United States Patent [19]

Koon

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[54] **VACUUM CASTING FURNACE**

[76] Inventor: **Howard T. Koon,** 21922 Ottawa Rd., No. 36, Apple Valley, Calif. 92307

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[21] Appl. No.: **240,212**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 24,618, April 1, 1970, abandoned.

[52] **U.S. Cl.** **164/255,** 164/62, 164/250, 164/DIG. 4

[51] **Int. Cl.** **B22d 17/14,** B22d 27/08

[58] **Field of Search** ..... 164/62, 63, 65, 250, 255, 164/251, DIG. 4, 298

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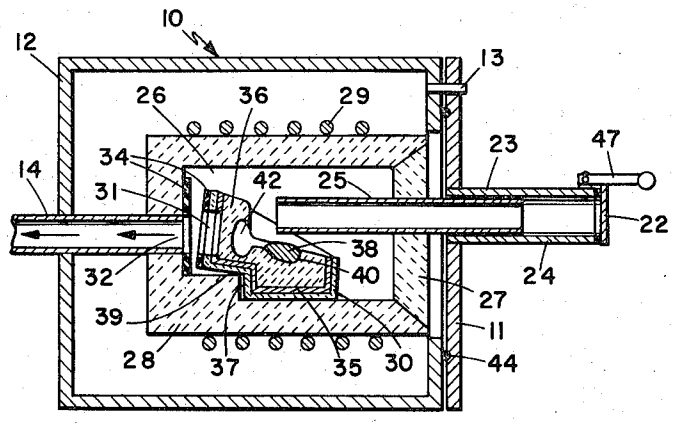
Primary Examiner—Robert D. Baldwin
Attorney, Agent, or Firm—Brown and Martin

[57] **ABSTRACT**

Apparatus and method for molding or casting high temperature melting point material in a heated mold. The material is placed in a well or crucible communicating with the mold cavity and is heated in a closed muffle. When the material is molten, a vacuum is drawn in the muffle and the mold is tilted so that the molten material is propelled into the cavity and seated by the vacuum. Air can be admitted to the muffle behind the molten material to cause a pressure differential which enhances the drawing of the material into the mold. The apparatus can also be used, without the mold tilting action, for precision soldering such as used in constructing dental bridgework.

