Aug. 16, 1938. S. M. STOODY 2,127,239

MEANS FOR PRODUCING HIGH MELTING POINT ALLOY CASTINGS

Filed Dec. 11, 1935

Fig. 1.

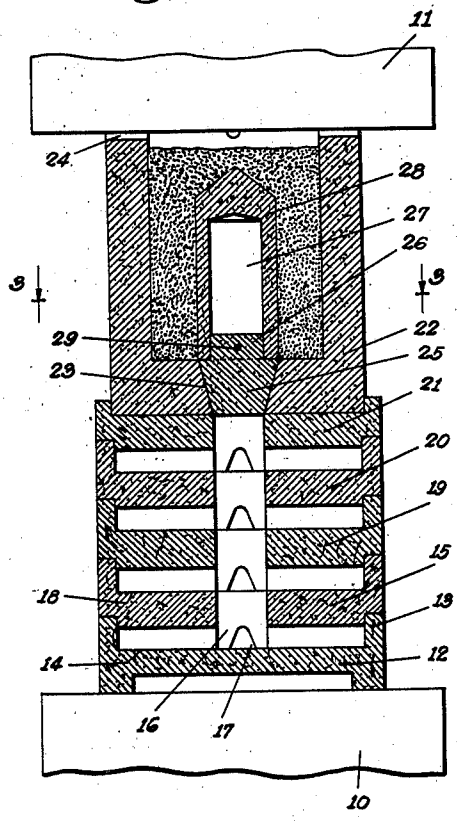


Fig. 2.

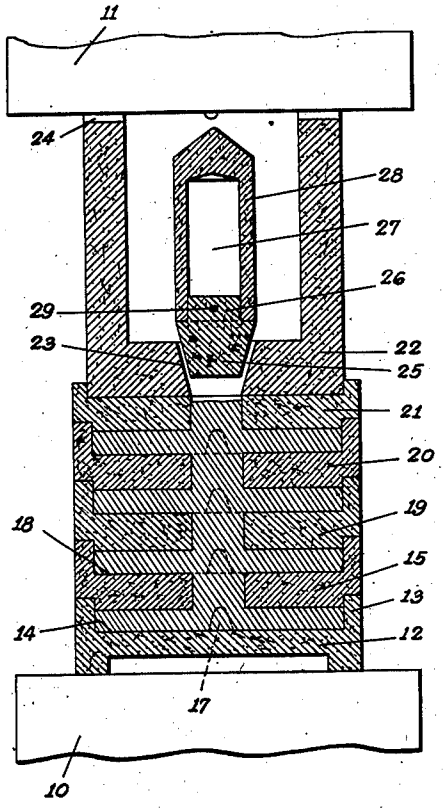


Fig. 3.

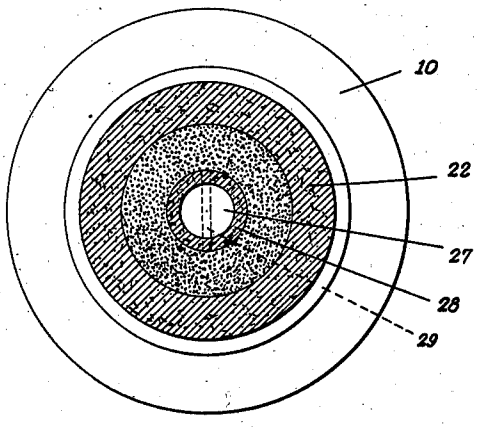
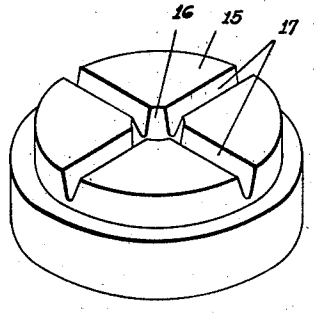


Fig. 4.



