J. F. MONNOT.

PROCESS AND APPARATUS FOR PRODUCING COMPOUND METAL OBJECTS.

APPLICATION FILED MAY 11, 1907.

910,405. Patented Jan. 19, 1909.

4 SHEETS—SHEET 1.

Fig. 2,

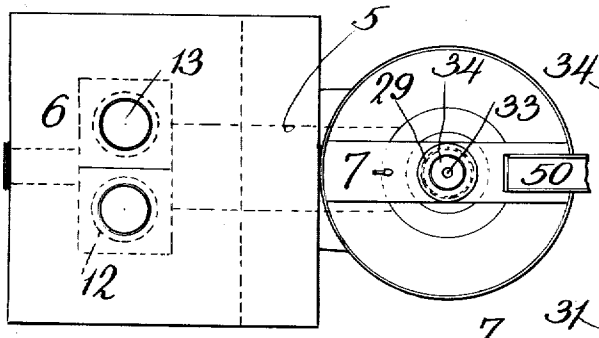


Fig. 1,

Fig. 3,

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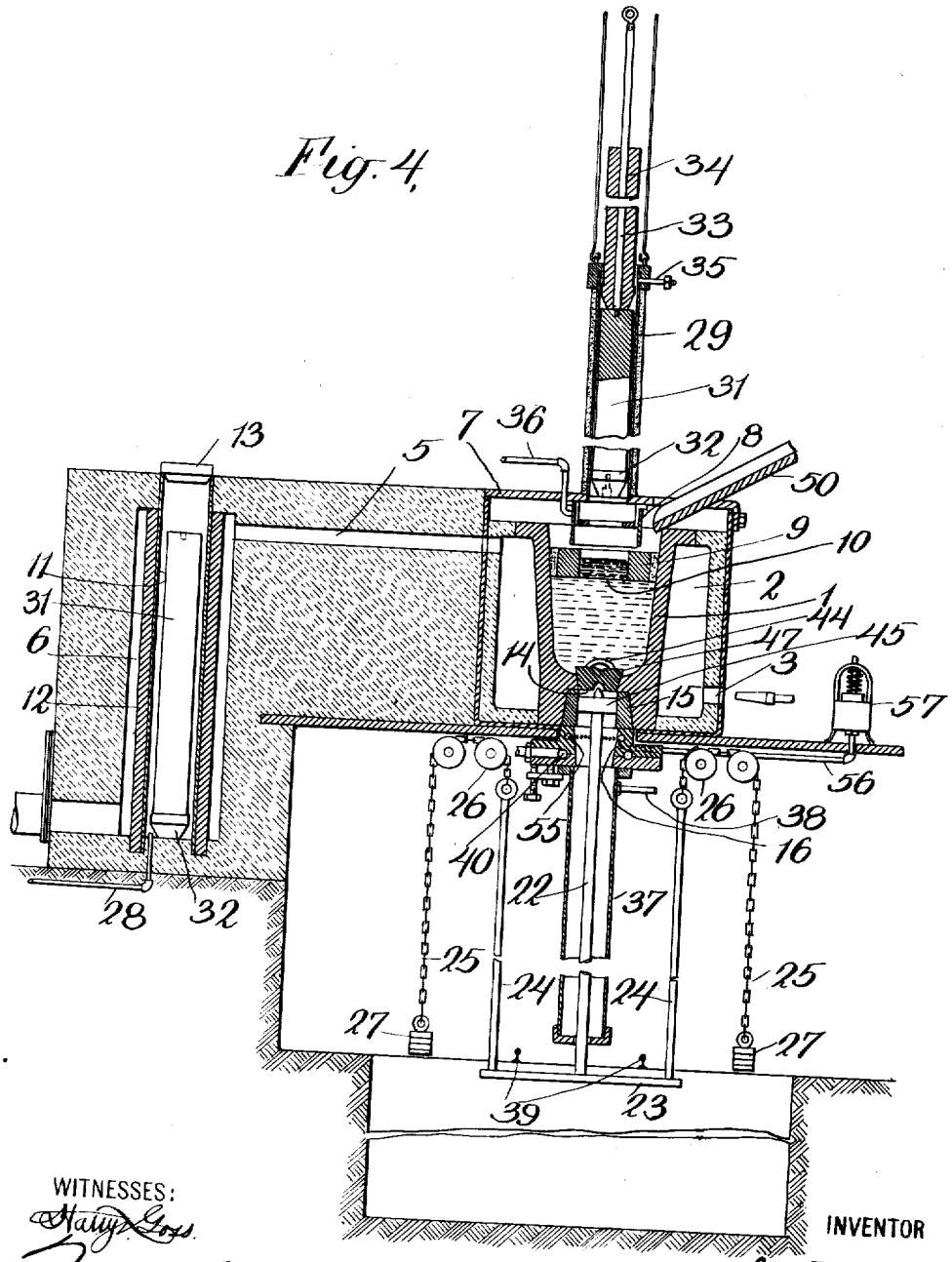
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4 SHEETS—SHEET 2.

Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 6,

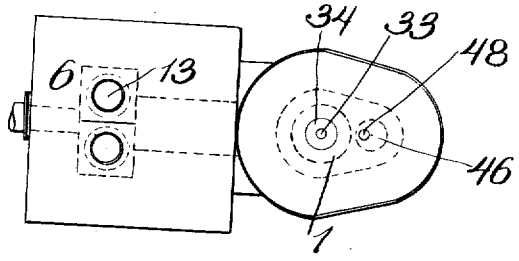


Fig. 5,

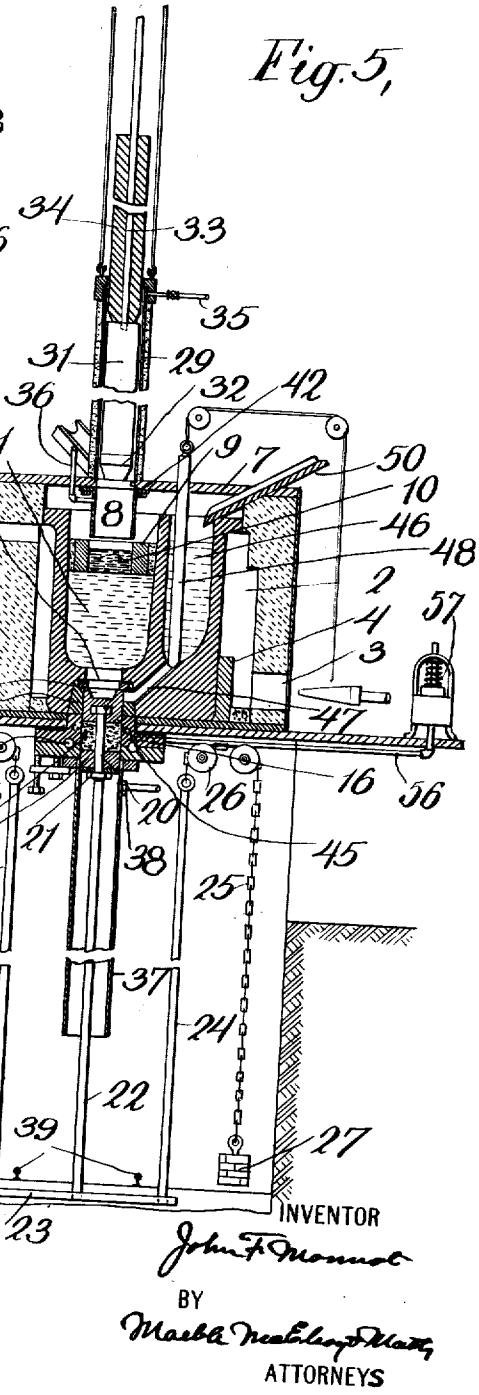


Fig. 7.

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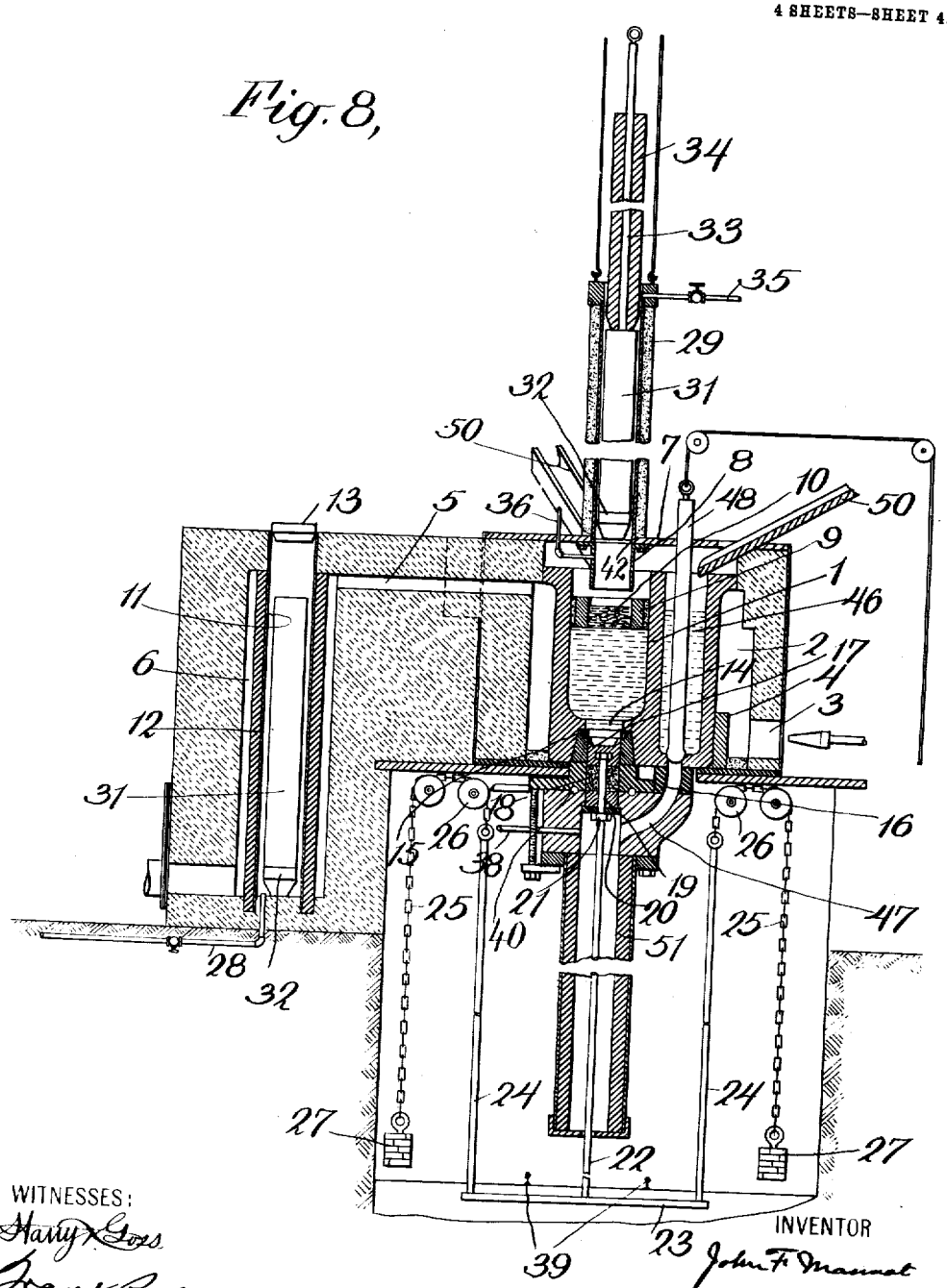
APPLICATION FILED MAY 11, 1907.

