

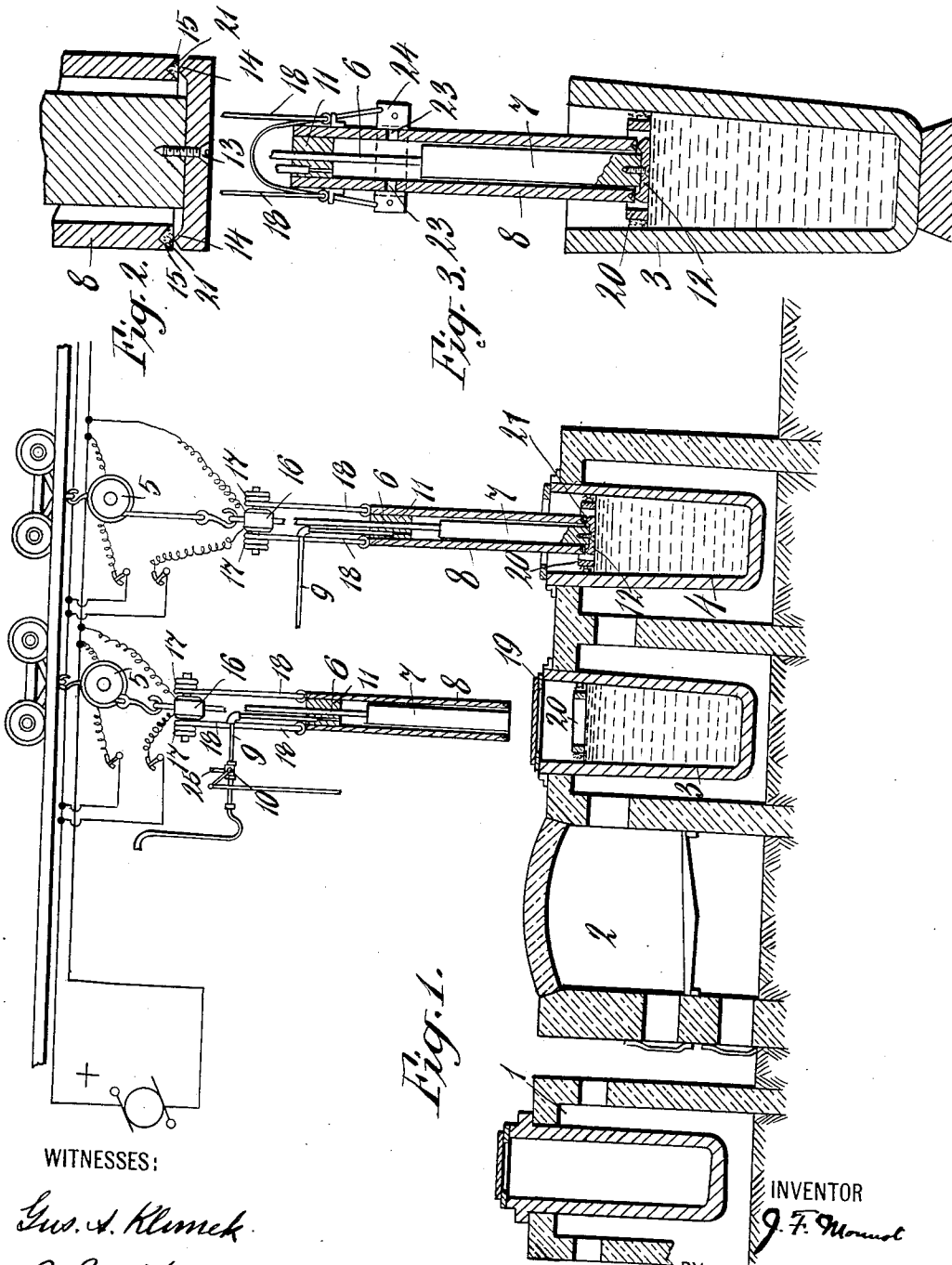
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J. F. MONNOT.

COMPOUND METAL BODY AND PROCESS OF PRODUCING SAME.

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COMPOUND METAL BODY AND PROCESS OF PRODUCING SAME.

No. 894,184.

Specification of Letters Patent.

