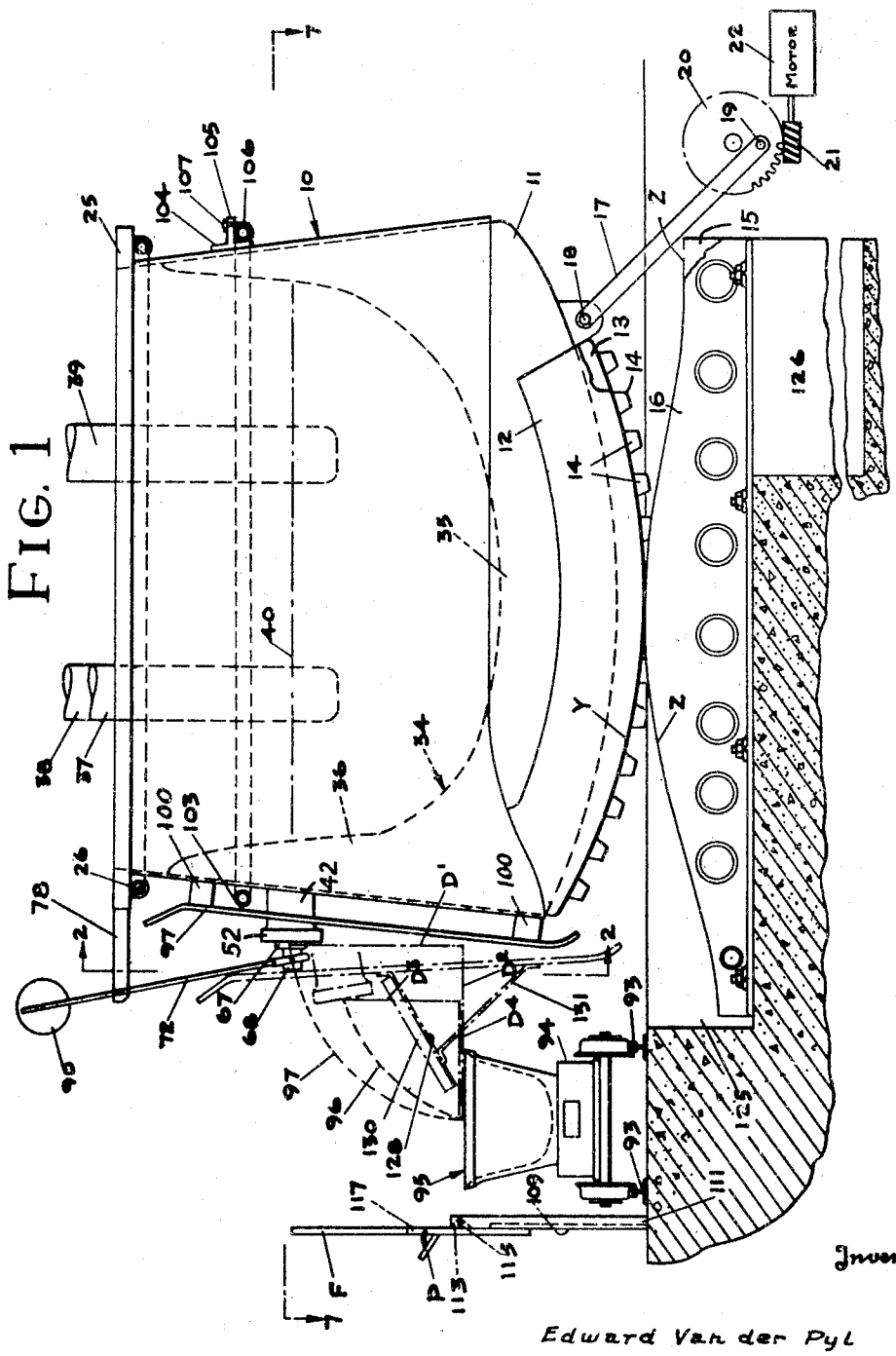
Sept. 2, 1947. E. VAN DER PYL 2,426,644

FURNACE CONSTRUCTION FOR FUSING REFRACTORY MATERIALS AND THE LIKE

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FIG. 1



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FURNACE CONSTRUCTION FOR FUSING REFRACTORY MATERIALS AND THE LIKE

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Fig. 2.

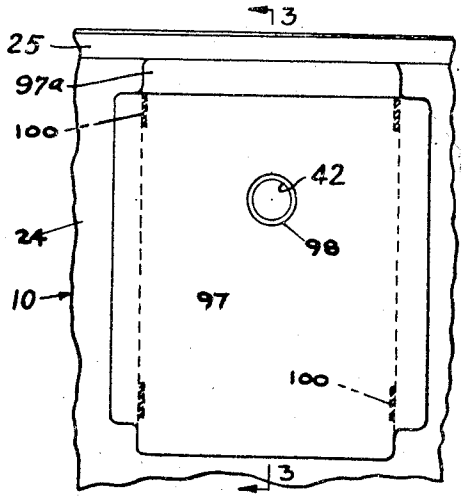
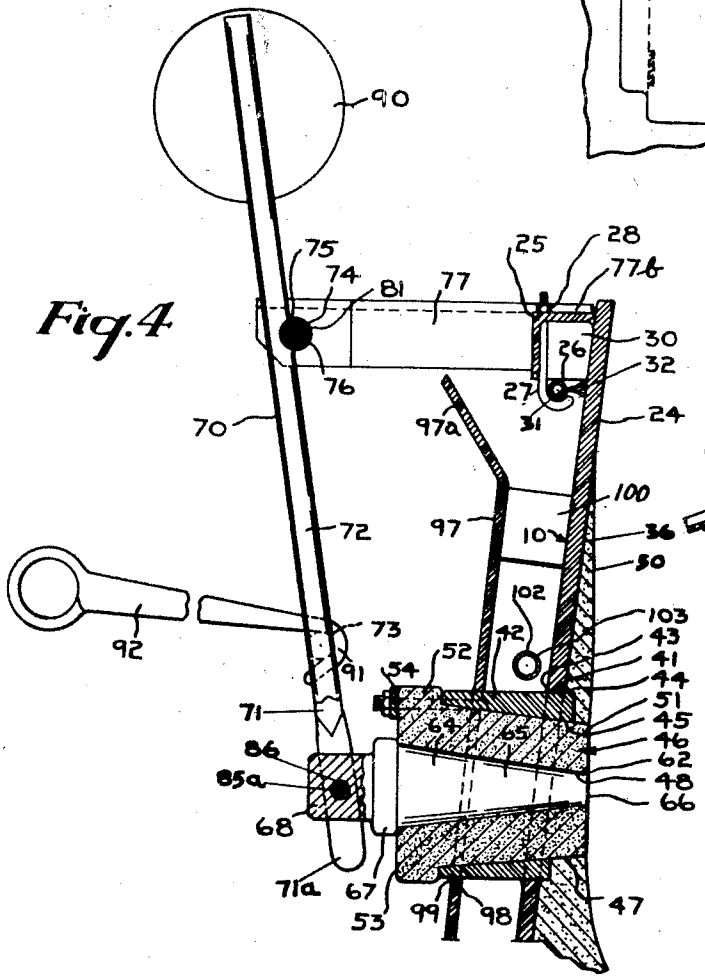


Fig. 4.



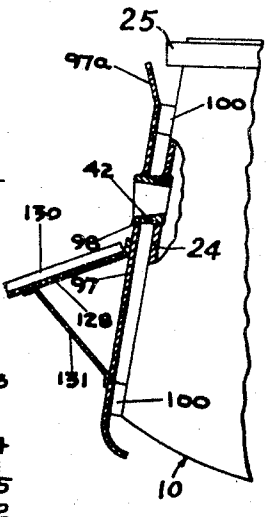


Fig. 3.

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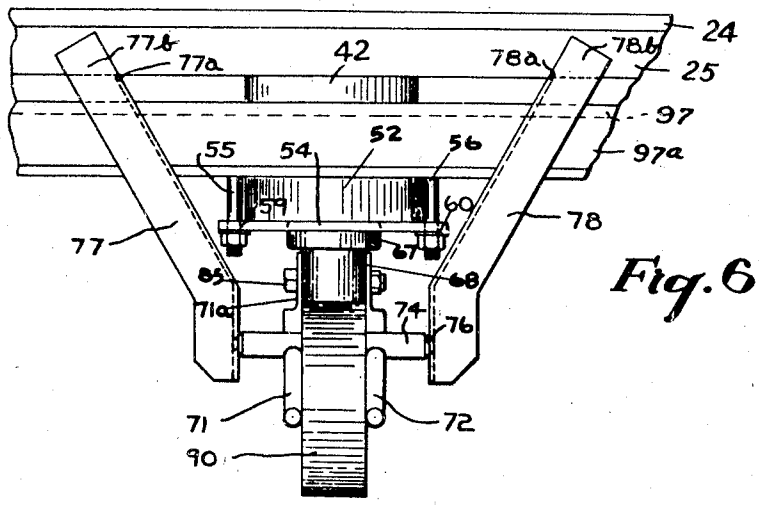


