United States Patent

[11] 3,633,648

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[54] **METHOD OF CASTING IN INVESTMENT MOLDS HAVING A RADIATION SHIELD**
4 Claims, 3 Drawing Figs.

[52] U.S. Cl. 164/60, 164/121
[51] Int. Cl. B22d 25/06
[50] Field of Search 164/60, 351, 352, 357, 121; 249/206

[56] **References Cited**

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ABSTRACT: In making columnar grained or single-crystal castings, the mold is heated prior to pouring and a meltable metallic shield is placed on the chill plate to serve as a heat shield between the mold and the plate during heating of the mold and also to prevent condensation of impurities on the chill plate.

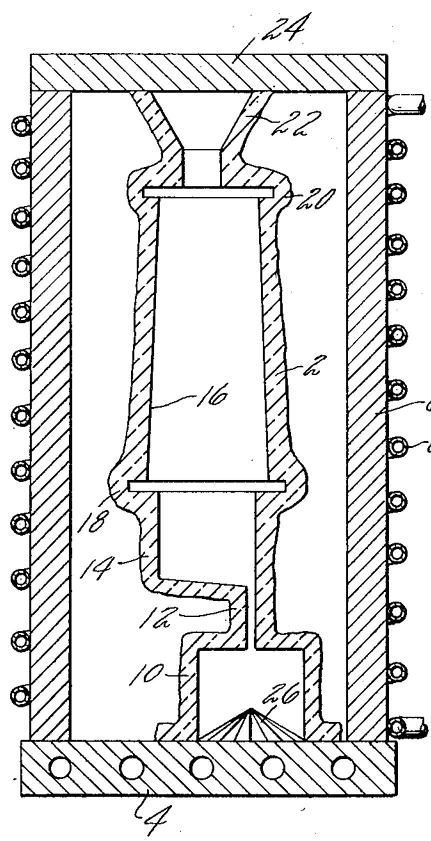


FIG. 1

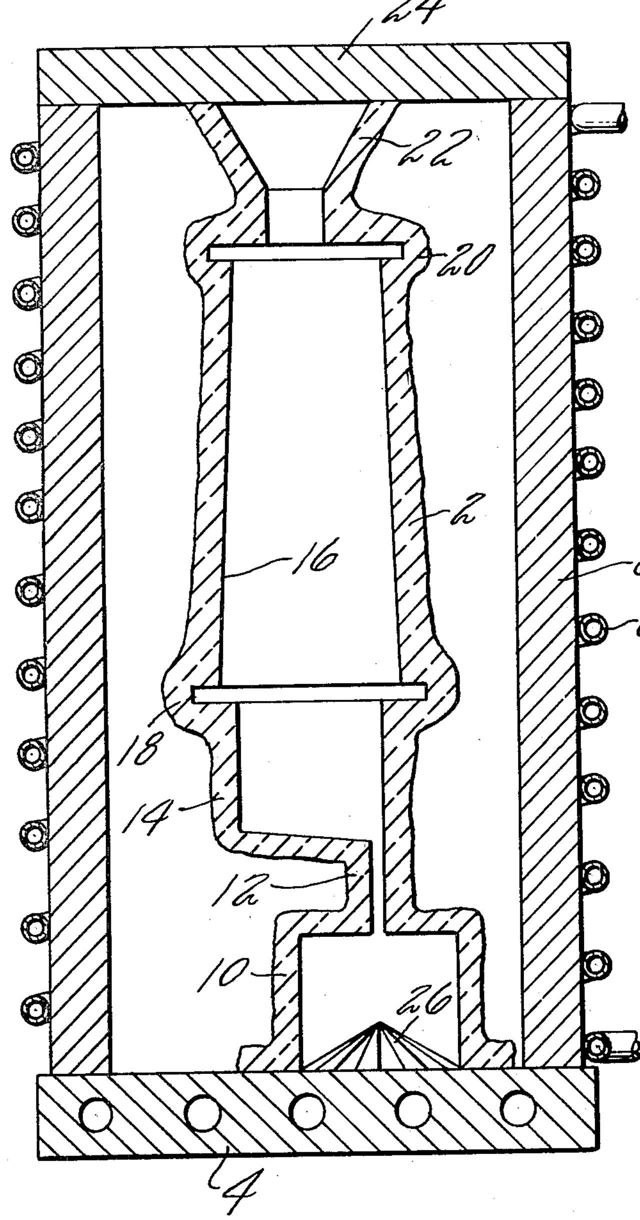


FIG. 2

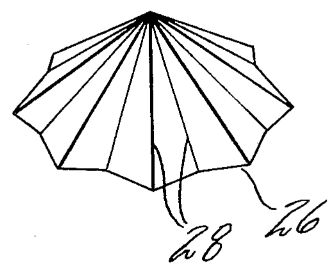
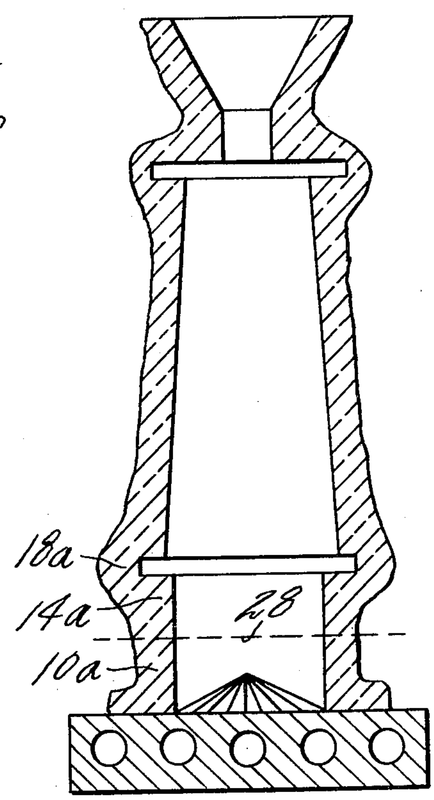


FIG. 3



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METHOD OF CASTING IN INVESTMENT MOLDS HAVING A RADIATION SHIELD

As taught in the VerSnyder patent, U.S. Pat. No. 3,260,505 for columnar grained castings, or in the Piearcey patent, U.S. Pat. No. 3,494,709 for single-crystal castings, such castings are best produced in a shell mold, the open bottom end of which rests on a chill plate. The mold is heated to above the melting temperature of the alloy before being poured and a suitable thermal gradient is established in the mold after pouring by the effect of the chill plate. The presence of the chill plate during heating of the mold necessitates a longer period of heating, and during this time impurities that may be within the furnace or within the mold structure including the ceramics or binder may be vaporized. If some of the vaporized impurities enter the mold cavity and are condensed on the chill plate, this condensed material may, when the alloy is poured result in imperfections or porosity in the cast part. Any substantial amount of deposited material on the chill plate may also result in a violent reaction with the alloy further producing imperfections or impurities within the casting.

SUMMARY OF THE INVENTION

A feature of this invention is a heat shield positioned in the open end of the mold and resting on or adjacent to the chill plate to prevent loss of heat, from the mold being heated, to the colder chill plate and to prevent the accumulation of foreign matter which condenses on the chill plate. Another feature is the use of a metal for the shield that will remain solid until the alloy is poured but that will be dissolved by the alloy and mix with it. Preferably the metal of the shield is one of the components of the alloy.