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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 certain new and useful Improvements in Compound Metal Bodies and Processes of Producing Same; 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 compound metal bodies and processes of producing the same and consists in metal articles composed of layers of silver united to unlike metals, and particularly to ferrous metals, such as iron or steel (including the various compound steels), by an intermediate layer of a third metal; also in the process of producing such articles.

The present application is a division of my prior application filed Sept. 6, 1906, Sr. No. 333,570, and on which has issued Patent No. 853,716, dated May 14, 1907, said application itself based on an earlier application filed June 16, 1905, Sr. No. 265,508, in both of which prior applications the subject matter of this invention is substantially disclosed, but not specifically claimed.

It is well known that it is very difficult to unite, permanently, silver to ferrous metals, such as wrought iron and the various steels, and to nickel, cobalt, and certain other metals. In my said prior applications I have set forth a discovery made by me, which is that the lack of affinity between silver and such unlike metals, which exists at all common temperatures, and which renders it difficult to unite them by any of the known processes, although existing at the common casting temperature of silver, disappears when the silver is raised to a temperature much above its melting temperature. Copper also has the same quality, as has gold and certain other metals. To the condition of such metals and other metals having the same property, in which they become capable of entering into permanent union with iron, steel and like ferrous metals, I have applied the term "super-molten condition", and in my said Patent No. 853,716 I have claimed broadly the process of uniting such unlike metals involv-

ing the bringing of one of them to the super-molten condition. In another application for Letters Patent, Ser. No. 367985, filed April 13, 1907, I have described and claimed a process of uniting silver to iron and other unlike metals, consisting in contacting super-molten silver with such unlike metal and causing a portion of such molten metal to solidify thereon. There are practical objections, however, to keeping in the super-molten condition precious metals, such as silver, gold, etc.; the principal objection being that since in the supermolten condition the metals are very subject to contamination or oxidation or deterioration of various sorts, there is apt to be considerable loss of precious metal. It is therefore preferable to form the union between silver and the unlike metal to which it is to be united, by means of a third cheaper intermediate metal having, like silver, the quality of uniting with iron and the like at the supermolten condition, and with which silver at substantially ordinary casting temperature will unite readily. Copper is one such metal, the qualities of which particularly fit it for uniting silver to iron and the like; for it is highly ductile and malleable, and has high electrical conductivity. In another application, Serial No. 368,770, filed April 17, 1907, I have claimed the process of uniting other metals to iron and the like by means of an intermediate metal such as copper. Therefore in this case I do not claim such process broadly, but only the species thereof involving the use of silver.

In the accompanying drawings I illustrate apparatus such as may be used in carrying out my said process.

In said drawings: Figure 1 represents a sectional view of one form of apparatus for carrying out the said process. Fig. 2 shows in detail section the construction of the bottom plate and lower portion of the casing of such apparatus. Fig. 3 shows a sectional view of another form of casing which may be employed.

In Fig. 1, 1 is a preliminary heating chamber for the ingot or core, 2 a furnace for heating a crucible 3, containing a body of super-molten coating metal. 5 designates a power hoist, here shown as an electrical hoist, mounted on a suitable track so that it can be moved from place to place; and from said

hoist is suspended, by means of a porter bar 6, the ingot 7, which is the object to be coated. Said ingot is shown surrounded by a casing 8 having an internal diameter slightly larger than the external diameter of the ingot, and to said casing is connected a pipe 9, a portion of which is flexible, said pipe provided with a three-way valve 10. This pipe and the valve 10 are provided for supplying to the casing; when desired, an atmosphere of indifferent or neutral gas, such as producer gas. Casing 8 has a weighted head 11 which insures that when the casing is lowered into the molten metal it shall sink therein to the desired depth. 12 designates a bottom plate for the casing arranged to be secured to the ingot 7 itself, by means of a screw 13. Said bottom plate is provided with a raised rib or ring 14 matching a corresponding groove 15, in the lower edge of the casing, and adapted to coact with said groove to make a tight joint. For raising and lowering the casing 8 with respect to the ingot 7, a special hoist 16, suspended like porter bar 6 from hoist 5, is provided. It has, in the form shown, two winding drums 17 upon which are wound cables 18 connected to opposite sides of the casing, so that said casing may be raised and lowered truly vertically.

