Jan. 25, 1938. K. S. HOWARD ET AL 2,106,456

APPARATUS FOR HANDLING MOLTEN METAL

Filed July 24, 1935 5 Sheets-Sheet 1

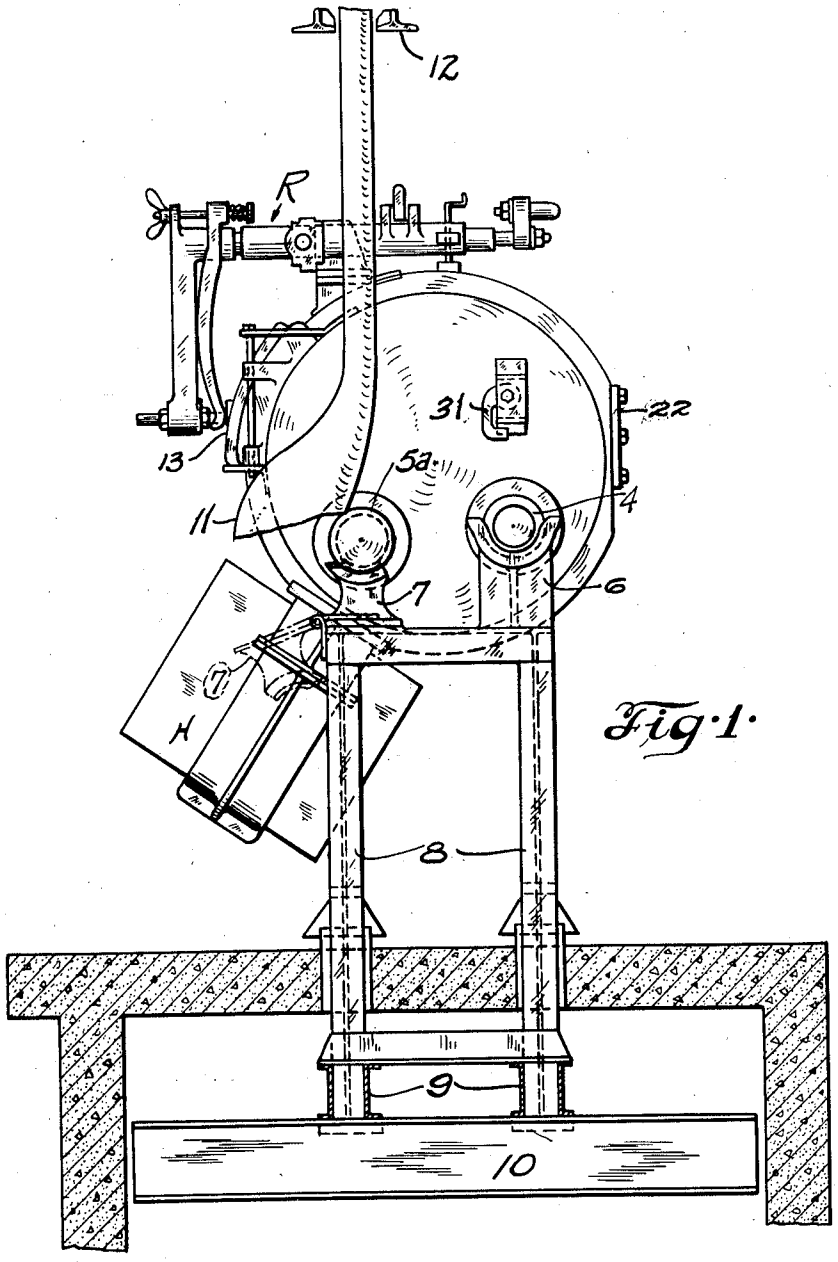


Fig. 1.