Fig. 6

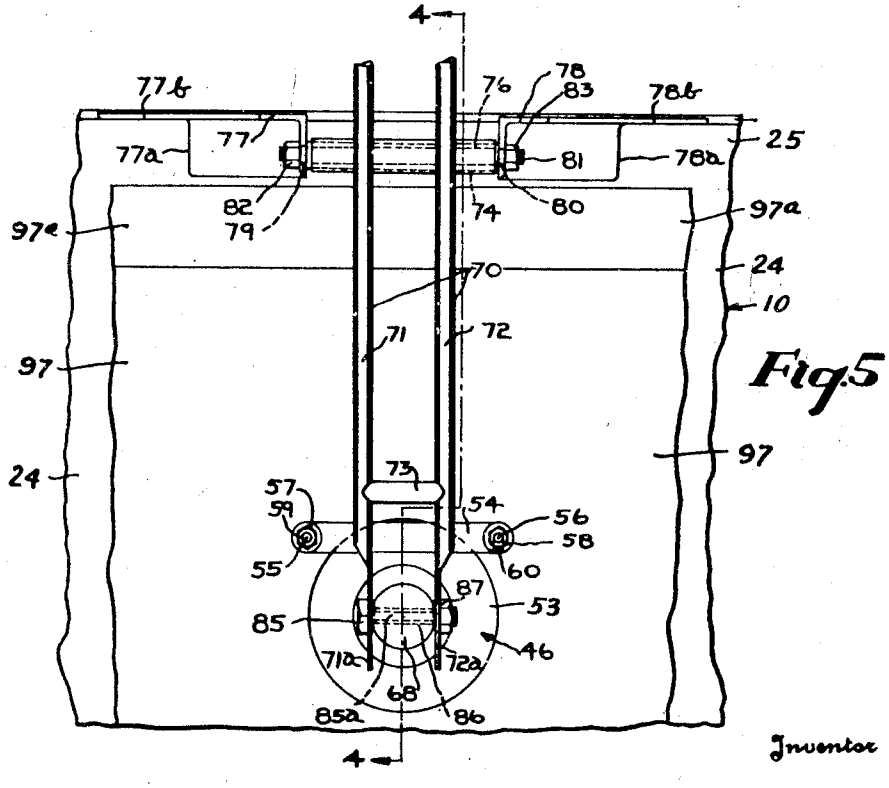


Fig. 5

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FURNACE CONSTRUCTION FOR FUSING REFRACTORY MATERIALS AND THE LIKE

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FIG. 7

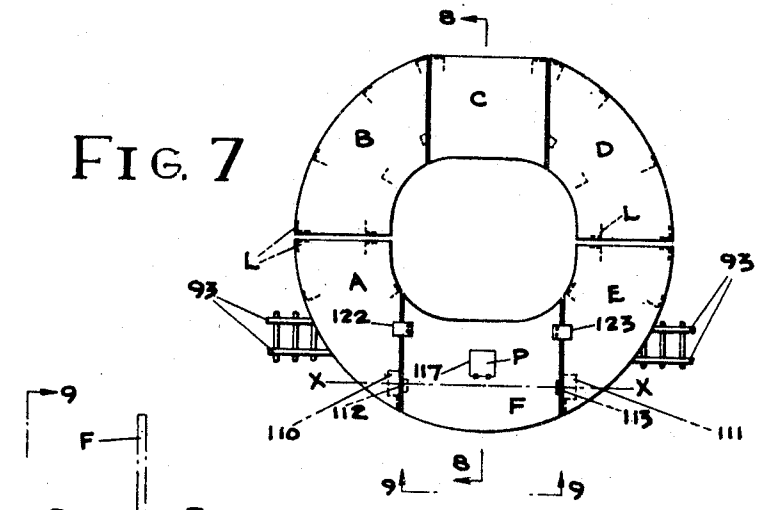


FIG. 8

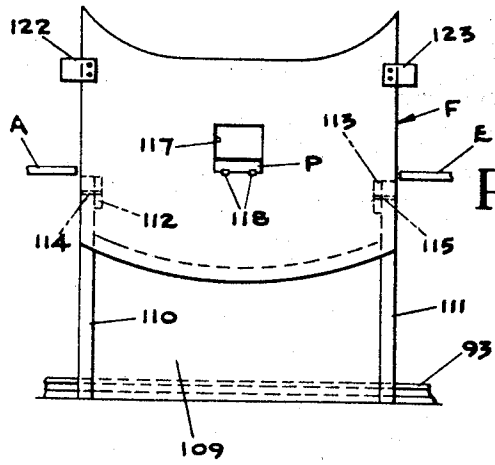


FIG. 9

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UNITED STATES PATENT OFFICE

2,426,644

FURNACE CONSTRUCTION FOR FUSING REFRACTORY MATERIALS AND THE LIKE

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Application August 11, 1944, Serial No. 549,007

29 Claims. (Cl. 263—48)

1

This invention relates to spout construction and control therefor, for the withdrawal, from a furnace, of high-fusing-point molten materials of which fused alumina is a good illustration, having a melting point on the order of 2000° C.

One of the objects of this invention is to provide a simple, practical and reliable spout construction that will be well adapted to meet and cope with the peculiar conditions that have to be met in the handling of high-fusing-point materials, such as alumina. Another object is to provide a simple, practical, efficient and reliable control for a spout construction of the above-mentioned character. Another object is to provide a strong, durable and simple mounting or assembly of a spout and its control relative to a furnace structure whereby also ease and speed of replacement of parts may be efficiently effected.

Another object is to provide a spout construction capable of handling such high-fusing-point materials in a manner to improve and lengthen the life and durability of the spout per se and in a manner to lessen or avoid detrimental effects, particularly during pouring, of the fused or molten material upon the steel or other metallic shell of the furnace in such cases where such a shell is employed.

Another object is to provide a simple, practical and efficient system and apparatus for protecting the spout structure against excessive rise in temperature during pouring of the molten material, and yet avoid detrimental reduction in temperature of the material being handled by the spout. Another object is to provide a water-cooling system or arrangement for preventing excessive temperature rise of the spout structure. Another object is to provide a water-cooled spout construction that will be efficient in action and safe in operation. Another object is to provide a spout construction capable of safe association with high temperature furnaces of the externally-water-cooled type.

Another object is to provide a spout and closure-plug construction for high temperature furnaces and to provide for the speedy, dependable and efficient control or handling of the plug relative to the spout for effecting starting or stoppage of the pour through the spout. Another object is to provide a construction of the just-mentioned character that will dependably and reliably function and coact with a tilting type of high temperature furnace.

Another object is to provide a spout construction of a suitable refractory material and capable of simple and effective inter-relationship with a

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refractory furnace lining of variable thickness. Another object is to provide for safety to the operators in controlling or handling the spout and plug construction and mechanism. Another object is to provide simple, practical and efficient protective means for the operators, more specifically to shield them not only against risk, but also against the heat during pouring at such times as the plug and spout mechanism has to be manipulated. Another object is to carry out these last-mentioned safety objectives in a manner effectively also to cope with the problems presented where the furnace is of the tilting type. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown one of the various possible embodiments of this invention,

Figure 1 is a small-scale side elevation of a furnace showing the assemblage thereto of the spout and plug construction and control mechanism;

Figure 2 is a fragmentary front elevation of the furnace as seen along the line 2—2 of Figure 1 with the spout and plug per se and related mechanism omitted;

Figure 3 is a fragmentary central vertical sectional view as seen along the line 3—3 of Figure 2;

Figure 4 is a fragmentary vertical sectional view on an enlarged scale through the furnace as seen along the line 3—3 of Figure 2, but showing the spout and plug and related mechanism in assembled relation;

Figure 5 is a front elevation as seen from the left in Figure 4;

Figure 6 is a top plan view looking down on Figure 5;

Figure 7 is a plan view as seen along the line 7—7 of Figure 1, certain parts, such as the furnace, being omitted or indicated in broken lines, showing a platform construction surrounding the furnace;

Figure 8 is a sectional view along the line 8—8 of Figure 7 showing a portion of the platform construction shifted to function as a protective shield and to permit tilting of the furnace, and

Figure 9 is a fragmentary elevation as seen along the line 9—9 of Figures 7 and 8.

Similar reference characters refer to similar

parts throughout the several views of the drawings.

Referring first to Figure 1, the furnace, generally indicated by the reference character 10, illustratively and preferably is constructed to be tiltable in order to effect pouring of the molten material and any suitable means may be employed to mount the furnace 10 so that it may be so tilted. For example, its bottom 11, which is preferably downwardly convex, such as a segment of a sphere, may be mounted upon two spaced arcuate rockers 12—13, provided with downwardly projecting teeth 14, the rockers 12—13 resting respectively upon suitable and similarly spaced guideways 15 and 16 respectively, the latter in turn being provided with suitable apertures (not shown) in their upper faces for the reception of the teeth 14 and if desired the upper surfaces of the guideway members 15 and 16 may also be curved, being upwardly convex as shown. Accordingly, the furnace 10 may be tilted about a horizontal axis, the coaction of the teeth 14 in the rockers 12—13 with the apertures in the guideway supports 15—16 holding the furnace against transverse displacement.

The tilting of the furnace 10 thus in effect takes place by rolling contact of the rockers 12—13 with their guideway supports and any suitable means may be employed to control the tilting of the furnace 10. By way of illustration, a link 17 may be pivotally connected as at 18 to a suitable bracket secured to the furnace 10 and at its other end is connected to the pin 19 of a crank 20 driven by suitable gearing 21 from a suitable source of power such as an electric motor 22.

In the position shown in Figure 1, the furnace 10 is in normal or horizontal position. Rotation of the crank disk 20 in clockwise direction accordingly effects tilt of the furnace 10 in counterclockwise direction, the extent of tilt, within any selected limits, being controllable in any suitable way as by controlling the extent to which the motor 22 rotates the crank disc 20; return tilt of the furnace 10 to normal position is effected by appropriate rotation of the crank disk 20 to carry the crank pin 19 back and thus restore the furnace 10 to its normal position.

To better illustrate certain features of the invention, let it be assumed that alumina (Al_2O_3) is to be fused and cast; in such case, the sides 24 of the furnace 10 are preferably frusto-conical, with a substantial slope as shown. The sides 24 and the bottom 11 are made of suitably heavy sheet steel, the upper periphery of the frusto-conical side shell 24 has welded about it a reinforcing angle-sectioned member 25 (see also Figure 4), thus serving to strengthen and make rigid the upper substantially circular periphery of the side shell 24 and serving also as a means for supporting a water pipe 26 that encircles the upper part of the shell 24, being spaced somewhat outwardly from the shell and being supported from the rim member 25, at suitably spaced intervals, by any suitable means such as a hook-shaped pipe hanger or bolt 27 (Figure 4) whose vertical threaded shank extends through suitable apertures in the upper or horizontal flange of the angle-sectioned rim member 25 and being assembled thereto as against withdrawal, by a nut 28.