4 Claims, 9 Drawing Figures



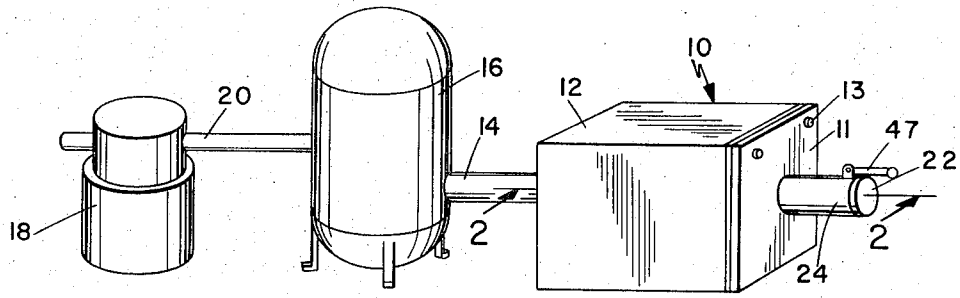


Fig. 1

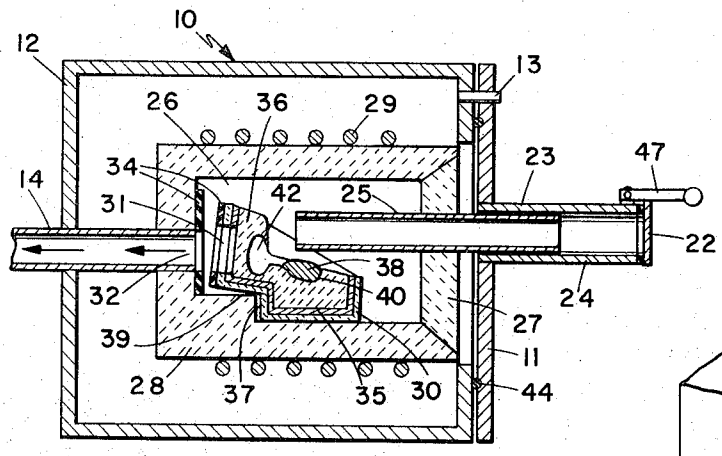


Fig. 2

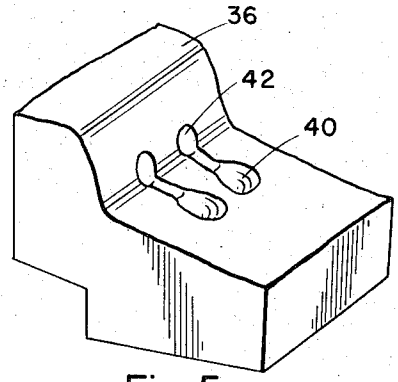


Fig. 5

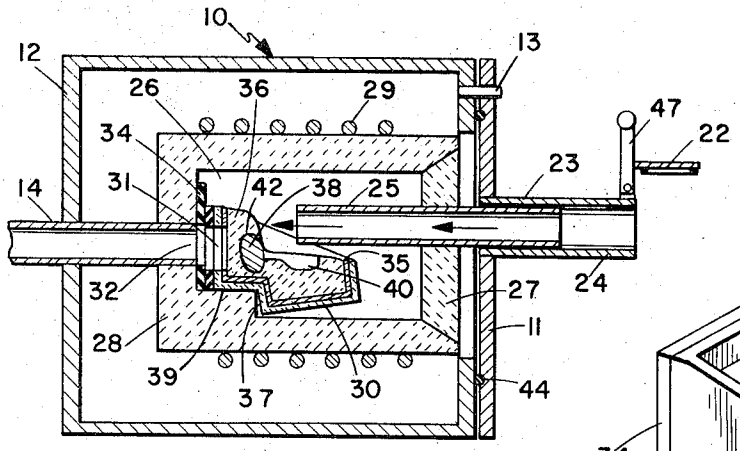


Fig. 3

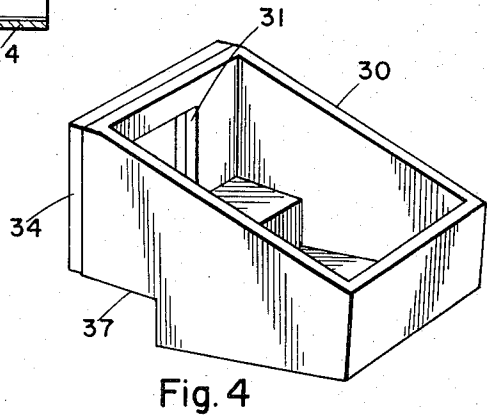


Fig. 4

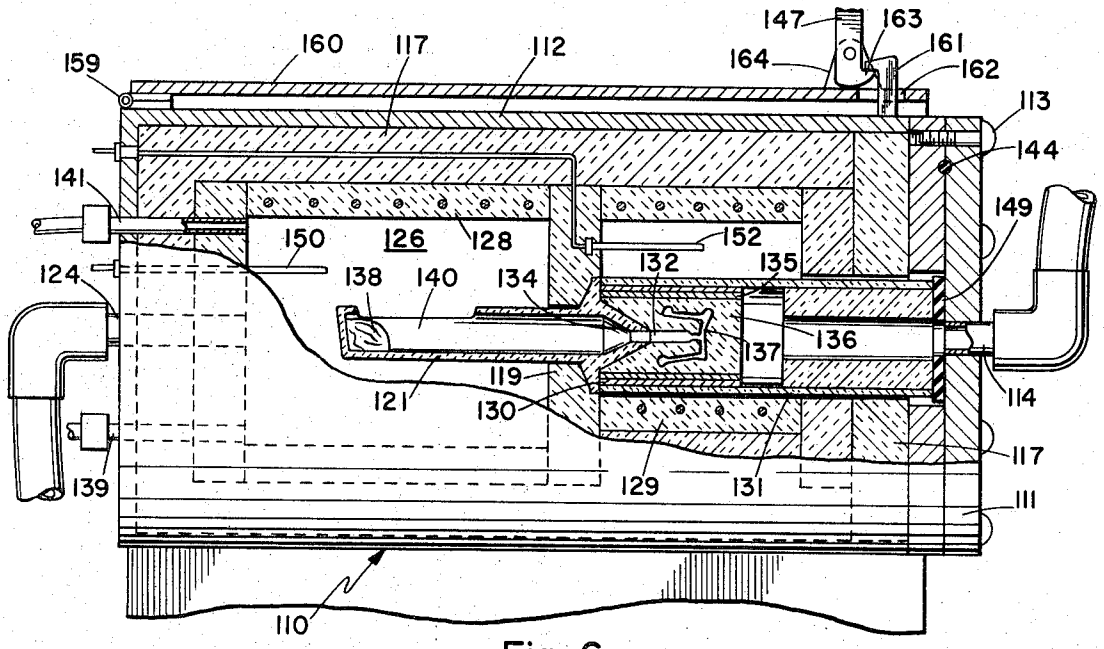