910,405.

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4 SHEETS—SHEET 4.

Fig. 8,



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UNITED STATES PATENT OFFICE.

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PROCESS AND APPARATUS FOR PRODUCING COMPOUND METAL OBJECTS.

No. 910,405. Specification of Letters Patent. Patented Jan. 19, 1909.

Application filed May 11, 1907. Serial No. 373,117.

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 and Apparatus for Producing Compound Metal Objects; 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.

My invention relates to a process of and apparatus for producing compound metal bodies; which process and apparatus are capable of being so performed and used as to produce bodies in which layers of unlike metals such, for example, as iron and copper, are united by a union equivalent to, and analogous to, and probably constituting, a weld union corresponding in nature and permanency to a weld union between layers of steel.

In my Patent No. 853,716, dated May 14, 1907, I have set forth a discovery made by me, which is that unlike metals, such as steel and copper for example, which do not unite readily or at all at ordinary metal working temperatures and by ordinary procedure, even when the copper is cast at ordinary copper casting temperatures into contact with the surface of the steel, nevertheless unite readily and permanently when the copper is heated to a temperature considerably above the ordinary casting temperature, reaching a condition to which I have applied the term "supermolten condition"; the metal when at such high temperature being apparently highly reactive. In said application I have claimed the process of uniting unlike metals involving the heating of one of them to this supermolten condition.

The specific method of procedure set forth in said application of causing a layer of metal to solidify from the molten condition upon the surface of an object to be coated, is what I have termed the segregation method and is set forth in U. S. Patent No. 851,684, issued to me April 30, 1907.

The process and apparatus herein described offer more expeditious means for coating metal objects with a layer of metal solidified from the molten state, and avoid certain mechanical difficulties experienced in the making of large compound billets by the segregation method.

According to my present invention an article to be coated (hereafter termed the billet) is preferably first preliminarily heated as hereinafter described, and then passed through a body of supermolten coating metal and out through a suitable die gaging accurately the thickness of coating formed by the action of the supermolten metal on the surface of the billet and causing the solidification of the molten metal. Preferably, though not necessarily, the billet is passed vertically through the bath of supermolten metal, the crucible containing the supermolten metal having in its bottom an opening for the passage of said billet, said opening registering with the bore of a suitable die, which bore is of a diameter precisely adapted to permit the passage of said billet with the predetermined thickness of coating thereon, and to cause the solidification of such coating during the passage of the billet through the die, so that the billet as it emerges from the die will be covered with a coating solidified from the molten metal. The said opening in the crucible is closed normally by a suitable closure (commonly a graphite plug) which is forced down and out by the billet as the latter is passed through the crucible and said opening; and the said billet in turn carries at its top a plug by which as the upper end of said billet passes through said opening in the bottom of the crucible, the said plug closes such opening temporarily and until the permanent closure forced downward by the billet can be replaced. As the billet emerges from the die it is preferably received within a suitable casing containing a protective atmosphere, whereby the billet is permitted to cool without contact with air.

In my said Patent No. 853,716 I have described two methods of forming coatings by means of supermolten metal; one involving the formation of the complete coating from the supermolten metal, the other involving the formation of a mere film coating from the supermolten metal and then the addition of a further coating, constituting the greater part of the desired coating, from a second bath of molten metal. The process and apparatus herein described permit an analogous method of forming coatings, the billet being passed through a bath of supermolten metal,

as just described, and out through an orifice of such size that only a film coating is formed on the surface of the billet, and thence into a space containing another body of molten metal, preferably at a temperature more closely approximating ordinary casting temperature of such metal, and thence out through a die adapted to regulate the thickness of the coating and to cause solidification of the molten metal, as already described.

My invention consists both in the process above outlined and hereinafter more fully described and claimed, and in the apparatus for carrying out such process, hereinafter described.

The objects of my invention are to facilitate the production of compound metal objects, particularly those comprising unlike metals welded together, to overcome difficulties heretofore experienced in carrying out the commercial production of such objects, to avoid the use of large crucibles and deep baths of molten metal, to avoid oxidation of the objects to be coated and of the molten metal, and to make the apparatus simple, durable, easily used, reliable, and capable of uniform, rapid, and even continuous work.

In the accompanying drawings I illustrate certain forms of apparatus for carrying out the process above outlined.

In said drawings: Figure 1 shows a central vertical section and Fig. 2 shows, (on a relatively smaller scale) a plan view, of one form of my said apparatus, adapted for forming the entire coating from a single bath of molten metal. Fig. 3 is a detail view illustrating the connections for supplying cooling water to the die. Fig. 4 is a view similar to Fig. 1 but illustrates a slightly different and alternative method of closing the opening in the crucible through which the billet passes, and an alternative form of cooling and gaging die. Fig. 5 is another view similar to Fig. 1 but showing apparatus adapted to form the complete coating from two bodies of molten metal with which the billet makes contact successively, and Fig. 6 shows a plan view of said apparatus. Fig. 7 is a detail view of one form of billet which may be used, showing means whereby billets may be fitted together one on top of another to be passed through the coating apparatus in continuous succession. Fig. 8 is a view similar to Fig. 5 of a further alternative form of apparatus in which a thin or film coating is formed by passing the billet through molten metal and the main coating is formed by casting.