INVENTORS
John H. Locke.
Karl S. Howard.
BY Rodney Bedell
ATTORNEY

Jan. 25, 1938. K. S. HOWARD ET AL 2,106,456

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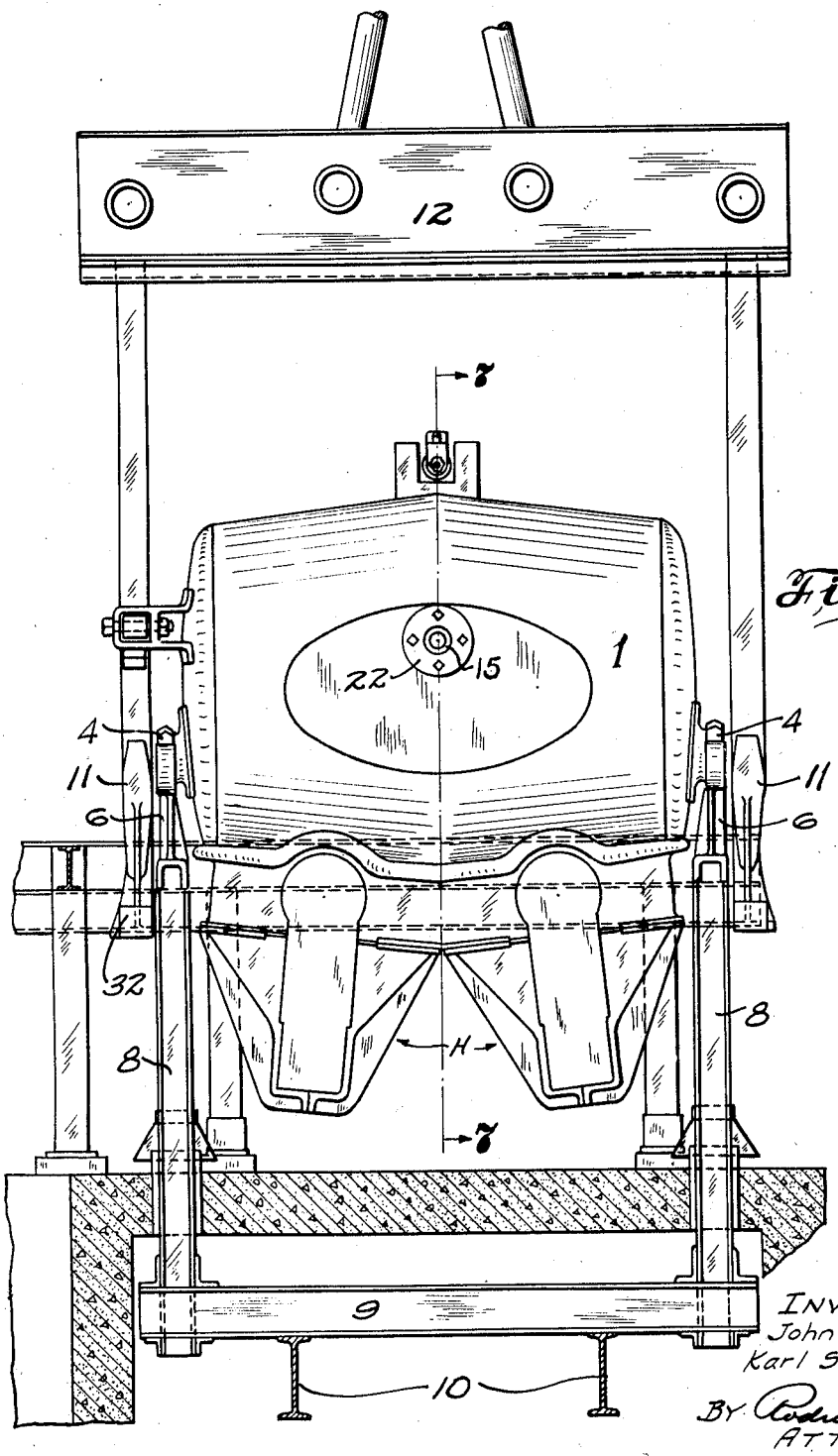


Fig. 2.

