

Nov. 5, 1957

R. T. BANISTER
CENTRIFUGAL CASTING

2,811,757

Filed Jan. 11, 1956

2 Sheets-Sheet 1

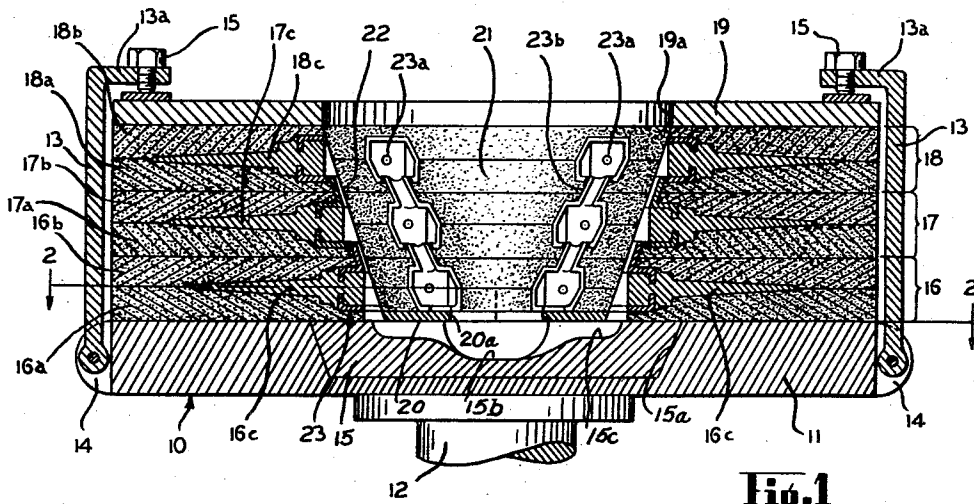


Fig. 1

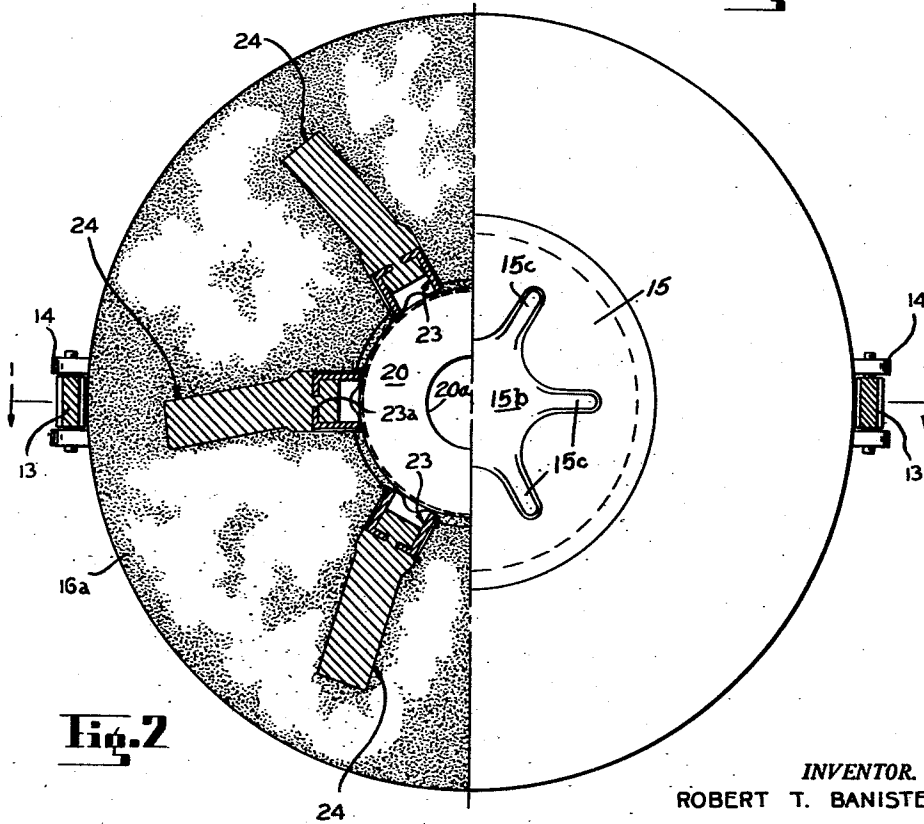


Fig. 2

INVENTOR.
ROBERT T. BANISTER

BY

Nice, Skuman, Morris, Gershting
ATTORNEYS

Nov. 5, 1957

R. T. BANISTER
CENTRIFUGAL CASTING

2,811,757

Filed Jan. 11, 1956

2 Sheets-Sheet 2

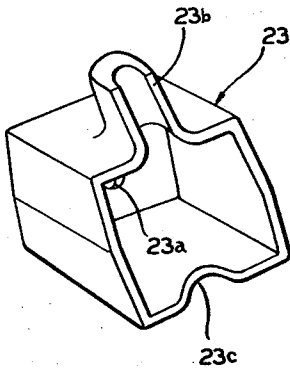


Fig. 3

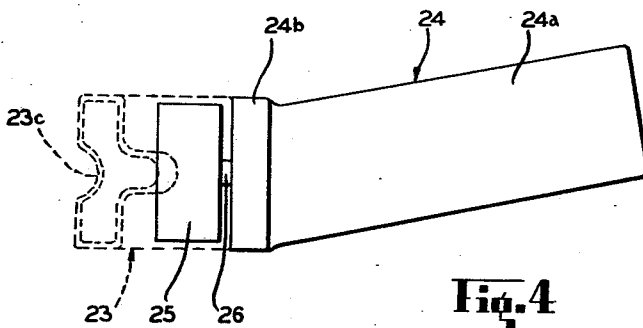


Fig. 4

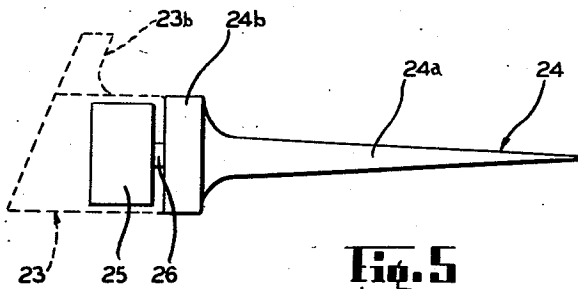


Fig. 5

INVENTOR.
ROBERT T. BANISTER

BY

Shel, Sherman, Morris, Good & Singer
ATTORNEYS

1

2,811,757

CENTRIFUGAL CASTING

Robert T. Banister, Chester, Ohio, assignor to Thompson Products, Inc., Cleveland, Ohio, a corporation of Ohio

Application January 11, 1956, Serial No. 558,433

4 Claims. (Cl. 22—65)

The present invention is concerned with improvements in methods for casting articles, and to an improved apparatus used in carrying out the methods.

The present invention finds particular applicability to the casting of metals which are highly reactive in their molten state. Titanium and alloys containing appreciable amounts of titanium are good examples of such metals. Titanium, as a pure metal or as an alloying element is difficult to handle because of the ease with which the metal reacts not only with oxygen but with gases such as nitrogen and hydrogen to form compounds which adversely affect the characteristics of the casting. Because of this high degree of reactivity, it is necessary when melting titanium and the like to operate in an atmosphere which excludes the reactive gases. Hence, it is common practice in casting highly reactive metals of this type to conduct the casting under vacuum conditions, or in the presence of an inert gas such as argon, helium, or the like.

The problem incident to producing castings under these conditions are quite numerous. For one, the pour time required to fill a multiplicity of molds is usually excessive, particularly when the casting is done under vacuum conditions which require manipulation of molds, etc. by remote control. The molten metal has a tendency to undergo changes in temperature during such a prolonged casting period so that the castings do not have the uniform structure desired.

Another problem is the space required for a multiplicity of molds which in many cases would require a melting and casting chamber of impractical size. Furthermore, the mechanical problem of distributing the metal by normal techniques to such a multiplicity of molds inside an enclosed chamber is difficult.

