MEANS FOR LIFTING GREEN CERAMIC CASTINGS

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This invention relates generally to the art of handling hollow, unfired ceramic shapes and is particularly concerned with new apparatus and a new method for removing green, slip clay castings from molds.

Hollow green ceramic shapes, for example, castings made in water-absorbent molds from clay slip, have very little tensile strength. When such castings are closed at one end and the mold when the casting is moved out of the mold. The effect of this vacuum is to increase the force required to overcome the force of gravity acting on the casting. This force and the force of gravity may exceed the tensile strength of the casting, particularly where the walls of the casting are thin and the weight of the casting is large. Hence, the removal of such hollow shapes from molds presents a serious problem, particularly in the making of large castings, such as tanks for water closets, deep bowls and the like.

The present invention aims to avoid breakage of such castings during their removal from the molds and attains that objective by providing a new combination of elements, some of which are new, and a new method, for moving such castings upwardly out of their molds.

The present invention will be better understood by those skilled in the art from the present disclosure including the drawings, in which:

FIG. 1 is a side elevational view, partly in section, of one form of apparatus embodying the present invention;

FIG. 2 is a fragmentary, end elevational view of the apparatus of FIG. 1;

FIG. 3 is a transverse sectional view showing a mold and a casting with casting-removing apparatus embodying the present invention disposed in the casting;

FIG. 4 is a fragmentary enlarged view of part of the apparatus of FIG. 3;

FIG. 5 is a perspective view, with parts broken away, of the lifting apparatus shown in FIGS. 1 to 4;

FIG. 6 is a top plan view, partly in section, of the apparatus of FIGS. 3 to 5; and

FIG. 7 is an enlarged side elevational view, partly in section, of the apparatus of FIG. 6.

In FIGS. 1 and 2, carriage 1 is mounted for travel on wheels 2 on a trackway 3 in a mold room. A table 5 is provided with wheels 6 at its ends to run on tracks at the ends of carriage 1. The table is a little wider than the base of the molds 18, which are disposed on it, and is approximately half as wide as the carriage 1 so that the table can be moved back and forth on the carriage 1 to an extent approximately equal to the width of the table.

Similar molds 10, in this instance six, are mounted on table 5. These molds may be fixed in position on table 5 in any suitable manner but the means shown in FIG. 2 includes rods 11 which have hooks at their lower ends to engage the underside of the table 5 and nuts at their upper ends to bear on the top of plates 12 which rest on the tops of the molds and through which the rods extend. Each plate 12 engages two adjacent molds and one or more rods 11 extend down from each plate between adjacent molds. This mold-fixing means retains the molds in place on the table 5 at all times and effectively prevents lifting of the molds when the castings are being lifted out of the molds.

At a predetermined position along the track 3 traversed by carriage 1 is disposed means for removing clay slip castings from molds on the table 5. While various types of apparatus might be used for this purpose, a satisfactory form of apparatus embodying the present invention is shown in FIGS. 1 and 2 with special parts of the apparatus being shown in greater detail in the remaining figures.

This casting-removing apparatus includes a trackway consisting of rails 15 suitably supported by structural members including uprights 16 and horizontal beams 17. Only one set of these members 16 and 17 is shown but it will be understood that similar assemblies are used at various places to afford adequate support to rails 15.

A car 20 is supported above members 17 by axles 21 and wheels 22 which run on rails 15.

A vertical post 25 depends from car 20 and is braced against displacement from its vertical position by rods 26. An arm 27 is mounted for vertical movement along post 25. As will be noted, the post 25 is in the form of an I-beam with a web of considerable width and with flanges extending at right angles therefrom. The arm 27 is approximately as wide as the post and is provided with two pairs of large rollers 28 to run on the flanges of the post which are remote from the mold side of the post and with two pairs of smaller rollers 29 which roll on the edge of the mold side of the post. The arm 27 projects horizontally from post 25 and at its overhung end has affixed thereto the cable 35 of an electric hoist 36 which is suspended from car 20 as by hook 37. It will be understood that when the motor of hoist 36 is actuated, the arm may be moved vertically along post 25, the rollers 28 and 29 assuring that the arm 27 will remain in substantially horizontal position and yet will move freely up and down on the post between its upper position indicated by dot and dash lines, and its lower position indicated by full lines on FIG. 1.

