April 7, 1964 R. C. UPTON 3,128,327

METAL MELTING FURNACE

Filed April 2, 1962 2 Sheets-Sheet 1

FIG.1.

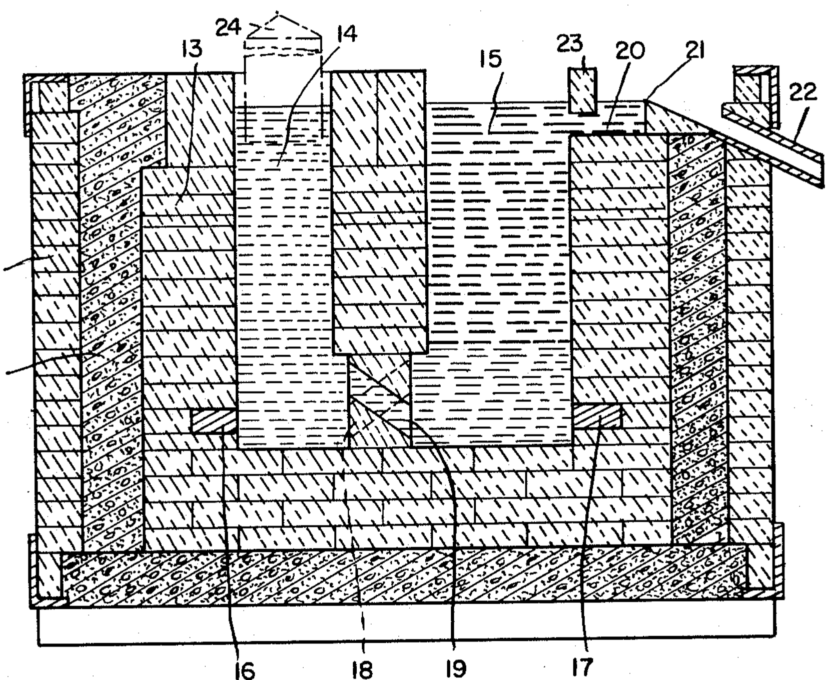


FIG.3.

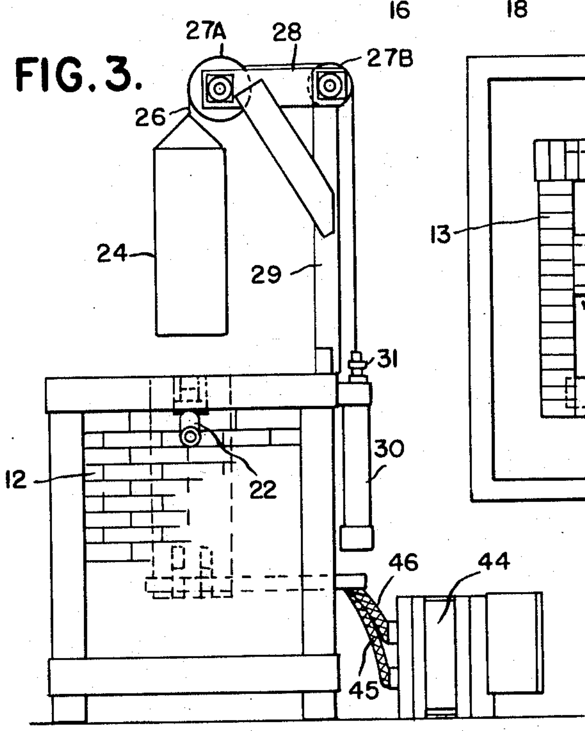
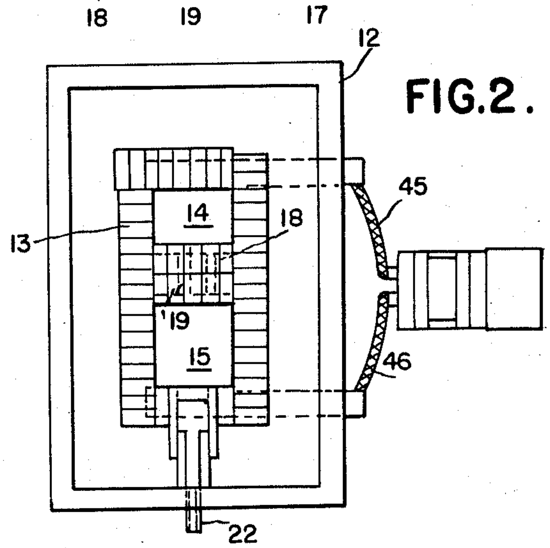


FIG.2.