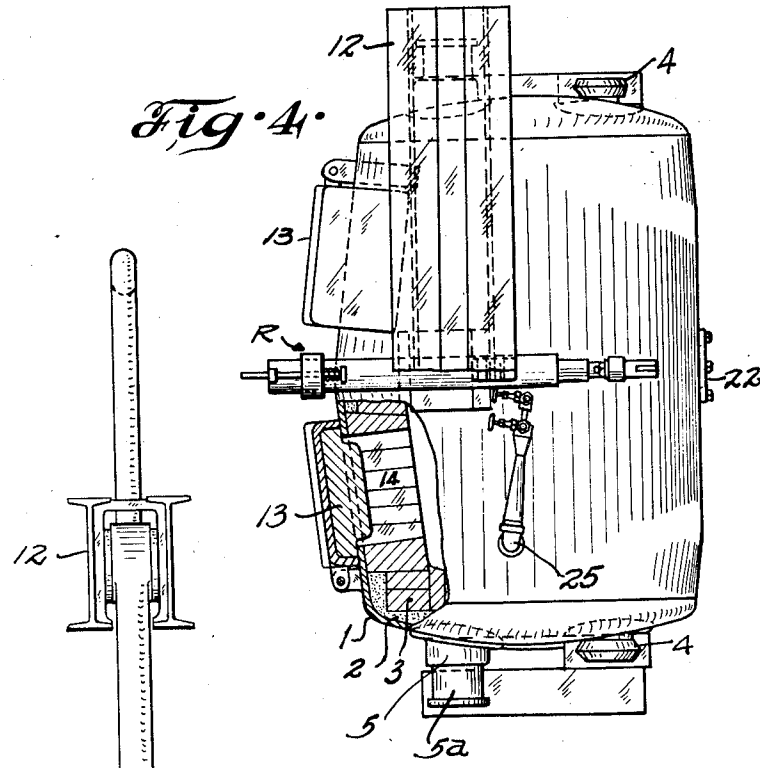
INVENTOR
John H. Locke.
Karl S. Howard.
BY Rodney Redall
ATTORNEY

Jan. 25, 1938. K. S. HOWARD ET AL 2,106,456

APPARATUS FOR HANDLING MOLTEN METAL

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Fig. 4.



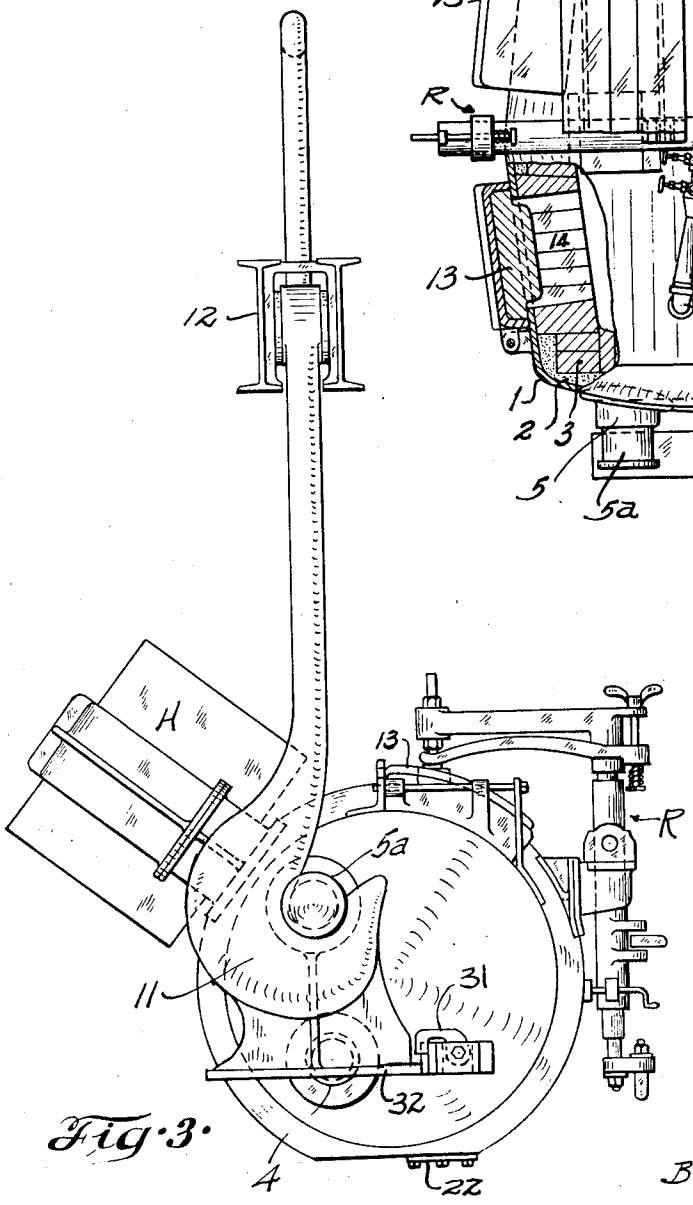


Fig. 3.