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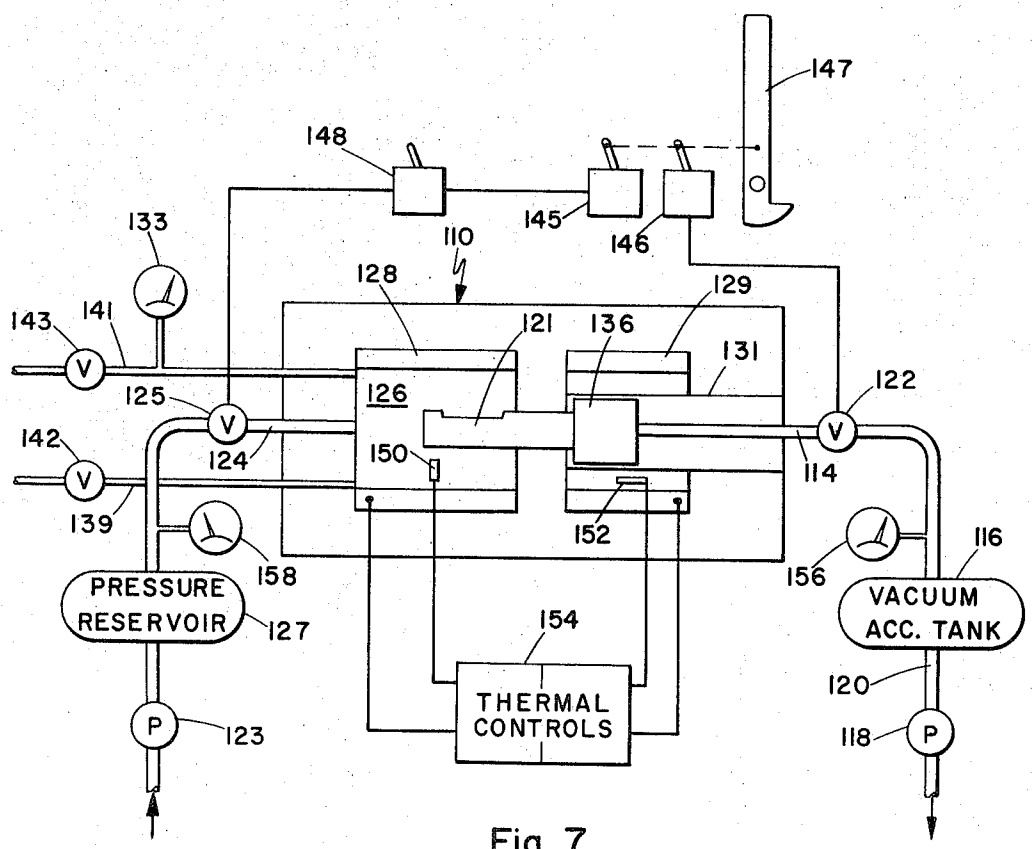
Fig. 6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PRESSURE RESERVOIR
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154
VACUUM ACC. TANK
THERMAL CONTROLS
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123
118
P