With the foregoing in mind, an object of the present invention is to provide an improved casting method which is particularly applicable to the production of castings of highly reactive molten metals.

Another object of the invention is to provide a method for centrifugally casting molten metal into superimposed molding cavities supplied from a single central source.

Still another object of the invention is to provide a centrifugal casting apparatus which automatically feeds a plurality of molds and completely discharges the molten metal so that the castings are not connected by runners.

Still another object of the invention is to provide an improved apparatus for casting metals in which the amount of excess casting metal is held to a minimum.

Another object of the invention is to provide an improved casting apparatus of the centrifugal type which includes means for metering the flow of molten metal into the molding cavities.

In the casting assembly of the present invention, the molding members preferably take the form of pairs of cooperating disks, each pair when placed in axial alignment serving to define at least one molding cavity between the pair of disks. Obviously, other types of mechanical arrangements such as pairs of cooperating blocks or one-piece molds of the precision casting type may be em-

2

ployed as well. The arrangement within the molding assembly is such that when a number of pairs of the molding members are arranged in alignment, there is provided a central cavity into which the molten mixture or molten metal is poured, the cavity being in communication with the molding cavities contained in the molding members. One of the features of the present invention resides in the provision of a tapering or sloping wall adjoining the central recess, whereby the molten metal, under the influence of centrifugal force will rise and successively fill the molding cavities beginning at the bottom of the assembly and extending to the uppermost molding member.

As another feature of the invention, there is provided a readily frangible insert which is positioned at the inlet to the molding cavity and serves to direct the molten metal centrally of the molding cavity and also channels the molten metal into the next higher molding cavity after its own molding cavity has been filled. The insert also provides a convenient means for removing excess metal or gates from the casting, as will be apparent from the succeeding description.

Further objects and features of the present invention will be apparent to those skilled in the art from the following description of the attached sheets of drawings which illustrates a preferred embodiment thereof.

In the drawings:

Figure 1 is a vertical cross-sectional view, partly illustrating the molding assembly of the present invention, the view being taken substantially along the line 1—1 of Figure 2;

Figure 2 is a cross-sectional view taken substantially along the line 2—2 of Figure 1;

Figure 3 is a view in perspective of an insert and runner to provide a gate for limiting the area of the connection between the gate metal and the cast device;

Figure 4 is a plan view of the finished casting, illustrating by means of dotted lines, the manner in which the insert is received about the casting; and

Figure 5 is a view in elevation of the assembly illustrated in Figure 4.

The particular assembly illustrated in the drawings is arranged to produce castings suitable for the manufacture of turbine blades, but it will be recognized that the invention herein described is equally applicable to any type of cast article.

In Figure 1, reference numeral 10 indicates generally a centrifugal casting machine embodying the principles of the present invention and including a solid base plate 11 mechanically coupled to a shaft 12 which, in turn, is connected to a suitable driving means such as a motor (not shown). A pair of oppositely disposed clamps 13 are secured to the base plate 11 through a pair of hinges 14, as best seen in Figure 1. The clamps 13 have inwardly turned end portions 13a through which are received a pair of bolts 14 for clamping the molding units together in stacked relationship.

The base plate 11 is recessed to receive a refractory disk 15 having a tapered peripheral edge 15a tightly received within the recess provided within the base plate 11. The disk 15 has a centrally located well 15b which is arranged to receive the molten metal and to deliver the same to a plurality of radially disposed runners 15c. A cover ring 20 is disposed over the disk 15 and has a central aperture 20a overlying the well 15b. As shown in Figures 1 and 2, the outer diameter of cover ring 20 is considerably less than the length of the runners 15c so that molten metal is free to flow upwardly from the outer ends of the runners 15c, upwardly past the peripheral edge of the cover ring 20 and into the molding units.

The molding units themselves may consist of pairs of cooperating metal, ceramic or carbon disk-like members

3

generally indicated at numerals 16, 17, and 18 in Figure 1. The molding members 16 through 18 consist of a co-operating pair of disks including a lower disk 16a and an upper disk 16b forming the molding member 16 and the correspondingly numbered disks forming the molding members 17 and 18 respectively.

