said container including edge areas projecting abruptly inwardly and an elongated spout positioned radially inwardly of said edge areas, said cover means permitting the escape of process gases from said reaction vessel.

2. An improved reaction vessel as set forth in claim 1 wherein said tuyere means direct said pressurized fluids substantially toward the center of the bath, said pressurized fluids being injected in a direction substantially parallel to the surface of the molten metal and said tuyere means are of constant cross section throughout at least an inner portion of said inner lining whereby erosion of said lining and said tuyere means with successive heats of refined metal does not alter the cross-sectional configuration of the tuyere means.

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