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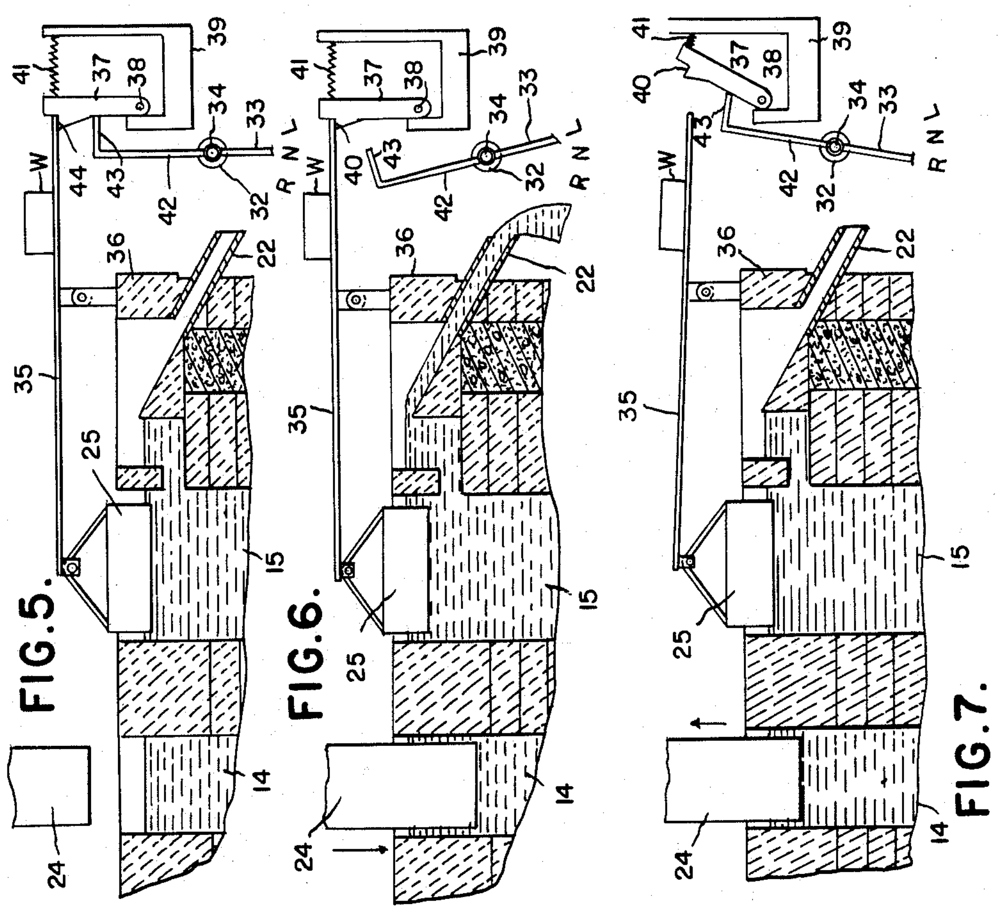

FIG. 5.
FIG. 6.
FIG. 7.

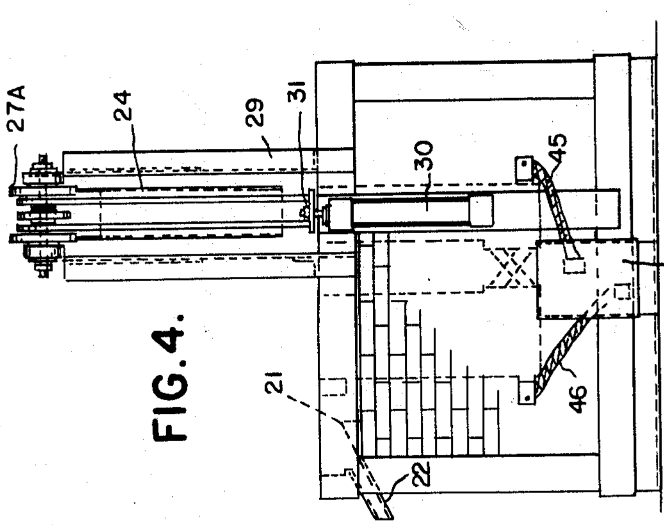

FIG. 4.

