Oct. 6, 1936. L. E. HOWARD 2,056,673

METHOD OF AND APPARATUS FOR MAKING COMPOSITE INGOTS

Original Filed Dec. 5, 1930

Fig. 1.

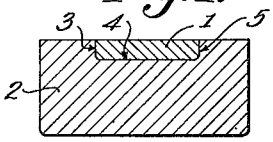


Fig. 2.

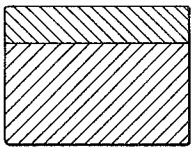


Fig. 3.

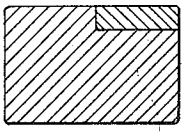


Fig. 4.

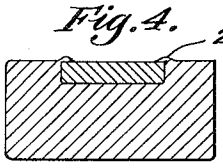


Fig. 5.

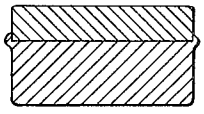


Fig. 6.

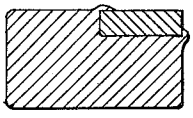


Fig. 7.

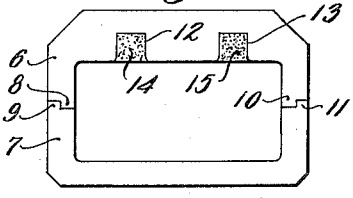


Fig. 8.

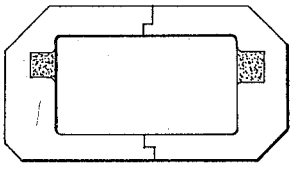
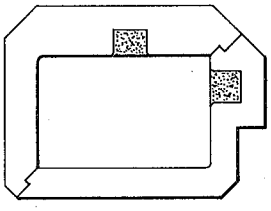


Fig. 9.



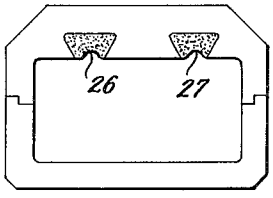


Fig. 10.

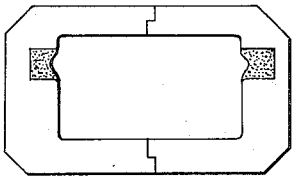


Fig. 11.

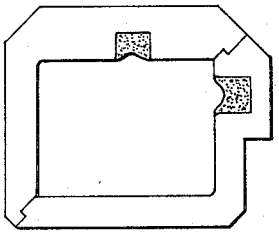


Fig. 12.

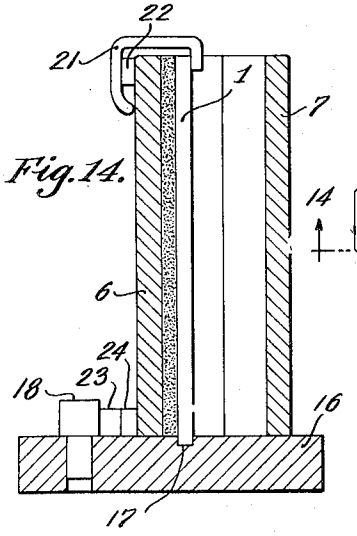


Fig. 14.

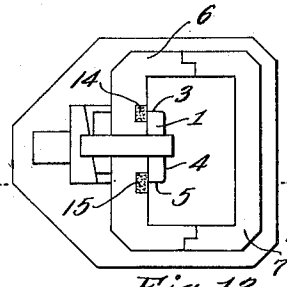


Fig. 13.

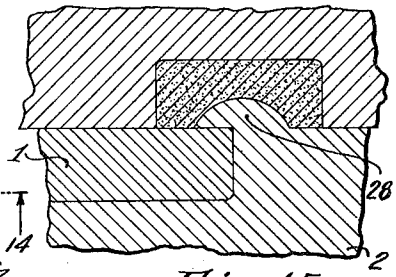


Fig. 15.

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Attys.

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR MAKING COMPOSITE INGOTS

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Original application December 5, 1930, Serial No. 500,327. Divided and this application November 15, 1932, Serial No. 642,699

6 Claims. (Cl. 22—203)

The present invention relates to a method of making composite metal ingots and to the product or products derived therefrom.

In the art of metallurgy it is frequently desirable or essential to provide an ingot or a finished product which is composed of two or more metals having decidedly different properties and compositions. For example, "composite steel", by which is meant a steel ingot or a finished product containing two or more steels of different types which are joined together, is commonly made by effecting incipient fusion of the steels at their junction or plane of mutual contact.

Two general methods of making such ingots have heretofore been practiced. One method consists in pouring one of the steels in a special mold, and as soon as it is set sufficiently, manipulating the mold members in such a way as to provide space for the other steel, which is then poured into the space thus provided, while the steel first poured is still very hot. The heat from the second steel poured is sufficient to raise the temperature of the surface or "skin" of the partially cooled steel first poured to a point where the latter will again become molten and the two steels will fuse together. The second method consists in pouring one of the steels only, the other being in the form of a slab or billet which may be prepared in various ways, such as pickling, sand blasting and the like, and is usually preheated somewhat before pouring the other steel against it. In some cases the starting material may be a soft steel slab or billet and a high carbon steel is poured against it; in others, the starting material may be a tool steel or alloy steel slab against which a soft steel is poured.

