J. F. MONNOT.

PROCESS OF MAKING AND CASTING ALLOYS.

APPLICATION FILED JULY 16, 1908.

944,371. Patented Dec. 28, 1909.

Fig. 1.

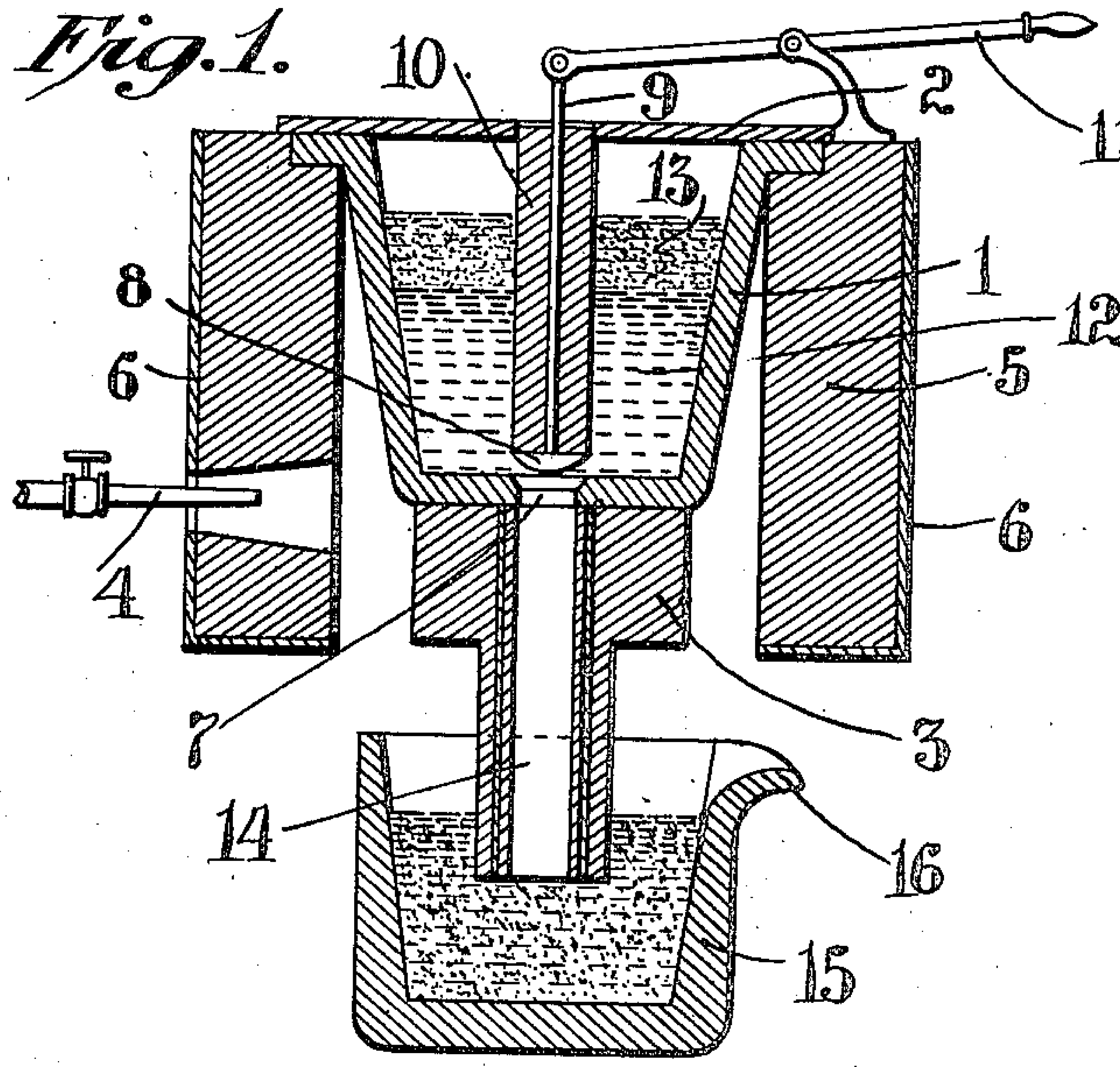


Fig. 2.