The disks making up each of the molding units are suitably recessed to provide a plurality of molding cavities about the periphery of the disks when the disks are in axial alignment. The cavities occurring in the molding member 16 are labeled 16c, those for the molding members 17 labeled 17c, and those for the molding member 18 being labeled 18c.

When the molding members 16 through 18 are stacked in vertical alignment, i. e., with their axes coinciding, they serve to define a central recess 21 into which the molten material is received during casting. The well 15b serves as a reservoir for molten metal poured into the mold.

A top plate 19 having a central aperture 19a is positioned above the stacked array of the molding members and is pressed by the bolts 14 to hold the molding members 16 through 18 in tight engagement.

One of the features of the present invention resides in the provision of a sloping wall portion 22 provided by the inner annular walls of the molding members 16 through 18 when the latter are in alignment. As seen in Figure 1, the sloping inner wall 22 is substantially an inverted frusto-conical section having its major axis at the top of the assembly and the minor axis at the base.

In order to distribute the casting material properly within the various cavities, and for other reasons, each of the molding cavities may be provided at its inlet with a readily frangible refractory insert 23 composed of plaster of Paris or similar material. As best seen in Figure 3, each insert 23 has a base wall including a central aperture 23a which provides an orifice for the flow of the casting material into the center of the associated molding cavity. A runner 23b extends from one side wall of the insert 23, and the opposed side wall is relieved as indicated at 23c to receive the runner 23b of an adjoining insert (see Figure 1).

As the molten material is introduced into the molding units by centrifugal action, it is injected into each of the molding cavities through the orifice provided by the aperture 23a. A stream of the molten metal is thus injected substantially at the center of each molding cavity, resulting in a better filling of the mold than would occur in the absence of the restriction afforded by the aperture 23a.

When the molten casting material is introduced into the central cavity 21, and the entire casting assembly is rotated at a sufficiently high velocity, the molten material will be distributed by centrifugal force along the runners 15c and then upwardly into the confining runners 23b. Initially, the well 15b will become filled with the molten material almost immediately after the introduction of the casting material into the central recess 21. As the casting material flows into the runners 23b, it is resisted by forces which can be resolved into a horizontal component opposing the centrifugal force acting upon the molten material, and a vertical component tending to raise the liquid material against the action of gravity. If the speed of rotation is sufficiently high, this vertical component will permit the molten material to overcome the force due to gravity and will cause the molten material to rise along the runners 23b and successively fill the cavities 17c and 18c which are in open communication with the runners 15c. Since the runners 23b are composed of a refractory material, substantial chilling of the metal is avoided, as might occur with heat conductive molds. In addition, the refractory runners 23b provide a head of metal which remains liquid longer than the metal in the mold cavity. This head or reservoir of liquid metal feeds the casting as it solidifies and shrinks volumetrically, so that internal shrinkage is avoided.

4

The rough turbine blade castings are identified by numeral 24 in the drawings. As best seen in Figures 2, 4, and 5, the casting 24 includes a tapering, narrow vane portion 24a and a relatively massive root 24b. After removal of the readily frangible insert 23, as by shattering the same, there remains a solidified residue 25 which is connected to the root 24b by small diameter neck portion 26 resulting from metal solidified within the aperture 23a of the insert. After removal of the insert 23, it is a simple matter to trim the casting 24 to size by simply breaking or sawing off the residue 25 from the remainder of the castings at the small diameter neck portion 26.

The assembly described is particularly adaptable to operation under vacuum conditions in sealed containers. The pour time involved in filling the cavity is extremely short so that there is little possibility of changing the composition of the casting material during pouring. In addition, there is very little excess metal solidified during casting, and substantially no sprue is produced in the central cavity.