Referring now to the drawings, and at first to Figs. 1 and 2, 1 designates a crucible containing, or adapted to contain, molten coating metal, preferably supermolten metal; said crucible being shown mounted within a suitable furnace chamber 2 having a port 3 through which flame may be introduced.

Without limiting myself to any particular source of heat, I will state that I prefer a jet flame such as may be produced by well known atomizing oil burners. To receive the impact of the flame and reduce wearing action of the flame on the crucible itself, the flame is caused to impinge on a renewable face 4 of refractory material; from which it is reflected and diffused and caused to fill chamber 2, rising up around the crucible 1 and passing off through an offtake 5, whence it passes to a furnace 6 for preliminary heating, as hereinafter described. Above the crucible 1 there is a top plate 7 having an orifice for the passage of the billet to be coated, centered over the crucible; and a sleeve 8, forming a continuation of such orifice, depends from said plate. A ring 9 of crucible mixture, carborundum, or other suitable refractory material, may float on the surface of the molten metal within the crucible, serving to confine a body of molten flux, 10, through which the billet will pass before it reaches the molten metal. However, this ring and body of flux are not necessary, particularly when, as hereinafter described, suitable precautions are taken to prevent oxidation of the surface of the billet to be coated; nevertheless such layer of flux is always convenient, because of the efficient protection of the surface of the molten metal thereby.

Within the preliminary heating furnace, 6, are one or more receptacles for the billets to be coated, each consisting, in the form shown, of a metal casing 11 protected by a covering of refractory material 12. There may be as many of these billet receptacles as desired in furnace 6; I have shown two such receptacles but do not limit myself to any particular number. There are openings in the top of the furnace 6, over these receptacles and normally closed by covers 13, for the introduction and withdrawal of the billets.

In the bottom of crucible 1 there is an opening 14 for the passage of the billet; and inasmuch as there is apt to be some wearing away of the margins of this opening the bottom of the crucible is recessed and provided with an inserted bushing 15 of crucible mixture, graphite, or the like, which may be renewed from time to time to keep the orifice in the bottom of the crucible of substantially uniform size. Beneath said bushing there is a gaging and cooling die, 16, suitably held up against the bottom of the crucible. This die contains an opening of the exact size of the billet plus the desired thickness of coating. The orifice in the bottom of the crucible 1 is closed normally by a plug 17 of graphite or similar material; beneath which, and separated therefrom by a body of graphite paste 18, is a metal plug 19, fitting closely the bore of the die 16, and held to graphite plug 17 by a bolt 20 having a T-head fitting within a suitable recess in plug 17 and provided with a screw-nut 21. Beneath the plug 19 is a

rod 22 connected to means for pressing it up against the end of the bolt 20, such for example as the cross-head 23, rods 24, chains 25 passing over pulleys 26, and counterweights 27; but the particular means employed for pressing the rod 22 upward is unimportant, except that preferably it should be something which holds said rod up yieldingly, and with a pressure which is readily adjustable. The pressure exerted by the mechanism shown is readily adjustable by adding to or taking from the weights 27.

While the presence of a layer of flux 10 over the body of molten metal in crucible 1 makes thorough cleaning and protection of the surface of the billet against oxidation less important than would be the case if said flux were not present (flux, such for example as borax, having the power of dissolving oxid on the surface of the billet) yet I prefer to clean the surface of the billet thoroughly before heating, and to heat it preliminarily and transfer it to the metal in crucible 1 under conditions precluding oxidation. To this end I do not expose the billets to the action of the heating gases of furnace 6, but provide the receptacles 11, already described; and preferably I further provide means for filling said receptacles with a protective atmosphere, such as producer gas made from coke, charcoal or anthracite, and containing no decomposible hydrocarbons; to which end I provide a pipe 28 leading to each receptacle 11, and through which producer gas may be introduced therein. I further provide means for surrounding the preliminarily-heated billet with a similar protective atmosphere during its transfer from furnace 6 to furnace 1, such as a bell-jar 29. The billet usually is provided, at its lower end, with a tip of clay or other refractory material, adapted to force out the plug 17 at the bottom of the crucible, and the porter bar by which it is handled is provided with a covering of refractory material adapted to form a temporary closure for the opening 14 at the bottom of the crucible until the plug 17 can be replaced. 31, in Fig. 1, designates the said billet, 32 the clay tip at its bottom, 33 the porter bar, and 34 the refractory covering therefor. Suitable means, not shown, are provided for raising and lowering the porter bar and the bell-jar 29, together or separately, as required. The bell-jar is provided with a valved flexible pipe, 35, for supplying a protective atmosphere, such as the producer gas above mentioned, thereto, and another pipe 36 is adapted for supplying producer gas or other suitable protective atmosphere to the space within sleeve 8 and between the surface of the contents of the crucible and the cover 7. Beneath the die 16 I provide a casing 37 adapted to receive the coated billet, said chamber also provided with a pipe, 38, for filling it with a protective atmosphere. Casing 37 is readily detachable from die 16, and serves to receive the coated billet and then, when detached from the die 16, to protect said billet against oxidation while it is being carried away and while it is cooling. Rails 39 permit the passage of a car adapted to pick up and carry away the casing 37 and its contents.