I customarily provide the crucible with a loose removable cover 19, which cover is designed to exclude air from the molten metal so far as possible, and is removed only when and so long as necessary to lower an ingot and casing into the crucible, or to inspect the molten metal, or for similar reason. To further exclude air from the surface of the molten metal, I cover so much of its surface as possible with a layer of charcoal, a ring 20 of refractory material which floats on the surface of the molten metal serving to maintain a clear space in the center for the passage of the ingot and casing. To assist in forming a tight joint between the bottom plate and casing, I provide in the groove 15 at the bottom of the casing packing material 21.

As an alternative to the above described apparatus for carrying out my process, I may use that shown in Fig. 3, which is much the same as that above described except that the casing 6 is provided with inlets 23 in its sides, said inlets arranged to be closed at will by a sliding shield or valve 24. In carrying out the process with this apparatus the casing without the bottom plate 12 thereon is placed over the heating chamber 1, said casing being at the time filled with a protective atmosphere as above described, and the porter bar is lowered down through the casing, secured to the ingot or core to be coated and raised up into said casing again with the said ingot or core. The casing with the core 7 within it, is then moved to one side, the bottom plate 12 applied, and then the casing is

moved over the crucible 3 containing super-molten coating metal, and is lowered into said supermolten metal; the valve or closure 24 being raised as the openings 23 come to the surface of the molten metal so that said casing fills through said openings 23. The casing with ingot and molten metal within it is then raised and the molten metal allowed to cool as before. In carrying out the process in this apparatus, the protective atmosphere within the casing when the filling holes 23 are open, protects the surface of the ingot and the molten metal which enters the casing against oxidation; and in fact no air can enter the casing, because the holes 23 are submerged in the molten metal almost instantly after the closure 24 is raised, and during the possible brief instant while said openings are open but not completely submerged the out-rush of gas from the casing will prevent the entrance of air.

To hasten the filling of the casing with molten metal, and to prevent trapping of gas in the molten metal as it solidifies, I preferably apply suction to the outlet 25 of valve 10, having first set said valve so as to cut off the entrance of gas and to place outlet 25 in communication with the interior of the casing. This is done, however, only after the molten metal has commenced to flow in. And when necessary or expedient, I reduce the fluid pressure upon the joint between the bottom plate and casing, while raising either the casing shown in Fig. 1 or the casing shown in Fig. 3, by applying suction to the outlet 25 of valve 10.

The coated ingot produced in either of the ways above described is usually worked, as by rolling (either at once, or after submission to a "soaking" heating to bring all the parts to a uniform temperature), to condense the metal of the coating and to extend it to shapes desirable for future working, such as bars, rods, and plates. In such extension the joined metals extend together without rupture of union between them and the final article usually contains the same relative proportion of coating and base as the finished ingot.

The core or base or ingot coated as described in this specification need not be iron or steel, but for most purposes an iron or steel base or core will be preferred. Hence in certain of the following claims I specify steel as the metal of such core or base; and this term "steel" I employ generically to designate all forms of iron, including not merely ordinary carbon steel, both low-carbon or mild and high-carbon or hard, but also wrought iron (the properties of which are nearly identical with those of mild steel) and various compound steels, such as tungsten steel, titanium steel, vanadium steel, chrome steel, nickel steel, manganese steel, cobalt steel; also substantially pure iron,—

i. e., the chemical element Fe, substantially free from carbon and other metalloids or impurities and modifying ingredients.

In the methods of uniting silver and iron or steel above described, the excessively high temperature of the abutting layers of unlike metals exists only temporarily as the heat of the molten metal "soaks" into the steel core, while the heat of the molten metal is transferred outwardly by the cooling of the casing walls, and no opportunity is afforded for detrimental action upon either the main body of the steel or that of the molten metal. Such changes as take place, or may take place, in either metal, are only in the excessively thin joining layer between; and since, as already explained, I do not limit myself to any theory of how the union between the unlike metals takes place, therefore I do not assert positively, that when the operation is properly performed, any change of the two metals, or either of them, at the point of juncture, actually takes place. As previously explained, the time of contact of the steel and silver or other coating metal used, while such silver or other coating metal remains in the supermolten condition, is very brief, for long contact of the two metals with the gold or other coating metal in the very high reactive condition afforded by the supermolten temperature, would of course be detrimental to both. By limiting to a few seconds the period of contact of the metals while one of them is in the supermolten condition, I limit to extreme thinness the joining layer of alloyed, mixed, interpenetrating, or otherwise molecularly-united metals, the layer which links the core metal and the fused-on layer of coating metal.