If desired and preferably, suitably shaped plate members 30 (Figure 4) may be fitted into the three-walled space formed by the flanges of the rim member 25 and the shell 24, and welded in place and to these three walls, being suitably spaced and distributed throughout the substantially circular extent of the furnace rim 25; these plate members 30 materially reinforce the mounting of the rim member 25 to the furnace shell and materially increase the rigidity and strength of the shell, resisting forces or stresses that might tend, particularly due to temperature differentials, to warp or distort the shell out of its intended curve configuration. These plate members 30 preferably terminate so that their lower edges fall in a horizontal plane coincident with the lower edge of the vertical web or flange of the rim member 25 and preferably constitute also suitably distributed stop elements against which the pipe 26 may abut and by which it may thus be easily and quickly located in its desired position; moreover, it is against these plate elements 30 that the pipe 26 may be held by the hook-shaped hanger bolts 27, forming with the latter in effect clamping elements for securely holding the pipe in its intended position.

The pipe 26 forms part of a water-cooling system, being connected to a suitable source of supply of cooling water (not shown), by any suitable flexible pipe connection (not shown) and throughout the extent of the pipe 26 and suitably and relatively closely spaced are discharge apertures 31 (Figure 4), formed as by drilling, and located and drilled so that water discharged therefrom emerges in small streams against the shell 24; in Figure 4 one of these apertures 31 is clearly shown in cross-section and the resultant spray or stream is indicated at 32, being preferably directed somewhat upwardly as well as inwardly against the shell 24.

The water thus discharged from the pipe 26 ultimately flows down in a substantially uniformly distributed or uniformly thick sheet, moving downwardly along the outer surface of shell 24, preventing the latter from getting too hot in that the downwardly moving sheet or streams of water remove heat from the shell at a rate calculated to limit the rise in temperature of the metal of the shell 24 beyond the desired upper limit; the webs or flanges of the rim member 25 form an upper apron-like baffle or enclosure which reliably prevents any of the water sprayed by the pipe 26 from getting over the top edge of the shell 24 and thus safely permit the water-cooling action to take place and commence at the very upper end of the shell 24 itself.

Moreover, the downwardly and outwardly inclined external walls of the shell 24, achieved in the illustration by making the shell 24 substantially frusto-conical, have a slope such that, throughout the normal range of tilting of the furnace, for example, from the normal full line position shown in Figure 1 to the normal pouring tilt position indicated in broken lines in Figure 1, the downwardly moving streams or sheet of water remain unbroken and continue to flow downardly along and hence in continued contacting relation with the external surface of the shell 24, particularly at the front or pouring side, in order to achieve certain coactions later described with the pouring spout itself.

The furnace 10 is lined internally with any suitable refractory, depending upon the material and hence temperature to be handled, and in Figure 1 the refractory lining is generally indicated by the reference character 34, comprising a bottom layer 35 of substantial thickness which at its outer peripheral portions merges into the upwardly extending side wall lining 36, the latter being preferably of progressively diminishing thickness as

is indicated in Figure 1, terminating at or even below the uppermost periphery of the metal shell 24. Illustratively, the lining may comprise graphite or any suitable refractory and where alumina is to be fused in the furnace 10, the lining 34 preferably comprises fused alumina.

Heating of the charge of material placed in the furnace 10 is preferably accomplished by means of electrical energy applied to the charge by means of electrodes of graphite or carbon or the like, energized preferably from any suitable source of alternating current energy and hence a 3-phase source may be employed in which case three electrodes 37, 38 and 39 may be used; any suitable means may be employed for suitably mounting the electrodes and for controlling or varying their positions in an up and down direction, and hence only the electrodes are shown in the drawings. They are suitably spaced from each other and where three are employed for energization from a 3-phase circuit they are positioned at the apexes of an equilateral triangle.

With the water-cooling system including the above-described water pipe 26, put into operation and with the furnace 10 in normal upright position, the furnace is started in any suitable way; for example, where the material of the charge is substantially non-conductive when cold, suitable rods of carbon or graphite may be laid in the charge from electrode to electrode so as to form a high-resistance conductive path between the electrodes, whence the resultant current flow and initial arcing begins the fusing of immediately adjacent portions of the charge which then becomes conductive, whence the carbon rods may be fished out of the furnace and removed, the conductivity of the fused and fusing material maintaining current flow to effect continued heating of the charge and hence fusion of the material. In Figure 1, the broken line 40 indicates a possible normal level of charge and as indicated the electrodes project downwardly into the charge to a suitable extent.

In the front wall of the shell 24 of furnace 10 is positioned, at a suitable height, a pouring spout, illustratively at a height just about the same as the level 40 of a normal or intended-capacity charge of the furnace and in a preferred form it is constructed as is about to be described, and reference may now be made preferably to Figures 4, 5 and 6. In the front wall 24 is cut a hole 41 into which is received and fixed a metal sleeve 42, preferably of steel; externally the sleeve 42 is for convenience preferably cylindrical and it is positioned in the hole 41 so that its axis is at right angles to the vertical axis of the furnace 10 and hence is horizontal when the furnace is in normal upright position. The front or outer edge of the sleeve 42 is in a plane at right angles to the axis of the sleeve 42 while its inner end edge is in a general plane oblique to the axis of the sleeve 42 to an extent to achieve substantially the same extent of projection inwardly of the shell 24 of metal of the inner end of the sleeve 42 itself, these relationships being effected because of the normal slope of the front wall of the shell 24.

The sleeve 42 is welded to the shell 24 both externally as at 43 (Figure 4) and internally as at 44; it is to facilitate the internal welding at 44 that the sleeve 42 preferably projects inwardly somewhat beyond the inner surface of shell 24. Thus the sleeve 42 is securely and virtually integrally mounted or attached to the shell 24 and, moreover, security against leakage of water from the outside surface of shell 24 to the interior

thereof is doubled because of the two-fold peripheral welding achieved at 43 and 44.

Interiorly, the sleeve 42 is turned to a taper, thus providing a frusto-conical surface or bore 45 with its larger diameter at the outer end as shown in Figure 4. Into the bore 45 is inserted a spout element generally indicated by the reference character 46 made of a suitable refractory material such as graphite and provided with an external frusto-conical or tapered surface 47 that matches the taper of the bore 45 and hence, when inserted into the latter, makes a snug and tight fit. Spout element 46 has extending therethrough and preferably coaxially therewith a discharge passage or bore 48 later described in greater detail and it extends inwardly beyond the inside surface of the shell 24 to an extent to match the interior side wall lining 36 which as above described is of diminishing thickness as it approaches the upper end of the furnace 10. Due to the slope or inclination of the wall of shell 24, the inside face 50 (Figure 4) of the lining 36 is, though of diminishing thickness, substantially vertical at the height where the spout construction is mounted to the furnace shell 24 and hence the inner end face 51 of the spout element 46 is preferably in a plane at right angles to the axis of the spout element, a feature which facilitates manufacture of the spout element, and accordingly, when the latter is inserted in and assembled to the sleeve 42 the inner end face 51 thereof falls into substantial alignment with the inner face 50 of the lining 36 which is built up or constructed in any suitable way to leave an opening therein, preferably tapered to match the taper of the outer surface 47 of the spout element 46, thus to accommodate the inner end portions of the spout element.

This inward projection of the spout element 46, that is, beyond the inner face of shell 24 and the mounting of the spout element 46 are made furthermore to coact in a unique way with the lining 36 where the latter is built up or put in final condition as a lining, not manually, but by control of the fusion, by the action of the electrodes, of the lining material itself, as may be done with material, such as alumina, and as is more particularly described and claimed in the copending application Serial No. 534,653, filed May 8, 1944.

In such case the spout element 46 is inserted into the sleeve 42 to project inwardly beyond the inner face of shell 24, and secured in place as later described herein; there is built up manually out of suitably sized chunks or blocks of alumina, with interstices filled with granular alumina, a side wall lining corresponding to that indicated at 36 in Figures 1 and 4, such a structure being built up around the inwardly projecting portion of the spout element 46 and substantially flush with the inside face 51 thereof. When this manually built-up structure is thereafter fused in the manner described in the above-mentioned application, it becomes one continuous uninterrupted and unbroken line of fused alumina snugly molded and fitted about the tapered inwardly projecting portion of the spout element 46. During subsequent operation of the furnace, if used to fuse alumina, the thickness of that lining 36 may diminish somewhat by fusion or may increase somewhat by solidification thereon and junction therewith of portions of the charge undergoing fusion in the furnace, depending upon variability of control factors as described in the said application. But any such change

in thickness does not affect the spout element 46 and simply varies the extent to which its inner end projects beyond the face 50 of the lining 36, that portion of the spout element always maintaining a taper-walled boundary of the lining 36 about the inwardly projecting portion of the tapered external surface 47 of the spout element 46.

Accordingly, in such case, whenever it is necessary to replace the spout element 46, the latter is simply withdrawn from the tapered bore 45, aided if necessary by a slight tapping from the interior of the furnace, and when withdrawn leaves the lining 36 intact but with the above-mentioned boundary in the form of a tapered surface molded or pre-shaped by the spout element 46 itself and in fact an inward extension of the tapered bore 45 of the sleeve 42; hence a new spout element 46 can be easily and quickly put in place without damaging or harming the lining 36 and without requiring patching up of the latter, for the new spout element thus inserted snugly interfits with the correspondingly tapered faces of the bore 45 and of the above-mentioned preformed boundary of the lining 36.

