May 26, 1931. A. KEUP 1,807,536

PROCESS FOR CENTRIFUGAL CASTING

Filed March 14, 1929

Fig. 1

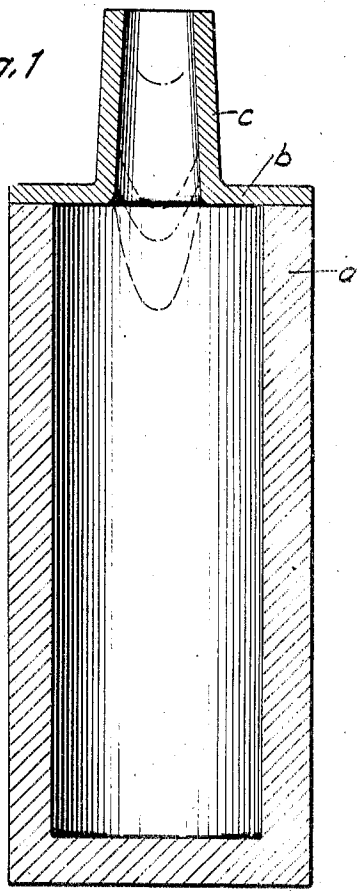
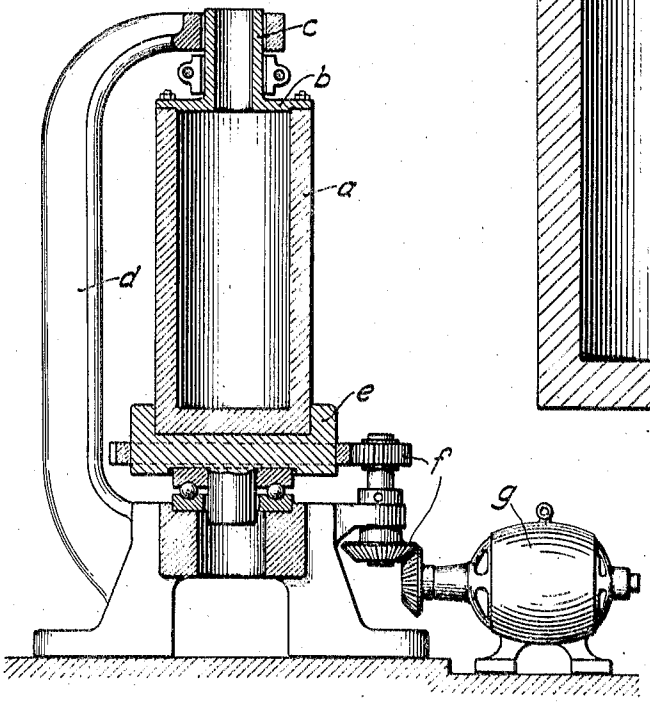


Fig. 2



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UNITED STATES PATENT OFFICE

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PROCESS FOR CENTRIFUGAL CASTING

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My invention relates to centrifugal casting, particularly the casting of iron and steel, and is applicable to the casting of either solid or cylindrical blocks.

One form of the invention is illustrated by way of example in the accompanying drawings, wherein—

Figure 1 is a vertical mid-section through the mold which is used,

Fig. 2 is an elevation partly in section of a complete apparatus for casting in accordance with the invention.

Heretofore solid ingots have been cast by pouring metal into a mold which is at rest. Various defects in this method of casting are well-known in the art. This method of casting in a stationary mold permits all the slag-like and other impurities, which are distributed throughout the metal, to remain imprisoned therein. Pipes, blow-holes, and flaws are formed during solidification, which result in considerable loss in both quality and quantity of metal. Thus there is a high percentage of defects, and the cost of manufacture is therefore great.

The present method avoids these disadvantages by pouring the ingot in a vertically-placed mold which rotates during casting. Rotation of the mold causes a violent outward movement of the metal away from the axis of rotation, and solidification of the liquid metal takes place under the influence of centrifugal force. During this action the lighter substances contained in the liquid metal, including non-metallic and gaseous components which are deleterious to quality, are separated out of the metal with which they are mixed or are shifted to a position where they may be readily removed. Centrifugal force causes the outward movement of the heavy metal to be cast and consequently the lighter substances, including non-metallic and gaseous impurities which are contained in the liquid metal, move inwardly and are separated out of the primary metal. This action gives the gases opportunity to escape and permits the other impurities to be gradually floated upward into the so-called lost head as the central surface of the liquid metal rises.

In carrying out the present invention, it is preferred to start the pouring when the mold is turning slowly and to maintain a steady stream of metal into the mold. As the pouring proceeds the speed of rotation is gradually increased to a maximum which depends, of course, on the dimensions of the ingot being cast. I may bring the speed of rotation to a maximum after the metal has risen along the walls of the mold to its cover. Owing to the rotation and the action of centrifugal force, there is formed in the molten metal in the mold a centrally-disposed hollow space which extends downwardly in the form of a paraboloid from the upper surface of the metal. Slag, impurities, and gases work inwardly and upwardly through the molten metal into this paraboloid. As the pouring and the rotation proceed this paraboloid rises so that the ingot is cast gradually and is completed from below upward. This rise permits the apex of the paraboloid to be brought wholly up out of the limits of the finished ingot; that is to say, up into the so-called lost head. Thus all of the impurities are brought out of that portion of the ingot which is destined to be worked.

In the drawings there is shown, by way of illustration, a mold *a* which is adapted for use in carrying out the invention. Upon the mold *a* there is fitted a cover *b* having a central tubular extension *c* thereon, preferably with a tapered opening. A frame *d* is provided for rotatably mounting the mold. Suitably mounted in the frame *d* is a revoluble chuck *e* into which the base of the mold fits and with which the mold rotates. Suitable gearing is provided on the chuck *e* for meshing with gear unit *f*, which in turn is driven by a motor *g*. Thus when the motor *g* operates the chuck *e*, is rotated, and with it the mold *a*, which is held at all times in a vertical position.