The steel coated in any of the foregoing ways possesses a cohering, as distinguished from an adhering, layer or stratum of silver which can be drawn, beaten or rolled together with it at ordinary steel working temperatures without parting, even in the finest of wire, or in thin leaf. In an ingot so clad, a cutting tool, such as a cold chisel, refuses to discover or follow the line of union, veering off into the softer metal; and heating and sudden quenching do not separate the joined metals. The adjacent molecules of the joined metals mutually cohere in the same sense in which the silver molecules cohere among themselves or the iron molecules cohere to each other.

According to the process of this application, I apply the coating in two operations, film-coating the ingot 7 by immersing it momentarily in the supermolten metal in crucible 3 and then, without lowering the casing into the supermolten metal, withdrawing the ingot, now covered with a thin film-coating formed by the action of the supermolten metal, back into the casing, moving said casing over the crucible 4, the

molten metal in which is preferably at the ordinary casting temperature or thereabout, applying the bottom plate to the ingot, lowering said ingot into the metal of bath 4 and thereafter lowering the casing and so confining against the film-coated surface a layer of the metal from bath 4, and then withdrawing the casing with its contents from the molten metal and permitting the molten metal within it to solidify. Or, instead of using the apparatus of Fig. 1, that of Fig. 3 may be used; the consequent variation in the procedure just described being obvious.

In carrying on the process in two steps, as above described, the supermolten metal of bath 3 will ordinarily be some cheaper metal than silver which has the power of combining with iron or steel or other metal of which the base is composed, when in the supermolten condition, and with which the silver will combine at or near ordinary casting temperatures; copper for instance, though silver may be used. Employing a third metal in the supermolten bath is, in fact, quite advantageous, for the reason that metals exposed to air or furnace gases or other contaminating influences while in the supermolten condition are very rapidly contaminated; which, if the supermolten metal be a precious metal, such as gold or silver, may add materially to the cost of the process, because of the waste of expensive metal involved. By employing a less expensive metal, such as copper, the possible loss due to contamination of the metal is greatly reduced. Silver at ordinary casting temperature will unite readily with a copper coating formed from supermolten copper, so as to be as inseparable from the copper as the copper is from the iron or other base; and the thickness of the copper layer may be so slight as to be almost inappreciable, and quite inappreciable in the extended product. Copper and silver both having melting points around 1800° F., and both being ductile and malleable at all lower temperatures, the compound metal body can be conveniently worked at steel working temperatures and in much the same manner as steel.

It will of course be obvious that instead of applying a film-coating of copper or other metal unlike both the base metal and the metal of the main coating, I may apply a film-coating of silver and then form on such film-coating a further coating of silver as above described. This has the disadvantage of requiring silver to be maintained at supermolten condition; which, however, is not so objectionable when the main portion of the coating is formed from metal at lower temperature; the metal used in forming the film coating being inconsiderable in amount as compared with that used in forming the main coating. For some purposes, also, it is preferable to apply the silver by a two-step opera-

tion instead of by a single-step operation. The process of coating a ferrous metal by film-coating the same with super-molten unlike metal and then forming a further coating on such film-coating, is claimed in my Patent No. 853716; above mentioned.

The supermolten temperature of silver is from 2500° to 2800° F. or higher, as near as I am able to measure it; all measurements of such extreme temperatures being exceedingly unreliable, as well known; and that of copper is substantially the same. It is easy to determine when the supermolten or film-coating bath has reached the desired condition, by dipping a test piece into the bath and then withdrawing it and permitting the film-coating on it to solidify under conditions precluding oxidation. If the metal is at the proper temperature, the test-piece will be found to have a coating which cannot be stripped off. In practice it is not necessary to make such test, or to measure the temperature, as the workmen soon become able to tell by surface appearance when either silver or copper is in the supermolten condition.