According to the invention a metallic heat shield, preferably in nonflat form and of sheet material is placed on the chill plate within the open end of the mold and resting on the chill plate in only a few locations. The shield substantially covers the area of the open end of the mold and is made of a material that is dissolved by the alloy when it is poured into the mold and that will mix with and be compatible with the alloy. This shield allows for quicker heating of the mold and also prevents collection of impurities on the chill plate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view through a mold and chill plate with the shield therein and all located within a mold heating means.

FIG. 2 is a perspective view of one form of shield.

FIG. 3 is a sectional view similar to FIG. 1 of a modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1 the mold **2** is positioned on a chill plate **4** and is surrounded by a susceptor **6** by which the mold may be heated and by which the rate of cooling of the mold may be controlled. The susceptor is surrounded by an induction coil **8** by which the susceptor is heated and this latter is preferably in the form of a tapped coil such that the top portion of the coil may be energized separately from the bottom portion. The susceptor is preferably in the form of a sleeve with adequate space therein to receive the mold. It will be understood that the entire assembly may be positioned within a vacuum furnace for use in providing the vacuum desirable in casting many of these alloys and in getting the mold to the desired pouring temperature.

The mold consists of a growth portion **10** at the bottom, the bottom end of which is open to the chill plate and rests thereon. The growth portion is connected by a restricted passage defining portion **12** which selects and establishes the growth of a single crystal from the growth portion **10** into the root portion **14** directly above the restricted passage. Above the root portion is the blade portion **16** with a platform portion **18** therebetween. At the top of the blade portion **16** is a shroud **20** and above that is the sprue **22** by which the alloy is poured into the mold. When he entire mold is positioned within the susceptor a cap **24** may be positioned thereon as shown.