INVENTORS
John H. Locke.
Karl S. Howard.
BY Rodney Redell
ATTORNEY

Jan. 25, 1938. K. S. HOWARD ET AL 2,106,456

APPARATUS FOR HANDLING MOLTEN METAL

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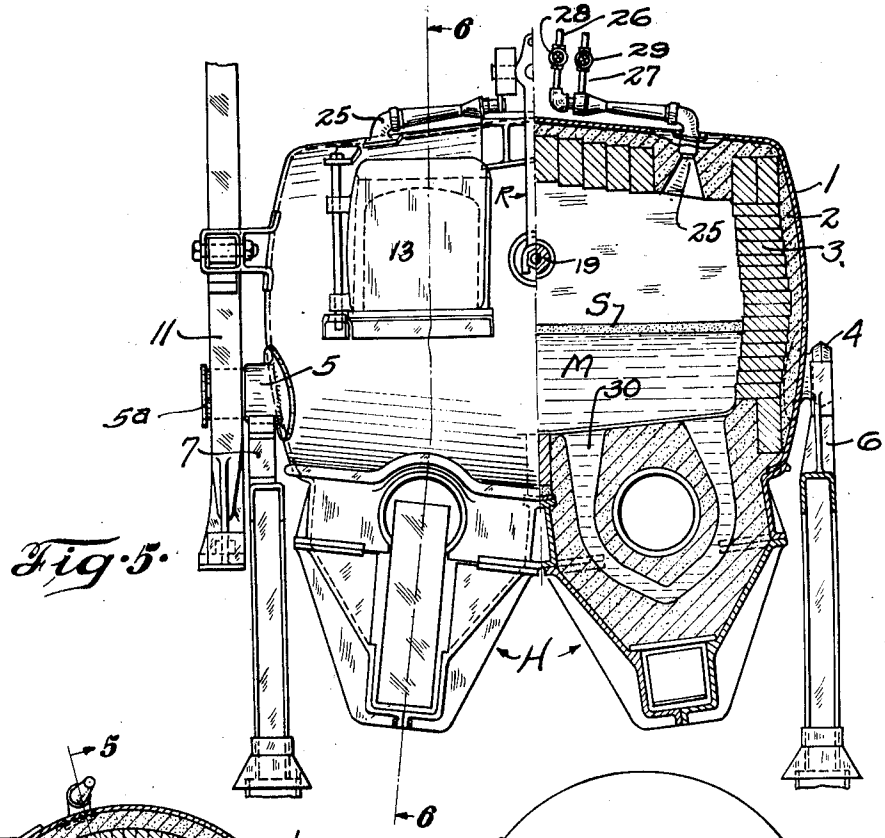


Fig. 5.

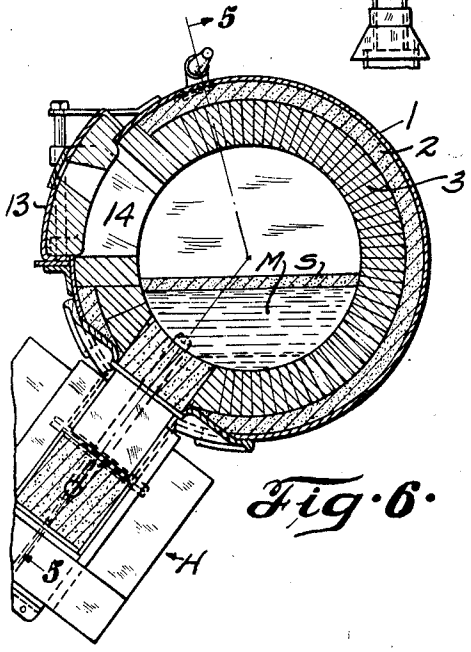


Fig. 6.