Instead of using silver itself for the outer coating I may use silver-containing mixtures or alloys, such for example as silver bronzes. I intend the term "silver" to include the commercial mixtures consisting principally of silver but containing slight proportions of other metals (usually added to harden the silver) and commonly termed "silver." Coin silver is an example.

In an application filed June 19, 1908, Sr. No. 439,284 I have claimed compound or clad metal articles comprising a coating of copper, silver, gold, aluminum and like metals, alloyed with ferrous metals, weld united to ferrous metals, and a process of making such articles.

What I claim is:—

1. The process of producing compound bodies of silver and an unlike metal inseparably united, which consists in contacting a body of such unlike metal with a supermolten mass of another unlike metal and then contacting the coating formed by such supermolten metal with a mass of molten silver and causing a layer thereof to solidify thereon.

2. The process of producing compound bodies of unlike metals united together, which consists in contacting a surface of one such metal with a supermolten mass of an unlike metal and then contacting the coating formed by such supermolten metal with a molten mass containing silver and causing a layer thereof to solidify thereon.

3. The process of producing compound bodies of unlike metals united together, which consists in contacting a surface of one such metal with a supermolten mass of another metal unlike the first and also unlike silver and then contacting the coating

formed by such supermolten metal with a molten mass containing silver and causing a layer thereof to solidify thereon.

4. The process of producing compound bodies of unlike metals united together, which consists in contacting a surface of one such metal with a supermolten mass of copper and then contacting the coating formed by such supermolten metal with a molten mass containing silver and causing a layer thereof to solidify thereon.

5. The process of producing compound bodies of unlike metals united together, which consists in contacting a ferrous metal base with a non-ferrous metal at a temperature much above its melting point and uniting a layer of a metal comprising silver to the treated base.

6. The process of producing compound bodies of unlike metals united together, which consists in contacting a ferrous metal base with copper at a temperature much above its melting point and uniting a layer of a metal comprising silver to the treated base.

7. The process of producing compound bodies of unlike metals united together, which consists in contacting a ferrous metal base with supermolten copper and thereby forming a coating on the surface of such base, and then contacting such surface with molten silver and causing a layer thereof to solidify thereon.

8. The process of producing compound bodies of unlike metals united together, which consists in contacting a ferrous metal base with a supermolten unlike metal and thereby forming a coating on the surface of such base and then contacting such surface with molten silver and causing a layer thereof to solidify thereon.

9. As a new article of manufacture, a compound metal body comprising a ferrous metal base and a poreless layer of a metal comprising silver united thereto by an intermediate layer of metal of high melting point, said intermediate layer being also poreless and molecularly-united to the metal on either side at all points between abutting surfaces.

10. As a new article of manufacture, a compound metal body comprising a ferrous metal base and a poreless layer of silver united thereto by an intermediate layer of metal of high melting point, said intermediate layer being also poreless and being molecularly-united to the metal on either side at all points between abutting surfaces.

11. As a new article of manufacture, a compound metal body comprising a ferrous metal base and a poreless layer of a metal comprising silver united thereto by an intermediate layer of copper, said intermediate layer of copper being itself molecularly-united both to said ferrous metal base and to

said layer of metal comprising silver at all points between abutting surfaces.

12. As a new article of manufacture, a compound metal body comprising a ferrous metal base and a poreless layer of silver united thereto by an intermediate layer of copper, said intermediate layer of copper being itself molecularly - united both to said ferrous metal base and to said layer of silver at all points between abutting surfaces.

13. As a new article of manufacture, a compound metal body comprising a metal comprising silver and an unlike metal, each inseparably molecularly-united to an intermediate layer of metal unlike both.

14. As a new article of manufacture, a compound metal body comprising silver and an unlike metal each inseparably molecularly-

united to an intermediate layer of a third metal.

15. As a new article of manufacture, an extended metal article comprising a ferrous metal base and a continuous poreless, dense coating of silver, each inseparably molecularly united to an intermediate layer of a third metal of high melting point by a union resisting temperature changes, cutting tolls and mechanism stresses, said ferrous base and silver and intermediate coatings having been extended together.

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

JOHN F. MONNOT.

Witnesses:

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