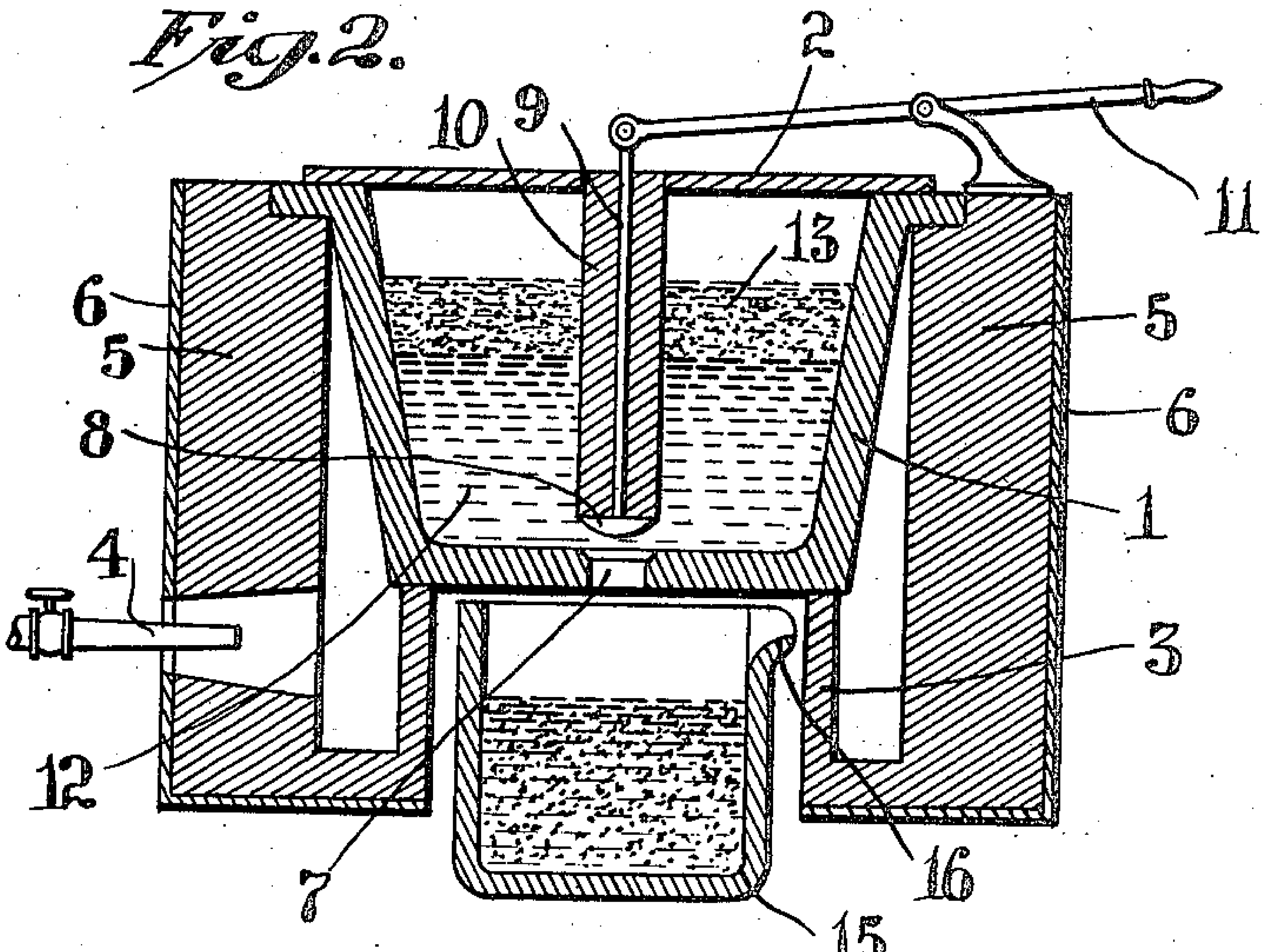