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3,128,327
METAL MELTING FURNACE

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11 Claims. (Cl. 13—33)

The invention relates to electric furnaces wherein the heat is supplied by the passage of electric current through a molten resistance material such as a chemical salt. More particularly, the invention relates to a molten salt furnace adapted for melting metals, especially aluminum.

This application is a continuation-in-part of my co-pending application Serial No. 30,794, filed May 23, 1960, now Patent No. 3,085,124.

The principal object of the invention is to obtain a practical and efficient electric furnace for melting aluminum, maintaining it in molten form, and conveniently discharging the molten aluminum.

Another object of the invention is to provide an electric furnace in which a molten chemical salt is used as the medium for melting the metal and maintaining it at the desired temperature for pouring.

A further object is to provide an electric melting furnace with an improved means for pouring the molten metal without tilting.

A more particular object is to accomplish the discharge of the molten metal from the furnace by a displacement means which is immersed in the molten salt and does not contact with the molten metal.

Another object is to provide a displacement pouring system having an auxiliary device designed to cause an immediate cessation of flow whenever the operator desires.

Still another object of the invention is to provide a control mechanism for the discharge device by which an auxiliary displacer is co-ordinated with the main displacer to aid in the halting of the discharge of the metal at the precise predetermined moment.

These and other objects are accomplished by the electric furnace hereinafter more fully described.

In the drawings:

FIGURE 1 is a vertical sectional view of a furnace.

FIGURE 2 is a top plan view partly in section.

FIGURE 3 is a side elevation.

FIGURE 4 is a rear view.

FIGURES 5, 6 and 7 are diagrammatic views, showing an auxiliary displacer and the method of controlling the discharge of molten metal.

As shown in the drawings, the furnace has a monolithic ceramic wall **11**, and outer brick wall **12** and interior brick walls **13**. The inner brick portion **13** is built to provide two interconnected chambers **14** and **15**, the first for molten salt only, and the second for molten metal on top of the molten salt. These two chambers each extend vertically within the furnace and are of rectangular cross section. Near the bottom of the chambers **14** and **15** are the rectangular electrodes **16** and **17** extending horizontally across the furnace, with one face of each in alignment with an outside wall thereof. Between the bottom portions of the two chambers are one or more pairs of cross channels **18** and **19**. Channel **18** extends upwardly from left to right as shown in FIGURE 1 while channel **19** extends upwardly from right to left. Each of the passageways is of small cross section relative to its length, so that the electrical resistance through the molten salt in each is high compared with the electrical resistance through the molten salt in the chambers themselves. The electric current flows between the electrodes **16** and **17** passing from electrode **16** through the salt in chamber **14**, then dividing and flowing through the two separate

passageways **18** and **19**, and finally passing through the salt in chamber **15** to the electrode **17**. The heat is developed to a greater extent within the cross passages **18** and **19** then it is in the chambers **14** or **15**. This heating effect causes the heated molten salt to rise in the inclined passageways which, in turn, causes a turbulence or circulation of the molten salt between the two chambers **14** and **15**. The development of heat by the cross passageways in this manner is disclosed and claimed in my co-pending Patent No. 3,085,124 issued April 9, 1963.

The metal is melted in the chamber **15** by feeding ingots or scrap metal into the top of the chamber. When the furnace is filled to capacity, the molten aluminum floats on top of the salt in the chamber **15**. The furnace is initially supplied with sufficient molten salt of greater specific gravity than the molten metal so that the salt not only occupies all of the chamber **14** and the cross passages **18** and **19** but also occupies the lower portion of the chamber **15** to a point substantially above the height of the top of the passage **18**. A hydrostatic balance is maintained because the two chambers are in communication through the cross passages.