The arm 27, at its overhung end, has suspended therefrom apparatus which carries the casting-removing mechanism. While various types of apparatus might be used for this purpose, FIGS. 1, 2 and 5 show one form of apparatus which has been found to be quite satisfactory.

This apparatus of FIGS. 1, 2, and 5 comprises a rectangular frame composed of horizontal side bars 40, parallel rods 42 which extend downwardly therefrom and, at their lower ends, carry plates 45, each of which has two pairs of rollers 46 spaced apart sufficiently to engage the opposite vertical edges of two flat plates 47 which project upwardly from carriage 1. These plates 47 are thin and, hence, may be spread apart by plate 45 when the latter are lowered between the oppositely diverging upper edges 48 of these plates. It will be understood that an assemblage of the rods 42, plates 45, rollers 46 and plates 47 at each end of the side bars 40 will act as guides in accurately positioned the framework comprising bars 40 and 41 relative to the molds on table 5.

The casting-removing apparatus includes devices for insertion into each of the castings in the several molds on table 5, these devices being shown in general in FIGS. 1 and 2 but in more detail in FIGS. 3 to 7, inclusive. Since these devices are all in use in construction, a description of one will suffice for all.

In certain respects, each of these devices resembles the lungs and trachea of a human being in that it includes two opposed bodies or lungs which can expand and contract and in a tube between and connected to each lung for conducting air into and out of the lungs. This slight similarity makes it possible to describe these devices by applying familiar anatomical terms to certain parts of these mechanical devices.

Each of the casting removing devices includes a trachea 50 having bronchi 51 connected thereto and connected
at their remote ends to lungs 52, and supporting members 49 depending from cross bars 41 and attached to the bronchial 51. Since these members 49 may not be required when the casting is light in weight they may be omitted. In that event the tracheas may be made rigid and attached to cross bar 41 and will function not only to conduct air to and from the lungs but also to carry the lungs and a casting.

Each hollow body or lung consists of a relatively rigid member 54 and a flexible member 53. The former member includes a C-shaped part which forms the top, bottom and rear walls 55, 56 and 57, respectively, of the lung, round posts 60 which are connected to the top and bottom walls 55 and 56 near their free edges to afford rigidity to the C-shaped part and angles 61, 62 and 63 which are secured to the walls 55, 56 and 57, respectively. Each tube 51 projects through back wall 57 of its lung and is secured thereto and to a brace 65 which is disposed on the underside of tube 51 and is attached to the inner side of wall 57. The parts of the rigid member 52 may be made of thin sheet aluminum or other similar weight material.

The bronchial tubes 51, are, preferably, one integral tube and serve not only to conduct air between the tracheas 50 and the lungs but also as a compression member which prevents the lungs from moving toward one another when the flexible walls of each lung are pressed against the adjacent walls of the casting. In other words, the flexible walls of each pair of lungs are simultaneously flexed outwardly by air pressure applied to the tracheas and the tube 51 prevents movement of the lungs toward each other when the flexed walls are pressed against the casting. Thus, the lungs 52 and tubes 51 function as a rigid unit having flexible walls at its outer extremities and enclosing a single air chamber.

The flexible member 53 consists of a sheet 64 and strips 66. The sheet 64 is attached at its edges, as by means of glue or any other suitable adhesive, to angles 61, 62 and 63 and together with the rigid member 52 defines a chamber into which air may enter from tube 51. Each sheet 64 is provided with a plurality of horizontally narrow, vertically long friction strips 66 (FIGS. 5-7) secured on its outer surface in any suitable manner, for example by an adhesive or by bonding.

These strips are composed of non-stretchable material, such as a fabric, preferably linen, and have friction creating outer surfaces which, may be formed by impregnating the fabric with a suitable resin containing hard small particles which will provide a rough surface, such as Carborundum. Thus, these strips are substantially non-stretchable lengthwise and yet may be flexed into and out of contact with the inner surfaces of a green casting in the mold when in contact with the casting the roughened surface is pressed, or prickingly-embossed, into the surface of the casting far enough to cause a frictional engagement therewith. The sheet 64 may be made of compounded natural rubber, synthetic rubber or any other material which is flexible, capable of stretching to a small extent and is impervious to air under low pressure.