Among the most common applications of composite metals or steels is the making of wood planer knives, paper cutting knives, veneer cutting knives, and similar edged tools in which it is common to weld a strip or "face" of tool steel to a low carbon, low grade steel "back". Another application is in making a thermostat metal in which metals of different coefficients of thermal expansion are joined together and rolled into bars of the desired cross-section. A thermostat commonly used is made of "invar" comprising 36% nickel steel as one of the metals and muntz metal (one of the brass or bronze series) as the other. These are brazed together and serve very well for indicating low ranges of temperature, but it is becoming increasingly important to provide thermostatic bars for indicating high temperatures (much above the melting points of non-ferrous metals), such as invar and nickel-chromium steel, for example.

Such bars have been produced by welding, brazing, and the like, but the losses entailed in manufacture are enormous, the thermo-electro properties of the finished product are not constant and many failures of such elements occur after they have been used for only a comparatively short time at elevated temperatures. Moreover, in addition to the usual difficulties which are inherent in the welding of steel, as by overheating and "burning" of high carbon tool steel, there is a high percentage of "loose" welds, and the welding of long lengths of bars is not practicable. Accordingly, the costs of the process are high so that it is more desirable to roll such bars from composite carbon or alloy steel ingots.

Heretofore in the manufacture of composite steel ingots serious difficulties have developed in the junction between the two metals. These occur especially in those portions of the joint which come in contact with the mold walls and which are not so intimately united as the other parts of the joint between the two metals. Moreover, the metal in these portions of the joint may show a different structure from that in the remaining portions.

It is therefore an object of this invention to provide an improved composite metal ingot (and/or finished product) and a method of making the same. It is a further object to effect an intimate and uniform joint between the two metals, throughout their contacting surfaces, and especially in the marginal portions of the joint therebetween. It is a further object to overcome the localized chilling of the margins of contact of the two (or more) metals comprising the ingot whereby the thermal continuity of the integrated ingot may be attained and the structures of the metals may be substantially uniform throughout the respective sections. It is also an object to provide means for effectuating such results. Other objects will appear from the following disclosure.

In accordance with the method of the present invention, composite metal ingots are prepared by forming a section of the ingot, maintaining the marginal portions of the exposed surface or surfaces of the same at substantially the same temperature as the rest of the surface and casting the second metal against said exposed surface or surfaces of the first. The two metals thereupon effect intimate contact and are fused together uniformly throughout their common

surface or surfaces of contact, and upon cooling they produce a uniform integrated composite ingot of the two metals. The finished ingot is especially characterized by an intimate association between the two metals and by the fact that such association is preserved even in the marginal portions of their plane of contact. It is also characterized by uniformity of structure of such marginal portions as contrasted with the rapidly cooled structures heretofore observable in such areas.

While especially applicable for the production of composite steel ingots, the invention is similarly adapted in the preparation of composite ingots of other metals, such as the thermostatic bars mentioned above.

A typical instance of the practical application of the invention will be described as carried out in the manufacture of composite steel ingots and with reference to the accompanying drawing, in which:

Figs. 1 to 6, inclusive, are cross-sectional views of various types of composite steel ingots in which the cross-sectional areas of the two sections vary both in size and in their relative positions in the ingot;

Figs. 7 to 12, inclusive, are cross-sectional views of molds which may be employed in accordance with the invention, for the casting of the ingots shown in Figs. 1 to 6, respectively;

Fig. 13 is a plan view of the assembled mold;

Fig. 14 is a cross-section of the assembled mold in the plane 14—14 of Fig. 13; and

Fig. 15 is an enlarged, detailed cross-section of the joint between the two metals of the ingot and of the mold adjacent thereto.

For the preparation of an ingot of the type indicated in Fig. 1, for example, having a section 1, surrounded upon three sides by the section 2 and intimately joined throughout the surfaces of contact 3, 4, 5, a mold such as that shown in Fig. 7 may be employed. As shown, this comprises a split mold having two sections 6 and 7, preferably provided with rabbets 8, 9 and 10, 11, respectively, along their parting plane. The section 6 is provided with longitudinal grooves 12, 13 (corresponding to the surfaces of contact, 3, 5, between the sections of the ingot to be cast therein) which are filled with a suitable refractory, heat insulating material 14, 15. For this purpose diatomaceous earth in combination with fire clay, crushed brick and the like is satisfactory. Thus, a ganister made of crushed fire brick scrap mixed with enough clay to serve as a binder is especially suitable, and it is found that such material has a conductivity factor which is less than 1/400 of that of the usual cast iron or cast steel ingot mold.

