

Feb. 20, 1973

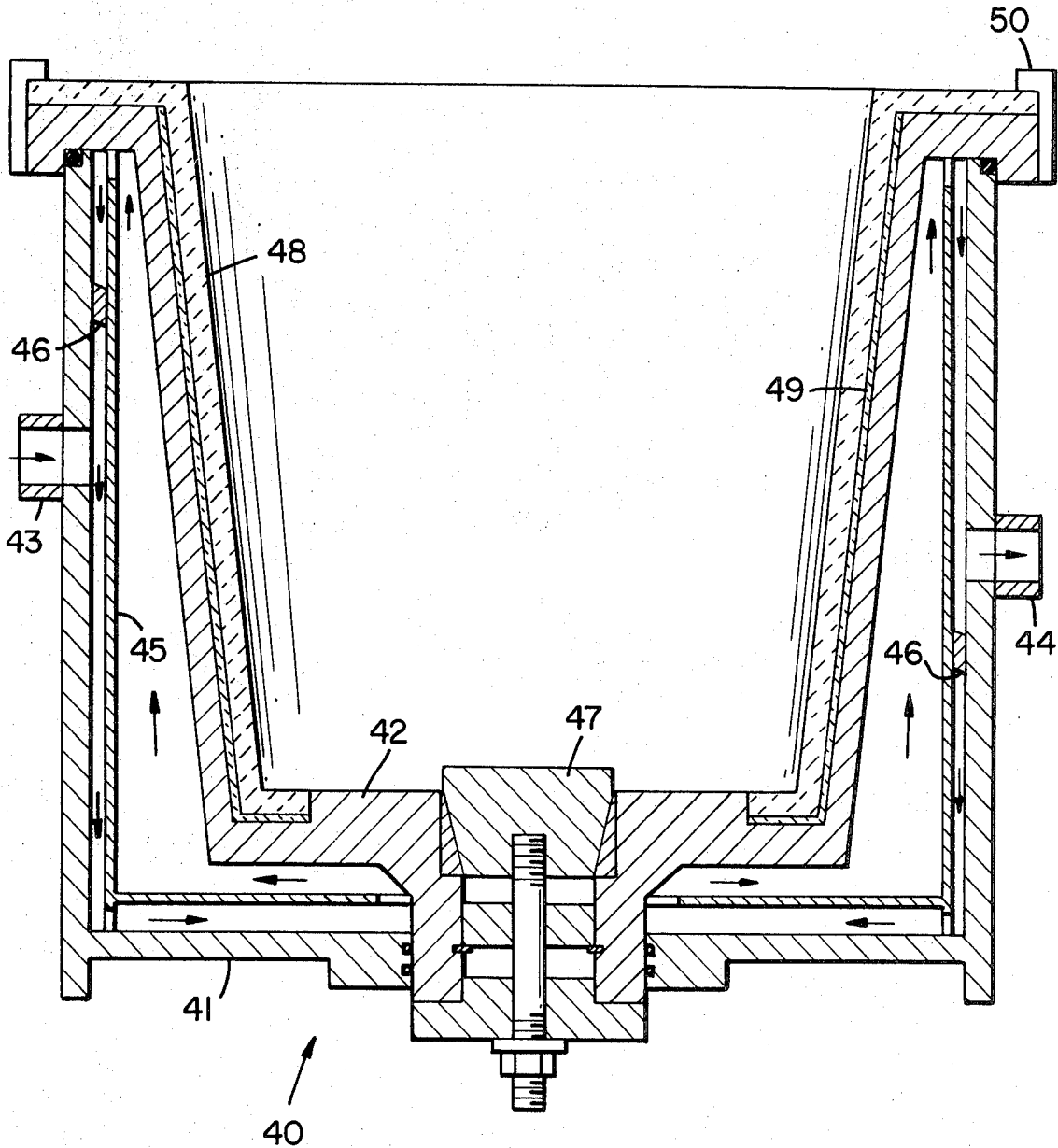
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3,717,713

ARC FURNACE CRUCIBLE

Filed Feb. 18, 1971

2 Sheets-Sheet 2



FIG_2

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ARC FURNACE CRUCIBLE

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Filed Feb. 18, 1971, Ser. No. 116,428

Int. Cl. H05b 7/02; F27b 14/10

U.S. Cl. 13-9

15 Claims

ABSTRACT OF THE DISCLOSURE

An arc furnace crucible having a central recess. A pre-formed, conically-tapered plug of the material to be melted is secured within the recess in good electrical connection with the inner wall of the crucible. The plug of material to be melted may be employed as the starting material for the arc furnace and will thereafter insure good electrical conductivity between the crucible and the melt. According to a second embodiment of the present invention, an arc furnace crucible is provided with a liner of refractory material covering the sidewalls of the crucible. The refractory liner functions to minimize heat conduction from the melt to the crucible, thus improving the thermal efficiency of the arc furnace. A layer of heat insulating material may be disposed between the refractory liner and the crucible to further minimize heat loss.