In the operation of the assembly, the various molding units 16 through 18 are assembled in stacked relation, and the shaft 12 is rotated at the appropriate velocity. The casting metal is then introduced into the well 15b where centrifugal force propels the metal along the runners 15c, and into the molding cavity 16c. When additional metal is introduced into the well 15b, the configuration of the sloping side wall 22 and the runners 23b and the speed of rotation urges the body of metal upwardly along the side wall 22, so that the metal is then injected into the second molding unit 17 and so on until all of the molding cavities are filled. When the casting is completed, and the metal solidified, the molding units are removed from the casting machine individually. The frangible inserts 23 are then broken off and the casting is trimmed by severing the casting from the residual metal along the restricted neck portion 26.

It will be evident that various modifications can be made to the described embodiment without departing from the scope of the present invention.

I claim as my invention:

1. A centrifugal casting mold assembly which comprises a base having a central recess, a refractory disk in said recess, wall means in said disk defining both a central well and blind ended open-topped runner passages radiating from said well, a ring covering said disk having a central aperture aligned with the well and an outer periphery inwardly from the outer ends of the runner passages, a stack of molds on the base defining a central pour hole bottomed by the ring, said molds having mold cavities communicating with the pour hole at a plurality of levels, means providing upstanding gate passages at spaced intervals around the pour hole each communicating with a runner passage beyond the ring and with mold cavities at different levels, and said pour hole increasing in diameter upwardly from said ring whereby introduction of molten casting material into the pour hole and rotation of the mold assembly will cause the metal to flow from the central well through the runners upwardly through the gate passages and into the mold cavities.

2. A mold assembly which comprises mold means defining a central pour hole and a plurality of mold cavities communicating with said pour hole at different levels, means at the bottom of said pour hole defining a well communicating with the pour hole, a plurality of runners extending from said well, and gate passages in direct fluid communication with said runners and angularly upwardly therefrom along the sides of the pour hole means providing a plurality of superimposed mold cavities, and means communicating said gate passages with said mold cavities, whereby rotation of the mold assembly and introduction of molten casting material into the pour hole will cause the material to flow from the well through

5

the runners and upwardly through the gate passages into the mold cavities.

3. A mold assembly which comprises a stack of molds defining a central pour hole and a plurality of mold cavities at different levels communicating with said pour hole, means providing a central well at the bottom of the pour hole and a plurality of runners extending from said well having top wall means separating the runners from the pour hole, stacked refractory cups embedded in the sides of the pour hole at spaced intervals and registering with mold cavities at the different levels in the mold assembly, and each stack of cups communicating with a runner whereby molten casting material poured into the pour hole will be deposited in the well and will flow therefrom under the influence of centrifugal force through the runners and upwardly through the cups into the mold cavities.

4. A centrifugal mold assembly comprising a plurality of pairs of disk type molds in stacked relation, the inner peripheral edges of said molds defining an outwardly and upwardly extending surface of revolution, means at the base of said assembly providing a reservoir for molten material introduced into the said assembly, runner means extending radially from said reservoir arranged to deliver molten material from said reservoir to said surface, a plurality of aligned frangible inserts received within said surface and having liquid directing portions arranged to in-

6

roduce molten material within the molding cavities of said molds and other liquid directing portions arranged to deliver liquid upwardly into the next succeeding insert, the lowermost of said inserts being in fluid communication with said runner means, and means for rotating said mold assembly.

References Cited in the file of this patent

UNITED STATES PATENTS

900,970	Washburn	Oct. 13, 1908
969,015	Washburn	Aug. 30, 1910
1,300,732	GutmueUler	Apr. 15, 1919
1,385,201	Chapple	July 19, 1921
1,403,347	Rockwell	Jan. 10, 1922
1,425,927	Wolf	Aug. 15, 1922
1,993,655	Floyd	Mar. 5, 1935
2,001,583	Poe	May 14, 1935
2,378,042	Sorensen et al.	June 12, 1945
2,385,631	Levinson	Sept. 25, 1945
2,450,755	Higgins	Oct. 5, 1948
2,638,646	Rubissow	May 19, 1953
2,662,347	Giffen	Dec. 15, 1953
2,671,932	Pique	Mar. 16, 1954

FOREIGN PATENTS

579,097	Great Britain	July 23, 1946
---------	---------------	---------------