

- [54] APPARATUS FOR CARRYING OUT
FULL-FORM CASTING PROCESS
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254, 255, 323, 324, 326, 349, 361, 411

[56]

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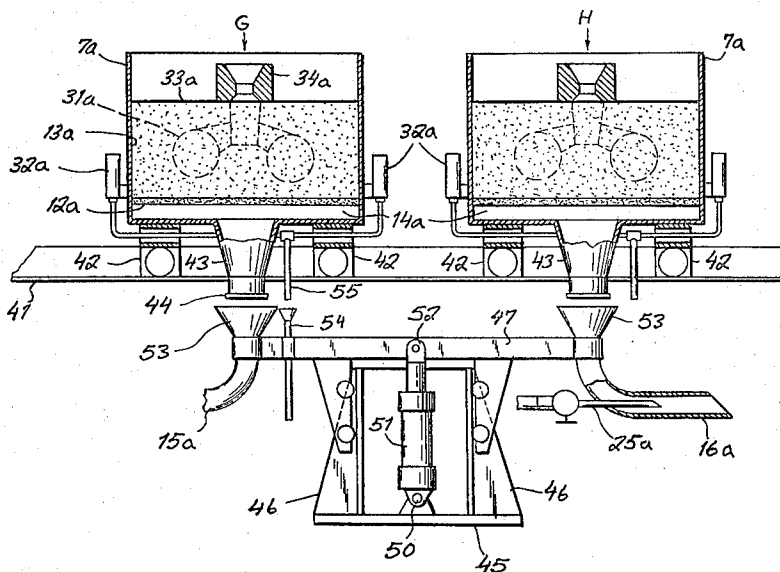
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[57]

ABSTRACT

A system for casting objects in molds with patterns which are destroyed in situ, i.e., one-piece casting, in which the mold flask, box, chest or casing is formed with a perforated support for the mold-forming material (e.g., sand) and is mounted on a turntable with other similar molds for stepping through a number of stations. The mold is provided with means for pressurizing the mold and subjecting same alternately to suction.

