Oct. 19, 1943. W. BONSACK 2,331,887

MELTING FURNACE

Filed July 10, 1941 3 Sheets-Sheet 1

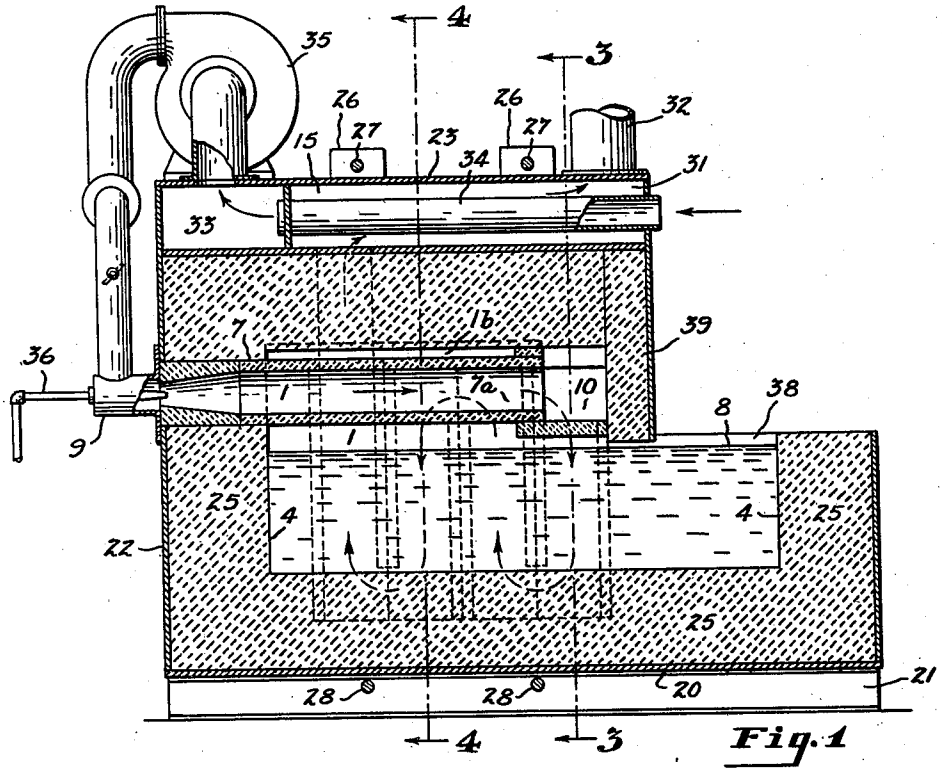


Fig. 1

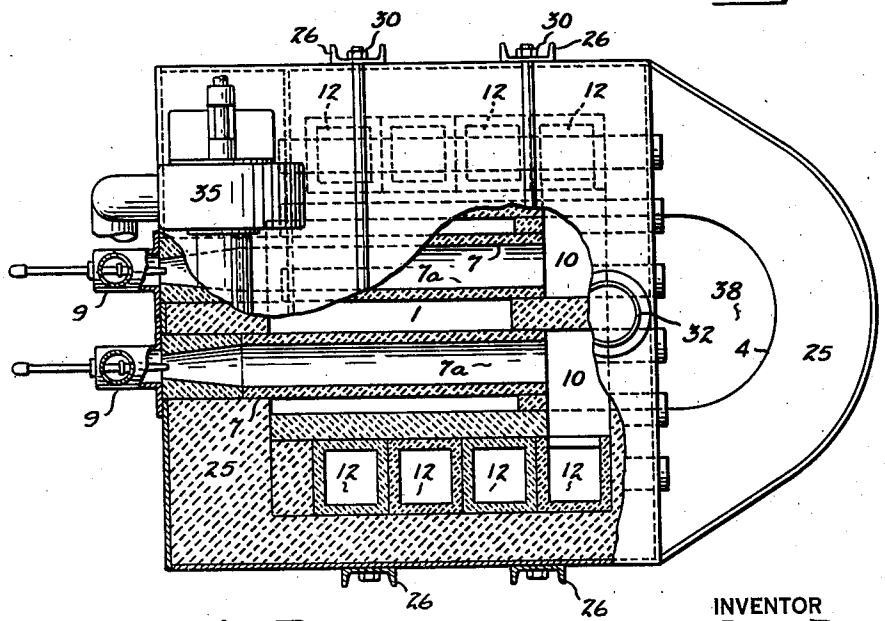


Fig. 2

INVENTOR
Walter Bonsack
BY
Evans & McCoy
ATTORNEYS

Oct. 19, 1943. W. BONSACK 2,331,887

MELTING FURNACE

Filed July 10, 1941 3 Sheets-Sheet 2

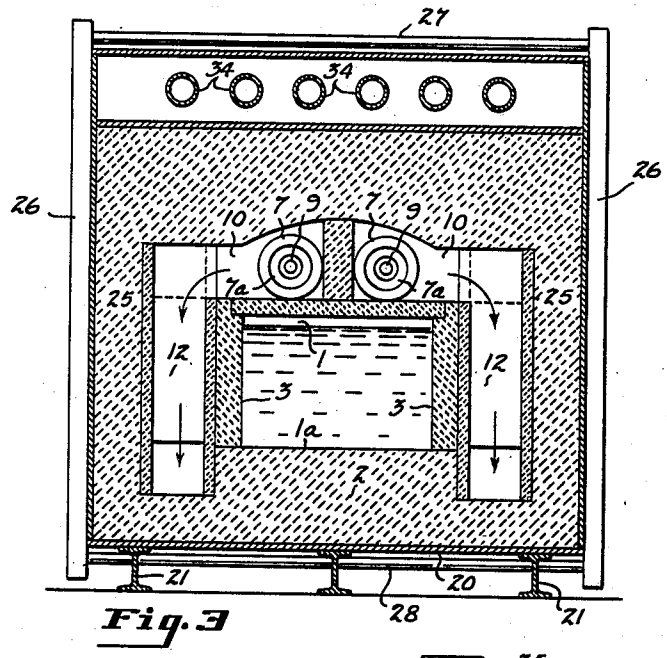


Fig. 3

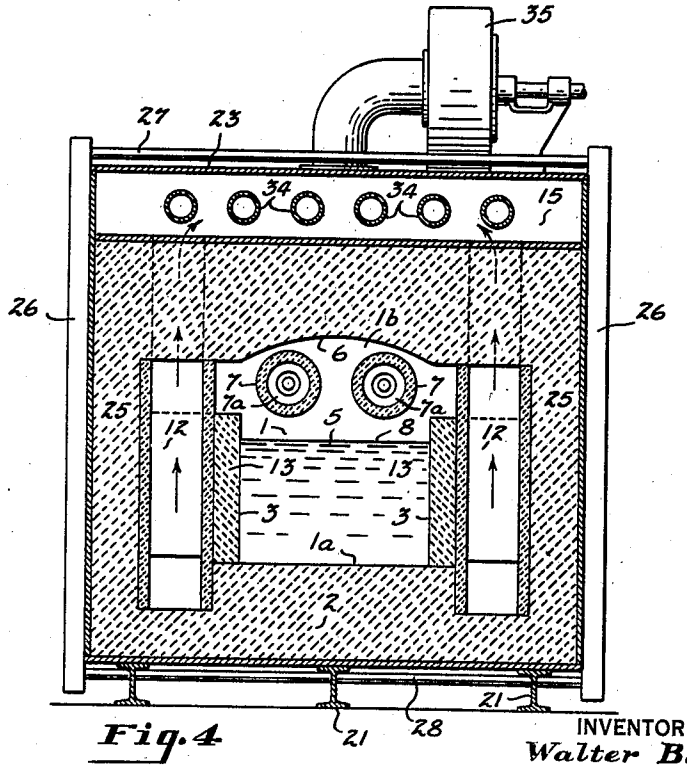


Fig. 4

INVENTOR
Walter Bonsack
BY
Evans + McCoy
ATTORNEYS

Oct. 19, 1943. W. BONSACK 2,331,887

MELTING FURNACE

Filed July 10, 1941 3 Sheets-Sheet 3

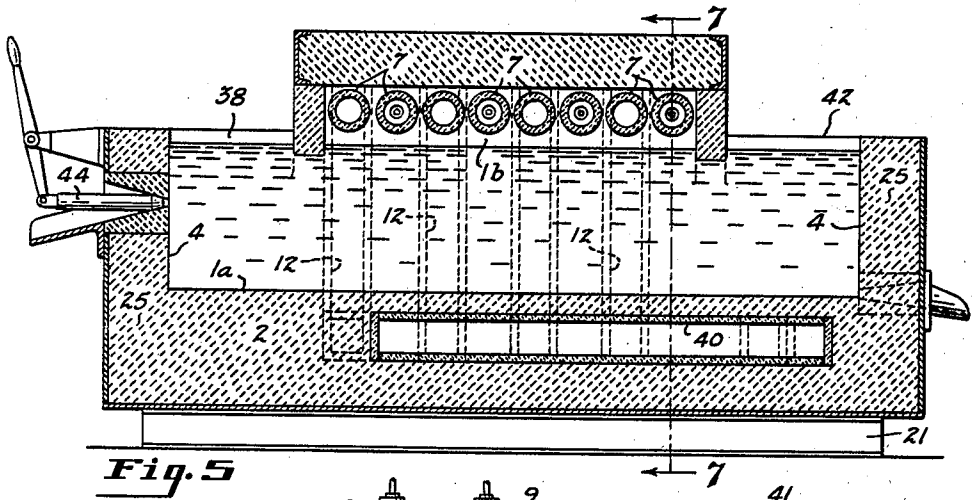


Fig. 5

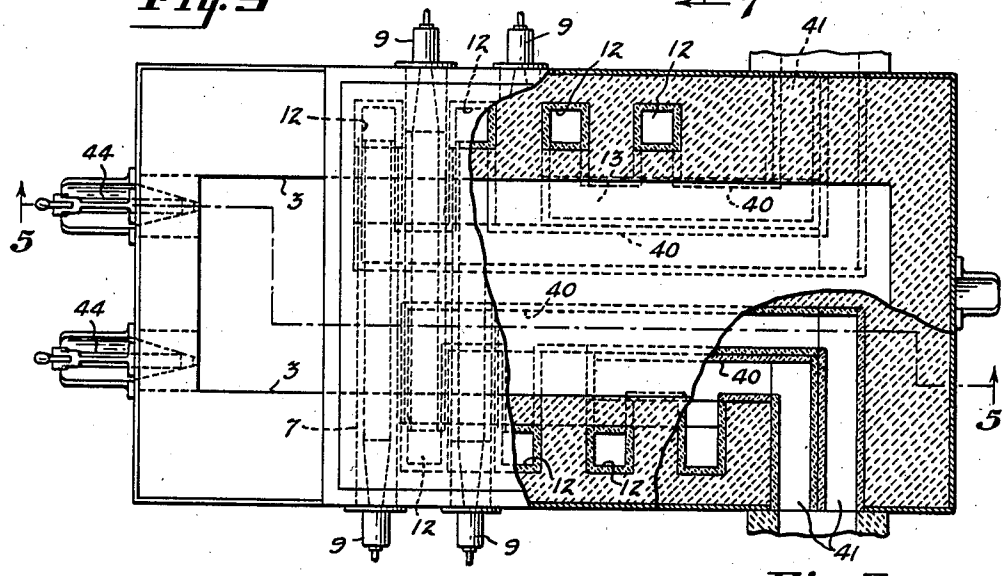


Fig. 6

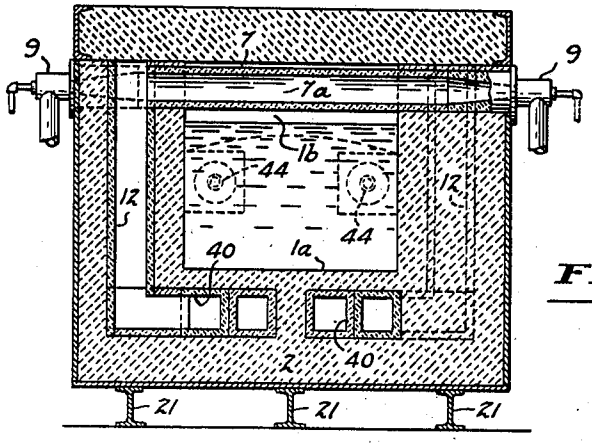


Fig. 7

INVENTOR
Walter Bonsack
BY
Evans & McCoy
ATTORNEYS

Patented Oct. 19, 1943 2,331,887

UNITED STATES PATENT OFFICE

2,331,887

MELTING FURNACE

Walter Bonsack, South Euclid, Ohio, assignor to The National Smelting Company, Cleveland, Ohio, a corporation of Ohio

Application July 10, 1941, Serial No. 401,770