The die 16 serves not only to regulate the thickness of the coating, but to cool to solid condition the coating metal which, as it emerges from the interior of crucible 1, is still molten and (if at supermolten temperature) highly liquid. To this end the die is provided with means for circulating cooling water or other cooling medium through it, such as a passage 40. In the construction shown in Fig. 1 and Fig. 3 I have shown the die provided with a number of such passages 40, supplied with cooling fluid through separate valves 41, so that by opening some or all of said valves the temperature of the die may be regulated, and if desired the lower portion of the die may be kept much cooler than the upper portion, or vice versa.

The method of carrying on the process with the apparatus as shown in Figs. 1, 2 and 3 is as follows: The metal in crucible 1 being molten and, (if a weld union is to be produced), in a supermolten condition, and the billet 31, previously cleaned, being within preliminary heating furnace 6 and heated to the proper temperature, the bell-jar 29 is moved over said billet, the cover 13 removed, the porter bar 33 lowered through the bell-jar and connected to the billet, and the billet raised into the bell jar. Said bell-jar and billet are then moved over the crucible 1, the bell-jar being centered accurately over the sleeve 8 as may be done readily; the top plate 7 having, as shown, an annular seat 42 to receive the lower edge of the bell-jar casing. The billet is then lowered through the bell-jar into the crucible and as said billet passes through the molten flux 10 any trace of oxid which may be on its surface is dissolved. Said billet is caused to pass somewhat slowly through the supermolten metal in crucible 1, the speed of passage being regulated so that each portion of the surface of the billet remains in contact with the supermolten metal in the crucible the required time (a few seconds usually suffices); and when the lower end of the billet, or the clay point 32 thereon, encounters the top of the plug 17 in the bottom of the crucible, said plug is forced down and out, the weights 27 being lightened, if necessary, to facilitate this, and pressure being applied upon the top of the porter bar if required for the same purpose. As the billet continues to descend it forces the plug 17 and the parts below it down into the casing 37, the billet following said parts down into the casing; when the lower end of the re-

fractory covering 34 of the porter bar reaches the bottom of the crucible it closes the opening in the bottom of the crucible, temporarily preventing the escape of the molten metal. The billet is then forced downward by the porter bar into the casing 37, and then detached and removed and said casing is detached from the die 16 and removed, a new plug 17 being then placed in the opening 14 in the bottom of the crucible, the space beneath filled with graphite paste 18, and the metal plug 19 inserted and screwed up so as to compress the plastic material 18 and completely close the opening in the bottom of the crucible and prevent all escape of molten metal. A new casing 37 may then be attached and the operations repeated as desired.

While it is practicable to coat a number of billets in the manner described, until the amount of coating metal in the crucible has been diminished considerably, and then add a further increment of molten coating metal, I prefer to add such molten metal continuously, heating it to supermolten condition in another furnace not shown, and then running it into the crucible 1 through a runner 50.

The billets may be passed through the crucible 1 in continuous succession, each billet having in its top a centering recess 43 (Fig. 7) to receive the taper point or refractory point 32 of the next billet. In such case as soon as the top of one billet has disappeared in sleeve 8, its porter bar will be detached, and bell-jar 29 removed, and another billet brought over it and lowered down until in engagement with it. In such case the casing 37 may be bottomless, (see Fig. 5), the lower porter bar, 22, being moved out of the way to permit a coated and sufficiently cooled billet to drop and then replaced to support the next succeeding billet in its descent until sufficiently cooled.

The apparatus shown in Fig. 4 is equivalent to that shown in Fig. 1, but instead of the plug 17 being removed through the bottom of the crucible, it is arranged to be lifted out by means of a ring 44 just before a billet is placed over the crucible, the opening in the bottom of the crucible being kept closed nevertheless by the plug 45 of refractory material until the billet forces said plug downward as above described. In this figure I have shown the die 16 as slightly tapering, to compensate for contraction of the coating in cooling.

The coating is formed in the same manner in both cases, the annular layer of molten metal which emerges with the billet through the opening in the bottom of the crucible being solidified upon contact with the walls of the die 16. The conditions which obtain are particularly advantageous for the formation of good close grained non-porous coatings of copper and like metals, for it is exceedingly desirable in the case of copper and many other non-ferrous metals to cool them as rapidly as possible from the molten to the solid condition. While the molten metal is solidifying under merely the hydrostatic pressure of the column of molten metal in the crucible above it, this pressure is uniform over all portions of the coating so that the coating is uniform throughout; and this pressure is sufficient to materially improve the quality of the cast metal, which quality is further improved by the extremely rapid solidification due to the cooling action of the die 16, and also because it is cast under conditions preventing absorption of air and other gases.

The apparatus shown in Figs. 5 and 6 permits the coating to be formed in two operations. The crucible is here substantially the same as that shown in Fig. 1, except that it is provided with a second chamber 46 adapted to contain molten metal for the formation of the main body of coating, a duct 47 leading from the bottom of this chamber 46 to an enlargement in the liner 15 corresponding to the size of the desired coated billet. In this case the opening 14 in the bottom of the crucible is as near as may be the diameter of the billet plus a very thin film coating formed by the action of the supermolten metal. The duct 47 is closed except during the casting operation, by a suitable plug 48 arranged to be raised or removed by convenient means such as commonly employed. The operation of this form of apparatus is the same as that previously described, except that the plug 48 is raised just as the lower end of the billet passes through the opening 14 in the bottom of the crucible and engages plug 45 to force the same downward. The molten metal from the second chamber 46 then fills the annular space between the billet and the walls of the liner 15, contacting with the film coating formed in the main chamber of crucible 1 and uniting thereto. The die 16 as before regulates the thickness of the complete coating. Preferably, the fluid metals in the two chambers have about the same level, so that there is no tendency for flow of metal from one chamber to the other, and preferably the molten metal is supplied continuously to both chambers, during the coating operation, so that the coatings are formed under practically constant pressure.