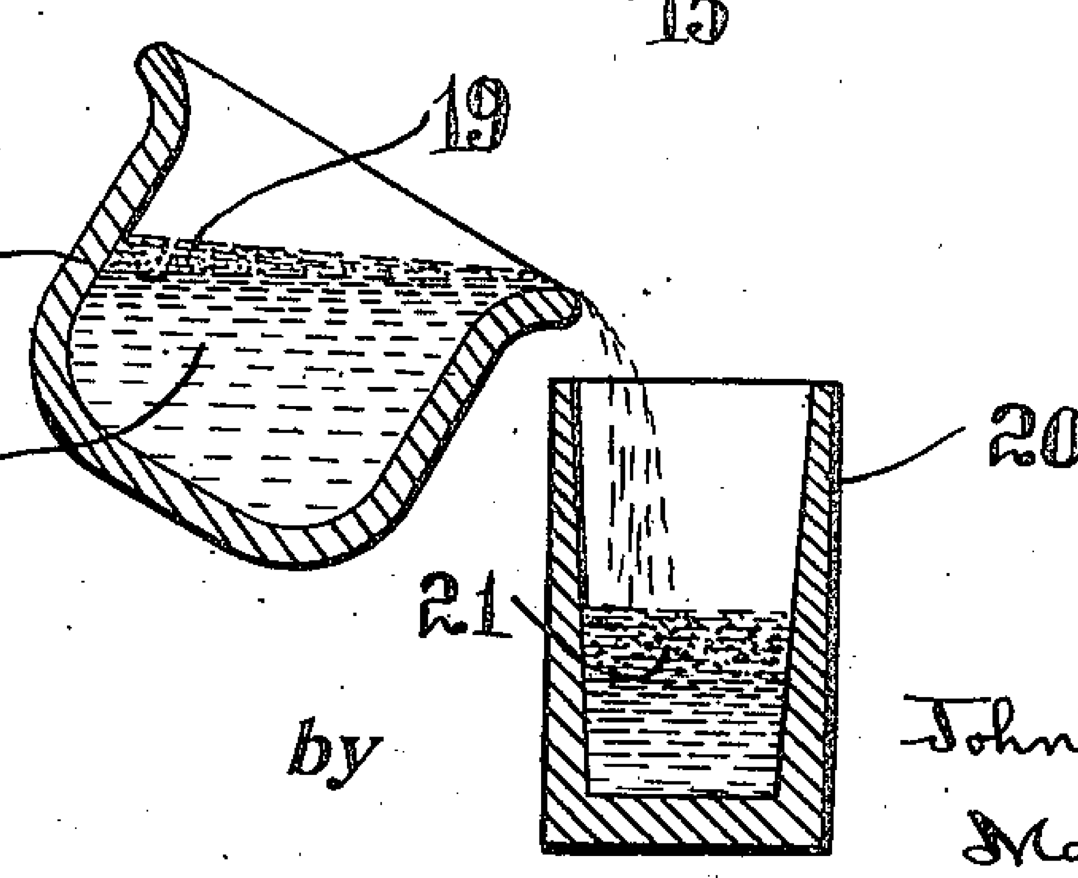