8 Claims. (Cl. 266—33)

This invention relates to improvements in melting and holding furnaces for use in connection with the melting of light alloys, such as aluminum and magnesium alloys.

Even though it is recognized that it is undesirable to permit the products of combustion and the flame to come into direct contact with the surface of the metal, it has been considered necessary in the furnaces heretofore proposed to allow the products of combustion or the flame to pass into the melting chamber in order to obtain the requisite heat and efficiency.

It is an object of the present invention to provide a furnace having high efficiency wherein the products of combustion are completely isolated from the melting chamber.

It is another object of the present invention to provide a furnace wherein the products of combustion are prevented from contacting the metal, and the molten metal is substantially gas-free, whereby degasifying treatment is unnecessary and the metal may be used directly to make non-porous castings.

It is a further object of the present invention to provide a melting and holding furnace which permits ready access to the molten metal for casting purposes, which utilizes a larger proportion of the heat energy from the fuel than do furnaces heretofore proposed, and which is adapted to rapidly melt aluminum alloys and maintain them at the correct temperature.

It is another object of the present invention to provide a furnace having efficient operation wherein the flame and the products of combustion are entirely excluded from the melting chamber and wherein heat from the fuel is rapidly transmitted to the metal, and which may be operated in a continuous manner.

Other objects will be apparent from the following description of the invention as illustrated by the drawings, in which:

Figure 1 is a side elevational view of a furnace embodying the present invention, with parts broken away and partly in section;

Fig. 2 is a plan view of the furnace shown in Fig. 1, with parts broken away to show the arrangement of the passageways for the products of combustion;

Fig. 3 is a vertical sectional view, taken on the line 3—3 of Fig. 1;

Fig. 4 is a vertical sectional view, taken on the line 4—4 of Fig. 1;

Fig. 5 is an elevational sectional view of a modified form of furnace especially designed for relatively continuous operation;

Fig. 6 is a plan view, with portions broken away, of the furnace illustrated in Fig. 5; and

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 5.

The melting furnaces of the present invention have a melting chamber entirely separated from the combustion gases by a plurality of heat conducting ducts of ceramic material and, preferably, of silicon carbide which has superior heat conductivity. The metal is heated both by heat radiated from suitable means, such as highly heated combustion tubes or ducts, over the metal and by conduction from ducts or flues arranged about the side walls and preferably about the bottom of the melting furnaces to provide a tortuous or circuitous passageway for the hot gases.