Each lung has a resilient foot 78 attached to the bottom wall 56 and extending down to the lower edges of angles 62 and 63. This foot will rest on the inner surface of the casting and space the rigid parts of the lung from the inner surface of the casting.

One lung of each pair is, preferably, provided with a bleed-off valve 75 and either lung of the pair may be provided with a pressure gauge 76.

**Operation**

The operation of the above described apparatus is substantially as follows:

After ceramic castings 80 (FIGS. 1 and 3) have been formed in molds 10 and the cores having been removed, the carriage 1 is brought into position relative to the casting-removing apparatus, substantially as shown in FIGS. 1 and 2. The hoist 36 is actuated to permit the arm 27 to move downwardly on post 25 from the dot and dash position shown in FIG. 2, and to bring the plates 43 into position between the upper ends of plates 47 at the ends of the carriage 1. When these plates 45 so engage between plates 47, and the rollers 46 engage the edges of plates 45, further downward movement of the arm 27 and parts carried thereby bring the several lungs of FIGS. 3, 7, inclusive, into the castings in the several molds on the 50. Depending on this actuation the flexible sheets 64 will be in approximately the position shown in FIG. 7 and the strips 66 will be out of contact with the inner surfaces of the casting.

It will be understood that each casting removing device is dimensioned to leave a small clearance between it and the inner surface of the casting it is to remove.

Since the flexible sheet 64 is attached, while taut, to three sides of the rigid member 54, that sheet will normally occupy a retracted position when the air in the lung is at atmospheric pressure. In this condition, the several lungs can be moved downwardly into their castings without engaging the inner surfaces of the latter. Preferably, the closures are kept from engaging the bottom wall of the casting as by feet 78.

When the lungs are in the proper position in the castings, fluid under pressure, for example air, is brought into the interior of the lungs through pipes 50 and 51 and, as a result, sheets 64 will move outwardly and strips 66 will move outwardly toward the dot and dash line positions shown in FIGS. 3, 4 and 7 and are brought into engagement throughout most of their length with the inner surfaces of the casting. The vertical length of the strips 66 and the roughness of their surfaces are such that the lifting apparatus will overcome the force of gravity exerted on the castings and the vacuum force created between the bottoms of the castings and the opposed walls of the mold when the devices are lifted.

When the electric hoist 36 is actuated with resultant upward movement of arm 27, the green castings will be lifted out of the molds. Each casting will be lifted by the pressure applied by the flexible strips 66 on the opposed inner surfaces of the castings. After the castings have been lifted above the top ends of the molds, the car 20 may be moved along rails 15 and the castings may be deposited on a suitable conveyance (not shown). While this operation is in progress, the carriage 1 with its table 5 and molds 10 may be moved along its trackway for the performance of other operations including the making of a new set of castings in the mold.

While the pressure of fluid required in the closures will vary from casting to casting, depending on variations in the weight of the castings, an air pressure ranging between about 20 and about 24 ounces per square inch has been found to be sufficient for lifting from a mold a green clay slip casting about 8" wide, about 21" long, about 16" deep, and with walls about 5/8" thick. Such a casting weighs about 50 pounds. Those skilled in the art can readily determine from the just stated illustration the pressure required for lifting castings of other sizes out of the molds.

As FIGS. 1 and 3 show, the lungs of the casting lifting apparatus are disposed in the bottom part of the casting and exert friction against the end walls of the casting. These walls are attached to the bottom wall and to the side walls. The maximum outward pressure is exerted on these end walls in the first stage of removing the casting from the mold and is resisted by the mold. As the casting is moved upwardly, the mold no longer affords support to the end walls, and these walls are strong enough to resist breakage by the pressure in the lungs, which pressure need be only great enough to overcome the force of gravity exerted on the casting and the force required to break the contact of the casting with the mold.
The primary function of valve 75 is to cause all the strips 66 to exert substantially equal pressure on the casting while it is being moved by the lifting apparatus. A valve is preferred because it can be adjusted to bleed air out of the lungs at various rates but a hole alone will serve for a given rate.