The grooves 12, 13 are ordinarily disposed longitudinally of the mold but may be arranged otherwise, if desired, for special purposes.

Preparatory to use, the sections of the mold 6, 7 may be placed upright upon a refractory base or stool 16 (Fig. 14) which is provided with a slot 17 and an upstanding projection or block 18. Section 6 of the mold is placed with its inner surface adjacent to the slot 17 into which the previously heated and shaped bar or section 1 is dropped—preferably fitting the same snugly so that it is retained in upright position, against the inner side of the mold 6, its lateral surfaces 3, 5 extending along the central portion of the fire clay inserts 14, 15, respectively (Fig. 13).

The bar or section 1 is preferably first sand blasted and/or pickled, and then preheated out of contact with the air (as by coating or dipping the same in a fluxing material, such as borax or borax and black oxide of manganese, etc.) and then quickly taken from the furnace and inserted in position, as above described. It is held in position at its upper end by a clamp 21 and wedge 22 and at its lower end by wedges 23, 24 which are inserted between the mold and the fixed block 18 and driven in.

Section 7 of the mold may be secured to section 6 by rings and wedges, not shown, which are of conventional type or by other mechanical means well known to those skilled in the art of casting molten metals in metal molds.

The molten metal, corresponding to section 2 of the ingot, is now poured into the unfilled portion of the mold, filling it nearly to the top. After cooling, the mold is stripped off in the usual way, and it will be found that the two steels have become thoroughly integrated into a solid piece of steel, or composite steel ingot as above described.

The margins of section 1 being thus preserved at substantially the same temperature as the remainder of the metal,—instead of cooling more rapidly which is a common property of heated bodies at edges and corners,—the molten metal heats them to substantially the same temperatures as the remainder of the contacting surfaces and a uniform adhesion is secured between the two sections. Furthermore, upon cooling the structure of the entire ingot is substantially uniform, inasmuch as all portions start to cool from approximately the same temperature,—at least throughout the contact zone,—and this temperature is above that at which intimate integration of the two is accomplished.

This effect may be enhanced by employing a modified form of mold,—prepared and assembled as shown in Fig. 10,—in which the fire clay in the grooves 12, 13 is channeled, as at 26, 27. In this case, the edges of section 1 of the ingot may extend to the centers of the channels, as shown in Fig. 15. When the molten metal of section 2 is poured, it flows around the corner of section 1 and forms a projecting rib 28 which contributes a larger proportionate quantity of heat to this portion of section 1, thus still further assuring a rise of temperature in the latter to a point where intimate contact and adhesion will take place.

The cooled ingot, as thus formed, will have ribs 29, as shown in Fig. 4, but these, if formed of the softer of the two steels, may be readily removed by grinding, if necessary.

The other modifications of molds illustrated in Figs. 8 to 12 which may be employed in accordance with the invention, and the ingots made therein (Figs. 2 to 6) correspond substantially to those above described, as will be obvious from the foregoing description. Other modifications and adaptations of the invention will occur to those skilled in the art and are to be considered as comprehended by the disclosure and included within the terms of the following claims.

This is a division of application Serial No. 500,327, filed December 5, 1930.

I claim:

1. Method of making composite ingots, comprising the steps of providing a heat-insulating insert, in the interior surface of a mold, corresponding to the surface of the ingot adjacent to the margin of the surfaces of contact between the sections of the ingot to be formed therein, filling a portion of the mold with one of the

metals, the margin thereof substantially coinciding longitudinally with the middle line of the surface of said insert, and pouring the second metal into the mold and into contact with the first.

2. Ingot molds, for casting composite ingots, made of heat conductive material and characterized by having a narrow strip of heat insulating insert in the interior surface thereof, the longitudinal middle line of the surface of said insert being substantially coincident with the margin of the plane of mutual contact of the ingot materials to be cast therein.

3. Ingot molds, for casting composite ingots, made of heat conductive material and characterized by having a narrow strip of heat insulating insert in the interior surface thereof and a channel in said heat insulating insert, the longitudinal middle line of said channel being substantially coincident with the plane of contact of the ingot materials to be cast therein.

4. Ingot molds for casting composite ingots, characterized by having a peripheral channel in the inner surface thereof, formed in a refractory material of lower heat conductivity than the rest of the interior of the mold, the longitudinal middle line of the surface of said insert being substantially coincident with the plane of contact of the metals to be cast therein.

5. Method of making composite metal ingots comprising the steps of shaping one section thereof, solidifying and placing the same in a suitable mold, adapted to receive the same and to leave a space coincident with and surrounding the edge of the exposed surface of said section and pouring the second section of molten metal upon said surface and into the space surrounding the edges of the first section, thereby to heat and protect the margin of contact between said metals from rapid cooling.

6. A mold for casting composite ingots, characterized by having heat-conductive walls determining the mold space, a continuous groove in the inner surface of said mold corresponding to the margin of the surfaces of contact and adjacent surface areas of the metals of the ingot to be formed therein, and a refractory heat-insulating material contained in said groove.

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