Referring more particularly to the drawings, in which like parts are indicated by like numerals of reference, the melting chamber 1 is formed by a furnace bottom 2, side walls 3 and end walls 4, and a top or cover portion, the inner surface of which may be curved to form a dome which concentrates radiant heat on the metal. The melting chamber has a heat reflecting dome 6, a hearth 1*a*, which is adapted to receive and support the metal 5, and a radiant heating portion 1*b* above the metal supporting portion or hearth and above the normal level of the metal 5. Radiant heating means, such as one or more combustion ducts or tubes 7, each having a combustion chamber 7*a* through which the flame is projected, is provided in the radiant heating portion to radiate heat to the metal in the portion 1*a*.

In the modifications illustrated in Figs. 1 to 4, the radiant heating means, such as the combustion tubes 7 which are preferably of silicon carbide and may have any desired cross sectional shape, but which are preferably tubular, extend longitudinally within the melting chamber and are substantially above the normal liquid level 8. Burners 9 are suitably carried at one end of each of the combustion ducts. The other end of the combustion ducts terminates in suitable headers 10, which are in substantially gas-tight connection with said combustion ducts and are adapted to receive the gases from the combustion ducts 7 and divert them, without loss of gas, into suitable conductive heating means, such as vertical ducts 12. The vertical ducts 12 are arranged in the walls of the melting chamber, preferably substantially adjacent each other, and extend throughout a substantial proportion of the walls of the melting chamber. Conducting liners 13 separate the vertical ducts from the melting chamber.

Adjacent vertical ducts may be connected together alternately at their upper and lower portions, as shown, to provide a tortuous, heat conducting passageway, terminating on the one end in substantially gas-tight connection with the header 10 or the combustion chamber in the radiant heating tubes or ducts 7. At the other end, one of the passageways in the conduction heating means connects with a stack. A heat exchanger 15 is preferably disposed between the stack and the passageway of the conductive heating means to improve the efficiency of the furnace.

The furnace preferably has an outer casing of steel or other metal, which casing has a base 20 supported on suitable stiffening members, such as I-beams or channels 21, one or more casing ends 22, and a top portion 23, which may, if desired, also house the heat exchanger 15 which is adapted to withdraw a large proportion of the sensible heat from the flue gases.

Insulation 25 is disposed between the melting chamber 1 or the conductive heating means and the outer surface of the furnace. The insulation serves to insulate both the heating means and the melting chamber from the outer casing and prevents a large proportion of the heat lost to the outside of the furnace.

Preferably, and especially when the furnaces are to be moved frequently or transported, a frame comprising vertical supports 26 on each side of the furnace, upper connecting tie bars 27 which extend horizontally over the top of the furnace, and a lower clamping member 28 which extends horizontally through and substantially perpendicular to the stiffening members 21, is provided for reinforcing the furnace walls. With such a frame holding the casing together, disassembly of the furnace is facilitated.

The heat exchanger 15 has a hot gas chamber 31 which is connected with a stack 32 and the passageway in the conductive heating means. A plurality of metal pipes 34 extend through the hot gas passageway 31, one end of the pipes terminating in a header 33 and the other end terminating at the atmosphere. Air for combustion, sucked through the pipes 34 by suitable means, such as a blower 35, withdraws a substantial amount of heat from the flue gases passing through the hot passageway 31 with the result that the heat output of the burners 9, which are supplied with fuel from the pipe 36, is substantially increased.

It is usually preferable to have at least portions of the side walls and the bottom of the furnace extend beyond the upper portion to provide a dipping chamber 38 in communication with the melting chamber to facilitate withdrawal of metal from the melting chamber. The dipping chamber 38 is substantially entirely separated from the radiant heating chamber 5 by the skimmer wall 39, which extends from the top of the furnace to almost the surface of the metal in the melting chamber.