The form of cover *b* may, of course be varied as desired, as it is not necessary that there be a sudden break between the large diameter of the mold and the smaller diameter of the tubular extension *c*. Contrary to present practice in using covers for metallic molds, the cover *b* is preferably of the same

metal as that of the mold and need not be warmed up prior to casting. However, the cover *c* may be of refractory material in accordance with present practice.

Successive positions of the paraboloid, which has been referred to above, are indicated by broken lines in Figure 1. Thus the tubular extension *c* upon the cover *b* permits the gradual removal of the impurities contained in the metal as the pouring progresses. This is accompanied by a decrease in the paraboloid cavity.

In casting hollow ingots the procedure is varied somewhat.

According to known practice in casting hollow ingots by the centrifugal method, after pouring the metal into a mold which is held in the vertical position, the rotating mold is brought to a horizontal position and a considerable increase is given to the speed of rotation. By turning the mold into the horizontal position it has been attempted to produce under the increased speed, a hollow ingot having walls which are as uniform as possible. However, this method has never been able to secure a foothold in practice because it is too complicated and difficult in operation. It is expensive and requires an excessively expensive plant. The method has also remained without practical significance because the products have not been satisfactory. Probably nowhere today are hollow ingots being cast by this method.

The present invention avoids the above mentioned disadvantages and produces an ingot having a thoroughly dense and flaw free texture. It is, therefore, preeminently suited to the manufacture of the highest quality of hollow ingots.

According to the present invention, the liquid metal is poured from a ladle into a vertically-positioned rotating mold. The mold is first rotated at a very moderate speed. As the liquid metal is added, the speed of rotation is steadily increased, care being taken that the speed and volume of metal poured into the mold are maintained at such a ratio that the metal does not rise along the inner wall of the mold in so thin a sheet that it solidifies too soon. If the speed of rotation is increased too rapidly, certain defects in the product will result: cracks and scale form which greatly diminish, or even prevent the further utilization of the hollow ingot. Thus it is best to adjust the rate of pouring and speed of rotation to give sufficient time for the impurities and gases to escape through the liquid metal to the inner wall of the casting.

In the present invention there is employed, of course, the known method of warming the mold, but this alone is far from sufficient to eliminate the defects which have been mentioned, as experiments have shown.

During pouring the speed of rotation is maintained at a point where the wall thickness of the ingot is such that the lighter impurities, such as slag and gases, will not be caught and imprisoned by too rapid freezing of the metal, but will be given time to be pushed toward the inner wall of the casting by the force of the heavier metal which is being urged outward by centrifugal force. It may be further noted that the progressive freezing of the metallic mass from the outer surface inward promotes the movement of these impurities through the still fluid metal nearer the inner surface of the casting. Experiments have also developed the fact that the gases escape from the metal more rapidly and completely in a vertically-positioned mold than in molds which are positioned horizontally as in the past. In the latter case the greater specific gravity of the metal cannot react to separate the impurities to the same extent as is possible in an upright mold. Hollow ingots produced according to the present invention show a wholly dense metallic structure.

Where actual slight variations in wall thickness are found they may be easily rendered harmless by appropriate further treatment. However, such variations are not to be expected and are slight wherever they occur. The present process yields in particular a supremely dense material, so that objects made therefrom will satisfy the strictest requirements as to quality.

It may be further mentioned that as soon as the impurities in the metal have ceased separating out and the metal has cooled to a certain degree of rigidity, the cooling may be hastened by introducing into the central hollow of the ingot a fluid, that is to say a liquid or gaseous cooling material. This shortens the time during which the ingot must remain in the mold, and the apparatus is made sooner available for the next pouring.

With the understanding that the specific constructions illustrated and the description here given are presented merely by way of illustration,

I claim:

1. In a process for producing metal ingots in a centrifugal mold the steps of pouring the metal into a vertically-placed mold while the mold is being slowly rotated, and gradually increasing the speed of rotation during the pouring without decreasing the speed of rotation until the casting is made.

2. In a process for producing metal ingots by centrifugal casting, the steps of pouring the metal into a vertically-placed mold while the mold is being slowly rotated, gradually increasing the speed of rotation during pouring, and proportioning the rate of pouring and speed of rotation to maintain such a ratio that the metal does not rise along the wall of the mold to form a quickly solidified sheet.

3. In a process for producing metal ingots in a centrifugal mold, the steps of pouring the metal into a vertically-placed mold while the mold is being slowly rotated, gradually increasing the speed of rotation during pouring, adjusting the rate of pouring and speed of rotation to give sufficient time for the impurities and gases to escape through the liquid metal to the inner wall of the casting, and accelerating cooling of the resulting ingot by introducing a fluid cooling medium into its hollow portion.

4. In a process for producing metal ingots in a centrifugal mold, having a cover, the steps of pouring the metal into a vertically-placed mold while the mold is being slowly rotated, gradually increasing the speed of rotation during the pouring, bringing the speed of rotation to a maximum after the metal has risen along the walls of the mold to its cover, and accelerating cooling of the resulting ingot by introducing a fluid cooling medium into its hollow portion.

5. In a process for producing metal ingots by centrifugal casting, the steps of slowly rotating an empty mold on a vertical axis, pouring molten metal into the slowly rotating mold, gradually increasing the speed of rotation until the metal has risen along the walls of the mold to a point adjacent its top, and continuing the pouring with a steady maximum speed of rotation until the ingot is cast.

In testimony whereof I have signed my name to this specification.

ALBERT KEUP.