Should there be in such case any gap or deficiency in the lining 36 about the inwardly projecting portion of the spout element 46 so as to permit ingress toward the metal of the shell of the high-fusing-point molten material, the inwardly projecting portion of the sleeve 42 is of sufficient extent and mass to block access of the molten material to the metal of the shell 24 itself so that the latter thus is dependably protected against damage, while molten material that would thus collect in any such space or gap soon cools and solidifies, becoming part of the lining 36 and becoming neatly molded in shape by the frusto-conical surface of the inwardly projecting portion of the spout element 46. Particularly in the case of such a lining, the above-described features of construction achieve a self-repairing action should such be necessary, such action being in turn aided by cooling actions upon the shell 24 as above described and by cooling actions upon the metal sleeve 42 later described.

Any suitable means may be employed to hold the inserted spout element 46 assembled to the sleeve 42. Thus the external front end of the spout element may have a peripherally extending flange 52 of substantial cross-section but which preferably falls short of the outer end face of sleeve 42 in order not to interfere with the wedge-like fit of the spout element in the tapered bore 45; by such a flange 52 the diameter of the front face 53 of the spout element 46 is increased so that a cross bar 54 may be bridged across along a chord of the circular face 53 (see Figure 5) and detachably mounted as upon stud bolts 55 and 56 suitably mounted upon the furnace structure and upon whose threaded ends are nuts 57 and 58 respectively which, upon being tightened up, draw the cross bar 54 inwardly toward the furnace and thus force and clamp the tapered spout element 46 against and into the tapered bore 45 of the sleeve 42.

Preferably one end of the cross bar 54 has a hole 59 (Figures 5 and 6) through which the bolt 55 extends while the other end of cross bar 54, instead of having a hole, is provided with a slot 60 (Figure 5) into which the bolt 56 is accommodated. Accordingly, replacement of a spout element may be more quickly achieved for, upon loosening up of the nuts, which thus need not be removed, the cross bar 54 may simply be swung in counterclockwise direction as seen in Figure 5 out of overlapping relation to the front face of the spout element 46 and upon replacement of the latter by a new one, a reverse swinging of the cross bar restores it to spout-engaging position and also into underlying relation to the nut 58; the nuts then need simply be tightened up to the desired extent.

The bore 48 of the spout element 46 is preferably tapered as is better shown in Figure 4, being otherwise of circular cross-section. This relationship is preferred where control of the rate of pouring of molten material for varying hydraulic heads is desired, for in such case the inner end of the bore 48 indicated in Figure 4 at 62, and being circular, may be made to function substantially like a true orifice. The taper is accordingly preferably substantial, to get a better orifice effect and also to provide a progressively increasing channel or passageway, leading away from the orifice 62, to effect quick rate of flow of molten material passed by the orifice. For, according to circumstances, and particularly in the case of fused alumina, it is desirable to effect as little loss of heat content during pouring, that is, from the molten material after it passes the orifice 62, as is possible, and hence the increasing cross-section of the bore or passageway 48 offers lesser resistance to flow, the slope due to the taper coupled with the angle of tilt shown in broken lines in Figure 1 having the effect of increasing velocity of flow and hence lessening the time that the molten material remains in contact with the spout element 46. Also, the spout element 46 is preferably of substantial wall thickness for, as is later described, external water-cooling of the sleeve element 42 continues during pour and by the substantial wall thickness a lesser rate of heat withdrawal by the water-cooling action takes place during pouring, and hence there is lessened cooling off of the molten material flowing along the passage 48 from the orifice 62.

The tapered shape of the passage or bore 48 in the spout element 46 is preferred also in order to achieve coaction with the spout element of a stopper or plug, generally indicated by the reference character 64; plug 64 is made of a suitable refractory material, preferably the same material that is employed in the spout element 46, such as graphite, and the plug 64 has a tapered plug portion 65 that matches the spout bore 48 as to taper and preferably also as to length so that, when entered into stopping position as shown in Figure 4, the smaller or inner end face 66 thereof falls substantially in the plane of the inner face 51 of the spout element 46, thus closing off the orifice 62 and insuring a clean and unobstructed opening of the orifice when the plug 64 is removed or withdrawn. Preferably the plug 64 is provided with a flange 67 of substantial dimensions so dimensioned and positioned that, when the plug is entered into the bore 48, flange 67 acts somewhat to limit the extent of wedging of the plug 64 in spout-closing position, thus to avoid such jamming thereof in closed position as would make it more difficult to withdraw the plug and hence making for substantially uniform resistance to withdrawing movement during successive plug withdrawals for corresponding successive pours.

Extending forwardly of the flange 67 and coaxially with the plug portion 65, the plug structure 64 has an extension 68 conveniently cylindrical and of substantial dimension so as to form a strong and integral part of the structure. By

this extension 68 connection to the plug structure may be effected to a mechanism for facilitating the control or handling of the plug 64 itself.

Such mechanism preferably comprises an arrangement for movably supporting the plug structure 64 to achieve certain coactions and preferably and conveniently this mechanism comprises a lever generally indicated by the reference character 70 and having the plug structure 64 suitably connected thereto at its lower end and being itself mounted for pivotal movement about a horizontal axis.

Conveniently and preferably, the lever 70 is built up of steel piping or tubing and may comprise two parallel and transversely spaced pipe elements 71 and 72 (Figures 5 and 6) held in such relation by a cross-tube 73 welded to both adjacent its lower end and by a longer tube element 74 welded to both elements 71 and 72 but offset therefrom so as not to wholly intersect them, the tube elements 71, 72 being partially milled or cut away as indicated at 75 in Figure 4 to form seats for the cross-tube 74, the welding being effected at such seats.

The cross-tube 74 thus not only takes part in the compound light yet strong construction of the lever 70 but it is also made to function as a bearing for the lever in that a steel tube 76 (Figures 4 and 5) passes therethrough and is suitably supported from the furnace structure to form a rigid and fixed axis about which the lever may pivot.

In the preferred construction, the just-mentioned axis is formed by the above-mentioned steel tube 76 which as better appears in Figures 5 and 6 is somewhat longer than the bearing tube 74 of the lever 70; tube 76 is received between the vertical webs of angle-sectioned brackets 77 and 78, the vertical webs being provided with holes 79 and 80 through which and through the sleeve 76 passes a bolt 81 preferably threaded at both ends to receive nuts 82 and 83 which upon being tightened up securely clamp the bearing tube or sleeve 76 between the vertical webs of the brackets 77 and 78, forming a dependable horizontal pivot for the lever 70 and moreover one which is easily disassembled should it become necessary, for example, to replace the bearing sleeve 76.

Brackets 77 and 78 are secured to the furnace in any suitable way and preferably are shaped as shown in Figures 4, 5 and 6, to diverge from each other (Figure 6) so as to space the points at which they are secured to the furnace structure. Preferably they are secured as by welding to the angle-sectioned rim member 25 and for that purpose the vertical web of each is cut away as at 77^a and 78^a, respectively (Figures 5 and 6) so that the horizontal webs 77^b and 78^b may overlie and rest upon the horizontal web of the rim element 25 to which they are secured preferably by welding, the vertical ends of the vertical webs 77^a and 78^a abutting against the vertical web of the rim member 25 to which they are also preferably secured as by welding.

The dual-tube construction of the lever 70 also facilitates connection thereto of the plug 64 whose shank extension 68 is received between the lower ends of the spaced tubes 71—72 (Figure 5) which are preferably flattened out as at 71^a and 72^a where they are also drilled to receive a bolt 85 which passes through a hole 86 that extends diametrically through the shank extension 68, thus forming an articulated or pivotal connection between the plug 64 and the lever 70. As indicated in Figure 5, the hole 86 in the plug shank 68 is materially larger than the shank 85^a of the bolt 85 thus to provide for sufficient play to achieve self-accommodation between the parts and avoidance of jamming or binding during pivotal movement of the lever 70 in such ranges thereof as are commensurate with the fixing of the position of the plug 64 in and by the tapered bore 48. The bolt 85, as by its nut 87, is readily removable so that the plug 64 may be quickly disassembled therefrom and replaced when and as necessary.

At its upper end the lever 70 carries a weight 90 of, for example, cast iron and preferably dimensioned to be received between the upper otherwise free ends of the tubular elements 71—72 to both of which the weight 90 is welded thus becoming also a structural part of the lever to strengthen it.

As better appears from Figure 4, where the plug 64 is shown in spout-closing position, the brackets 77 and 78 are of such length in relation to the normal projection of the plug shank 68 outwardly from the spout element 46 that the axis of pivoting of the lever 70 is positioned to the left as seen in Figure 4 of the vertical plane of the pivotal connection between the lever and the plug, thus bringing the center of mass of the weight 90 also to the left and thereby causing the weight, through its resultant lever arm to exert a constant force upon the plug 64 to hold the latter in spout-closing position. The parts are preferably so proportioned as to dimensions and weight that the action of the weight 90 holds the plug 64 in closing position even though the fit of the plug portion 65 in the bore 48 of the spout element 46 is somewhat loose and even though there may be some hydraulic head of molten material exerted against the end face 66 of the plug portion 65; safety of spout-closure and dependable maintenance of the plug in spout-closing position may thus be achieved, whether or not such action is aided by the frictional fit of the plug portion 65 in the bore.

The cross-tube element 73 may be used as a member onto which may be hooked the hook end 91 of a suitably handled bar or implement 92 (see Figure 4) for manually withdrawing the plug 64 from the spout element, when it is desired to withdraw molten material from the furnace, the implement being inserted between the tube element 71, 72 for that purpose and thus aiding in achieving a safe and secure engagement of the lever by the implement 92, and it will be noted that the cross-tube 73 is located closely adjacent the connection of the plug 64 to the lever so that any pull exerted by the implement 92 to unplug the orifice is applied almost directly to the plug 64 and hence without loss of energy. Manipulation of the member 92 and hence of the plug is preferably effected in coaction with certain safety features later described. Once the plug 64 has been loosened from the bore of the spout element 46, the implement 92 need be actuated only a short distance to the left in Figure 4 to bring the center of mass of the weight 90 to the right of the axis of the lever pivot 81—76, whence the weight of the member 90 is sufficient to continue the swing of the lever in clockwise direction to a position where the weight 90 strikes the rim 25 of the furnace shell 24 which thus acts as a stop; that places the lever 72 in an almost horizontal position, the weight 90 continuing to hold the lever in that relationship and hence with the plug 64 well removed from the region of the dis-

charge end of the spout element 46 and out of possible interference with the stream of molten material emerging from the spout; the weight, moreover, holds the lever and plug in such position during the tilt of the furnace into pouring position indicated in broken lines in Figure 1.