Fig. 3.



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PROCESS OF MAKING AND CASTING ALLOYS.

944,371. Specification of Letters Patent. Patented Dec. 28, 1909.

Application filed July 16, 1908. Serial No. 443,795.

To all whom it may concern:

Be it known that I, JOHN F. MONNOT, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented a certain new and useful Process of Making and Casting Alloys; and I do hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to processes of making and casting alloys; and comprises a method of making alloys of precise composition even when the melting points of the constituent metals differ greatly and when one or more of the constituent metals is readily volatilizable or oxidizable, and of casting such metallic mixtures or alloys.

According to my invention, the alloy to be cast is formed, or else brought to a molten condition, under the protection of a deep sealing molten layer of floating flux or slag operating both to exclude air and to prevent volatilization, and is drawn off from a point beneath such layer and passed into and through a substantial or deep layer of molten flux or slag contained in a suitable mold, such tapping operation being preferably so conducted as to prevent or minimize any intermediate contact with air.

In many metallic mixtures and alloys where precise composition is of great importance, as in the various brasses, bronzes, alloy steels, etc., under the present practice it is a matter of some difficulty to maintain this precise composition during long treatments or during remelting since volatilizable or oxidizable components tend to disappear. In brass, for instance, since the boiling point of zinc is comparatively low, being about the melting point of copper, in making, melting, casting, and remelting brass, there is a steady loss of zinc which tends to volatilize from exposed surfaces of the melted metal and, since zinc vapors are readily inflammable, to burn out. In handling brass in the melted state there is, therefore, a steady loss of zinc and the composition of the alloy steadily varies. As fairly precise ratios between the copper and the zinc are desirable and are often necessary in making alloys for special purposes, this represents a grave inconvenience in the art, and the principal method of obviating it now in use is to add more zinc from time to time as the zinc burns out, or to use an excess of zinc in making the brass or other alloy. These methods are obviously disadvantageous. Similar difficulties are met with in handling other alloys. The tin of bronze, though not very volatile at bronze-casting temperatures, is very oxidizable, and burns out, not only changing the composition of the alloy but injuring it by leaving infusible particles of oxid. Nickel, cobalt, lead, iron and other metals also tend to burn out of copper alloys. In the manufacture of the modern alloy steels, the alloying bodies, such as vanadium, titanium, chromium, etc., are generally more oxidizable than the iron and readily burn out, and, from their usual small quantity, any such loss seriously affects the qualities of the alloy. In casting these mixed metals, the stream of molten metal passing through or in contact with the air, in addition to taking up or entraining more or less air by occlusion or adsorption, tends to oxidize, becoming covered with oxid pellicles which prevent good contact with the mold and accurate shaping. In the case of brass and other zinc alloys, the loss of zinc in casting is quite serious. In the evaporation of any liquid, such as the zinc from the molten alloy, the amount evaporated in a time unit is directly proportional to the surface exposed and inversely proportional to the amount of its vapor already present in the space into which evaporation proceeds. As the melting point of brass is not far below the boiling point of zinc, so that the tension of zinc vapor from molten brass is quite large, it follows that, irrespective of the oxidizing effect of air, the conditions for the loss of zinc are nearly ideal in pouring a thin stream of molten brass through free air into a mold, a maximum surface of high-temperature metal being exposed to an atmosphere which is free of zinc vapors, since zinc vapor and air cannot coexist. Furthermore, apart from changes in composition of the alloys incident to melting and pouring, in pouring much air is generally carried forward by entrainment and adsorption into the mold where it continues the oxidation and where it leads to sponginess of the metal. In the mold itself, the walls are always covered with a thin layer or film of air, moisture, etc., adsorbed or condensed thereon, and it is difficult to displace this film by the molten metal, such metal generally having no real wetting action on the mold walls. In producing a casting, this air, etc., as it is slowly displaced accumulates to form blowholes, blebs, pits, etc., in the surface of the casting.

In another application, Serial No. 391,674, filed Sept. 6, 1907, I have disclosed methods and means of counteracting the difficulties due to adsorbed air and moisture in the cast metal and the mold, the invention, broadly stated, consisting in pouring the molten metal down through a layer of molten wiping material of substantial depth, whereby its surfaces are wiped free of entrained or adsorbed air and also of adhering oxids, the heavy molten metal itself passing down through the wiping material as clean metallic-surfaced metal, the several drops or portions of which are as ready for mutual union as drops of clean mercury. For this purpose and to accomplish this end, the layer of wiping material must be quite deep.

In the present invention, I preferably carry out the entire operation under exclusion of air, making or melting the alloy or metallic mixture under cover of a comparatively thick layer of molten flux or slag and pouring the melted metal from a point beneath such layer directly into and through a substantial depth of molten flux or slag contained in a suitable mold, the melted metal, preferably, not being allowed to pass through free air in transit. The stated method I regard as particularly adapted to brass or bronze and other alloys of copper comprising zinc or tin, but it may also be used for a variety of other metallic mixtures containing volatile or oxidizable components.