At the top of the chamber **15**, there is a laterally extending offset portion **20** terminating in a discharge weir **21**. **22** is a discharge spout leading downwardly from the weir through the furnace wall. A skimming weir **23** prevents dross from escaping into the discharge spout.

With the furnace in full operation, the level of the molten metal in chamber **15** is slightly below the discharge weir **21**. When it is desired to discharge metal from the furnace, it is necessary to raise the level of the metal in chamber **15** higher than the weir. This is accomplished through the operation of a displacement member **24** which can be lowered into the liquid in the furnace. This displacer is never in contact with the molten aluminum but operates entirely in the chamber **14** and is immersed only in molten salt. By displacing the salt in chamber **14**, the level of the salt is raised and this in turn creates additional hydrostatic pressure sufficient to raise the level of the molten metal in chamber **15**. When the level rises above the discharge weir, it flows through the discharge spout **22** into the mold or other receptacle beneath the spout. The discharge can be halted by raising the displacer **24**, thus causing the level of molten metal in storage chamber **15** to recede below the top of the discharge weir.

Although my furnace can be operated successfully with a single displacer **24** as above described, an improved feature of the present invention resides in the provision of an auxiliary displacer **25** at the top of the storage chamber **15**. The invention contemplates various ways of combining the operations of the primary and auxiliary displacers to improve the pouring control of the metal. In its broader aspects, the auxiliary displacer can be operated independently of the primary displacer, but preferably I provide a control mechanism which co-ordinates the functioning of both displacers. This is illustrated diagrammatically in FIGURES 6, 7 and 8.

This primary displacer **24** is suspended by a cable **26** passing over pulleys **27A** and **27B** on a cantilever arm **28** extending from a post **29** fastened to the rear wall of the furnace. A hydraulic cylinder **30** secured to the furnace wall has the movable member **31** thereof connected to cable **26**. The arrangement is such that the displacer **24** will fall by gravity into the molten salt chamber except as the displacer is restrained by the action of the fluid pressure within the hydraulic cylinder. A control valve **32** for the hydraulic cylinder is of conventional design and is not shown in detail. It is oscillated by a shaft **34** controlled by a handle **33**. This shaft operates the valve in a known manner from its neutral position N by movement of the handle to either of the two positions R or L.

FIGURE 5 shows the handle in neutral position N with the displacer 24 above the salt in chamber 14. Moving the handle and the valve shaft 34 counterclockwise to position L operates the valve to lower the displacer 24 into the salt. This is shown in FIGURE 6. A clockwise movement of the handle to the position R as shown in FIGURE 7 raises the displacer 24 from the salt.

The auxiliary displacer 25 is made of a ceramic material resistant to attack by molten aluminum, such as nitride bonded silicon carbide. The displacer is suspended from one arm of lever 35 which is pivoted on a post 36. A weight W on the opposite side of the pivot acts as a counterbalance so that auxiliary displacer 25 floats on top of the molten aluminum as illustrated in FIGURE 5. The auxiliary displacer has a horizontal sectional area only slightly less than the area of the chamber 15. The displacer is of hollow construction so that it is buoyant and is only slightly immersed in the molten metal when floating freely.

A latch device is provided for operating the auxiliary displacer in predetermined relation to the primary displacer. As diagrammatically shown, the latch is fulcrumed on a pivot 38 on a fixed frame 39. The latch is notched to form a rest 40 for the free end of the lever 35 and the latch is normally held in engagement with the lever by spring 41. The handle 33 has an oppositely extending arm 42 with a laterally extending finger 43 in alignment with the latch. When the handle is in neutral position, the auxiliary displacer 25 floats on the aluminum and the primary displacer 24 is above the molten salt. The finger 43 engages the latch 37 while the spring 41 holds the latch in engagement with the end of the lever 35.