With a normal level of molten charge indicated at 48 in Figure 1, a suitable tilt of the furnace for pouring can be on the order of 10°; that is the tilt indicated in Figure 1. At the front of the furnace suitable means such as rails 93 and a car 94 may be provided to support a suitable receptacle or series of receptacles indicated generally by the reference character 95 (see also Figures 7 and 8), the latter being made, in the case of handling fused alumina, of cast iron and being arranged on the car or cars 94 in continuous succession with the adjacent peripheral lips of successive cars in substantial engagement with each other so that the car or train of cars 94 may be moved by any suitable means and step by step to successively receive the molten material without having to interrupt the discharge stream, indicated in Figure 1 at 96, of molten material. Accordingly, a reverse tilt to normal position of the furnace 10 need not be effected until any desired number of receptacles 95 have been thus successively filled.

In one form or size of construction, the height of the upper edge of the furnace 10 above the floor or rail level may be substantial and in order for the operators to gain access to the electrodes as for repair or replacement, or to be in position for inspecting the interior of the furnace during its operation, or for such other purposes as charging the furnace, there is provided about the furnace a platform or walk at a suitable and usually substantial level above the floor and above the station to which receptacles or molds 95 are successively brought to receive the molten material; it is preferably at a suitable level below the upper rim of the furnace 10. Preferably, this platform is made in suitable sections of, for example, steel plate, the sections being in number and shape appropriate to surround the furnace to the desired extent. In Figure 7, by way of illustration, where it is desired to surround the entire furnace with a platform, the platform may comprise six sections so shaped that when grouped around the furnace their external periphery forms a circle whereas their internal periphery is shaped to be geometrically symmetrical with the cross-section of the furnace in normal upright position at the level of the platform but spaced from the shell 24 of the furnace preferably uniformly by an appropriate district. Sections A, B, C, D and E shaped, respectively, as shown in Figure 7, are preferably built up in the form of tables, being provided with legs L suitably distributed and being fixed in grouped or assembled relation in any suitable way, as by bolting to the floor. These five sections A, B, C, D and E it will be noted are insufficient to extend around the front side of the furnace and preferably leave a parallel-sided gap across the front of the furnace 10 and into this gap is movably mounted, in a manner and for purposes later described, the sixth section indicated by the reference character F. It is underneath this platform, more particularly underneath sections A, F and E that the rails 93 extend and along which rails the car or train of cars 94 carrying the receptacles 95 is to be progressively moved or advanced during pouring to bring them to the pouring station.

Thus access to the upper peripheral regions of the furnace may be gained for such purposes as those noted above and when it is desired to effect unplugging of the spout or to effect tilting of the furnace, the platform section F, mounted to pivot about a horizontal axis indicated at X—X in Figure 7 as is later described is tilted into substantial vertical position as indicated in Figure 8, thus making way for the tilt of the furnace, and in the section F is a substantial-sized opening normally covered by a closure plate P constructed and mounted so that the closure plate P automatically opens up upon tilt of the platform section F into the above-mentioned substantially upright position, exposing the opening in a position substantially in line with the spout of the furnace.

Accordingly, an operator standing behind and to the left of the substantially vertically positioned platform plate F which now acts as a shield and which has also uncovered the theretofore underlying rails and properly positioned car or train of cars, inserts the implement 92 through the above-mentioned opening in the tilted platform plate to engage the plug lever 76 at the cross-piece 73 thereof to unplug the spout element 46; this he may do, according to circumstances, before or after tilt of the furnace, to commence the pour. Having effected withdrawal of the plug 64 from the spout 46, the operator can disengage the hooked implement 92 from the plug lever, leaving the weight member 98 to effect movement and subsequent holding of the plug in an out-of-the-way position from which, after ultimate completion of the pour, the operator again restores the plug to orifice-closing position by manipulating the lever with the implement 92 again injected through the opening in the tilted platform plate or section F.

During the tilted position of the furnace 10 and as the pour continues, the water-cooling above described is continued as above noted but spaced upwardly from the front wall of the furnace is a shield plate 97 (Figures 1, 2, 3 and 4) which is mounted in spaced relation from the wall of the furnace; as is better shown in Figures 2, 3 and 4, the plate 97 has a hole 98 into which the sleeve 42 fits, plate 97 being welded to the sleeve 42 as at 99, the weld also providing a sealed joint between the two. The plate 97 extends parallel to the outside wall of the furnace from which it is held spaced by its just-described connection to the metal sleeve 42 of the spout construction and by suitable brackets 100 suitably distributed, illustratively four in number (see Figures 2 and 3) and welded to the furnace and to the plate itself. These brackets thus firmly mount the plate 97 onto the furnace shell and the plate thus reinforces and strengthens the mounting of the sleeve 42 to the shell 24, giving it two axially spaced regions of support and thus making for greater strength and permanency of construction. It is to the plate 97 that the inner ends of the bolts 55 and 56, which coact with the spout-holding cross-bar 54 (Figures 4 and 5) are rigidly secured (see also Figure 6). The plate 97 may be given suitable curvature to substantially match any curvatures of the furnace shell, thus to maintain substantial parallelism to the furnace wall and at its lower end (Figures 1 and 3) it may be curved inwardly underneath but spaced from the bottom shell 11 of the furnace; at its upper end it extends outwardly and upwardly as at 97a so as to clear and be spaced away from the rim member 25 and

leave an upper open passageway for air circulation or movement and also for the escape of such water vapor as might result from evaporation from the water running down the external furnace wall.

Spaced downwardly from the water-cooling pipe 26 (Figures 4 and 1) is another pipe 102 that encircles the shell 24, passing transversely through the space between the shield plate 97 and the furnace wall and, like pipe 26, being apertured as at 103 and connected in any suitable way to a source of water supply, to effect a continual spraying of water against the shell and thus to add to or supplement the downwardly moving sheet or streams of water that originate from the upper pipe 26. Pipe 102 is supported in spaced relation from the shell 24 by suitably distributed clamping brackets or supports which preferably utilize a hook-shaped bolt like the bolts 27 related to the pipe 26 as above described. Thus, referring to Figure 1, these brackets, welded at suitable peripheral intervals to the outer side shell 24 may be constructed to provide a base portion 104 which rests against the shell and is welded to the latter, being of a thickness equal to the desired spacing of the pipe 102 from the shell 24 so that the pipe may rest against the lower portion of the base 104, and they may have an overhanging lateral extension 105 through a hole in which extends the vertical shank of the hook-shaped bolt 106 so that when the nut 107 is tightened up the pipe 103 is clamped securely against the underface of the overhanging bracket portion 105.

Going back to Figure 4, the water flowing down the outside surface of the shell 24 strikes the sleeve 102 and spreads over the surface of the latter, running down on both sides thereof to rejoin the downwardly moving sheet of water on the shell 24 below the sleeve 42, but the shield plate 97, which may also act as a heat radiator to dissipate heat from the sleeve 42 and its related parts, restricts the flow of water over the external part of the sleeve 42 against reaching in any way the outlet end of the spout element and hence also from reaching the molten material being poured when the furnace is tilted, the welded joint 99 being water-tight. During the tilt of the furnace, water continues to run down the front face of the shell 24 even though the front face is thereby given a substantially vertical position or a tilt somewhat beyond the vertical as indicated in broken lines in Figure 1, but such tilt is effective to cause a greater amount of water than during the normal position of the furnace to be diverted over and around the external surface of the sleeve 42, thus adding to the cooling of the latter and preventing damaging heat rise therein during the time period that molten material is running through the spout element 46 for it is during that period naturally that the entire spout element 46 becomes materially raised in temperature; as a result also of the pouring tilt, some of the water that runs off of the exterior surface of the sleeve 42 is spread onto and runs down the inside face of that portion of the shield plate 97 that is below the axis of the sleeve 42, and thus the radiator or cooling effect of the shield plate 97 is increased during the pouring period. Also, during this pouring tilt, should any water, at the front face of the furnace, drip or spill from the portions of the shell 24 above the spout sleeve 42, the upwardly extending portion of the shield plate 97 catches and receives it and again the radiator effect of the shield plate is increased. Also, in any case, the shield plate will be seen (Figures 1, 2 and 3) to be of substantial lateral and vertical extent to guard against any spillage of cooling water from the side walls of the shell onto the cast iron or other receptacles 95 into which the molten material is being poured or onto the stream 96 (see Figure 1) of the material itself, it being here noted that the combination of water and such high-fusion-point material is a violently explosive one.

When it is desired to cut off the flow, the furnace is tilted back to normal, whence, with the aid of an implement like the member 92 of Figure 4 the lever 70 is swung in counterclockwise direction to bring the effect of the weight 90 again to the left of its horizontal pivoting axis 81—76, that effect continuing such rotary movement of the lever 70 and acting to inject the plug 64 back into the passageway or bore 48 of the spout element 46, thus to close off the orifice 62. In this connection, it is to be noted that the tubular elements 71 and 72 are, at the lower flattened ends 71^a and 72^a (Figures 4 and 5) extended downwardly below the axis of the bolt 85, the diameter of the external flange portion 67 of the plug 64 being so much greater than the diameter of the shank 68 that these portions 71^a—72^a extend transversely of the circular flange 67 like two parallel similar chords of a circle (see Figure 5) and their inner edge faces (right-hand faces as seen in Figure 4) form two laterally spaced stops with which the outer or left-hand face of the plug flange 67 engages to thereby limit the extent of clockwise rotary movement of the plug 64 relative to its pivot bolt 85 after withdrawing movement of the plug from the spout has commenced. These parts are so proportioned that, in coaction with the smaller-diametered end face 66 of the plug in relation to the larger-diametered front end of the tapered bore 48 of the spout 46, the plug 64 cannot swing clockwise to a vertical position or partake of pendulum-like swing in that range of counterclockwise movement of the lever 70 that carries the plug 64 back toward the spout element 46, with the result that the plug 64 freely enters its forward smaller-diametered end into the lower portion of the larger-diametered front end of the bore 48, whence the tapered relationship of the parts effects simply a camming of the plug into final seated position or at the worst requires but a small counterclockwise tilting upwardly by an implement like the member 92 to effect entry of the plug into the spout passage.