The flux or slag used may be one having oxid-dissolving properties, as borax or waterglass or their mixtures, or a high silica slag, or it may be substantially neutral toward oxids, like borax or water glass neutralized with soda, since in the described method of operation little chance for oxidation is afforded.

In melting or making brass under a cover of flux or slag since there is, if the cover be thick, no exposure of the surface of the alloy to a free atmosphere into which zinc vapors can expand, nor any absorption of such vapors, nor is there any opportunity for oxidation, the composition of the alloy remains substantially constant. If the flux cover be relatively thin on the other hand, exposure of bare metal and oxidation and evaporation will occur during stirring and mixing. The flux cover therefore should be quite deep. In tapping off the molten alloy into a deep body of flux or slag, evaporation and oxidation are similarly precluded if the metal be tapped from a low point in the mass thereof and sent into the flux through a closed conduit. In this method of operation, the wiping function of the flux or slag in the mold upon the molten metal itself is not so important as in the process of said application Sr. No. 391,674, since such metal does not come into substantial contact with air and cannot entrain it or be oxidized thereby, though the wiping function remains important as far as the mold walls are concerned; for as the molten metal accumulates in the mold, the wiping material, being lighter, rises, progressively wiping the mold walls free of adsorbed or occluded gases and leaving a surface against which the metal may solidify without the formation of blow-holes or pores. The flux or slag acts toward the molten alloy more as a sealing means, preventing contact with air and preventing evaporation and oxidation of sensitive components. Furthermore, the wiping material has an important effect on the strength of the cast metal; for the several particles of the cast molten metal being clean, are in good condition to unite one with another during solidification and produce sound metal.

It is a familiar fact that superheated liquids introduced into vessels having walls which are not "chemically clean" tend to evolve vapors at localized points or "nuclei" on said walls, and, similarly, that liquids containing crystallizable components tend to a localized crystallization on similar foci or nuclei. In vessels with "chemically clean" walls neither of these segregations takes place. One of the valuable features of the presence of a large body of molten flux or wiping liquid in the molds in the present invention is that such flux causes the mold walls to become "chemically clean." In molten brass the vapor tension of the zinc is very high, the casting temperature of brass being very near the boiling point of zinc, and in casting into the ordinary molds "nuclei" in the walls tend to cause evolution of zinc vapors whereas in casting into molds having walls kept "chemically clean" by flux or wiping material this phenomenon does not occur and the castings are sound and homogeneous. Furthermore, since many of the valuable alloy compositions are not eutectics but tend to segregation or crystallization of alloys or metals of different composition from that desired, the absence of crystallization-aiding "nuclei" in the walls in the flux-filled molds of the present invention aids materially in securing sound, homogeneous castings of such compositions.

The described method, it will be perceived, gives means of producing sound ingots or castings, free from oxid, blow-holes, sponginess or porosity, from alloys of predetermined and precise composition. While particularly applicable to brass and other alloys containing the readily volatile and oxidizable metal zinc, it is also advantageous for use with bronzes and other alloys containing tin, and for ferrous metals containing such oxidizable components as chromium, aluminum, vanadium, tantalum, titanium, manganese, nickel, cobalt, etc., and for steels containing precise amounts of carbon. The molten metal being shielded from contact with air, these substances do not burn out.

In the accompanying illustration, I have shown, more or less diagrammatically, certain typical arrangements of apparatus adapted for use in the described method. In this showing:—Figure 1 shows a vertical section of an ingot casting apparatus; and Fig. 2 shows a section of a modified form of such apparatus. Fig. 3 shows a section of a pouring ladle and of an ingot mold in connection therewith, both containing deep layers of molten flux, as described.