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MEANS FOR PRODUCING HIGH MELTING POINT ALLOY CASTINGS

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4 Claims. (Cl. 22—79)

This invention relates to a means for producing castings and has been primarily designed for producing castings of the high melting point substances, such as tungsten carbide and tungsten-carbide-like materials, although the invention may be used in producing castings of other substances.

In producing tungsten carbide castings a customary manner of casting is to place a quantity of tungsten powder in a carbon crucible. The crucible is heated to melt the tungsten either by passing electric current through the crucible so as to heat it by resistance or to play an electric arc on the contents of the crucible. When the tungsten powder becomes molten it absorbs and combines with carbon obtained from the walls of the crucible and is converted into tungsten carbide. The molten tungsten carbide is then quickly poured from the crucible into a mold, usually formed of carbon. Because of the extremely high melting point of tungsten carbide and its consequent high freezing or solidifying temperature the pouring of the tungsten carbide from the crucible into the mold is done very quickly.

The above outlined procedure is disadvantageous for several reasons. Although the pouring of the tungsten carbide from the crucible into the mold is done very quickly it is generally done in the presence of air with the result that some oxides form. Furthermore, if the mold is at room temperature, which is generally the case, the pouring of the molten tungsten carbide at extremely high temperature into the room temperature mold results in a very quick and severe chilling.

It is an object of this invention to provide a new means for casting wherein the tungsten powder may be melted in a carbon crucible and converted into tungsten carbide and then emptied into a mold in the absence of air, the mold being heated to substantially the temperature of the crucible so that when the molten tungsten carbide enters the mold the sudden and extreme chilling will be eliminated. In this manner tungsten carbide castings may be produced of a homogeneous, fine-grain structure and which will not be as brittle as the chilled tungsten carbide but at the same time there will be retained the inherent extreme hardness of tungsten carbide.

It has been proposed to introduce into tungsten carbide toughening ingredients, such as, for example, cobalt, iron, nickel, and even copper. These toughening ingredients when mixed with tungsten carbide make the resulting alloy usually slightly softer than pure tungsten carbide but as substantially all of the hardness is retained for all practical purposes the very slight sacrifice in hardness is compensated for by the increased toughness, which is desired in many instances.

The melting points of toughening ingredients proposed are very materially lower than the melting point of tungsten carbide with the result that when tungsten carbide is molten, containing a toughening ingredient, the toughening ingredient is at a temperature very much above its melting point. Consequently, if an attempt is made to pour from the conventional carbon crucible through the air into the conventional carbon mold although the pouring is done very quickly, the toughening ingredients oxidize almost instantly with the result that segregations occur and the resulting product or alloy is neither homogeneous in grain structure nor of the desired characteristics. By means of the present invention it is possible to introduce into tungsten carbide toughening ingredients, such as those above mentioned, and although the temperatures of these toughening ingredients will be far in excess of their melting points during the pouring, in view of the fact that the pouring takes place in the absence of air, no oxides form and the resulting product is of a homogeneous character having a fine grain without segregations or large crystals. The toughening ingredient being present and throughout the composition serves to toughen the casting over the toughness of pure tungsten carbide and by the absence of any tendency to oxidize even though at high temperature the castings will not split or readily divide upon any regular planes of cleavage as is apt to occur where the toughening ingredient oxidizes.

With the foregoing and other objects in view which will be made manifest from the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawing for an illustrative embodiment of the invention, wherein:

Fig. 1 is a vertical section through the mold and crucible prior to the contents of the crucible becoming molten.

Fig. 2 is a view similar to Fig. 1 illustrating the contents of the crucible as having been emptied into the mold, the float valve being shown in elevated or open position.

Fig. 3 is a horizontal section taken substantially upon the line 3—3 upon Fig. 1.

Fig. 4 is a perspective view of one of the mold sections.