These features greatly facilitate manipulation of the plug handling mechanism through the opening in the upwardly tilted platform plate section F.

The platform section F, where it is tiltable as above briefly described, is pivotally mounted to swing about the axis X—X (Figure 7) in any suitable way, as for example by providing two spaced upright studs or columns 110 and 111 rigidly anchored or secured, for example, to the flooring and pivotally connecting the platform section F thereto; thus, as seen in Figure 8, the studs 110—111 are of the same height as the legs L of the table platform sections A, B, C, D and E and hence the tiltable section F can overlie them, being provided with two downwardly directed plate elements 112 and 113, welded thereto and extending respectively alongside of the studs of columns 110 and 111 to which they are pivotally connected as by bolts 114 and 115.

With that kind of hinged connection, when the platform section F is tilted in counterclockwise direction, as seen in Figure 8, and hence to the broken line position in Figures 8 and 1, the weight of the plate is swung over to the left of the axis X—X with which the pivoting bolts 114 and 115 coincide and the portion of the platform F that extends below the pivot point abuts against the columns 110—111 which thus act as a stop against which the upstanding or slightly tilted plate is held by its own weight which as above noted is to the left of the axis X—X. Bridged across and between the columns 110—111 and welded thereto and thus also strengthening the structure is a plate 109 whose bottom edge coincides with the floor and whose upper edge is of sufficient height so that the lower edge of that portion of the tilted platform section F (Figure 8) that extends below the pivoting axis overlaps the plate 109 (see Figure 9), thus completing a shield of adequate expanse and extending upwardly from the floor behind which the operator may stand to manipulate the plug mechanism and to be shielded against danger or risk during the pouring action and also against the heat. The columns 110—111 and hence also the upright shield structure comprising the fixed plate 109 and the overlapping tilted platform section F are positioned (see Figures 7, 8 and 1) on that side of the tracks 93 that is remote from the furnace so that movement of the platform section F into upright position uncovers the receptacles 95 and also shields the operator against any spillage from the receptacles carried by the car or train of cars 94.

The opening 117 in the platform plate section F and that is covered by the cover plate P may conveniently be square in shape and is so located with respect to the axis X—X (Figure 7) that, when the section F is tilted into upright position, the opening 117 is brought, as earlier above mentioned, substantially in line with the plug and spout construction.

Preferably the cover plate P is arranged to be automatically opened during or upon completion of the upward tilt of the platform section F and this is preferably achieved by hinges 118 which hingedly connect the cover plate P to the platform section F to swing about an axis parallel to the axis X—X and to swing relative to the platform section F in the same direction as the latter swings during movement into shielding or upright position. Accordingly, when the platform section F reaches its above-mentioned upright position as indicated in broken lines in Figure 8, the cover plate finds itself in unstable equilibrium relative to its axis of hinging and by its own weight swings counterclockwise as viewed in Figure 8, thus uncovering the opening 117.

Preferably, the extent of this opening movement of the cover plate P is limited to an angle slightly less than 90° and for this purpose the hinges may be appropriately constructed with stops or the plate P may be provided with arcuate stop arms 119 and 120, one on each side thereof and suitably secured on the underside thereof as by welding and provided with laterally projecting stop elements 119a and 120a which take in under and engage the underside of the platform section F to either side of the opening 117, thus functioning to stop the opening movement of the plate P at the right point and also functioning as brackets to hold or support the plate P in its substantially horizontal position as shown in broken lines in Figure 8; with such a bracket-stop arrangement, less strain is put upon the hinges than would be the case if the hinges alone were provided with stop elements.

Upon completion of the pouring operation, achieved preferably by tilting the furnace back to normal position, the platform section F may be returned to its horizontal position (see Figure 8) and this may be achieved by simply pushing as with the implement 92 upon the upwardly projecting portion of the section F to start it moving in counterclockwise direction from its broken line position shown in Figure 8, for the axis X—X (Figures 7 and 8) is sufficiently to one side of the center of mass of the platform F to give the platform adequate over-balance to move and to be held in horizontal position, suitable stop elements, such as plates 122 and 123, secured to the upper face of the section F (see Figure 7) and projecting laterally from the side edges thereof so as to overlap and rest against the upper faces of platform sections A and E, respectively, being provided to take part with the platform hinge or trunnion construction in lining up the horizontal position of the platform section F with its adjacent section.

During the return to horizontal position of the section F and just about when it reaches its final position of rest, the hinged cover plate P again finds itself in unstable equilibrium relative to the axis of its hinges 118, its weight now being to the other side of that axis and accordingly it swings into closing position and into alignment with the plane of the section F, the opening 117 being suitably rabbeted for that purpose, as for example, by a strip or plate 124 secured as by welding (see Figure 8) to the underside of the section F and projecting over the opening 117 sufficiently to form a stop for the closure plate P. According to circumstances, particularly where the material is alumina, the supply of electric energy to the electrodes is continued even during the pouring operation and the water-cooling system is likewise in such case continued in operation; the water runs down the frusto-conical shell 24 from the spray created by the pipe 26 (Figure 4), augmented by the supply from the lower band of pipe 102, in order to compensate for increased area of the shell, increased need of cooling in the lower portions, and also for loss by evaporation, and some of it drips off and some of it runs along the downwardly convex bottom against which additional water is sprayed by piping (not shown), and all of the water is caught in a pit 125 (Figure 1) in which the rocker guide rails 15—16 are mounted, the pit 125 connecting with a deeper pit 126 at the rear of the furnace and from which the water is removed in any suitable way, the pitch of the flooring of pit 125 being such that water does not collect in it but quickly flows off into the main pit 126 which is at the rear of the furnace and thus remote from the front or pouring end thereof. The rocker guide rails 15—16 are laterally spaced as above noted and may bridge across the main pit 126 at the rear, as indicated in Figure 1. In this manner possible spillage of molten material, were it to take place, is segregated from the water-collecting pit 126, the catch pit 125 because of the rapid drain therefrom of water, always containing a minimum so that any spillage into it gives rise to minimum risk. The front end of the catch pit 125 is positioned inwardly from the point where the receptacles 95 are positioned as much as possible, the shield plate 97 acting when the furnace is in tilted position to dependably direct water spillage from the front

of the furnace into the front end of the catch pit 125, and thus the floor on which the rails 93 are carried is kept free from being wet.

The stream 96 of pour nevertheless crosses a gap, but here adequate safeguards function or are provided to minimize risk of spillage from the spout into the catch pit 125. For example, a drip deflector 128 (Figure 1) may be provided to bridge the gap between the receptacle 95 and the pouring spout and this may take the form of a steel plate laterally flanged as at 130 and welded or otherwise secured to the shield plate 97 reinforced, if desired, by a bracket 131. Its upper edge extends transversely immediately beneath the spout structure and it is of such a length and angularity as indicated in Figure 1, that when the furnace is in tilted position, its lower edge overlies the receptacle 95, but falls short of the normal trajectory of the stream 96. Any spillage from the latter is thus caught by the drip deflector plate 128 and prevented from spilling into the catch pit 125.

However, it is possible to function safely without the drip deflector 128 due to certain other features of construction and action in which the features of construction of the spout element 46 (Figure 4) above described take part. As above mentioned, the spout element 46 is constructed to have its inner opening 62 function as an orifice in order thereby to substantially fix the rate of flow of molten material and such an orifice arrangement and functioning are preferred to achieve the coactions about to be described. With the orifice determining the rate of flow therethrough of molten material, the stream 96 (Figure 1) is, other factors being appropriate, of substantially constant characteristic insofar as volume per time unit movement of molten material is concerned and hence has a substantially fixed trajectory characteristic. It is thus possible to avoid having to contend with change in trajectory characteristic caused by change in rate of flow.

Depending upon the charge in the furnace and hence upon the amount of molten material contained therein, the hydraulic head of the latter, at the center of the orifice 62 (Figure 4) may vary or may be made to vary according to the extent to which the furnace is tilted, and the axis of tilt of the furnace is preferably displaced from the orifice in order to achieve change in position of the orifice and particularly of the discharge end of the spout passageway 48 relative to the "target" which, as indicated in Figure 1, is to be considered as the midpoint of the plane of the upper open end of the receptacle 95. According to the invention, tilting of the furnace is made to effect such movement of the discharge end of the spout both horizontally and vertically toward the target so that the discharge stream 96 hits the target for all pouring positions of the furnace, or substantially so, and adequately so for practical purposes, bearing in mind some variations caused by change in hydraulic head at the orifice.

Accordingly, the faces Y and Z (Figure 1) of the coacting pairs of rockers and rocker guideways 12—15 and 13—16 are given shapes so that, for any position within the operating tilting range of the furnace the horizontal distance of the discharge end of the spout from the target is always equal, or substantially so, to the vertical distance of the spout discharge end from the target.

For example, and referring to Figure 1, let it be assumed that the hydraulic head in the furnace is sufficient to effect pour with the furnace in normal or tilted position; when the spout orifice 62 is unplugged, the stream of pour, of substantially fixed volume per time unit as determined by the orifice 62, emerges from the spout structure and in an almost arcuate curve strikes the target, without spillage. The vertical distance D^1 is equal to the horizontal distance D^2, particularly for molten alumina.