Fig. 7

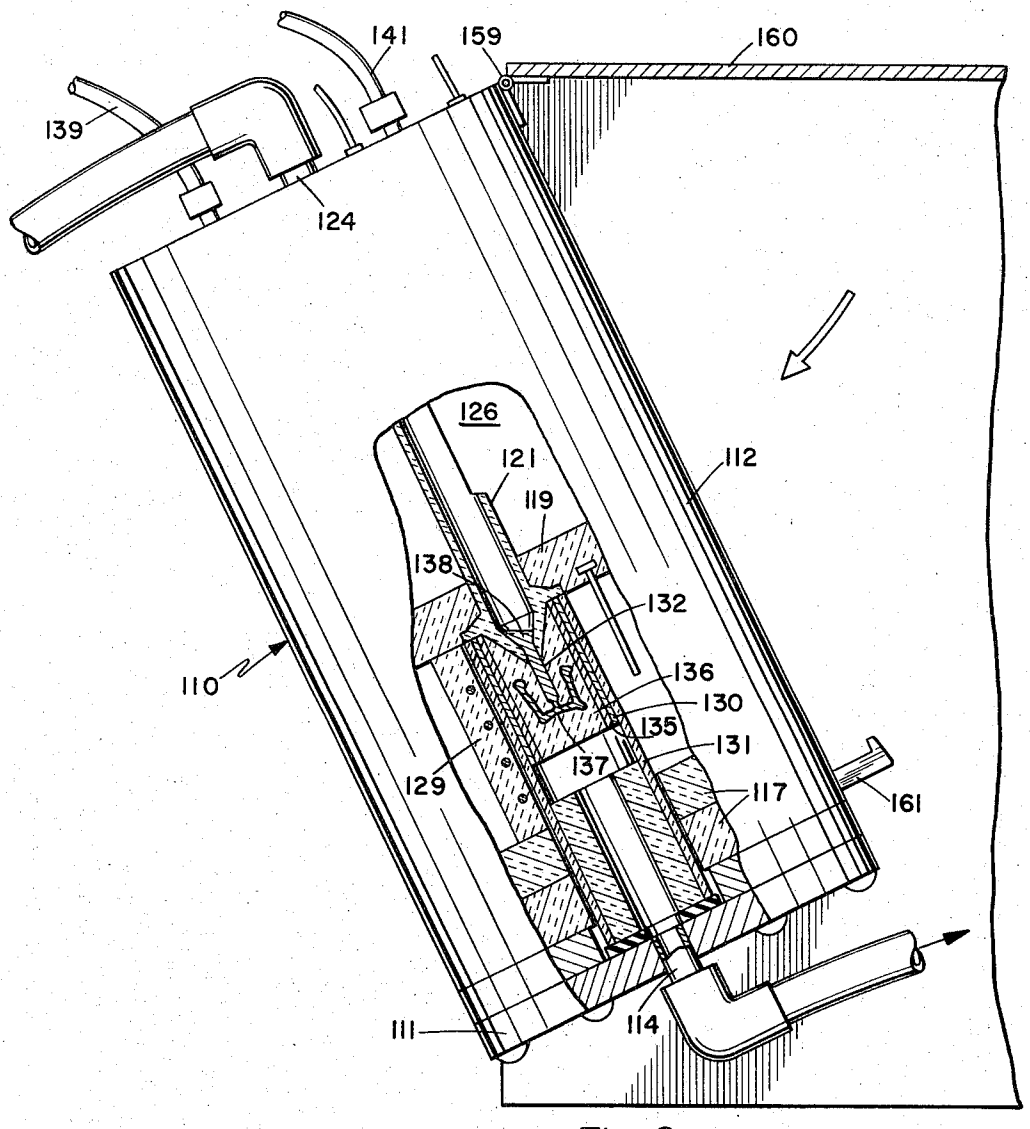
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Fig. 8

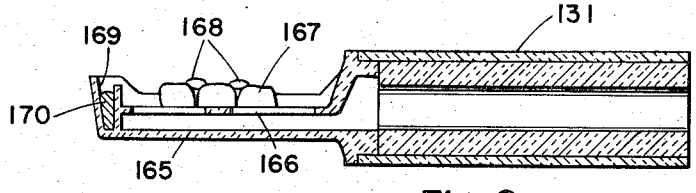
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Fig. 9

VACUUM CASTING FURNACE

This application is a continuation-in-part of an application entitled Vacuum Furnace, Ser. No. 24,618, filed Apr. 1, 1970, now abandoned.