Referring to the accompanying drawing,

wherein similar reference characters designate similar parts throughout, 10 designates a lower carbon electrode and 11 a similar upper electrode. These electrodes may be suitably water cooled and the upper electrode is vertically movable so as to move into or out of engagement with the top of the crucible. The mold which, like the crucible, is made of carbon, may be of any preferred design. The mold illustrated consists of a bottom section 12 having an upstanding rim 13 surrounding a concavity 14. A superposed section 15 is nested in the bottom section 12 and has a central aperture 16 forming a part of the gate or sprue of the mold. The superposed section 15 also has on its bottom radially extending grooves 17 communicating at their inner ends with the central aperture 16. The top surface of section 15 is concave as indicated at 18 corresponding to concavity 14. Superposed mold sections 19, 20 and 21, which are similar to section 15 may be nested one within the other on top of section 15 to complete the mold. The top of the crucible may be notched as indicated at 24 to permit the escape of gases during the melting of the contents of the crucible. The outlet 23 is normally closed by a type of float valve consisting of a tapered plug 25 designed to fit the tapered outlet which has an upwardly extending stem 26 fitting the hollow interior 27 of valve body 28. The plug is secured in place in the hollow valve body by a diametrical pin 29. The float valve body 28, the pin 29, and plug 25 are also preferably formed of carbon similar to the mold and crucible.

The float valve is first placed in closed position in the crucible as shown in Fig. 1 and then a quantity of tungsten powder is placed in the crucible, which is sufficient when converted into tungsten carbide to fill the mold. The crucible is then placed on the mold and the mold and crusible are placed between electrodes 10 and 11. The upper electrode 11 is brought down into contact with the top of the crucible. The electric current is then turned on which, on passing through the crucible and mold will, by resistance, heat the mold and crusible to the incandescent heat required to melt the tungsten powder. As soon as the tungsten powder becomes molten it absorbs carbon from the walls of the crucible, converting the tungsten into tungsten carbide. This takes place very quickly, if not instantly, at the time that the tungsten becomes molten. Just as soon as the contents of the crucible becomes fluid the float valve has a tendency to float therein and lifts from its seat, allowing the molten contents to flow through outlet 23 into the gate of the mold and to fill the mold cavities. As soon as this occurs the current may be turned off and electrode 11 lifted, after which the mold and crucible are allowed to cool. The tungsten carbide which quickly solidifies in the mold may thereafter have its cooling hastened by plunging the entire mold into a bath of water. The mold may then be broken open and the castings recovered.

I find that in using the above described apparatus that although the walls at the top of the crucible may become pitted that the walls at the bottom of the crucible, the bottom, the sides of the outlet 23, and the sides of the float valve are hardly affected. The mold empties very cleanly and neither the float valve nor the bottom of the crucible are pitted to any noticeable respect. Consequently, it is possible to use the same crucible and float valve time after time in consecutive heats.

If it is desired to produce a comparatively tough tungsten carbide by means of the improved method and apparatus the following steps are suggested. If, for example, it is desired to introduce into the tungsten carbide twelve percent of cobalt, I find it advantageous to take 88% of tungsten powder and twelve persent of cobalt powder and mix these thoroughly in a mixer. Thereafter the combined mix is extruded into a cake or block which is baked in a suitable baking oven. The baked cake or block may then be ground up into a powder.

Such treatment of tungsten and cobalt powders is not essential but is recommended in order to secure a thorough mixture of the tungsten and cobalt. It is possible to merely mix these powders together and place the mixture directly in the crucible. The heating and melting of the crucible contents is the same as that previously described and the emptying of the crucible into the mold takes place in the same manner. Although the melting point of tungsten carbide may be very much higher than that of the toughening ingredient, cobalt, or other toughening ingredients such as iron, nickel, vanadium, chromium, copper, and the like, the emptying of the crucible into the mold takes place in substantially an entire absence of air. The extreme heat of the mold which is very nearly that of the crucible, if not the same, serves to expel practically all oxygen from the mold cavities or to cause it to enter into combination with the carbon walls of the mold. Consequently, during the pouring no opportunity is afforded for the toughening ingredient to oxidize although it is in a quickly oxidizable condition due to its extremely high pressure. As the toughening ingredient will not oxidize no slags are formed which would otherwise tend to poison the complete casting. I find that castings produced in this manner have a uniform, fine grain throughout and that there is no segregation nor are objectionable pipes formed in the castings. I have noticed, however, that sometimes at the top of the gate there occur coarse crystals but as the gate or sprue is wasted these crystals are not objectionable when they occur in this part of the mold. A find that by introducing twelve percent of cobalt into tungsten carbide in the above described manner that while there is a very slight sacrifice of hardness of the product, the toughness, so as to resist shattering under blows of a hammer, is materially increased over that of pure tungsten carbide, especially when it is prepared by pouring molten tungsten carbide into a mold at substantially room temperature.