Forming the coating in two stages, as by the apparatus shown in Figs. 5 and 6, has the important advantage that thereby the bulk of the coating is formed from metal applied at or near ordinary casting temperatures. I have found that copper in particular, when in the supermolten condition, is very readily contaminated. It appears to take up iron by direct solution and for that reason is apt

to be contaminated by iron dissolved from the billets themselves; the electrical conductivity of the metal being thus decreased. When the coating is conducted in two stages as with the apparatus of Figs. 5 and 6, only the supermolten metal in the main chamber of the crucible has any opportunity to become contaminated with iron from the billet or from a part of the apparatus; and as the film coating formed from the supermolten metal froms an almost inappreciable part of the complete coating, the main portion of such coating being of metal which has practically no opportunity for contamination, the electrical conductivity of the coating as a whole may be very high.

In the alternative form of apparatus shown in Fig. 8, instead of a casing 37 to receive the coated billet I provide a mold 51; and the die 16 in this case is of such diameter that the coating formed on the billet during the passage of the latter through said die is very thin—hardly more, preferably, than a film coating. The film-coated billet as it emerges from the die is centered within the mold by engagement of its lower end with the plug 17, which, with the plug 19, is adapted to form the bottom of the mold 51. The duct 47 leads to the space just beneath die 16. In this case, the film-coated billet is lowered to the bottom of the mold 51, still centered therein at the bottom as previously described, and centered at the top by its porter bar, and then molten metal from the second chamber 46 is caused to run into the mold and fill the space between the film-coated billet and the sides of the mold; after which the mold may be removed, a permanent closure for the opening 14 in the crucible inserted, a new mold put in place, and the operation repeated. The molds may be provided with means for filling them with a protective atmosphere, the same as the casings 37.

While I have described the use of a preliminary heating furnace in which the billets are protected against oxidation, and I have described means for transferring the billets to crucible 1 which also protects said billets from oxidation, I do not mean to confine myself to the use of these devices, though I consider their use desirable. If a layer of flux 10 of oxid-dissolving material and of sufficient depth be employed, and the billets be not passed through such layer too rapidly, a moderate layer of oxid on the surface of the billet can be dissolved off by the flux. For example, using a flux layer of sufficient thickness, it is practicable to heat the billet preliminarily in an ordinary furnace—preferably one operating with a reducing flame—and then to transfer said billet quickly through the air and lower it into the flux layer and thence into the molten metal; the flux dissolving off the oxid and dirt as the billet descends.

The apparatus and methods above described are adapted for the coating of billets of various shapes; not only round or oval billets, but square, rectangular, triangular, angle, and other non-circular shapes.

I do not claim herein the broad process of applying a coating formed from fluent material by forcing out and around the object to be coated an annular envelop of the fluent material and causing the latter to solidify. Such process, sometimes termed an "extrusion" process, is well known in certain connections; for example, the insulation of electric conductors and the application of lead coverings to insulated cables. My process above described is clearly distinguished from such extrusion processes in many important respects; for example, the absence of, or of necessity for, great pressure, the coating being formed under merely the pressure due to the small hydrostatic pressure of the column of molten metal above the die and the pressure due to the action of the die; also in the extreme fluidity of the metal from which the coating is formed, the fluidity of the coating material used in common extrusion processes being due usually to the enormous pressure employed; also in the formation of a film-coating by the action of the supermolten metal on each portion of the surface of the billet while such portion is still in the main body of molten metal and before the formation of an annular envelop around such portion has begun; also in the high temperature of the molten metal, to which high temperature the formation of such film-coating is due. That a film-coating will be formed by the supermolten metal if the billet be merely contacted with the supermolten metal for a few seconds and then withdrawn and allowed to cool under conditions precluding oxidation, and that such film-coating so formed is united to the billet by a union which is, or is analogous and equivalent to, a true weld-union, so that the coating cannot be stripped off as can an ordinary cast-on coating, has been set forth in several of my prior applications. It is obvious that the same welded-on film must be formed on the billet by the supermolten metal, whether that billet be withdrawn from the supermolten metal after brief contact therewith and allowed to cool under conditions precluding oxidation, or whether the billet be passed on through the molten metal and a layer of such molten metal caused to form about and solidify upon said billet; and this welded-on film coating obviously serves as the means for uniting the unlike metals of the billet and body of the coating.

In the case of coatings formed in two steps, as for example the apparatus of Figs. 5 and 8, it is not essential that both bodies of

molten metal be of the same kind. The first may be copper or silver or like metal and the second an alloy, such as brass or bronze, which cannot be heated, or heated safely, to the supermolten temperature. In general, all the various metals which in prior applications I have stated are preferably applied by the double-coating method, may be applied by the method above described with reference to Figs. 5 and 8.

It will be noted that the method and apparatus above described permit the coating of objects of great length in relatively shallow crucibles, so that the size of the billets treated is not limited by the practicable depth of the crucibles employed. It is desirable that the crucibles be not of great depth, because the crucible material is weakened by the high temperature to which it is subjected, and should not be exposed to too great pressure.