5 Claims, 6 Drawing Figures



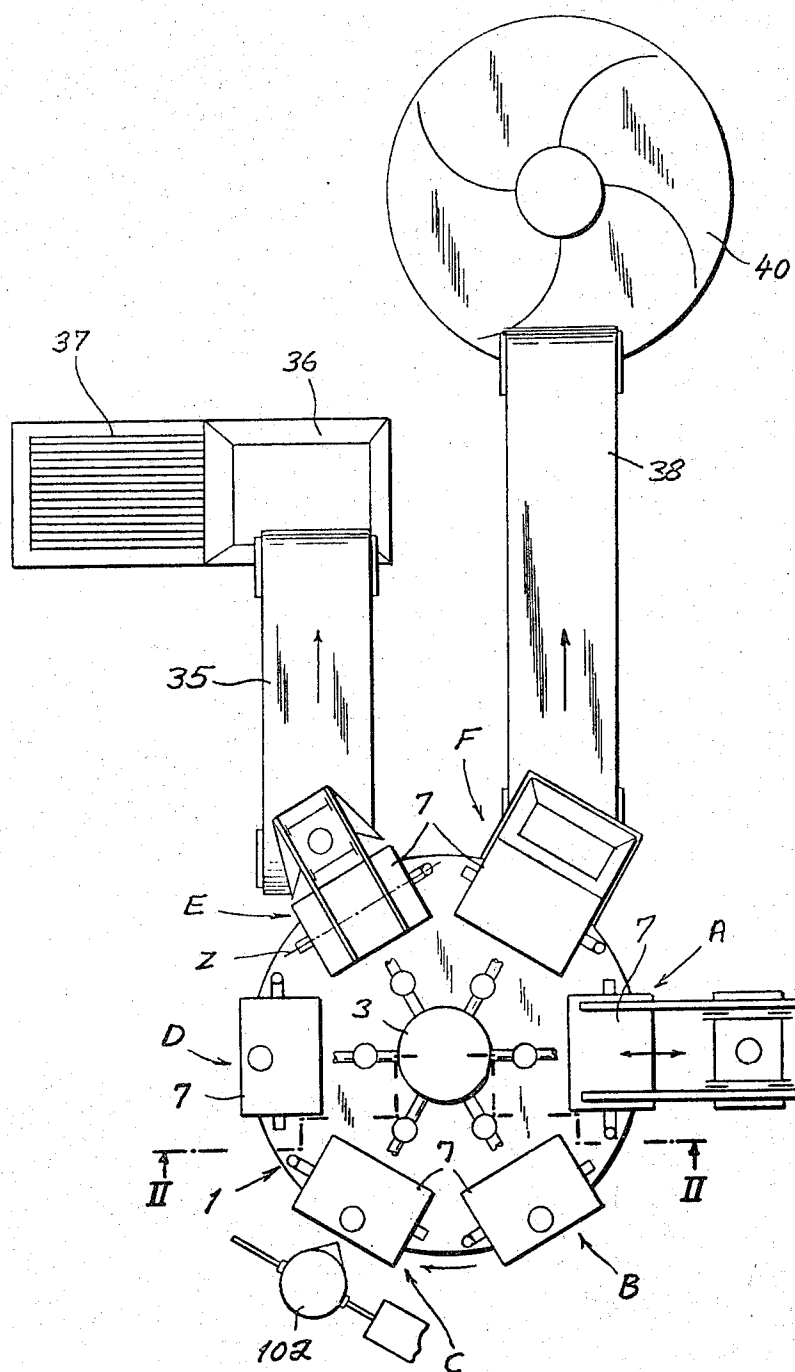
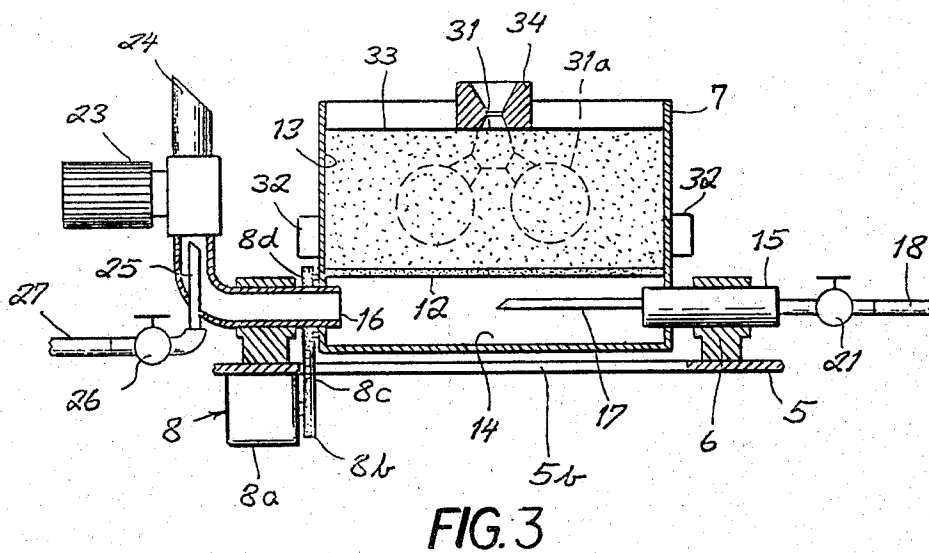