BACKGROUND OF THE INVENTION

In the casing of small quantities of high melting point material, such as the construction of dental bridgework from gold, a major problem is distortion due to uneven cooling and shrinkage. Centrifugal casting methods have been used to ensure filling the mold cavity or pattern completely, but termperature control is difficult under such conditions. The usual technique of soldering built up bridgework also results in distortion due to temperature differences. The various problems can be overcome by performing the casting or soldering operations in closely controlled temperature conditions in an impurity free enclosure and forcing the molten material into place.

SUMMARY OF THE INVENTION

The apparatus disclosed herein includes a furnace having a temperature controlled muffle enclosing a chamber. A mold containing the required pattern is mounted in a holder having a well or crucible to hold the material to be melted. The holder is inserted into the chamber so that the mold and material are both heated. A source of vacuum is connected to the chamber and a vacuum is applied as the mold is tilted to throw the molten material into the mold cavity. The vacuum acts through the micro-porous material of the mold to pull the molten material into the cavity, the mold then being cooled at a controlled rate to solidify the cast.

In one form of the apparatus the mold is tilted by an air blast admitted through a valve into the chamber, which adds to the pressure differential caused by the vacuum. In another form of the apparatus the entire furnace unit is hinged to swing down and throw the molten material into the mold cavity, while the vacuum is applied. In the latter form the furnace has one heated chamber in which the material is melted and a separate chamber in which the mold is heated to a lower temperature, at which the material will set up in the mold. The first chamber is also provided with means for purging impurities and admitting air to raise the pressure differential of the vacuum.

The primary object of this invention, therefore, is to provide a new and improved vacuum furnace.

Another object of this invention is to provide a new and improved vacuum furnace in which molten material is drawn into a mold cavity by vacuum.

Another object of this invention is to provide a new and improved vacuum furnace in which the mold is tilted to initiate entry of the molten material.

A further object of this invention is to provide a new and improved vacuum furnace in which the material is melted and the mold heated in an enclosed chamber with controlled temperature means.

Other objects and many advantages of this invention will become more apparent upon a reading of the following detailed description together with an examination of the drawings wherein like reference numerals refer to like parts throughout and in which:

FIG. 1 is a perspective view of a furnace with a connected vacuum source.

FIG. 2 is an enlarged sectional view taken on line 2—2 0f FIG. 1.

FIG. 3 is a similar sectional view, showing the tilting action of the mold.

FIG. 4 is a perspective view of the mold holder.

FIG. 5 is a perspective view of a typical mold to fit the holder.

FIG. 6 is a side elevation view, partially cut away, of an alternative furnace structure.

FIG. 7 is a diagram of the complete operating system for the furnace of FIG. 6.

FIG. 8 is a view similar to FIG. 6, showing the furnace tilted.

FIG. 9 is a sectional view, similar to a portion of FIG. 6, showing the mold holder adapted for soldering.

In the configuration illustrated in FIGS. 1 through 5, the furnace 10 has a casing 12, from one end of which a vacuum tube 14 extends to a vacuum accumulator tank 16. Vacuum is drawn in the tank by a pump 18 through a tube 20. The other end of casing 12 has a removable cover 11 held by retaining means 13 and sealed by an O-ring 44. Extending from cover 11 is an air inlet tube 24 having on its outer end a hinged valve 22, actuated by a lever 47. Inside the casing is a muffle 28 heated by an electrical coil 29, the vacuum tube 14 extending into one end of the muffle. The other end of muffle 28 has a removable portion 27, in which is fixed a tube 25 having an extended portion 23 fitting closely inside inlet tube 24.

An investment or mold 36 is positioned in the muffle 28 in a tray or holder 30 of refracting material which is lined with asbestos 35 to allow for slight exapnsion. Holder 30 has a stepped portion 37 shaped to rock on a shoulder 39 formed in the muffle. The muffle wall at the entrance 32 of vacuum tube 14 and the confronting face of holder 30 surrounding an opening 31 are surfaced with heat resistant sealing material 34. Mold 36 is of micro-porous refractory type material and contains one or more cavities 42 of the shape to be cast, with connecting wells 40 which hold the metal 38 to be melted.