When it is desired to discharge the molten metal from the furnace, the handle is moved counterclockwise toward position L. This moves the hydraulic valve 32 to cause the primary displacer 24 to move downwardly into the molten salt in chamber 14. This is illustrated in FIGURE 6. The immersion of displacer 24 in the salt raises the level of the fluid in chamber 14, thereby causing a corresponding rise of level of the molten metal in chamber 15. The upward movement of the molten aluminum exerts an upward force on auxiliary displacer 25 but upward movement of the displacer is restrained because the other end of lever 35 is held by latch 37. This restraint prevents the auxiliary displacer from moving upwardly with the rising metal to float thereon and instead compels the displacer to remain held down in the aluminum. Molten aluminum rises in the chamber 15 around auxiliary displacer 25 to above the level of the weir 20 and then flows downwardly through the spout 22. FIGURE 6 illustrates the parts in pouring position.

When it is desired to stop the pouring, the handle is moved clockwise to position R, thereby operating the valve to raise the primary displacer from the molten salt. This is illustrated in FIGURE 7. The movement of the handle to position R causes finger 43 to move the latch from beneath the arm 35, thus freeing the displacer from the restraint holding it down in the aluminum. Immediately the auxiliary displacer 25 moves upwardly to its floating position on top of the aluminum and the molten aluminum flows into the vacated space beneath the displacer. At once the level of the aluminum falls below that of the discharge weir 20 so that flow of molten aluminum through the discharge spout ceases immediately. By reason of the auxiliary displacer the discharge of metal is stopped more quickly than would be the case if reliance were placed solely upon the withdrawal of the primary displacer from the molten salt. The continued rise of the main displacer still further lowers the level of the aluminum. The handle is then replaced to neutral position N. The auxiliary displacer floating on the descending column of molten aluminum causes the other end of the arm 35 to become engaged again with the latch 37. The parts then resume the positions illustrated in FIGURE 5 and the furnace is ready for the next pouring.

The electric current is supplied from any suitable source such as a transformer 44 connected by electrical conductors 45 and 46 to the electrodes 16 previously described.

In the operation of the furnace as diagrammatically illustrated in FIGURES 5, 6 and 7, it was pointed out that the main and auxiliary displacers can be co-ordinated by the lever 33. It is not essential that the main and auxiliary displacers should be operated in timed relation. As long as the auxiliary displacer is prevented from rising during the pouring cycle by the latch 37, the pouring can be rapidly stopped merely by releasing the latch and quickly raising the auxiliary displacer. It is not necessary that the main displacer should be raised in order to quickly stop the discharge of metal from the furnace. It will also be understood that instead of raising the auxiliary displacer by reason of the counterweight and the buoyant effect of the molten metal, the auxiliary displacer may be quickly raised by any other lifting means such as fluid pressure.

What I claim as my invention is:

1. A metal melting and pouring furnace comprising a chamber containing an upper layer of molten metal and a lower layer of molten salt of greater specific gravity than said molten metal, a discharge spout connected to said chamber above the normal level of said molten metal, a second chamber containing molten salt, a displacer insertable into said molten salt, a fluid conduit hydraulically connecting said lower layer of molten salt in said first chamber with the molten salt in said second chamber, means for moving said displacer into the molten salt in said second chamber to thereby raise the level of molten metal in said first chamber and discharge said metal through said spout, and means for withdrawing said displacer from the salt in said second chamber.

2. A metal melting and pouring furnace comprising a chamber containing molten metal, a discharge spout connected to said chamber above the normal level of said molten metal, a second chamber containing molten salt, a primary displacer insertable into said molten salt, a fluid conduit hydraulically connecting said chambers, means for moving said primary displacer into the molten salt in said second chamber to thereby raise the level of molten metal in said first chamber and discharge said metal through said spout, an auxiliary displacer in the molten metal chamber positioned to float on the molten metal adjacent said discharge spout, means for restraining upward floating movement of said auxiliary displacer when the molten metal is raised above discharge level by said primary displacer and means for releasing the restraint on said upward floating movement to thereby lower the metal below discharge level.