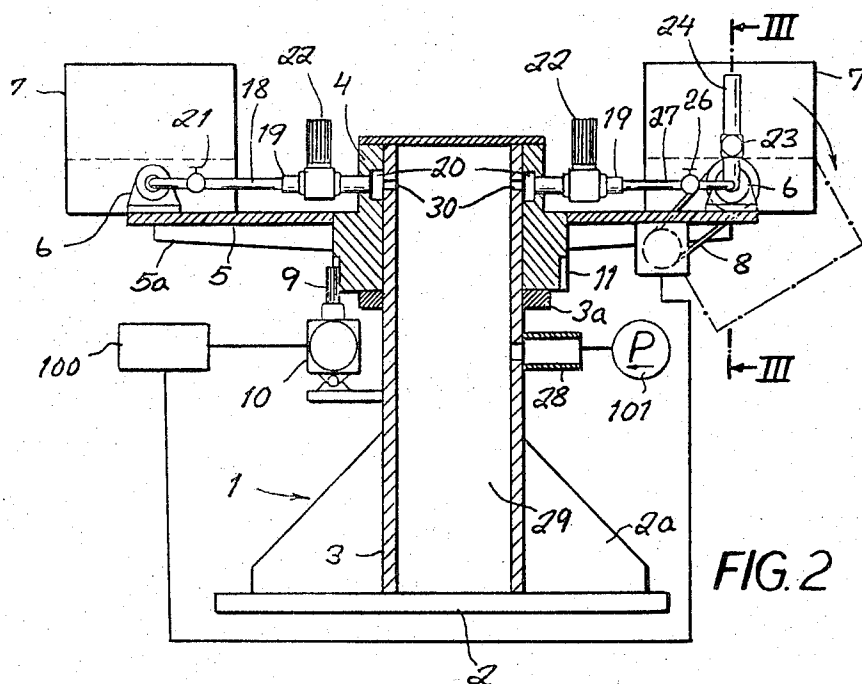
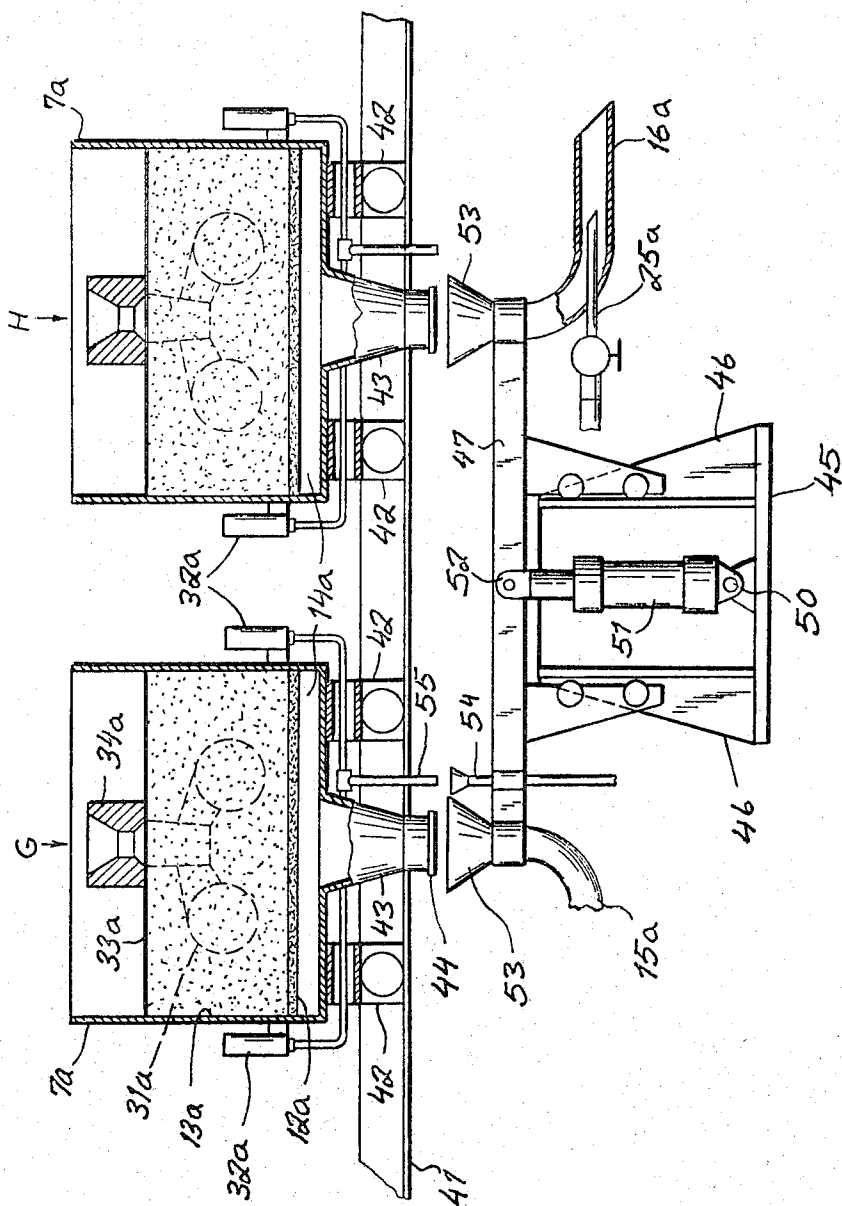