In Fig. 1, 1 designates a crucible or heating chamber, closed by cover 2, mounted on a hollow pedestal or support 3, against which plays the flame from an oil burner 4. The crucible and support are contained in a casing 5, having a steel jacket 6. In the bottom of the crucible is an opening 7, normally closed by stopper 8, carried by rod 9, said rod being protected by an encircling annulus 10 of fireclay or other refractory and indifferent crucible material. The rod is pivoted to a lever 11 by which it can be moved up or down, thereby permitting or preventing discharge of molten metal through the opening at the bottom of the crucible. Within the crucible, as shown, are a layer of brass or other alloy 12, and a layer of fused covering material or flux 13. Below the crucible and communicating with the hole in its bottom, is a conduit 14 extending downward some distance. In casting an ingot of brass or other alloy, a suitable mold 15, containing a deep layer of fused wiping material, or a solid layer of such material adapted to be melted by the heat of the metal cast, is placed below the crucible with this conduit dipping into the wiping material in the mold. The mold may be completely filled with the wiping material if desired. As molten metal enters and this wiping material is displaced, the latter flows over edge 16 to any suitable receptacle.

In making an alloy which it is desired to have precise in composition, for example, in making brass, one or more of the ingredients may be melted in the crucible 1, under cover of the flux or slag 13, and the other ingredient added thereto. For example, in making brass, copper may be melted in said crucible, under the coating 13, or may be introduced therein in molten condition, through such cover, and solid or molten zinc introduced into the molten copper; or preferably, the zinc may be melted in the crucible under cover of the flux coating 13, which prevents evaporation and oxidation and maintains the metal with a clean surface, and the molten copper poured through the flux or slag 13 into the zinc, or the copper may be poured through such cover 13 into contact with the zinc while the latter is still solid, the heat of the molten copper melting the zinc but the thick cover 13 preventing oxidation of the zinc below such cover and preventing material volatilization of the zinc. In these ways alloys or mixtures of very precise composition may be made, there being practically no escape of either metal prior to the mingling of the metals. Or, the brass, already formed, may be placed in the crucible 1 and melted under cover of the material 13, or it may be melted elsewhere and poured through such cover into the crucible. By whichever of the above described ways the alloy is formed or melted or heated to the desired condition for pouring, it will be preserved practically free from oxid and will maintain for a long period of time practically its original composition. The thick cover of flux or slag 13 permits free stirring, if such be needed, as is frequently the case, without exposure of metallic surfaces for oxidation or for volatilization of volatile components. In the case of molten brass, the zinc being at a temperature below its boiling point though at one where it has a high vapor tension, cannot form any material amount of vapor under the thick flux layer, the molten brass in this respect behaving like very hot water under a thick layer of floating oil. The brass therefore remains of substantially constant composition during this operation. With a thin flux coating, stirring exposes bare metal and zinc flashes into vapor form therefrom. After the desired casting temperature is obtained, the rod 9 is raised and the molten metal allowed to flow down through conduit 14 to a point below the surface of the flux layer in the mold. The small amount of air in the short conduit does not have any material oxidizing power nor will any material amount be entrained, but any oxid which may be formed or any air which may be entrained will be removed by the wiping material, and a sound, solid ingot formed.

In the modified apparatus of Fig. 2, the pedestal 3 carrying the crucible is hollow and the conduit 14 of Fig. 1 is omitted, the mold in use being placed near or against the bottom of the crucible, thereby minimizing the contact of metal with air.

In Fig. 3 I show an ordinary ladle 17 containing a body of molten metal 18 covered by a deep layer of flux or slag 19; and adjacent to said ladle I show a mold 20 containing a deep layer of molten wiping material 21. This ladle may be filled with solid or molten zinc or other metal, and copper or other desired metal introduced therein or vice versa, with or without use of the flux cover 18, and when an alloy of the desired composition has been produced, the molten metal may be poured into the mold. Or the ladle may be filled with molten brass or other alloy from any suitable source, and then the molten metal poured thence into the mold, the contact of the molten metal with the air during pouring being too brief to permit material oxidation or volatilization. As is well known, a relatively heavy liquid may be poured off from beneath a relatively light liquid or floating mass, with very little, if any, escape of the lighter substance, hence, as will be readily understood, it is easy to pour off the molten metal from beneath the layer 19 with practically no loss of material from said layer. However, there is no objection to the passing of more or less of this material 19 into the mold, as it merely adds to the amount of such material in the mold.