If the hydraulic head is insufficient for pouring without tilting the furnace, the spout structure may be unplugged, and the furnace tilted to commence pour; such tilt lowers the orifice relative to the substantially fixed level of the molten material so that orifice-controlled rate of pour may commence, but due to the coacting shapes of the faces Y and Z which are in rolling contact, the movement of the spout toward the left as viewed in Figure 1 that follows from the counterclockwise tilt of the furnace is accompanied by such change in vertical height of the discharge end of the spout structure that the above-mentioned equality of vertical and horizontal distances of the spout discharge end from the target is maintained and by way of illustration, assuming that the tilt is the illustrative 10° tilt indicated in broken lines in Figure 1, the vertical distance D^3 is made to become less than the distance D^1 by the same amount that the horizontal distance D^4 is made less than the distance D^2 by the leftward tilt of the furnace as viewed in Figure 1, and the trajectory is again such that the stream, for this illustration indicated at 96, again hits the target and enters the receptacle 95 without spillage.

Beyond this last-mentioned illustrative tilt or intermediate of that tilt and the normal vertical position of the furnace, the shapes of the rolling-contacting faces Y and Z of the furnace supports in a similar way maintain this relationship of equality of horizontal and vertical distances. These factors hold true for fused alumina and it will be understood that they may vary for other materials and in such case any desired fixed or variable relationship between the horizontal and vertical distances may be achieved, depending upon the trajectory characteristic of the material to be handled.

The rolling-contacting faces Y and Z form a convenient inexpensive and dependable way in which to achieve the desired relationship. Where the bottom shell 11 of the furnace is a segment of a sphere, the faces Y of the furnace rockers are preferably and conveniently given the shape of an arc of a circle of appropriate radius commensurate with or slightly greater than the radius of the spherical segment of the bottom shell 11 and the face Z of the supporting guideways 15—16 is, to the left of the normal vertical central axis of the furnace, shaped to so change the vertical position of the point or line of rolling contact as it moves leftward during tilting of the furnace to achieve the desired change in the above-mentioned vertical distance in the desired relation to the change in the horizontal distance of the spout discharge end from the target; in the illustrative case, particularly for alumina, that portion of the faces Z of the guideway rails 15—16 is curved substantially as indicated downwardly toward the left from the horizontal plane of the point of rolling contact when the furnace is in upright or normal position, instead of being horizontal which would seem to be the simpler way of making the guideway rails 15—16. Accordingly, as the furnace tilts, it effects a greater

downward displacement of the spout discharge end than would be the case if the faces Z were plane and horizontal. The shapes of the faces Y and Z will thus be seen to be complementary for the shape given the one will effect the shape required for the other to achieve the desired path of transition or of motion of translation of the spout discharge end to achieve the desired relationship of horizontal and vertical distances for any given trajectory characteristic, and either or both of these faces X and Y may be considered as cam surfaces empirically shaped to suit the pour characteristics.

In the illustrative embodiment above-described, where it is found that the material being poured has an effective trajectory or curve such that the horizontal projection (such as the distance D^2) is equal to the vertical projection (such as the distance D^1), the rolling contacting faces Y and Z are such that the movement of translation of the discharge spout is downwardly and toward the left in Figure 1 along substantially a straight line that makes an angle of 45° with the horizontal, that line being thus the hypotenuse of a 45° right-angled triangle of which the horizontal and vertical legs are always equal. Accordingly, the vertical and horizontal distances above-described are, for molten alumina, always equal at whatever position the spout has within the effective range of tilt of the furnace. In similar manner, the path of movement of the spout may be predetermined by correspondingly shaping the faces X and Y, or either of them, to maintain any desired ratio of rate of change of the vertical distance to rate of change of the horizontal distance or projection, according to whatever happens to be the trajectory characteristic of the particular molten material being handled.

Accordingly, the pour stream, due to the above-described coacting structural and functional features is found to be dependably controlled and capable of being made always to bridge the gap across which the drip deflector may, if desired, be nevertheless employed as an additional safety factor, and thus hazards of operating the furnace can be greatly reduced.

By way of illustration, in the case of molten alumina, the orifice may be proportioned to give a controlled rate of flow on the order of about 500 pounds of molten alumina per minute, the above-mentioned horizontal and vertical distances between spout discharge end and target varying, according to the angle of tilt, to cause the stream always to strike at substantially the same point, without material shift of the latter. It has been found that the control action of the orifice 62, though varying somewhat with the hydraulic head, nevertheless makes it possible to give the furnace, for pouring, the complete tilt desired, illustratively, on the order of 10°, and still maintain proper trajectory for filling or charging a suitable number of successively arranged receptacles 95 progressed or moved step by step along the rails 93 (Figure 1) to the pouring station and without having to interrupt the pour for each receptacle. It is preferred not to completely withdraw all the molten charge of alumina in the furnace, but to leave a substantial quantity after each pour so that upon return tilt to normal of the furnace, additional unfused alumina may be added to the furnace to the already molten charge retained therein and thereby also maintain continuity of heat action by the electrodes and the electrical energy supplied to them. Also it is preferred to continue feed of unfused material to the furnace during pour, as described in the above-mentioned Ridgway application.

It will thus be seen that there has been provided in this invention a furnace construction in which the various objects hereinbefore set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments might be made of the mechanical features of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A furnace construction comprising a furnace shell having a pouring spout projecting laterally therefrom and having means mounting the shell for tilting movement to effect pour via said spout, the external walls of the shell flaring outwardly and downwardly and having means for supplying externally to them a cooling liquid, said spout having thereabout and spaced from the shell wall means forming a baffle to guard against spillage of cooling liquid from the shell wall upon tilt of the shell for pouring, said spout having a stopper with means pivotally supported by said shell and connected to the stopper and adapted to guide the stopper in a path into or out of closing relation to the spout, a platform extending at least partially about said shell and below the height of the spout, said platform having a section thereof that is in the path of tilting movement of the furnace shell provided with means movably supporting it for tilting into a substantially vertical position out of the path of furnace tilting and to space it in said vertical position sufficiently from the pouring spout to accommodate a receiving container between it and the tilted furnace and form a protective shield during pour, said section having therein a movable member which, when moved, provides space through which an operator standing on the platform side of said vertical platform section may by a tool or the like operate upon said stopper-supporting means and control the relation of the stopper to the spout.

2. A furnace construction as claimed in claim 1 in which said movable member of said platform section is pivotally connected to said section to pivot about an axis so related to the center of mass of said member and to the horizontal and vertical positions of said platform section that restoration of the platform section to horizontal position causes the weight of said member to swing it into closing position and tilting of said platform section into upright position causes the weight of said member to swing it into open position.

3. A furnace construction comprising a furnace shell having a pouring spout projecting laterally therefrom and having means mounting the shell for tilting movement to effect pour via said spout, means at the spout side of said furnace shell for receiving the material of the pour stream when the furnace shell is tilted for pouring, a stopper for said spout provided with means pivotally carried by the shell and connected to said spout to guide the latter in a path into or out of stopping relation to said spout, a platform on the spout side of the furnace shell and normally intersecting the trajectory of the pour stream and overlying said receiving means, and means movably supporting said platform for tilting it out of overlying relation to said receiving means and into a substantially upright position on that side of said

material receiving means remote from said shell and to thereby move it out of the path of the pour stream and also to form a protective shield against splash or spillage from, and against heat emanating from, the poured material, said platform having an aperture therein through which an operator on the protected side of the shield may insert a tool to operate upon said stopper-supporting means and control the relation of the stopper to the spout.

4. A furnace construction comprising a furnace shell having a pouring spout projecting laterally therefrom and having means mounting the shell for tilting movement to effect pour via said spout, means for receiving molten material discharged from said spout, a platform at the spout side of said furnace shell, and means supporting said platform for movement into or out of two positions, in one of which positions said platform is substantially horizontal and overlies said receiving means and in the other of which positions said platform is substantially upright in a plane on that side of said receiving means that is remote from the furnace shell to thereby expose said receiving means to the pour trajectory from said spout and to be out of the way of tilting movement of the furnace and to form a protective shield during pour from said spout.

5. A furnace installation comprising a furnace having spout means through which molten material may be withdrawn therefrom, means for receiving molten material from said spout means, a platform at the discharge side of the furnace and having a normally horizontal position overlying said receiving means, and means mounting said platform for movement into a substantially vertical position on that side of said receiving means that is remote from the furnace and thereby form a protective shield during pour from said spout means.

6. A furnace construction comprising a furnace shell having a pouring spout projecting laterally therefrom and having means mounting the shell for tilting movement to effect pour via said spout, a stopper for said spout having means movably supported from the furnace shell to guide said stopper in a path into or out of stopping relation to said spout, said stopper-supporting means having a counter-weight and means inter-relating said counter-weight and said supporting means so that throughout the range of tilt of the furnace shell, the counter-weight acts to urge the stopper into stopping relation and acts, after the stopper has been removed from stopping relation, to urge the stopper away from said spout, a platform at the spout side of said furnace shell in a position normally overlying the region to which the pour stream from said spout discharges molten material, and means mounting said platform for movement into a substantially vertical position to clear the path of tilting movement of the furnace shell and into a position on that side of said region that is remote from the furnace shell to form substantially a shield during pour, said platform having means through which an operator, on the protected side of said shield, may insert a tool or the like to control movement of the stopper into or out of stopping relation to said spout.

7. A furnace installation comprising a furnace having means for withdrawing molten material therefrom, a platform adjacent said furnace at the discharge side thereof, and means movably supporting said platform to shift it from substantially horizontal position to a substantially vertical position spaced from the furnace to thereby serve as a shield during discharge of molten material.

8. A furnace installation comprising a furnace having spout means for withdrawing molten material therefrom, a platform having a section thereof that is at the discharge side of said furnace provided with means pivotally supporting said section for swinging movement about a horizontal axis to shift it from substantially horizontal position to substantially vertical position spaced from said furnace and form a shield.

