This invention relates to unitary precision casting molds and to a method of making the same. More particularly, this invention relates to a unitary precision casting mold formed by means of a pattern of the casting, or several patterns thereof, from a fusible or combustible substance such as wax or a synthetic resin.

The pattern is affixed to a sprue or pouring gate so that the pattern is protected from the high temperatures used to bake the mold, and a dry pulverulent substance having a large active surface serving as a carrier for the inorganic bonding agent.

Prior processes, particularly where an intricate shape of a casting is to be made, do not come up to the imposed requirements. The backing up compositions used in these prior processes are unable to completely fill up recesses and back-sloping areas of the surfaces of the pattern coatings with the result that the pattern coatings are not adequately supported by the backing up compositions.

One known method for the production of unitary precision casting molds consists of forming a pattern of the casting, or several patterns thereof, from a fusible or combustible substance such as wax or a synthetic resin. The pattern is affixed to a sprue or pouring gate so that the pattern is protected from the high temperatures used to bake the mold, and a dry pulverulent substance having a large active surface serving as a carrier for the inorganic bonding agent.

The greater flowability of the dry backing up composition also enables one to pack a larger number of patterns into a single molder's flask at the same time. Dry out of the finished mold also becomes entirely superfluous, and the formation of fissures or cracks, such as that which occurs when a thickly fluid backing up compound is dried, are prevented. The elimination of such a drying-out treatment and the withdrawal of the granular refractory material or sand from the cooled molder's flask likewise advantageously affect the economics of the casting process.

For a more detailed description of the invention, reference may be had to the accompanying drawing, in which:

Fig. 1 is a side elevation of a hollow cylindrical article with a flat bottom to be cast.

Fig. 2 is a schematic view of the destroyable pattern assembly.

Fig. 3 is a vertical section through a coated pattern in a molder's flask.

Fig. 4 is a vertical section of the fired mold ready for casting.

Fig. 5 is a top view of a hollow cylindrical article with a flat bottom to be cast.

Fig. 1 shows an article 10 to be cast which is a flat bottomed hollow cylindrical article. The wax patterns 11 are made of the article 10 according to the usual foundry practices taking into account the shrinkage of the metal to be cast. The wax patterns are made of a suitable die. In place of wax various thermoplastic resins, which may be destroyed in the mold, such as polystyrol, may be used. The wax patterns are cold-set and stripped from the dies, and assembled together conveniently for casting. The patterns are jointed on a wax feeder 13 by momentarily molding them at a point of contact with a heated instrument.

Fig. 2 shows a wax pattern assembly with patterns 11, ingate 12, and feeders 13. The ingates and feeders may also be composed of wax or a destroyable synthetic resin.
The pattern assembly as shown in Fig. 2 is ready for coating by immersing or spraying with a mixture consisting of a solid filler material and a suitable liquid binder. The binder serves to provide a close refractory film and the refractory filler material should have the property of forming a very smooth and refractory surface in contact with the wax pattern so that the cast article will be as smooth as possible.

The pattern assembly is then placed on a molten sand base plate 14 provided with a hole or perforation 15 as shown in Figs. 2 and 3. A cylindrical flask 16 is then lowered over the whole pattern assembly and the joint between base plate 14 and the flask 16 sealed with wax or by any other suitable sealing composition. A quick setting refractory mixture is then poured into the flask thus formed and permitted to stand until the mixture has sufficiently solidified to form a plate 19. Thereafter the dry, pourable backing material is filled into the flask.

The backing material consists of a refractory composition, a binder, or bonding agent, and a carrier for the bonding agent. The refractory material may consist of a granular material such as molding sand or quartz. The binder is a material composed of a dry, finely ground powder at room temperature which becomes an effective bonding agent at the temperatures used to bake the mold. The carrier for the bonding agent is a pulverulent substance having a large active surface and which will readily absorb the inorganic bonding agent. Advantageously, the pulverulent carrier substance is impregnated with a solution of the bonding agent or with a fluid medium containing the bonding agent in a finely divided solid form and subsequently dried. The dried pulverulent mass is then mixed with the refractory component of the investment composition. An advantage of using such a carrier for the bonding agent is that it brings a very large total surface area of the granular refractory molding compound into contact with the bonding agent adhering to the surface or pores of the pulverulent carrier. The pattern assembly provided with the thin non-self-supporting coating is then completely embedded in the backing material 18. The whole assembly is then placed on a vibration table, and vibrated sufficiently to insure that all surfaces of the coated pattern assembly are backed by the backing material. Thereafter a coating 20 is formed by pouring the same refractory mixture as used for the plate 19 on to the surface of the backing material.