Resting on the chill plate and fitting within the bottom open end of the growth portion **10** is a heat shield **26** preferably made of sheet material and preferably in a nonflat condition as shown so that only a few areas of the heat shield are in contact with the chill plate thereby reducing the heat conductivity from the shield to the chill plate. The nonflat condition may be provided by forming a plurality of creases **28** in the shield or alternatively it may be produced by using a corrugated form of shield. The latter is positioned essentially horizontally and in position substantially covers the area of the chill plate that is exposed to the growth portion of the mold and as such serves to prevent the radiation of heat from the mold directly to the chill plate and also preferably serves to reflect heat back into the mold.

The material of the heat shield is selected so that it will not melt during the heating of the mold to the desired temperature but will be dissolved by the alloy when it is poured into the mold and comes in contact with the heat shield. Where the device is used in the casting of some of the high-temperature alloys used for example in gas turbine engines, the material used for the shield is preferably one of the materials contained in the alloy. For example, in casting the alloy known as Mar—M—200 which is a nickel-base high-temperature alloy the shield may be either tungsten or columbium since the alloy contains each of these elements. It has been found that the heat shield dissolves readily in the alloy when it is poured.

The heat shield serves not only to minimize radiation from the mold to the chill plate during heating of the mold but also serves to prevent the condensation of gaseous material that could be an impurity for the alloy or could constitute foreign material that would be entrapped within the alloy during solidification. For example, a material that is caused to evaporate from the mold or the susceptor or any foreign material that may be within the furnace itself may produce this undesired gaseous material that could be deposited on the chill plate except for the presence of this shield. In a particular casting in which the diameter of the growth portion **10** of the mold was **3** inches in diameter a shield of columbium formed from sheet stock 0.012 of an inch thick accomplished the expected results. When the alloy was poured, the shield was dissolved completely within the alloy.

The arrangement of FIG. **1** is used for producing single-crystal castings. When the alloy is poured and the heat shield is dissolved columnar grains are formed vertically from the chill plate within the growth zone **10**. The restricted passage above the growth zone selects one of the columnar grains to grow into the root portion **14** and hence into the remainder of the mold. The columnar grains and the dendritic growth within the single crystal are caused to solidify in the desired form by the effect of the chill plate and the maintenance of the proper thermal gradient within the mold during solidification. The actual formation of the single crystal within the mold is described in the above-identified Piearcey patent, U.S. Pat. No. 3,494,709.

The arrangement of FIG. **3** is intended to produce columnar grained cast articles and to this extent the growth portion **10*a*** connects directly without restriction with the root portion **14*a*** the portions being shown as divided by the dotted line **30** representing the top of the growth zone. Above the platform portion **18*a*** the remainder of the mold is similar to that described in FIG. **1**. When a suitable alloy is poured into this mold, the latter having been heated to a temperature above the melting point of the alloy, columnar grains are formed growing vertically from the chill plate and such columnar grains continue directly through the entire mold. Such growth of crystal grains is described in the above-identified VerSnyder patent U.S. Pat. No. 3,260,505.

Although the heat shield and its use are described in the making of shaped articles such as turbine vanes, it has similar utility in casting ingots where the relatively large area of the exposed chill plate makes the heat shield particularly advantageous.

We claim:

1. The process of casting high-temperature alloys in a heated shell mold including,

providing a mold having an open lower end,

positioning the mold on a chill plate such that the plate closes the open end,

placing a thin nonflat metallic shield made from at least one of the metals of the alloy within the mold adjacent to and substantially covering the portion of the chill plate within the mold, with the greater portion of the shield spaced from the chill plate, to shield the chill plate from radiant heat from the mold as it is heated,

heating the mold to a temperature above the melting temperature of the alloy,

substantially preventing condensation of vaporized impurities in the casting cavity by heating the shield by radiant heat from the mold during heating of the mold, and

pouring melted alloy into the mold for forming the casting such that the material of the shield is caused to melt and be dissolved into the poured alloy.

2. The process of claim 1 in which the shield is positioned to shield the chill plate from the heat of the mold and including the step of supporting the shield such that the greater portion of the shield is out of contact with the chill plate.

3. The process of claim 1 including the additional step of

forming a plurality of creases in a sheet of metal to form the shield into a nonflat configuration prior to placing it in the mold.

4. The process of claim 1 including the additional step of causing solidification of the alloy by the removal of heat from the alloy to the chill plate.

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