This invention relates to arc furnace crucibles.

Arc furnaces generally incorporate a melt contained within a crucible and an electrode which is arranged to establish an arc to the melt in order to create a sufficient temperature gradient to melt materials. One commonly employed technique utilizes a previously molded, consumable electrode, in which the electrode itself constitutes the material which is to be melted. In other applications where powder or sponge material is to be melted, a non-consumable electrode is employed to create the requisite arcs. In all of such arc furnaces, the arcs result from the application of a high electrical potential difference between the electrode and the melt. Generally, a conductive crucible is employed, electrical connection to the melt being achieved by connecting one polarity of an electrical source to the crucible.

In such arc furnaces it is important to establish good electrical conductivity between the crucible and material contained therein. Specifically, poor electrical connection between the melt and the crucible will result in the formation of one or more secondary arcs between the melt and the crucible, which arcs will cause the erosion and deterioration of the crucible. Typically such poor electrical connection between the crucible and the melt occurs when the skull, or remnant of the previous melt which lines the inside of the crucible, becomes oxidized due to the presence of air in the furnace, which oxide possesses a high electrical resistance. Alternatively, poor electrical connection between the melt and the crucible may result from shrinkage of the skull due to the cooling thereof, thus resulting in a physical separation between the skull and crucible.

In addition, conventional metallic arc furnace crucibles suffer from considerable heat losses through conduction of melt heat to the crucible. This unduly burdens the crucible cooling system and results in low thermal efficiency, and thus inefficient arc melting.

These drawbacks are overcome in accordance with the present invention by providing an arc furnace crucible having a central recessed cavity. A pre-formed conically tapered plug of the material to be melted is secured within this cavity in good electrical connection with the inner wall of the crucible. The plug of material to be melted is

employed as the starting material for the arc furnace. In this manner, the plug will melt and become an integral part of the crucible skull. Thereafter, good electrical contact between the skull and the crucible is assured by the attachment of the plug within the cavity in the crucible.

In accordance with another embodiment of the present invention, there is provided an arc furnace crucible having a liner of refractory material covering the side walls of the crucible. Such a refractory liner will function to minimize heat loss through the side walls of the crucible, thus increasing the efficiency of the arc furnace. The refractory liner may be extended to cover a portion of the bottom of the crucible, and may be employed with a crucible incorporating the starting plug of material to be melted referred to hereinbefore. In addition, a layer of heat insulating material may be disposed between the refractory liner and the crucible to further minimize heat loss.

It is thus an object of the present invention to provide an arc furnace crucible particularly adapted to establish good electrical conductivity between the crucible and the material to be melted.

Another object of the present invention is to provide an arc furnace crucible having a central recessed cavity and a pre-formed plug of the material to be melted secured within the cavity, the plug of material to be melted being employed as the starting material of the arc furnace.

Yet another object of the present invention is to provide an arc furnace crucible that is particularly adapted to minimize heat losses and thus improve the efficiency of the arc furnace.

Still another object of the present invention is to provide an arc furnace crucible having a liner of refractory material covering the side walls of the crucible.

These and other objects, features and advantages of the present invention will be more readily apparent from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a side cross-sectional view of an arc furnace crucible according to a preferred embodiment of the present invention; and

FIG. 2 is a side cross-sectional view, similar to FIG. 1, of another embodiment of the present invention.

Referring initially to FIG. 1, there is provided an arc furnace crucible 15 having an outer housing 16 and an inner metallic crucible shell 17. The peripheries of housing 16 and crucible shell 17 are engaged, crucible shell 17 being disposed within housing 16, and an O-ring or other suitable seal 18 is disposed therebetween to insure fluid tight mating thereof. The central portion of crucible shell 17 comprises a downwardly extending tubular flange portion 17a which is engaged with a central aperture in housing 16. A plurality of O-rings or seals 19 are disposed between the flange portion 17a of crucible shell 17 and the central aperture of housing 16, insuring fluid-tight engagement thereof. Thus, crucible shell 17 and housing 16 are centrally and peripherally engaged to define a hollow crucible interior.