In the operation of the furnace illustrated in Figs. 1 to 4, inclusive, the air for combustion is drawn through the pipes 34 of the heat exchanger 15, where it is heated in substantial amount and forced by the blower 35 into the burners 9, supplied from a fuel source (not shown) through the pipe 36. The flame from the burners 9 is projected by the burners into the chambers 7a of the radiant heating tubes 7, which serve as a combustion chamber, causing the tubes to radiate heat against the surface of the metal in the melting chamber 1. The burning or substantially burnt gases from the tubes 7 first pass into the header 10 and are then deflected into the heat conducting, vertical duct 12 in communication therewith, and then successively in a tortuous manner through the remaining vertical ducts 12 and the heat exchanger, out of the stack 32. In the vertical ducts 12 a large proportion of the heat is withdrawn from the gases and transmitted into the body of the metal by conduction.

In the modification illustrated in Figs. 5 to 7, inclusive, the radiant heating means, such as the heat radiating combustion tubes 7, extend transversely of the melting chamber and the burners in alternate tubes are arranged on opposite sides of the furnace. Each of the combustion tubes terminates on the one end in the burner 9 and on the other side in the vertical ducts 12 contained in the side walls 3 of the furnace. These ducts 12 are separated from the melting chamber by the lining 13. Each of the vertical ducts 12 may communicate with one or more of the horizontal ducts 40, which may extend horizontally and preferably in a longitudinal direction underneath substantially the entire melting chamber. The ducts 40 are in substantially gas-tight connection to the combustion chamber in the radiant heating means and communicate with the stack or a suitable heat exchanger connected at their exits 41. Since the combustion gases have cooled substantially and occupy but a fraction of their original volume, two or more of the vertical ducts 12 may be connected into a single horizontal duct 40 without unduly restricting the passageway.

In the operation of the furnaces shown in Figs. 5 to 7, inclusive, the unmelted metal may be added at the metal charging end 42 and withdrawn from the dipping end or the dipping chamber 38 through a lever-operated discharge plug 44. The gas and air supplied through the burners 9 from a suitable source (not shown) are projected into the radiant heating tubes 7, causing them to glow. It then successively passes through the vertical ducts 12 and the horizontal ducts 40, arranged about the sides of the melting chamber, and into the stack. Heat is radiated against the surface of the metal from the silicon carbide radiant heating tubes 7 and conducted into the metal from the tubular vertical ducts 12 and the tubular horizontal ducts 40, also preferably of silicon carbide. The ducts comprising the conductive heating means are also preferably of silicon carbide, but are preferably of rectangular cross section to provide greater surface for conductive heat transfer.

It will be seen from the above that by providing a plurality of substantially parallel conducting ducts of relatively small cross section, that the surface for absorbing heat from the fuel is greatly increased by the furnaces of the present invention and it is unnecessary to have the flame or products of combustion come in contact with the metal. The impurities incident to products of combustion are substantially entirely eliminated when the alloys are heated in accordance with the present invention.

Although several embodiments of the invention have been herein shown and described, it will be understood that numerous modifications of the construction shown may be resorted to without departing from the spirit of this invention as defined in the appended claims.

What I claim is:

1. A melting furnace for melting light alloys wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion, together forming a melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on said hearth, portions of said hearth for contact with the metal being of refractory material, radiant heating means in said radiant heating portion, said radiant heating means having a combustion chamber separate from said melting chamber for the combustion of fuel, heating means for conductively heating the metal through said refractory in contact with the metal and being disposed in the side walls of said melting chamber, said heating means having a passageway connected to said combustion chamber, and insulation between said melting chamber and the outer surfaces of the furnace.

2. A melting furnace for melting light alloys wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion, together forming a melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on said hearth, portions of said hearth for contact with the metal being of refractory material, a plurality of combustion tubes in said radiant heating portion, said combustion tubes each having a combustion chamber for combustion of fuel, heating means having a plurality of chambers in substantially gas-tight connection with the combustion chamber in said combustion tubes, said heating means being in the sides of said melting chamber for conductively heating the metal through said refractory material in contact with the metal and having a tortuous passageway in gas-tight communication with a combustion chamber of at least one of said combustion tubes, and insulation between said melting chamber and the outer surfaces of the furnace and between said heating means and the outer surfaces of the furnace.