For some reason, as yet not understood, it appears that the operation of the lifting apparatus is certain and dependable when air is bleeding out of the lungs but that when the air is not bleeding out the lifting operation is erratic. Frequently, the castings will not be lifted entirely out of the mold. Thus, it is important that the air be permitted to escape slowly from the lungs while they are carrying a casting. Of course, air under pressure is applied to the lungs at all times during the casting carrying operation.

One theory which has been advanced as a possible reason for the foregoing results is as follows: When the air is being held in the lungs and the casting is lifted out of the mold and one or both of its walls move out of supporting contact with the mold, that wall or those walls may yield outwardly under the pressure exerted by the flexible walls of the lungs. During the instant of time required for the volume of air in the lungs to increase and reestablish the original pressure of the flexible walls on the casting, the casting may slip or be dropped. When the air is bleeding out of the lungs and the casting wall yields outwardly, the amount of air escaping will instantly decrease enough to provide the necessary increase in volume. Thus, there will be no instant of time when the casting could be dropped.

Having thus described this invention in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains to make and use the same, and having set forth the best mode contemplated of carrying out this invention, I state that the subject matter which I regard as being my invention is particularly pointed out and distinctly claimed in what is claimed, it being understood that equivalents or modifications of, or substitutions for, parts of the above specifically described embodiment of the invention may be made without departing from the scope of the invention as set forth in what is claimed.

What is claimed:

1. Apparatus for use in removing from a mold an elongated, hollow ceramic casting having an inner surface, portions of which are opposed, said apparatus comprising a casting lifting device including at least one closed hollow body having rigid end walls and laterally flexible side walls for substantially conforming to the opposed portions of said inner surface of said casting, a nonextensible, laterally movable friction strip carried by said hollow body so as to overlie each said flexible side wall, and means to conduct pressure fluid into said body to flex said flexible side walls laterally and frictionally engage said strips with the opposed portions of the inner surface of said casting.

2. Apparatus for use in removing from a mold a hollow ceramic casting having an opening and opposed side portions on the inner surface, said apparatus comprising opposed hollow bodies, said opposed hollow bodies having flexible side walls to conform substantially to the opposed side portions of said casting, at least one nonextensible, laterally movable, friction strip carried by each said opposed body to overlie said flexible side walls, means to conduct pressure fluid into said bodies to flex said side walls laterally and frictionally engage the opposed side portions on the inner surface of said casting with said frictional means.

3. Apparatus as defined in claim 2, having means continuously to bleed off a portion of the fluid pressure in said bodies while said friction means are in casting lifting engagement with said casting.

4. The method of removing from a mold an elongated, hollow, green ceramic casting having an open top and an inner side surface having opposed portions comprising the steps of, inserting a lifting device into said casting, applying fluid pressure to inflate said lifting device until it prickingly engages the inner opposed portions of said casting, continuously bleeding off a portion of the inflating pressure, applying sufficient additional fluid pressure to maintain a constant inflating pressure and raising said lifting device to extract the casting from its mold.

5. Apparatus for use in removing from a mold a hollow ceramic casting having an opening and opposed side portions on the inner surface, said apparatus comprising a casting lifting device including at least one closed hollow body having flexible side walls adapted to conform substantially to said opposed side portions of said casting, nonextensible friction means connected to said hollow body, said friction means movable laterally with said flexible side walls, and means to conduct pressure fluid into said body to flex said side walls laterally and frictionally engage the opposed side portions on the inner surface of said casting with said friction means.

6. Apparatus, as defined in claim 5, having means continuously to bleed off a portion of the fluid pressure in said bodies while said friction means are in casting lifting engagement with said casting.

7. Apparatus, as defined in claim 6, in which said hollow body is divided into two opposed sections, each said section having outwardly facing flexible side walls with common means to conduct pressure thereto and means continuously to bleed off a portion of said fluid pressure.

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