In the next operation, the assembly shown in Fig. 3 is transferred into a furnace and fired by heating at a temperature of approximately 800-900° C. for 6-8 hours. This firing treatment causes the pattern material and the sprue material to melt. The wax or synthetic resin will partly flow out through the hole or perforation 15 or be burned. On baking the mold the bonding agent imparts a uniform cohesive strength to the investment. The investment compound having thus been consolidated has the property of protecting the thin mold layer effectively against destruction by the inflowing metal.

Fig. 4 shows the fired mold ready for casting. Molten metal is poured through the ingate 21 while the mold is still hot. The melting of the mold transforms the backing material into a refractory body 22 to which the coating 17 adheres.

Various granular, dry, refractory materials such as molding sands or quartz may be utilized as the refractory constituent of the backing composition without departing from the scope of the present invention. The utilization of the dry pourable backing composition of the present invention entails a particularly careful bonding of the granular, refractory constituents of the backing up composition which on baking the mold imparts cohesive strength to the investment composition. Bonding agents employed for the aforesaid purposes are those inorganic compounds which bring about a bonding action during the baking of the mold and which have a high adhesivity or a great capacity of sticking to the granular refractory compound of the backing up composition. Particularly suitable are gel-like inorganic compounds which are fusible at temperatures above 600° C. and preferable between 800 and 1000° C. The backing up composition, having been bonded, is adapted to protect the thin mold layer reliably against destruction by the inflowing molten metal.

Some examples of suitable inorganic bonding compounds are liquid dispersions of gelatinous bonding agents such as complex aluminum pyrophosphates, alkali-metal zirconates, alkali-metal titanates, titanic acids, zirconic acids, or oxychlorides such as magnesium oxychlorides. These compounds are distinguished in that at room temperature they exhibit a gel-like structure in a dry condition. Other examples are solutions of borates, such as borax dissolved in water, phosphoric acid and boric acid. Solutions of phosphates such as primary sodium phosphate may also be used.

Various carriers for the inorganic bonding agents may be used in accordance with the present invention. Some examples of carriers which have large active surfaces and exhibit a high adhesivity or capacity of absorbing the inorganic bonding agents due to their porous constitution and their highly particulate surface are infusorial earth, magnesium silicates such as diatoms and asbestos. Other substances have a large active surface and the above properties may also be used as a carrier in accordance with the present invention. The above named compositions, however, have been found to be particularly advantageous in the present invention.

When larger size patterns are to be invested or baked it is also advantageous to admix with the backing up composition comprising a dry, pulverulent, refractory material, an inorganic bonding agent effective at temperatures above 600° C. and a carrier for the inorganic bonding agent, a second bonding agent dry at room temperature and becoming an effective bonding agent at temperatures below the baking temperatures of the mold, or below 600° C. Examples of such bonding agents are finely ground synthetic resins, such as silicone resins, which become an effective bonding agent at a moderately high temperature. This second bonding agent may be used when the rigidity of the raw unbaked molds do not resist the vibrations occurring during their transportation.

Example

A plurality of wax patterns of a small flat bottomed hollow cylindrical article were assembled together with a sprue in the form of a tree-like structure which serve as a positive pattern for the production of the casting mold. The sprue was similarly made of wax. The composite tree-like pattern thus constructed was then dipped into a liquid mold forming composition of a mixture prepared from finely comminuted quartz and partly hydrolized ethyl silicate dissolved in alcohol as is well known in the art. The thin non-self-supporting film deposited on the pattern was about 0.5-1 mm in thickness. This coating was then dried and the pattern placed with the sprue downward upon a plate perforated for the subsequent discharge of the molten wax pattern. A cylindrical molder's flask made of heat-resisting sheet metal was then placed over the entire coated pattern and the joint between the pattern and the plate was protected with a paste of waterproof wax. A small amount of a liquid mixture of quartz sand and water glass to which an acid, such as hydrochloric acid, had been added for the purpose of accelerating the hydrolysis, was then added to the flask. This fluid mixture was permitted to stand until solidified to form a covering plate surrounding the sides and the upper part of the mold. The mold was then filled up with a dry, pourable backing up composition which was prepared as follows: 600 grams of primary sodium phosphate was dissolved in 2
2,875,485

liters of water and the solution added to 2.4 kg. of com-

minuted infusorial earth. Infusorial earth consists of the

minute fragments of the shells of siliceous algae (di-

atomae). It is characterized by a very large active sur-

face. The mixture of primary sodium phosphate and

infusorial earth was thoroughly kneaded and dried over-

night at about 120° C. The dried composition was then

ground and particles above 40 microns removed there-

from by means of a fine mesh screen. 6 parts by weight

of the pulverulent substance thus obtained were mixed

with 94 parts by weight of quartz sand having a particle

size between 0.5 and 1.0 mm., and the whole throroughly

commingled in a rotary drum. This dry, pourable back-

ing up composition thus obtained, containing an inorganic

bonding agent, was packed into the molder's flask and

firmly settled therein on a shaking table. The top face

of the molder's flask was then covered with a slurry-like

mixture of quartz sand and water glass, to which an acid

had been added to accelerate the hydrolys is, to form a

second cover plate the same as that formed above. After

the cover had hardened the molder's flask was transferred

into a baking furnace and gradually raised to a baking

temperature of 900° C. During a period of 6-8 hours.