3. A furnace comprising two vertical chambers containing electrically heated molten material and interconnected at the lower portions thereof, one of said chambers having molten salt in the upper portion and the other of said chambers having molten metal in the upper portion, a discharge spout for the molten metal having its entrance end above the normal level of the molten metal, a displacement member downwardly insertable into the molten salt to thereby raise the height of the molten metal above the entrance end of said spout and thereby discharge the molten metal through said spout, an auxiliary displacement member in said molten metal during discharge thereof, means for moving the first mentioned displacement member upwardly in the salt to thereby correspondingly lower the level of the molten metal in the other chamber, and means for upwardly moving said auxiliary displacement member to lower the level of the molten metal and thereby quickly stop the discharge thereof.

4. A furnace according to claim 3 in which a control means is provided operatively connecting the auxiliary

displacement member with the first mentioned displacement member for simultaneous operation thereof.

5. A furnace according to claim 3 in which a control means is provided including a handle movable from a neutral position to a pouring position and a cease pouring position, means for holding said auxiliary displacement member in fixed position when said handle is in neutral position and in pouring position and means operated when said handle is moved to cease pouring position for releasing said holding means to quickly raise said auxiliary displacement member.

6. A furnace comprising a chamber for molten metal, a discharge spout having its entrance end above the level of said molten metal, a chamber for molten salt interconnected at the bottom thereof with the chamber for molten metal, a main displacer in said molten salt chamber, an auxiliary displacer floating in said molten metal chamber, means for positively lowering said main displacer into the salt to discharge molten metal, means for raising said main displacer out of the salt to terminate the discharge of molten metal, means for preventing upward movement of said auxiliary displacer while the molten metal is discharged, and means operated simultaneously with the raising of said main displacer to release said holding means and permit upward floating of said auxiliary displacer.

7. A furnace comprising a pair of chambers with a fluid connection therebetween, a layer of molten salt in both of said chambers and in the said fluid connection, electrodes in the respective chambers, an electric supply for passing current between said electrodes from one chamber through said fluid connection to the other chamber thereby heating said molten salt, a layer of molten metal above the salt in one of said chambers extending to near the top thereof, a pouring spout having its entrance end above the top level of said molten metal, the other of said chambers having molten salt in the upper ends thereof, a main displacer in the chamber having the salt at the upper level, an auxiliary displacer normally floating on the molten metal means for positively lowering said main displacer into the salt to discharge molten metal, means for preventing upward movement of said auxiliary displacer while molten metal is discharging, and means for simultaneously raising both primary and auxiliary displacers to terminate the metal discharge.

8. A furnace comprising one chamber containing electrically heated molten salt, another chamber containing a lower layer of electrically heated molten salt and an upper layer of molten metal, a passageway connecting the first and second chambers and also containing molten

salt, a discharge spout having its entrance end above the level of said molten metal, a displacement member in said first chamber, means for forcing said displacement member into the molten salt to move salt through said passageway into said chamber and thereby raise the level of the molten metal to the height of the entrance end of said spout, an auxiliary displacer in the molten metal adjacent the point of discharge and means for withdrawing said auxiliary displacer from said molten metal to thereby lower the level of the metal at the point of discharge.

9. A furnace according to claim 8 in which hydraulic means is provided for operating the displacement member in said salt, a control handle is provided having three positions of adjustment corresponding to neutral, raise and lower, an auxiliary control means is provided including latch means cooperating with said handle whereby said auxiliary displacer is restrained from upward movement until said handle is in raised position.

10. A furnace according to claim 8 in which said auxiliary displacer is vertically movable to float on the molten metal and a control means is provided therefor including means for restraining upward movement when the level of the molten metal approaches the height of said entrance end, and means for releasing the restraint on said upward movement to lower the molten metal to below the level for discharge.

11. A metal melting and pouring furnace comprising a ceramic body having laterally spaced chambers therein, a first chamber containing an upper layer of molten metal and a lower layer of electrically heated molten salt of greater specific gravity than said molten metal, a second chamber containing molten salt, a passageway connecting the molten salt in said second chamber with said lower layer of molten salt in said first chamber, electrodes in said molten salt, means for passing current from said electrodes through said molten salt to provide heat for melting, a discharge spout having its entrance end above the level of said molten metal, and a displacement member insertable into the molten salt in said second chamber to thereby raise the level of the molten metal in said first chamber to the height of the entrance end of said spout.

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