The mold into which the molten alloy is cast may be a mold of special configuration; that is to say, a mold of some machine part, a gear wheel, for example, or of statuary, or of any other special form. My process lends itself particularly to the casting of alloys in permanent molds of any desired shape.

What I claim is:—

1. In the production of castings, the process which comprises producing a mass of molten metal under a deep layer of molten covering material and tapping metal from a point below such layer and flowing it through a deep layer of wiping material into a suitable mold.

2. In the production of castings, the process which comprises producing a molten mass of an alloy containing easily oxidizable or volatilizable components under a deep layer of molten covering material and tapping the metal from a point below such layer and flowing it through a deep layer of wiping material into a suitable mold.

3. In the production of castings, the process which comprises producing a molten mass of a metal comprising zinc under a deep layer of molten covering material and tapping metal from a point below such layer and flowing it through a deep layer of wiping material into a suitable mold.

4. In the production of castings, the process which comprises producing a molten mass of brass under a deep layer of molten covering material and tapping the molten metal from a point below such layer and flowing it through a deep layer of fusible wiping material into a suitable mold.

5. In the production of castings, the process which comprises flowing a molten alloy or mixture containing a readily oxidizable or volatilizable ingredient into a mold through a deep layer of fusible wiping material contained in said mold, without substantial contact with air.

6. In the production of brass castings, the process which comprises flowing a molten alloy or mixture containing a readily oxidizable or volatilizable ingredient into a mold through a deep layer of fusible wiping material contained in said mold.

7. A process of forming and casting alloys of precise composition, which comprises melting one of the constituents of the alloy under a deep layer of molten covering material and adding the other constituent or constituents thereto while such first constituent is molten, and then casting the resulting alloy from beneath such covering material into a suitable receptacle.

8. A process of forming and casting alloys of precise composition, which comprises melting one of the constituents of the alloy under a deep layer of molten covering material and adding the other constituent or constituents thereto while such first constituent is molten, thoroughly mingling the constituents and then casting the resulting alloy from beneath such covering material into a suitable receptacle.

9. A process of forming and casting alloys of precise composition, which comprises melting one of the constituents of the alloy under a deep layer of molten covering material and adding the other constituent or constituents thereto while such first constituent is molten and casting the alloy so produced through a deep layer of wiping material into a suitable receptacle.

10. A process of forming and casting alloys of precise composition, which comprises melting one of the constituents of the alloy under a deep layer of molten covering material and adding the other constituent or constituents thereto while such first constituent is molten, thoroughly mingling the constituents and then casting the alloy so produced through a deep layer of wiping material into a suitable receptacle.

11. A process of producing alloys such as brass, bronze, etc., containing one or more readily volatilizable constituents which consists in melting such volatilizable constituent or constituents under a deep layer of molten covering material and thereby reducing loss of such constituents, and mixing the so melted metal with the other constituent or constituents of the alloy and then pouring the alloy so produced from beneath such covering material into a suitable receptacle.

12. A process of producing alloys such as brass, bronze, etc., containing one or more readily volatilizable constituents which consists in melting such volatilizable constituent or constituents under a deep layer of

molten covering material and thereby reducing loss of such constituents, and mixing the so melted metal with the other constituent or constituents of the alloy and then pouring the alloy so produced from beneath such covering material through a deep layer of wiping material into a suitable receptacle.

13. A process of producing brass of precise composition which comprises covering zinc with a deep layer of fusible covering material and pouring molten copper through such covering material into contact with the zinc and thereby melting the zinc and mingling it with the copper and then pouring the molten alloy so produced from beneath said layer of covering material into a suitable receptacle.

In testimony whereof I affix my signature, in the presence of two witnesses.

JOHN F. MONNOT.

Witnesses:
H. M. MARBLE,
FRANK E. RAFFMAN.