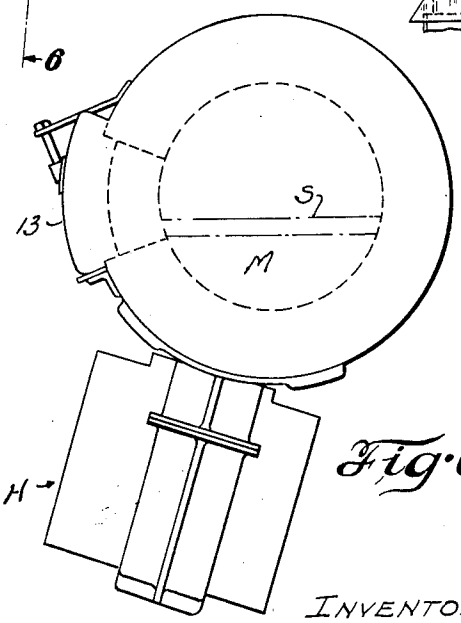


Fig. 6a.

INVENTORS
John H. Locke.
Karl S. Howard.
BY Rodney Bedell
ATTORNEY

Jan. 25, 1938. K. S. HOWARD ET AL 2,106,456

APPARATUS FOR HANDLING MOLTEN METAL

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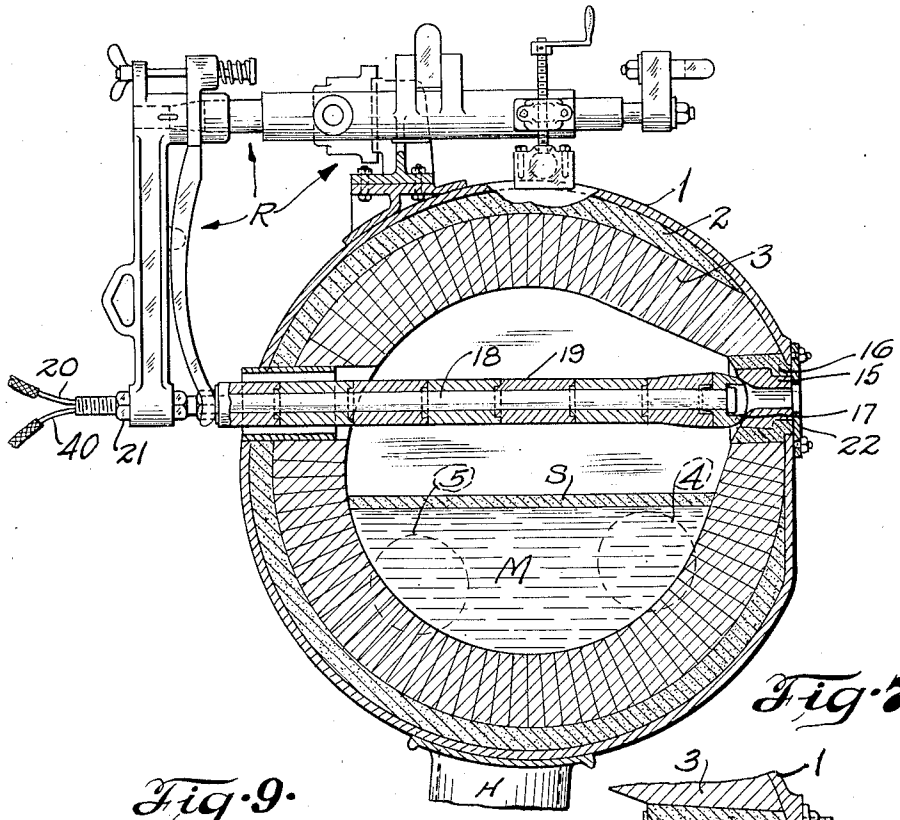


Fig. 7.