Access to an exit from the hollow interior thus defined between crucible shell 17 and housing 16 is respectively provided by an intake port or aperture 20 and an exhaust port or aperture 21 in housing 16. Disposed within the hollow interior defined by crucible shell 17 and housing 16 is a baffle 22. Baffle 22 includes a plurality of ducts or passages 22a. A diagonally-oriented angular ring 23 is disposed between baffle 22 and housing 16, baffle 22 and ring 23 cooperating to define a coolant fluid path as indicated by the arrows on FIG. 1. Thus, coolant fluid may be introduced into intake port 20 and exited from exhaust port 21, so to cool crucible shell 17. The foregoing cruci-

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ble cooling system is old in the art, and is described herein for illustrative purposes only, it being understood that the arc furnace crucible according to the present invention may be employed with alternative conventional cooling systems.

The interior of the downwardly extending tubular flange portion 17a comprises a stepped cylindrical aperture defining two bore portions 25 and 26, the upper bore portion 25 being of somewhat greater diameter than the lower bore portion 26. Disposed within the upper bore 10 25 is an annular ring 27 of wedge-shaped cross-section. A conically tapered plug 28 of the material to be melted is disposed within annular ring 27. In particular, plug 28 is threadably attached to a shaft 29. A nut 30 at the other end of shaft 29 bears against a disc or bottom plate 31 15 to urge plug 28 downwardly into ring 27. Preferably, but not necessarily, ring 27 may comprise a segmented copper ring, so that as plug 28 is urged downwardly, ring 27 will expand somewhat to provide tight mechanical fit between plug 28, ring 27 and bore 25. In this manner, good electrical conductivity between crucible shell 17 and plug 28 20 is assured. Furthermore, provision of a segmented annular ring 27 assists in the removal of plug 28, should this be desired. Typically, removal of plug 28 would be necessary if the material to be melted is to be changed. In 25 order to accomplish such removal, nut 30 may be removed allowing ring 27 to contract, and thus permitting plug 28 and ring 27 to be vertically withdrawn from bore 25.

Preferably, but not necessarily, plug 28 is of sufficient 30 length to vertically project above the bottom of crucible shell 17, so that if an electrode is disposed in proximity to the bottom of crucible shell 17, a preferred path of arcing will exist between the electrode and plug 28. As will be described in greater details hereinafter, plug 28 35 may thus be advantageously employed as the starting point or starting material of the arc furnace.

A disc 32 is mounted within bore 26 by a retaining ring 33. Disc 32 is thus disposed beneath plug 28 and 40 functions as a chill plate for solidifying melt material impinging thereon, should plug 28 melt. Accordingly, the leakage of melt material will be substantially prevented.

In operation, an electrode (not shown in FIG. 1) of either the consumable or nonconsumable types is initially 45 disposed adjacent plug 28. A source of high energy electrical power is provided, the respective polarities of which are connected to the electrode and crucible 15. This obviously establishes a high energy potential difference between the electrode and crucible 15, causing one or more arcs to be developed from the electrode to plug 28. The 50 arcs, of course, create a sufficient temperature to cause the desired melting action. Simultaneously with the foregoing melting action, coolant fluid may be introduced into intake port 20 and exited from exhaust port 21 to accomplish cooling of crucible shell 17.

As the arc melting progresses, the arc furnace crucible 15 may thereafter be employed in a conventional manner. However, by providing a plug 28 of melt material, 55 and starting the arc thereon, damage to the crucible due to secondary arcing is substantially eliminated. Furthermore, plug 28 will thereafter form an integral part of the skull or remnant of melt material left within 60 crucible shell 17, so that good electrical conductivity between the skull and the crucible will be assured.

Referring now to FIG. 2, there is provided an arc furnace crucible 40 according to another embodiment of 65 the present invention. Specifically, there is provided an outer housing 41 and an inner metallic crucible shell 42, housing 41 and crucible shell 42 being engaged in the same manner described with respect with the embodiment depicted in FIG. 1. Thus, crucible shell 42 and 70 housing 41 are centrally and peripherally engaged to define a hollow crucible interior.

Access to an exit from the hollow interior thus defined is respectively provided by an intake port or aperture 75

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43 and an exhaust port or aperture 44 in housing 41. Disposed within the hollow interior is a baffle 45 and a diagonally-oriented annular ring 46, which function to 5 define a path of coolant flow indicated by the arrows in FIG. 2, substantially identical to that described with respect to the embodiment depicted in FIG. 1.