FIG. 1





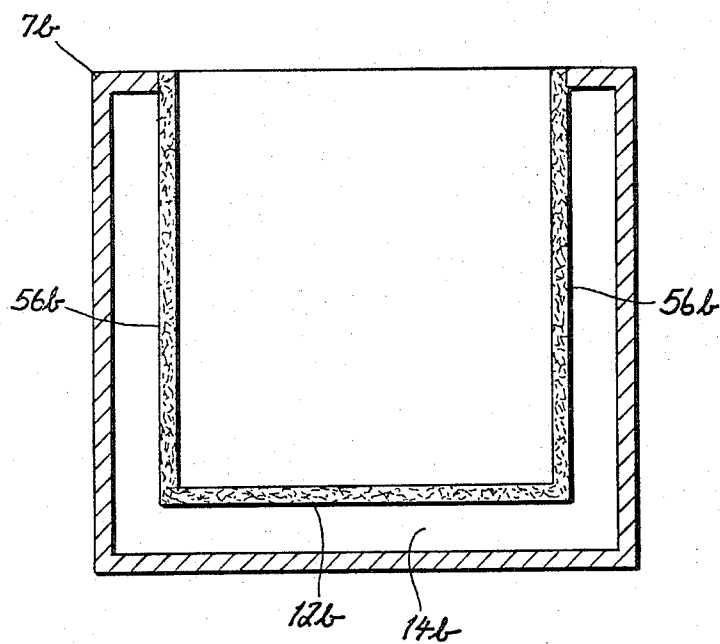


FIG. 5

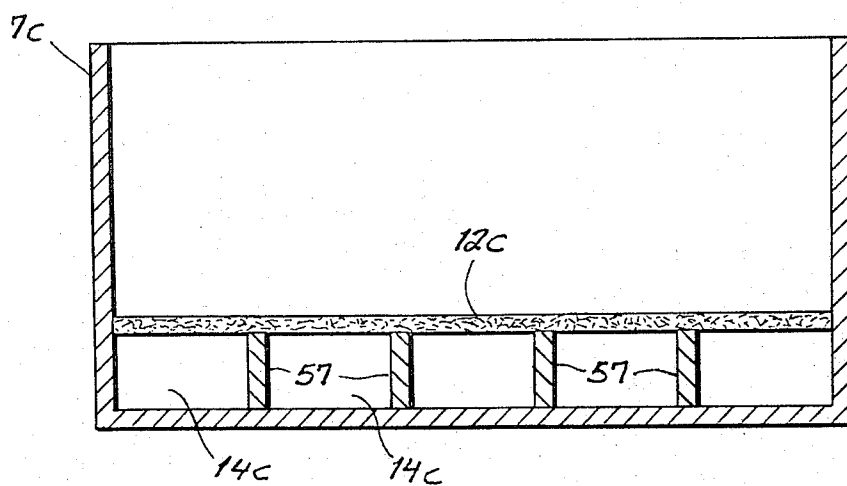


FIG. 6

APPARATUS FOR CARRYING OUT FULL-FORM CASTING PROCESS

This is a division of application Ser. No. 133,538, filed Apr. 13, 1971, now U.S. Pat. No. 3,741,281.

FIELD OF THE INVENTION

The present invention relates to a system, apparatus or device for one-piece mold casting and, more particularly, to a full-form casting device in which the pattern is destroyed in situ.

BACKGROUND OF THE INVENTION

Casting methods have developed over many centuries along several distinct lines, depending upon the nature of the mold, the relationship of the pattern to the mold, and the manner of introducing the solidifiable material into the mold. For example, sand-mold casting may be of the one-mold (one-piece flask) or multimold (multipiece-flask) type depending upon whether or not the pattern is removed. For example, in two-piece-flask sand casting, the molding sand is packed around a pattern in one mold half (cope or drag), a parting sand or other substance is applied to an interface and the second half of the mold is built thereon. When the two halves are separated, the pattern may be removed, the mold halves assembled together to define the mold cavity and the metal cast therein. A system of this type has the advantage that the pattern may be reused, the mold can have an intricate configuration and the product generally is an excellent reproduction of the pattern.

In one-piece flask molds, it is the general practice to use a pattern which is destructible in situ, generally a combustible or pyrolytical decomposable material which is disintegrated, burned or gasified during the casting step. Since the pattern does not have to be removed, sand or other mold-forming material may simply be packed around the pattern in a one-piece chest or casing. It is important in the latter case to provide evacuation to remove combustion products and it has been proposed to apply air under pressure to loosen the mass for insertion of the pattern and suction during casting to remove gases. These systems have not, however, been adaptable to serial or mass production of cast articles although such serial or mass production would represent a major advance in casting because other casting methods are not nearly as precise, efficient and capable of using substantially any matter, as sand or pattern casting.

OBJECTS OF THE INVENTION

It is the principal object of the present invention to provide an improved system for the casting of molten material, especially molten metals, in a pattern mold in which the aforescribed disadvantages are avoided.

It is another object of the invention to provide a system for the one-piece mold casting of metal bodies, using patterns which are destroyed in situ which alternates or increases the casting rate to allow the system to produce cast articles in a serial or mass-production mold.

SUMMARY OF THE INVENTION

The above objects and others which will become apparent hereinafter are attained, in accordance with the present invention which provides a casting system using, for example, flask-type or box molds and a casting

medium of the pulverulent or granular type, wherein a plurality of molds is mounted upon an endless, intermittently advanced support for movement in succession past a plurality of stations. Each of the molds is provided with means for alternatively supplying compressed air to the mold flask and for evacuating same as will be apparent hereinafter.