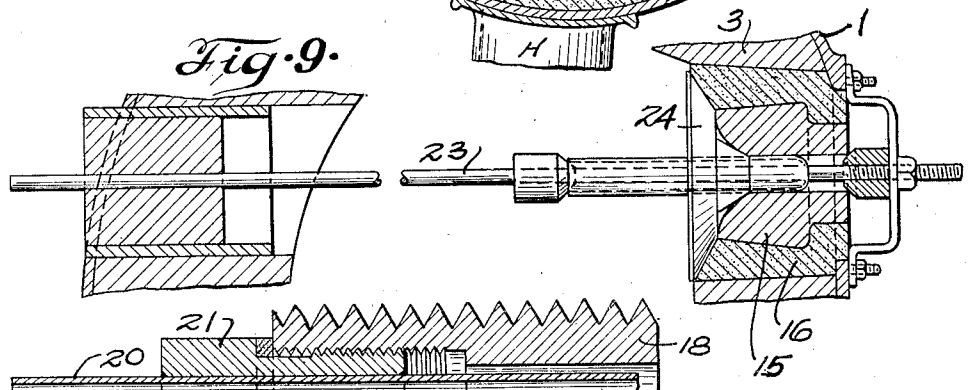


Fig. 9.

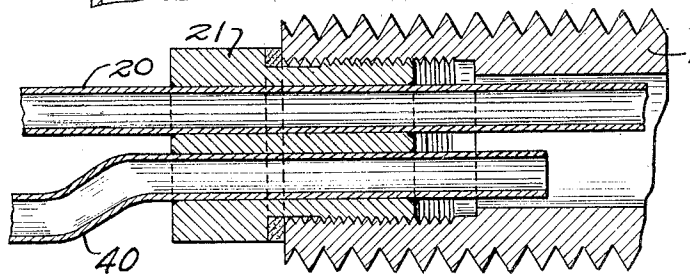


Fig. 8.

INVENTORS
John H. Locke.
Karl S. Howard.
BY Rodney Radell
ATTORNEY

Patented Jan. 25, 1938 2,106,456

UNITED STATES PATENT OFFICE

2,106,456

APPARATUS FOR HANDLING MOLTEN METAL

Karl S. Howard, Bryn Mawr, and John H. Locke, Villanova, Pa., assignors, by mesne assignments, to Ajax Electric Furnace Corporation, Philadelphia, Pa., a corporation of Pennsylvania

Application July 24, 1935, Serial No. 32,922

7 Claims. (Cl. 13—2)

The invention relates to the art of melting, refining, and alloying metal, and consists in a novel apparatus for heating metal in a furnace and pouring the metal from the furnace, and also consists in novel features of the furnace structure.

The main objects of the invention are to facilitate the treatment of metals, particularly alloys, in a furnace, to eliminate the transfer of metal from the furnace to a pouring ladle, to combine electric and fuel heating means in a furnace, to arrange for the transportation of the furnace to molds, and to control the flow of metal direct from the furnace into successive mold openings.

Other detailed objects of the invention will be apparent from the following description, reference being had to the accompanying drawings in which—

Figure 1 is an end view of a furnace mounted upon a supporting structure including a weighing mechanism. Part of the furnace handling mechanism is illustrated also.

Figure 2 is a rear view of the structure shown in Figure 1.

Figure 3 is an end view corresponding generally to Figure 1 but showing the parts in a different position.

Figure 4 is, in part, a top view of the furnace and, in part, a horizontal section through the rear wall thereof and a charging door.

Figure 5 is, in part, a front elevation and, in part, a longitudinal vertical section taken approximately on the line 5—5 of Figure 6.

Figure 6 is a vertical transverse section taken approximately on the line 6—6 of Figure 5.

Figure 6*a* diagrammatically illustrates the parts shown in Figure 6 when the furnace is tilted to a slag discharging position.

Figure 7 is a transverse vertical section taken approximately on the line 7—7 of Figure 2.

Figure 8 is an enlarged detail section of the water connection to the stopper structure.

Figure 9 illustrates the means whereby a new discharge nozzle is applied to the furnace from the outside of the furnace.

The furnace comprises a barrel-shaped body including an outer shell of metal 1, lined with insulation 2, and an inner wall 3 of refractory brick. Trunnions 4 and 5 project from each end of the body and may be engaged by suitable elements to support the body.

In Figures 1, 2 and 5, trunnions 4 and 5 rest in brackets 6 and 7, respectively, carried on the upper end of an upright structure 8 mounted on a framework 9 of a weighing scale structure 10. The furnace is stably supported upon the scale frame and the weight of the contents of the furnace and any additions thereto may be determined readily.