A conically tapered plug 47 of the material to be melted may be mounted in the bottom of crucible shell 42, substantially as described with respect to the embodiment of the present invention depicted in FIG. 1. Alternatively, plug 47 may be omitted and a conventional flat metallic crucible bottom provided.

According to this embodiment of the present invention, a crucible liner 48 of refractory material may be provided within crucible shell 42. Refractory liner 48 may be retained in crucible shell 42 by a plurality of retaining brackets 50. As depicted in FIG. 2, refractory liner 48 may completely cover the side walls of crucible shell 42, and may extend horizontally to cover a portion of the bottom thereof. Refractory liner 48 functions to reduce 20 the conduction of heat from the melt to the crucible, thus improving the thermal efficiency of the arc furnace. Additionally, an insulating layer 49 may be disposed between refractory liner 48 and crucible shell 42 to further minimize such heat losses. Preferably, but not necessarily, the bottom surface of crucible shell 42 includes a suitable recess for the periphery of refractory liner 48 and 25 insulating layer 49, so as to form a smooth crucible bottom.

In operation, crucible 40 may be employed in substantially the same manner described with respect to the embodiment of the present invention depicted in FIG. 1. However, the conduction of heat from the melt to the crucible will be minimized by refractory liner 48 and insulating layer 49, thus improving the thermal efficiency 30 of crucible 40 by minimizing such heat losses.

While particular embodiments of the present invention have been shown and described, it is apparent that adaptations and modifications may be made without departing from the true spirit and scope of the present invention, as set forth in the claims.

What is claimed is:

1. An arc furnace crucible comprising a crucible shell having a tapered recess in the bottom thereof, a downwardly tapering frusto-conical plug of the material to be melted, a shaft secured to the bottom of said plug, and means drawing said shaft downwardly within said recess for releasably engaging said plug in said recess.

2. Apparatus according to claim 1 comprising a metallic annular ring of wedge-shaped cross section complementary to the taper of said plug disposed within and defining said recess, said plug being engaged within said annular ring.

3. Apparatus according to claim 2 wherein said annular ring is segmented.

4. Apparatus according to claim 1 wherein said plug extends upwardly above the bottom surface of said crucible shell.

5. Apparatus according to claim 1 wherein the lower end of said shaft is threaded and said means urging said shaft downwardly comprises a nut threadably engaging the lower end of said shaft.

6. Apparatus according to claim 1 wherein said crucible shell is metallic and further comprising a liner of refractory material disposed within said crucible shell, said liner substantially covering at least the sidewalls of said crucible shell.

7. Apparatus according to claim 6 comprising a layer of heat-insulating material disposed between said liner and said crucible shell.

8. In a melting and casting arc furnace of the type having an enclosed housing forming a controlled ambient atmosphere, a crucible mounted in said housing for containing a melt and an electrode adapted to produce an arc to the melt, the improvement comprising: a down-

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wardly tapering frusto-conical plug of the material to be melted disposed in a tapered recess in the bottom of said crucible, a shaft secured to the bottom of said plug and means drawing said shaft downwardly within said recess for releasably engaging said plug in said recess.

9. Apparatus according to claim 8 comprising a metallic annular ring of wedge-shaped cross section complementary to the taper of said plug disposed within and defining said recess, said plug being engaged within said annular ring.

10. Apparatus according to claim 9 wherein said annular ring is segmented.

11. Apparatus according to claim 8 wherein said plug extends upwardly above the bottom surface of said crucible shell.

12. Apparatus according to claim 8 wherein the lower end of said shaft is threaded and said means urging said shaft downwardly comprises a nut threadably engaging the lower end of said shaft.

13. Apparatus according to claim 8 wherein said crucible shell is metallic and further comprising a liner of refractory material disposed within said crucible shell, said liner substantially covering at least the sidewalls of said crucible shell.

14. Apparatus according to claim 13 comprising a layer

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of heat-insulating material disposed between said liner and said crucible shell.

15. An arc furnace crucible comprising a crucible shell having a recess in the bottom thereof, a plug of the material to be melted complementary to said recess, a shaft secured to the bottom of said plug, extending downwardly through an aperture in said crucible and drawing means on said shaft below said crucible drawing said shaft downwardly within said recess for releasably engaging said plug in said recess.

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U.S. Cl. X.R.