9. A furnace installation comprising a furnace having means for the withdrawal therefrom of molten material, a platform at the material-withdrawing side of the furnace, means pivotally supporting said platform to pivot about a substantially horizontal axis so related to the center of mass of the platform that the weight of the latter is on one side of said axis when the platform is in horizontal position and is on the other side of said axis when the platform is in substantially vertical position, and stop means to limit pivoting movement of the platform so that it is in either horizontal position or substantially vertical position and held therein by its weight.

10. A furnace installation comprising a furnace having a pouring spout in a side thereof, stopper means comprising a stopper for said spout and means movably supporting said stopper for movement in a path to insert it in or withdraw it from said spout, a tiltable platform positioned at the spout side of said furnace at a height whereby access to the top and interior of the said furnace may be gained, and means for pivotally mounting said tiltable platform so that said platform may assume a substantially upright position spaced from said spout, thus providing a shield against material poured from the said spout, said platform having a port therein at a height, when the platform is tilted, substantially in line with said spout, whereby a tool projected through said port may be engaged with said stopper means to manipulate it for insertion into or withdrawal of the stopper from said spout.

11. A furnace installation as claimed in claim 10 in which said port is provided with a cover plate, and means for pivotally supporting said cover plate to swing about an axis positioned so that the plate is moved by its own weight into port-uncovering position when the platform is moved to substantially upright position and is moved by its own weight into port-closing position when the platform is moved to substantially horizontal position.

12. A furnace construction comprising a furnace shell of metal having a metal sleeve extending through a wall thereof and in sealed connection therewith, said sleeve having an internal tapered bore with the larger-diametered end at the outer end of the sleeve, a sleeve-like spout member of refractory material having an exterior tapered surface removably receivable in the tapered bore of said sleeve, said furnace shell having an interior refractory lining and said refractory spout member extending beyond the internal surface of said shell for coaction with said lining.

13. A furnace construction comprising a furnace shell of metal having a metal sleeve extending through a wall thereof and in sealed connection therewith, said sleeve having an internal tapered bore with the larger-diametered end at the outer end of the sleeve, a sleeve-like spout member of refractory material having an exterior tapered surface removably receivable in the ta-

pered bore of said sleeve, said refractory spout member having means coacting with the external wall of said furnace shell and in engagement with the front portion of said spout member for holding the latter against movement out of said tapered bore.

14. A furnace construction comprising a furnace shell of metal having a metal sleeve extending through a wall thereof and in sealed connection therewith, said sleeve having an internal tapered bore with the larger-diametered end at the outer end of the sleeve, a sleeve-like spout member of refractory material having an exterior tapered surface removably receivable in the tapered bore of said sleeve, and means adapted removably to clamp said refractory spout member in position, the clamping force being exerted in a direction to wedge said externally tapered spout member into said tapered bore.

15. A furnace construction comprising a furnace shell of metal having a metal sleeve extending through a wall thereof and in sealed connection therewith, said sleeve having an internal tapered bore with the larger-diametered end at the outer end of the sleeve, a sleeve-like spout member of refractory material having an exterior tapered surface removably receivable in the tapered bore of said sleeve, said spout member being of a length to project forwardly of said sleeve and having at the external portion thereof a peripheral flange of substantial dimension overlying the front end of said sleeve, and means coacting with the forwardly exposed portion of said spout member for removably holding it against movement out of said tapered bore.

16. A furnace construction comprising a furnace shell of metal having a metal sleeve extending through a side thereof and in sealed connection therewith, said sleeve having an internal tapered bore with the larger-diametered end at the outer end of the sleeve, a sleeve-like spout member of refractory material having an exterior tapered surface removably receivable in the tapered bore of said sleeve, said spout means having a tapered bore, a tapered stopper receivable into the latter, means connected with said stopper and movably supporting it for movement toward or away from said spout member, and means holding said spout member against outward dislodgment out of the tapered bore of said sleeve and thereby also resist the force of dislodgment of said stopper when said stopper-supporting means is actuated to move the stopper into position away from said spout member.

17. A furnace construction comprising a furnace shell having a pouring spout extending through a wall thereof, said spout having a tapered bore with the wider end thereof at its outer end of the spout, a stopper tapered correspondingly to the bore of said spout and adapted to be seated in said spout bore to close said spout against the flow of material therethrough, and means for supporting said stopper including an arm having connecitons with said stopper and means for pivotally supporting said arm to pivot about an axis so that said stopper is moved thereby toward or away from said spout.

18. A furnace construction as claimed in claim 17 in which said arm is in the form of a lever with a counter-weight which is moved to one side of said axis as the lever is swung to move the stopper toward said spout and which is moved to the other side of said axis when said lever is swung to move the stopper away from said spout.

19. A furnace construction as claimed in claim 17 in which said connections between said arm and said stopper have flexibility of self-accommodation of the path of interfitting movement between the stopper and the tapered spout bore relative to the arcuate path of movement of the arm.

20. Construction comprising a furnace shell having a pouring spout extending through a wall thereof, said spout having a tapered bore with the wider end thereof at its outer end of the spout, a stopper tapered correspondingly to the bore of said spout and adapted to be seated in said spout bore to close said spout against the flow of material therethrough, a lever having pivotal connection relative to said spout so one of its lever arms is movable toward or away from the spout, a pivotal connection between said lever arm and said stopper whereby said stopper, upon swing of said lever, is moved toward or away from said spout, at least one of said pivotal connections having sufficient play to permit self-accommodation between the path of interfitting movement between said stopper and said tapered spout bore and the arcuate path of movement of said lever arm.

21. A furnace construction as claimed in claim 17 in which said connections comprise means whereby said stopper has articulated connection with said arm and means limiting articulated movement of said stopper relative to the arm so that the lesser-diametered end of the stopper, upon movement of the latter toward said spout, is in alignment with and enters the larger-diametered end of said tapered spout bore.

22. A furnace construction comprising a furnace shell having a pouring spout extending through a wall thereof, said spout having a tapered bore with the wider end thereof at its outer end of the spout, a stopper tapered correspondingly to the bore of said spout and adapted to be seated in said spout bore to close said spout against the flow of material therethrough, said stopper having a peripheral flange adjacent its outer end and a shank of lesser diameter than said flange and projecting axially away therefrom, and means for supporting said stopper for movement toward or away from said spout and comprising an arm having bifurcations between which said shank is received, said bifurcations having means forming a pivotal connection with said shank, means movably supporting said arm for movement to carry said bifurcations toward or away from said spout, said bifurcations and said flange coacting to limit relative pivoting between said stopper and said arm.

23. A furnace construction comprising a furnace having a pouring spout, a stopper for said spout, means movably supporting said stopper for movement in directions toward or away from stopping relation to said spout, and means responsive to directional movement of said means for urging the stopper in closing relation to said spout upon movement into closing relation and for urging and holding said stopper away from said spout upon movement thereof away from the spout.

24. A furnace construction comprising a furnace having a pouring spout, a stopper for said spout, means movably supporting said stopper for movement in directions toward or away from stopping relation to said spout, and reversibly acting means for holding the stopper in the positions into which it is moved either away from the spout or in stopping relation thereto.

25. A furnace construction comprising a fur-

nace shell having a pouring spout in a side wall thereof and having means mounting it for tilting movement to effect pour of molten material through said spout, means at the spout side of said furnace for receiving molten material from the spout, a platform at the spout side of the furnace and normally overlying said receiving means and normally positioned in the path of tilting movement of the furnace, controllable means for tilting the furnace and operable to increase the tilt as pour from said spout continues to thereby increase the head of molten material within the furnace relative to the spout, said first-mentioned means being constructed and operating in response to continued tilt of the furnace to so shift the latter and the spout laterally that the point of incidence of the pour stream substantially always is in substantially the same position relative to said receiving means, and means mounting said platform for movement beyond the range of continued tilting of the furnace and into a substantially vertical position on that side of said receiving means that is remote from the furnace to thereby form substantially a shield during pour.

26. A furnace construction comprising a furnace shell of metal, a pipe for a cooling liquid positioned around the upper end of the metal shell and having discharge means to supply cooling liquid to the external side surface of the shell, said shell having extending about the periphery of its upper end metal flange means having portions extending laterally from the shell to strengthen the upper end of the shell against distortion and having portions extending downwardly at an angle to said first-mentioned portions to give said flange means increased rigidity and to form with the side walls of the shell a downwardly open pocket throughout the peripheral extent of said flange means, a plurality of vertically extending plate-like members in said pocket and presenting substantially aligned lower end edges, said pipe underlying said plate-like members, and means clamping said pipe against the lower edges of said plate-like members with the discharge means therein directed generally toward the furnace shell, said flange means and said pocket forming a guard to prevent access of liquid from said pipe to the top of the furnace.

27. A furnace construction as claimed in claim

26 in which said clamping means comprises a plurality of tension members having substantially hook-shaped lower ends to engage said pipe, and threaded means coacting between said tension members and said flange means to tension them and thereby clamp said pipe against said plate-like members.

28. A furnace construction comprising a furnace shell of metal having a metal sleeve extending through a side thereof and in sealed connection therewith, a sleeve-like spout member of refractory material in said metal sleeve and having means for holding it assembled thereto, a stopper adapted to close off said spout member, means connected with said stopper and movably supporting it for movement toward or away from said spout member, and reversibly acting means for holding the stopper in the positions in which it is moved either away from the spout or in stopping relation thereto.

29. A furnace installation comprising a furnace shell having means for supplying cooling liquid to the external sides thereof, said furnace having means for withdrawing molten material therefrom to a receiving point substantially at one side of the shell, means for supporting said furnace shell and providing a pit for catching liquid running off the external surfaces of the shell, shield means, and means mounting said shield for controllable movement into either a substantially vertical position on that side of said receiving point remote from the furnace shell or a substantially horizontal position overlying said receiving point to form a platform adjacent the furnace shell and at a level above said pit.

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