The ends 5*a* of trunnions 5 project outwardly beyond brackets 7 and may be engaged by hooks 11 depending from an overhead traveling crane structure 12 of ordinary construction. By raising hooks 11, the furnace may be tilted in a clockwise direction about the axis of trunnions 4. When trunnions 5 are raised, brackets 7 may be turned on their pivots to the dot and dash line shown, which permits the furnace to be tilted anti-clockwise from the position indicated in Figures 1 and 6 to the position indicated in Figure 6*a*.

The front of the furnace is provided with a pair of charging doors 13 for closing charging openings 14, and the rear of the furnace has a discharge opening fitted with a refractory nozzle 15 which is set in a bed 16 of ramming mix. Discharge from the nozzle is controlled by a stopper including a tip 17 and a composite tubular and refractory rod 18—19 whereby the tip of the stopper is held in nozzle closing position by a stopper rig, indicated generally at R, and not constituting in itself the present invention. A water inlet pipe 20 passes through a suitable bushing 21 in the outer end of tube 18 and extends to near the inner end of the tube from whence it is discharged and may flow through the tube to the outlet pipe 40 whereby circulation of cold water through the tube may be maintained while the furnace and its contents are being heated. This counteracts the tendency of the heat in the furnace to warp the rod and unseat the tip of the stopper from the nozzle.

The pouring nozzle has to be replaced after each heat and the setting of the same is so constructed that the nozzle can be removed and replaced from the exterior of the furnace, making it unnecessary to let the furnace cool down between heats sufficiently to permit workmen to enter the furnace. By detaching the removable plate 22, nozzle 15 and its bed 16 may be knocked out. A new nozzle may be inserted and held in place by a centering rod 23 (Figure 9) extending through the furnace along the axis of the stopper rod (which will be removed) and fresh nozzle bed material in plastic condition rammed between the nozzle, the adjacent refractories 3, and against a backstop 24. Rod 23 may then be removed and plate 22 replaced.

The furnace illustrated is of the induction heater type, including two single phase coils, although

any number of single phase coils could be used and the other features described could be embodied in any type of electric furnace. Gas burners **25** dry and heat the furnace prior to the functioning of the electric heaters and also supply additional heat during the operation of the electric heaters, thereby reducing the amount of electrical energy required for the furnace. The gas burners have supply conduits **26** and **27** for gas and air, respectively, the same being equipped with individual valves **28** and **29**, respectively, whereby the proportions of gas and air passing through the burners may be controlled and the atmosphere in the furnace can be made either oxidizing or reducing. If, for example, ten parts of air to one part of gas would form a neutral combustion jet, increasing the proportion of air would form an oxidizing atmosphere in the furnace which would burn out carbon, manganese, silicon, etc., whereas cutting down on the proportion of air would form a reducing atmosphere in the furnace resulting in adding the elements from the slag to the molten metal.

Each electric heating unit H includes a tube **30** for metal, it being an inherent characteristic in an induction furnace of this type that no heat can be obtained until metal is in the tubes surrounding the coils. The upper end of each tube **30** opens to the interior of the furnace above the face of the bottom wall whereby small residue of metal or slag left in the furnace after a pouring operation will not drain into the tubes and solidify when the metal is cold. Also fragments of the refractory **3**, or other debris, will not be so likely to fall into the tubes.

Operation.—It will be understood that the present furnace is not ordinarily used as a melting unit, but it supplements such use for superheating or for changing the chemical composition of the steel. The furnace, stabilized as indicated in Figures 1 and 2, will be charged usually with a quantity of molten metal **M** to which a suitable slag material S will be added, the quantity of each portion of each charge being readily and accurately determined by use of the weighing mechanism upon which the furnace is mounted. After adequate heating, and other treatment by means of the air and gas connections, the furnace will be tilted to the position shown in Figure 6*a* to discharge the slag through openings 14, after which the second slag producing material will be added to the furnace and treated, and the contents of the furnace oxidized or reduced by controlling the air and gas conduits.