During the baking operation the sodium phosphate de-

posited upon the infusorial earth fuses in that state

exerts the desired bonding action on the investment com-

position. If the wax pattern is to be recovered, the mold

prior to being baked, is transferred into a drying oven

in which the wax is caused to run out and to a slightly raised

temperature. Immediately upon removal of the mold-

er's flask from the baking furnace, liquid metal was

poured in the mold. After cooling the mold, the two

covers were broken up and the waste mold forming com-

position knocked out of the molder's flask. The castings

may be readily taken out of the backing up composition

and freed from any mold forming composition still ad-

hering thereto in any conventional manner. The fin-

ished castings exhibited a perfectly smooth surface free

from blemishes and form a particularly true replica of

the pattern parts.

In case of larger size molds, it is advantageous to use

armoring members for the purpose of strengthening the

investment compound. Casting molds produced in ac-

cordance with the process of the invention are adapted

for static castings as well as for making castings on a

centrifugal casting machine.

I claim:

1. The method of making a unitary precision casting

mold by means of a pattern destroyable in the mold

which comprises coating the pattern with at least one

mold forming layer having the form of a thin non-self-

supporting coating, placing the pattern in a mold's

flask, backing up the coated pattern with an investment

composition comprising a dry pourable composition con-

taining a granular, refractory, molding composition, an

inorganic bonding agent, and a carrier which is a mem-

ber selected from the group consisting of infusorial earth,

magnesium silicate, meerschaum, pumice, and asbestos

impregnated with the bonding agent comprising a dry,

pulverulent composition having a large active and porous

surface and a high capacity for absorbing inorganic bond-

ing agents, the particle size of said refractory composi-

tion being substantially larger than the particle size of

said impregnated carrier, and heating the mold to the

baking temperature of the mold to destroy the mold pat-

tern and to permit adherence of the pattern coating to

the backing up composition, said carrier impregnated

with said inorganic bonding agent being dry and pul-

verulent at room temperature and said bonding agent

becoming an effective bonding agent at the temperature

used to bake the mold.

2. The method of claim 1 in which the carrier is im-

pregnated with a composition selected from a member of

the group consisting of phosphates, phosphoric acid,

borates, boric acid, complex aluminum pyrophosphates,

zirconic acid, alkali-metal zirconates, titanic acid, and

alkali-metal titanates.

3. An investment back up composition for unitary pre-

cision casting molds in which the mold pattern is defined

by at least one mold forming layer in the form of a thin

non-self-supporting coating and in which the molds are

formed by baking the coated pattern and back up com-

position comprising a dry, pulverulent, pourable com-

position containing a granular, refractory, molding com-

position and a carrier which is a member selected from

the group consisting of infusorial earth, magnesium sil-

cate, meerschaum, pumice, and asbestos impregnated

with an inorganic bonding agent, said carrier comprising

a dry, pulverulent composition having a large active and

porous surface and a high capacity for absorbing in-

organic bonding agents, and said bonding agent being

dry and pulverulent at room temperature and becoming

an effective bonding agent at the temperature used to

bake the mold, said back up composition comprising

between about 85 to 96 parts by weight of refractory ma-

terial, between about 3 to 10 parts by weight carrier, and

between about 1 to 5 parts by weight of inorganic binder

on a dry basis.

4. The investment, back up composition of claim 3 in

which the carrier composition is impregnated with a

composition selected from the group consisting of phos-

phates, borates, phosphoric acid, complex aluminum

pyrophosphates, zirconic acid, alkali-metal zirconates,
titanic acid, and alkali-metal titanates.

References Cited in the file of this patent

UNITED STATES PATENTS

2,027,932 Ray ------------------ Jan. 14, 1936
2,388,299 Thielemann ------------ Nov. 6, 1945
2,441,693 Pengin et al. --------- May 18, 1948
2,521,614 Valyi ---------------- Sept. 5, 1950
2,682,692 Kohl ----------------- July 6, 1954
2,720,687 Shaw ------------------ Oct. 18, 1955
2,736,077 Bartlett ------------- Feb. 28, 1956

FOREIGN PATENTS

585,665 Great Britain ---------- Feb. 18, 1947
703,607 Great Britain ---------- Feb. 3, 1954