In operation, the mold and metal are heated in the muffle 28 until the metal 38 is melted. Vacuum is applied to the vacuum chamber 26 enclosed by the muffle and causes any impurities to be drawn off. When the metal is melted, the lever 47 is operated to open valve 22 and allow air to enter through tubes 24 and 25. The combination of vacuum and incoming air blast rocks the holder 30 back and seals opening 31 over entrance 32, so that vacuum is pulled entirely through the microscopic pores of mold 36. The combination of vacuum and tilting drives the molten metal 38 firmly into cavities 42 and ensures precise casting. The mold can then be cooled at a controlled rate while vacuum is maintained.

In the alternative configuration illustrated in FIGS. 6 through 9, elements equivalent to those in the structure described above are similarly numbered, but in a 100 series for clarity.

The furnace 110 has a casing 112, with a removable front cover 111 held by fasteners 113 and sealed by an O-ring 144. A vacuum tube 114 extends through cover 111 to a vacuum accumulator tank 116, and through a connecting tube 120 to vacuum pump 118. The interior of casing 112 is lined as necessary with thermal insulation mateiral 117, and has a transverse wall 119 of the same material dividing the interior into two portions. In

the portion remote from cover **111** is an electrically heated muffle **128** enclosing a vacuum chamber **126** in which the casting metal is to be melted. An air inlet tube **124** extends into vacuum chamber **126** and leads to a pressure reservoir **127** fed by a pump **123.** A solenoid operated valve **125** is installed in tube **124** and is coupled through a disabling switch **148** to an actuating switch **145.** Leading out of the lower portion of vacuum chamber **126** is a liquid drain tube **139** provided with a closure valve **142.** At the top portion of vacuum chamber **126** is a gas bleed tube **141** with a closure valve **143.**

The other portion of the furnace contains an electrically heated muffle **129,** for controlled heating of the mold in a lower temperature range than the material melting muffle **128.**

In this configuration, the mold holder **130** is tubular and is carried in one end of a sleeve **131** of refractory material. Sealed to the sleeve **131** is a crucible **121** having a well **140** for the metal **138** to be melted. The crucible has a sprue former portion **134** seating in mold **136** and connecting with a sprue way **132** leading to the cavity or pattern **137** formed in the mold, which is of micro-porous material. Holder **130** is lined with asbestos **135** to allow for expansion. The pattern **137** is formed by well known investment or lost wax techniques.

Sleeve **131** is mounted substantially axially in the furnace, with crucible **121** extending through wall **119** into vacuum chamber **126** and the mold containing portion of the sleeve enclosed in muffle **129.** A heat resistant gasket **149** inside cover **111** seals the vacuum tube **114** to the end of sleeve **131,** so that vacuum is drawn through the pores of mold **136.** A solenoid valve **122** is installed in vacuum tube **114** and is connected to an actuating switch **146.**

To facilitate precise operation of the furnace, a thermocouple **150** is installed in muffle **128** and a thermocouple **152** in muffle **129.** The thermocouples are connected to conventional thermal controls **154** to provide for temperature regulation of the respective muffles, in accordance with the requirements of the material being cast. A vacuum gauge **156** is installed in tube **114** to indicate the accumulated vacuum in tank **116,** and a vacuum gauge **133** is attached to bleed tube **141** to indicate the vacuum actually drawn in chamber **126.** A pressure gauge **158** is attached to reservoir **127** to show available pressure.

The entire furnace is pivoted on a hinge **159** attached to the top of casing **112** at the end remote from cover **111,** the hinge being secured to a supporting shed or frame **160.** A latch member **161** is fixed to the casing adjacent cover **111** and projects upwardly through an opening **162** in frame **160** when the furnace is horizontal, as in FIG. **6.** The latch member **161** is held by a latching lug **163** on an actuating lever **142,** pivotally mounted on a bracket **164.** Frame **160** is of sufficient height to allow the furnace to swing downwardly to a near vertical position when the latch is released, as in FIG. **8.**