When necessary I arrange to lubricate the surface of the die 16 to facilitate passage of the coated ingot therethrough. To this end I provide the die with an annular duct 55 (Fig. 4) having small openings as shown communicating with the bore of the die; and this annular duct 55 I connect by a pipe 56 with a cup 57 adapted to contain the lubricant (for example graphite made into a paste by means of oil,) said cup provided with suitable means for forcing the material through pipe 56 and duct 55 and the said perforations into the bore of the die; such means being for example, an adjustable loading spring.

What I claim:—

1. The process of producing compound metal objects, which consists in passing an object to be coated through and out of a bath of molten metal maintained at a temperature much above its melting point and in the described condition for forming permanent unions, causing a layer of such molten metal to flow out around said object as it emerges from such bath, and causing such surrounding layer of molten metal to solidify on said object.

2. The process of producing compound metal objects, which consists in passing an object to be coated through and out of a bath of molten metal maintained at a temperature much above its melting point and in the described condition for forming permanent unions, causing a layer of such molten metal to flow out around said object as it emerges from such bath, causing a further layer of molten metal to surround said first layer and unite thereto, and causing both layers of molten metal to solidify on said object.

3. The process of producing compound metal objects, which consists in preliminarily heating an object to be coated, transferring the same under conditions precluding oxidation, to, and passing said object through and out of, a bath of molten metal maintained at a temperature much above its melting point and in the described condition for forming permanent unions, causing a layer of such molten metal to flow out around said object as it emerges from such bath, and causing such surrounding layer of molten metal to solidify on said object.

4. The process of producing compound metal objects, which consists in preliminarily heating an object to be coated, transferring the same under conditions precluding oxidation, to, and passing said object through and out of, a bath of molten metal maintained at a temperature much above its melting point and in the described condition for forming permanent unions, causing a layer of such molten metal to flow out around said object as it emerges from such bath, causing a further layer of molten metal to surround said first layer and unite thereto, and causing both layers of molten metal to solidify on said object.

5. The process of producing compound metal objects, which consists in surrounding a moving object to be coated with an enveloping stream of molten metal flowing therewith and initially in the herein described supermolten condition, and causing such stream to solidify on the surface of such object.

6. The process of producing compound metal objects, which consists in passing an object to be coated downward through a bath of molten metal maintained in the described supermolten condition, and causing a stream of such molten metal to envelop and flow with said object as it emerges from said bath, and causing such stream to solidify on the surface of such object.

7. The process of producing compound metal objects, which consists in surrounding a moving object to be coated with an enveloping stream of molten metal flowing therewith and initially in the herein described supermolten condition, surrounding such stream with a further stream of molten metal and causing such second stream also to flow with said object, and causing both streams to solidify on said object.

8. The process of producing compound metal objects, which consists in passing objects to be coated downward through a bath of molten metal maintained in the described supermolten condition and causing a stream of such molten metal to envelop and flow with said object as it emerges from said bath, surrounding said stream with a further stream of molten metal and causing such second stream also to flow with said object, and causing both streams to solidify on said object.

9. The process of producing compound metal objects, which consists in preheating an object to be coated and passing the same through a layer of cleansing flux and then through an underlying layer of molten coat-

ing metal and causing a stream of such molten metal to flow in contact with said object and solidify thereon.

10. The process of producing compound metal objects, which consists in preheating an object to be coated and passing the same through a layer of cleansing flux and then through an underlying layer of supermolten coating metal and forming a film-coating on such object by the action of the supermolten metal and then causing an annular stream of molten metal to surround and flow with said film-coated object and solidify thereon.

11. Apparatus for producing compound metal objects comprising a receptacle for molten metal formed of refractory material and having at a point below the normal surface level of its contents an opening and a liner bushing fitting into a recess beyond and in line with such opening, and a die beyond said bushing.

12. Apparatus for producing compound metal objects comprising a receptacle for molten metal having a discharge opening, a plug of refractory material at the inner end of said discharge opening, another plug beyond the same, plastic packing material between said plugs, and means for compressing the same.

13. Apparatus for producing compound metal objects comprising a crucible having an opening in its bottom, a plug on the inner side of said opening, another plug on the outer side thereof, means for holding said latter plug upward, and plastic material between said plugs.

14. Apparatus for producing compound metal objects comprising a crucible having an opening in its bottom, a die forming a continuation of said opening, a plug in said opening, a plug in said die, and means for forcing the latter plug inward.

15. Apparatus for producing compound metal objects comprising a crucible having a discharge opening adapted to permit passage of the objects to be coated, a die in line with said opening, a receiving chamber beyond said die, and means for closing said opening.

16. Apparatus for producing compound metal objects comprising a crucible having a discharge opening adapted to permit passage of the objects to be coated, and a die in line with said opening and provided with cooling means.

17. Apparatus for producing compound metal objects comprising a crucible having a discharge opening adapted to permit passage of the objects to be coated, a die in line with said opening provided with cooling means, and a receiving chamber beyond said die.

18. Apparatus for producing compound metal objects comprising a crucible having a discharge opening adapted to permit passage of the objects to be coated and a die in line with said opening having a passage for the flow of a cooling medium.

19. Apparatus for producing compound metal objects comprising a crucible having a discharge opening adapted to permit passage of the objects to be coated, a die in line with said opening, and a receiving chamber beyond said die having means for supplying a protective atmosphere to it.

20. Apparatus for producing compound metal objects comprising a receptacle for molten metal having a discharge opening adapted to permit passage of the objects to be coated, a die in line with said opening, and means for supporting and guiding said objects after passing through said die comprising a yielding support.