While the float valve is preferably made hollow to insure its floating in the molten contents of the crucible, this in many instances is not essential as the specific gravity of carbon is ordinarily so much less than that of the molten contents in making tungsten carbide alloys that a solid carbon valve in some instances will suffice and will float and open the outlet as soon as the contents of the crucible become molten.

The use of the present apparatus in no way interferes with the accurate timing of the heating of the crucible contents. In the conventional manufacture of tungsten carbide the heating is accurately timed so as to prevent underheating or overheating, which detracts from the hardness and from the uniform grain structure in the finished product.

The further advantage of the present type of construction over previous methods of manufacturing and casting tungsten carbide is that the electric circuit between the electrodes 10 and 11 may be broken at the switch rather than between the electrode 11 and top of the crucible. Where the crucible was removed from between the electrodes and then manually poured into a mold, the quickness with which this had to be done in order to prevent the tungsten carbide from freezing in the crucible itself required that the arc be broken between the upper electrode and the crucible and the crucible then instantly poured. This resulted in the bottom of the electrode 11 becoming burned or pitted and from time to time the bottom surface of electrode 11 had to be resurfaced. In the present method and apparatus the electric circuit can be broken at the switch rather than at the electrode, thus eliminating burning or pitting of electrode 11.

From the above described method and apparatus it will be appreciated that it is possible to produce tungsten carbide and to cast it into a mold in substantially the complete absence of air so that no oxides will form, which is of great importance when relatively low melting point toughening ingredients are introduced. Furthermore, the casting takes place in a mold heated to practically the same temperature as the molten contents of the crucible so that the severe chilling of the tungsten does not take place. In this way pure tungsten carbide castings may be produced and also tungsten carbide castings containing toughening ingredients wherein the metal will be homogeneous, fine-grained, and without segregation, large or objectionable crystallization or oxidation taking place.

It is not essential that the mold sections rest one within the other as the construction of the mold may vary greatly with the type of castings to be produced but in some instances mold sections may be merely stacked one upon the other without nesting, the nesting being employed merely to keep the molten metal from running out of the mold from the outer ends of grooves 17.

While the improved method and apparatus have been primarily designed for use in connection with high melting point substances having characteristics similar to those of tungsten carbide it may be employed under other circumstances for casting virtually all meltable and castable materials.

Various changes may be made in the details of construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. Means for casting, comprising a mold, a crucible over the mold having an outlet leading into the gate of the mold, and a valve normally holding the outlet closed, adapted to float in the contents of the crucible when the contents become molten to allow the molten material to flow from the crucible into the mold.

2. Means for casting, comprising a mold, a crucible associated with the mold so that both the mold and crucible may be placed between electrodes and heated together by resistance, there being an outlet leading from the crucible into the mold, and means for keeping the outlet closed until the contents thereof become molten and then allowing the molten contents to flow into the mold.

3. Means for casting, comprising a mold, a crucible associated with the mold so that both the mold and crucible may be placed between electrodes and heated together by resistance, there being an outlet leading from the crucible into the mold, and means for keeping the outlet closed until the contents thereof become molten and then allowing the molten contents to flow into the mold, comprising a float valve seated in the outlet.

4. A crucible having an outlet in its bottom and a float valve seated in the outlet adapted to float in the molten contents of the crucible to open the outlet.

SHELLEY M. STOODY.