3. A metal melting furnace wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion, together forming a melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on said hearth, portions of said hearth for contact with the metal being of refractory material, radiant heating means in said radiant heating portion, said radiant heating means having a plurality of combustion chambers for the combustion of fuel, heating means in the sides and bottom of said melting chamber and having a passageway in substantially gas-tight communication with a combustion chamber in said radiant heating means, said heating means conductively heating the metal through said refractory material in contact therewith and insulation between said melting chamber and the outer surfaces of the furnace.

4. A metal melting furnace wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion substantially enclosed within a metal housing, a melting chamber substantially enclosed by said side walls, end walls, bottom and top portions, said bottom and portions of said side walls extending beyond said top portion to provide a metal dipping portion in communication with said melting chamber, said melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on said hearth, radiant heating means in said radiant heating portion, portions of said hearth for contact with said metal being of a refractory material, said radiant heating means having a plurality of combustion chambers for the combustion of fuel, heating means in the sides and bottom of said melting chamber to conductively heat the metal through said refractory material in contact with the metal and having a passageway in substantially gas-tight communication with a combustion chamber in said radiant heating means, and insulation between said melting chamber and the outer surfaces of the furnace.

5. A melting furnace for melting light alloys wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion, together forming a melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on said hearth, portions of said hearth for contact with the metal being of refractory material, a combustion tube in said radiant heating portion and extending longitudinally thereof, said combustion tube having a combustion chamber for the combustion of fuel therein, heating means in the sides of said melting chamber to heat the metal through said refractory material in contact with the metal and having a tortuous passageway, one end of which terminates at and is in substantially gas-tight relation with said combustion chamber, the other end being connected to a stack, a burner at one end of said combustion tube, means for supplying fuel to said burners and means for supplying air for combustion to said burners, and a heat exchanger between said tortuous passageway and said stack to withdraw heat from the flue gases to preheat the air supply for said burners.

6. A metal melting furnace wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion, together forming a melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on said hearth, portions of said hearth for contact with the metal being of refractory material, a plurality of combustion tubes in said radiant heating portion, said combustion tubes running substantially transversely of said melting chamber, heating means in the sides and bottom of said melting chamber having a passageway for receiving the products of combustion from said combustion tubes, one end of the passageway in said heating means being connected in substantially gas-tight relation to said combustion tubes and the other end of said passageway being connected to a stack, a refractory lining between said melting chamber and said heating means, and insulation between said heating means and the outer surfaces of said furnace.

7. A melting furnace for melting light alloys wherein the products of combustion do not contact the surface of the metal, comprising side walls, end walls, a bottom and a top portion, together forming a melting chamber having a hearth to receive and support the metal, and a radiant heating portion above the normal level

of the metal on said hearth, portions of said hearth for contact with the metal being of refractory material, radiant heating means in said radiant heating portion, said radiant heating means having a combustion chamber for the combustion of fuel, heating means in the side walls of said melting chamber for conducting heat through said refractory material in contact with the metal, said heating means having a passageway connected to said combustion chamber, the top of said melting chamber being curved to reflect heat from said radiant heating means to the surface of the metal, and insulation between said melting chamber and the outer surfaces of the furnace.

8. A melting furnace for melting light alloys comprising refractory side walls, end walls, bottom and top portions, together forming a melting chamber and having a hearth to receive and support the metal, and a radiant heating portion above the normal level of the metal on the hearth, a plurality of radiant heating tubes of refractory material in said radiant heating portion, a burner at one end of each of said tubes, tortuous passageways for combustion gases connected to the opposite ends of said tubes and disposed in the furnace side walls below the heating chamber so that refractory material which is in contact with the metal is between said tortuous passageways and the metal, and a stack into which combustion gases are delivered from such passageways, said top portion of said furnace being shorter than said bottom portion and having a depending skimmer wall spaced from an end of the bottom portion to provide an open dipping chamber free from radiant heating tubes.

WALTER BONSACK.