21. Apparatus for producing compound metal objects comprising a receptacle for molten metal having a discharge opening in its bottom adapted to permit passage of the objects to be coated, a die in line with said opening, and a yielding support beneath said die.

22. Apparatus for producing compound metal objects comprising a receptacle for molten metal having a discharge opening in its bottom adapted to permit passage of the objects to be coated, a die in line with said opening, a receiving chamber beyond said die, and a yielding support passing through said chamber.

23. Apparatus for producing compound metal objects comprising a receptacle for molten metal having two chambers, an opening in one of them for the passage of the objects to be coated, and a duct leading from the other chamber to a space beneath said opening.

24. Apparatus for producing compound metal objects comprising a receptacle for molten metal having two chambers, an opening in one of them for the passage of the objects to be coated, an apertured die beyond and in line with said opening, and a duct leading from the other chamber to the space between said opening and die.

25. Apparatus for producing compound metal objects comprising a receptacle for molten metal having two chambers, an opening in one of them for the passage of the objects to be coated, an apertured die beyond and in line with said opening adapted to cool molten metal flowing around and with objects passing therethrough, and means for conveying molten metal from such second chamber to a space adjacent such an object.

26. Apparatus for producing compound metal objects comprising a receptacle for molten metal having two chambers, an opening in one of them for the passage of the objects to be coated, an apertured die beyond and in line with said opening adapted

to cool molten metal flowing around and with objects passing therethrough, and means for conveying molten metal from said second chamber to an annular space surrounding objects passing through said opening and die, having its delivery at a point between said opening and die.

27. Apparatus for producing compound metal objects comprising a receptacle for molten metal having two chambers, an opening in one of them for the passage of the objects to be coated, means for closing said opening, a duct leading from the other chamber to space beneath said closing means, and a die forming a continuation of said opening.

28. Apparatus for producing compound metal objects comprising two chambers for holding molten metal, one having an opening for the passage through it of the objects to be coated, a die beyond said opening, means for closing said opening, a duct leading from the other chamber to a space surrounding objects passing through said opening and die, and means for closing said duct.

29. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its bottom an opening for the passage of objects to be coated, means for closing said opening, means beneath said opening for solidifying molten metal flowing from said opening, and guiding means above said receptacle.

30. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its bottom an opening for the passage of objects to be coated, means for closing said opening, means beneath said opening for solidifying molten metal flowing from said opening, and means above said receptacle having a centering seat in line with said opening, adapted to receive and center ingot-guiding means.

31. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its bottom an opening for the passage of objects to be coated, means for closing said opening, means beneath said opening for solidifying molten metal flowing from said opening, a support above said receptacle having a centering seat in line with said opening, and a chamber for transporting articles to be coated, adapted to be received in said seat.

32. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its bottom an opening for the passage of objects to be coated, means for closing said opening, means beneath said opening for solidifying molten metal flowing from said opening, and a cover over said receptacle having an opening in line with the opening in said receptacle and a sleeve depending from said opening.

33. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its bottom an opening for the passage of objects to be coated, means for closing said opening, means beneath said opening for solidifying molten metal flowing from said opening, and a cover over said receptacle having an opening in line with the opening in said receptacle and a sleeve depending from said opening, and means for supplying a protective atmosphere to the interior of said sleeve .

34. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its bottom an opening for the passage of objects to be coated, means for closing said opening, means beneath said opening for solidifying molten metal flowing from said opening, a ring of refractory material floating on the surface of the metal in said receptacle and a layer of cleansing flux within said ring.

35. Apparatus for producing compound metal objects comprising a furnace having a receptacle for molten metal, an annular flame space surrounding said receptacle and a removable flame diffusing body adapted to receive impact of flame projecting into said chamber, said receptacle having an opening in its bottom for the passage of objects to be coated, and means beneath said opening for solidifying molten metal flowing from said opening.

36. An apparatus for producing compound metal objects comprising a receptacle for molten metal having beneath the normal surface level of such molten metal an opening for the passage of an object to be coated, means for guiding an object to be coated through such receptacle and out through said opening and means for closing said opening.

37. An apparatus for producing compound metal objects comprising a receptacle for molten metal having beneath the normal surface level of such molten metal an opening for the passage of an object to be coated, means for guiding an object to be coated through such receptacle and out through said opening, means for closing said opening and an orificed die beyond and in line with said opening and forming a continuation thereof.

38. An apparatus for producing compound metal objects comprising a receptacle for molten metal having beneath the normal surface level of such molten metal an opening for the passage of an object to be coated, means for guiding an object to be coated through such receptacle and out through said opening, means for closing said opening, and an orificed die provided with cooling means beyond and in line with said opening and forming a continuation thereof.

39. Apparatus for producing compound

metal objects comprising a receptacle for molten metal having in its wall and below the normal level of the molten metal, an opening for the passage of articles to be coated, means for closing said opening and means for passing articles to be coated through molten metal in said receptacle and such opening comprising a porter bar adapted for connection to the article to be coated and provided with a plug of refractory material adapted to close said opening.

40. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its wall an opening for the passage of objects to be coated and an apertured die beyond and in line with said opening, having means for supplying a lubricant to its inner surface.

41. Apparatus for producing compound metal objects comprising a receptacle for molten metal having in its wall an opening for the passage of objects to be coated and an apertured die beyond and in line with said opening, having means for supplying a lubricant to its inner surface, said die further provided with means for cooling it.

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

J. F. MONNOT.

Witnesses:
H. M. MARBLE,
K. G. LE ARD.