In the first phase of operation, the muffle **128** heats the metal **138** to melting point and muffle **129** preheats the mold **136.** During preheating and purging, the valves **142** and **143** are open to allow impurities to exhaust from chamber **126.** Moisture in the mold and other structure will be turned to steam and washes out the interior of the chamber. If needed, the valve **125** can be actuated to purge the chamber with air or inert gas from the pressure source. In the second phase of operation, valves **142** and **143** are closed and valve **122** is opened to apply vacuum to chamber **126.** The temperature in muffle **128** is raised to melt the metal to the desired casting temperature. Lever **147** is then actuated to release the latch and allow the furnace to swing down. The tilting of mold **136** causes the molten metal to be thrown into and block sprue way **132,** so that the vacuum drawn through the porous mold pulls the molten metal firmly into the pattern cavity **137.** It is not necessary for casting action, but switch **146** can be conveniently connected to lever **147** for simultaneous application of vacuum with release of the furnace. The accumulated vacuum in tank **116** will be applied rapidly enough to draw in the molten metal as the furnace drops. Switch **145** may also be connected to lever **147** to release pressure into chamber **126** behind the vacuum as the furnace drops, to boost the effect when required. When the switches are connected to lever **147** in this manner, switch **148** is used for manual deactivation, of the pressure valve **125** when the boost is not required.

By using closely controlled temperatures and cooling the mold while the metal is held under vacuum oxidation, shrinkage, and distortion is minimized and voids in the cast are eliminated. With the molten metal held in an integral mold assembly in a rigid holder, proper entry of the metal into the mold is ensured when the mold is tilted. When the cast is cooled, the mold is removed from the furnace and broken away from the casting in the usual manner.

Without the tilting action, the furnace can also be utilized for soldering as in connecting components of dental bridgework. For this a special crucible **165** is attached to a sleeve **131,** as in FIG. **9,** no mold being necessary. Crucible **165** has a perforated grille **166** on which the structure **167** to be soldered is positioned. Solder **168** is placed over the joint areas as needed, the crucible having a pocket **169** for containing flux material **170,** such as carbon. When the assembly is heated in the furnace until the solder is melted, vacuum is applied to cause the solder to be pulled down into the crevices of the structure. In this manner a much more effective bond is achieved, than by relying on gravity or capillary flow of solder.

Having described my invention, I now claim.

1. A furnace for working high temperature melting point materials, comprising:

a casing having a removable end portion;

a heated muffle in said casing, enclosing a chamber;

a mold assembly mounted in said chamber, said assembly including a porous mold having a pattern cavity therein, and a molten material holding well communicating with said cavity;

said mold assembly is pivotally mounted for tilting said mold assembly to deposit molten material from said well into said cavity;

vacuum means for applying a vacuum to said chamber through the porous material of said mold to draw the molten material into the cavity,

means including a gas inlet for admitting gas to said chamber opposite to the vacuum means,

and said inlet being positioned to direct incoming gas against the mold assembly for tilting the assembly.

2. A furnace according to claim 1 including,
means for admitting gas simultaneously with tilting the mold assembly.

3. A furnace according to claim 2, wherein said vacuum means has an entrance opening in said chamber, said mold assembly having an open portion, exposing the porous mold, with means for sealing against the entrance opening when the mold assembly is tilted.

4. A furnace for working high temperature materials comprising,
a muffle having enclosing side walls with an opening in one end,
means for closing and sealing said opening,
a gas porous mold with a well and a pattern cavity that is inserted through said opening into said muffle,
means for heating said muffle,
means for drawing a vacuum in said muffle,
means for injecting a gas into said muffle after said vacuum has beendrawn therein,
said gas injecting means includes a tube that directs the gas against said mold,
said vacuum drawing means includes a vacuum tube that is positioned at an opposite side of said muffle from said gas injecting tube,
and said mold being positioned in a tray between said gas injecting tube and said vacuum tube with said tray being pivotally supported in said muffle, whereby gas from said gas inserting means contacts one end of said mold and rocks said mold into contact with said vacuum tube causing the heated metal to move into the pattern cavity and causing a decrease in pressure on the side of said mold opposite said gas injecting tube with the gas exerting a pressure differential on the heated metal in the cavity.

* * * * *