The air, gas, water and electric conduits will then be disconnected and the furnace lifted bodily by hooks 11 and transported by the overhead crane structure 12. The lifting of the furnace automatically rotates it to the pouring position shown in Figure 3 in which the discharge nozzle 15 is at the lowermost level and the stopper rig R is in position to be manipulated by men on the foundry or mill floor, or on suitable platforms adjacent the molds into which the contents of the furnace is to be discharged.

When the furnace is suspended by hooks 11, as indicated in Figure 3, the molten metal tends to counterbalance the weight of the transformer of the heating units. When the furnace is rotated to the position shown in Figure 3, the latch **31** engages the lug 32 on the downwardly extending portion of hook 16 and holds the furnace locked in the angular position shown so that the furnace will not be tilted accidentally, particularly during pouring operations, and divert the stream of fluid from its intended path.

By manipulating the stopper, the fluid may be discharged intermittently directly from the furnace into successive mold openings either in the same mold or in different molds. The location of heating units H about the circumference of the furnace body is such that with the furnace in pouring position, tubes **30** are inclined to the horizontal and any metal therein will flow out of the tubes into the body of the furnace. This avoids the tubes being filled with slag when the furnace is cold. The slag being non-inductive would prevent the electric heat units from functioning later.

The molten alloy remains in the closed furnace protected by its covering of slag until the moment of discharge into the mold. There is no undue exposure to oxygen in the air or to cooling temperatures as would follow transfer of the metal from the furnace to a pouring ladle for transporting the metal about the mill or foundry in the usual manner. Obviously, the handling and transporting of the metal is simplified and the temperature of the metal conserved. The furnace may be charged for successive heats and double slag operations with a minimum amount of lost time between pourings.

These and other advantages are attained by the general arrangement of the details described above, but it is not essential that each feature described be included in the furnace if its particular function is considered unnecessary. Most of the details of construction are relatively unimportant and may be varied substantially. The exclusive use of all modifications of the described structure coming within the scope of the appended claims is contemplated.

What is claimed is:

1. In a combined furnace and pouring ladle, an electric heating unit at one side of the furnace, a fuel burner at the other side of the furnace, and charging and discharging openings in the wall of said furnace intermediate said unit and burner.

2. In a furnace of the class described, a metal containing body having a bottom wall, a metal receiving tube with its upper ends normally opening upwardly into said body, said ends normally being above the lowermost portion of the inner face of said wall whereby material resting on said portion will not enter said tube by gravity.

3. In a furnace of the class described, a body for containing molten metal, there being a discharge opening in front of said body, trunnions projecting from the ends of said body located near the rear of said body, heating members mounted on the rear of said body, and means for tilting said body on said trunnions to discharge molten metal through said opening, said trunnions and members being constructed and arranged so that when said body is tilted to discharge the molten metal therein through said opening the mass of the metal tends to counterbalance said members.

4. In combination, base supports, a furnace having trunnions arranged to engage strut supports respectively to mount said furnace in stable position, means for tilting said furnace from said position in one direction about the trunnion on one of said supports, the other of said supports being movable out of the path of the corresponding trunnion to provide for tilting of said furnace from said position in the opposite direction.

5. In combination, a furnace having a plurality of external trunnion-like members at opposite ends, brackets for engaging said members to support said furnace in stable position, means for tilting said furnace on its trunnion on one of said brackets, the other of said brackets being rotatable to non-functioning position to accommodate tilting of said furnace.

6. In a metal refining furnace a chamber for holding a liquid charge, tilting trunnions extending from said chamber to hold said chamber in various angular positions and for tilting same, electric means for heating and stirring a charge in said furnace, fuel and air means for heating and controlling slag reactions in said furnace, means for admitting a charge to said furnace, and a controlled stoppered opening normally above the molten metal level in said furnace but relatively near the lowest part when same is tilted to pour a charge.

7. In a furnace, a barrel-like body, a plurality of trunnion-like elements projecting longitudinally from the end of said body whereby the furnace may be mounted upon external supports, at least one of said supports being located eccentrically of the axis of said body whereby the furnace may be tilted about the other element and a controlled stoppered discharge opening in the side wall normally above the level of a straight line passing through said trunnion elements.

KARL S. HOWARD.
JOHN H. LOCKE.