It has been found that, when a plurality of molds is mounted, as indicated, upon a turntable for movement through the successive stations, it is advantageous to provide one of these stations, at the starting point of the process, with means for supplying compressed air to the mold flask which is preferably provided with a gas-permeable floor upon which the form is built. In accordance with this feature of the invention, the first stage of the process includes a fluidification of the pulverulent or granular adapted to form the mold. When, for example, molten metals are to be cast in the molds, the particulate mass may consist of molding sand which is filled into the upwardly open mold flask at the first station, the sand being fluidized by the compressed air forced through the permeable floor. The latter preferably consists of a sintered-metal porous plate. During fluidization of the particulate mass, a thermally destructible pattern is introduced into the fluidized or fluent bed and is buried therein. The fluidization step facilitates introduction of the pattern, which may be composed of a foamed synthetic resin such as cellular polystyrene, and insures the elimination of cavities and the like at interfaces of the pattern with the molding medium. In a subsequent stage, the molds being advanced on the turntable, the particulate molding medium is rigidified and packed about the pattern by the application of suction or subatmospheric pressure beneath the porous floor of the mold. The use of atmospheric pressure above the pattern, therefore, facilitates the compacting of the mold material about the pattern without requiring mechanical tamping means.

Advantageously, the compacting operation is promoted by vibrating the mold or a wall thereof while the suction is applied and/or before or after application of suction. During the compacting stage or thereafter the usual sprue or vent is provided on the compacted molding medium and it has been found to be desirable to apply a fluid-impermeable surface in the form of a foil, to the upper face of the packed mass except in the region of the sprue. A casting funnel may be mounted upon the foil above the sprue to prevent extraneous flow of the molten metal.

According to yet another feature of this invention, the compressed air is supplied to the base of each mold subsequent to the solidification of the casting therein to fluidize the casting medium and facilitate removal of the casting from the mold as well as discharge of the molding sand. As noted earlier, the casting process involves the pouring of hot molten metal into the mold cavity which is formed as the metal destroys the pattern.

According to a more specific feature of the invention, each of the mold boxes is journaled between a pair of trunnions or gudgeons for tilting movement about a horizontal axis to enable the contents of the mold box to be dumped, e.g., upon a vibrating grate or sieve adapted to separate the particulate material of the casting medium from the cast body. Furthermore, the inlets and outlets for the fluid, i.e., compressed air or ex-

hausted air, preferably open into the mold body at these trunnions while the mold body is pivotable about an axis lying below the sintered porous plate. The base of the mold box, i.e., the fluid chamber below the plate, may be partitioned into a number of compartments and it has been found to be advantageous, at least in some cases, to define the mold space by gas-permeable (sintered metal) lateral walls. In this latter arrangement, the mold box is formed by a gas-impermeable casing while internal walls and a floor are provided by sintered-metal plates spaced inwardly from the casing walls, the conduits opening into the gap between the sintered porous wall and the impermeable walls. The turntable advantageously has the configuration of a horizontal plate or disk which is rotatably mounted on a vertical or upright stand and carries the trunnions about which the individual molds may be tilted, the trunnions extending generally along chords. Furthermore, each of the molds may be provided with inlet and outlet ducts which are continuously connected to an inlet conduit and an outlet conduit respectively mounted to register with the mold structures at the respective stations. Preferably, a fluid-responsive system is provided for vertically shifting these ducts which may have fittings registering with mating fittings on the conduits associated with each mold. The stand may, moreover, be hollow and constituted as a compressed air storage reservoir or tank which is connected to the compressed air source and can serve, in turn, to pressurize the mold boxes in which fluidization of the particles is desired. The openings of the mold may be blocked via suitable shutters at certain stations to prevent communication with the chamber beneath the porous plate while no shutters may be used at other stations to allow fluid communication. It has also been found to be practical to dispose the molds upon an endless band as an alternative to the turntable mentioned earlier.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will be more readily apparent from the following description reference being made to the accompanying drawing in which:

FIG. 1 is a plan view, partly in diagrammatic form, of a turntable system for producing metal castings in accordance with the invention;

FIG. 2 is a vertical cross-sectional view taken along the line II — II of FIG. 1 in slightly enlarged scale;

FIG. 3 is a vertical cross-sectional view taken along the line III — III of FIG. 2;

FIG. 4 is a longitudinal cross-sectional view through a conveyor belt apparatus according to the present invention;

FIG. 5 is a vertical section through a mold box according to another embodiment of the invention; and

FIG. 6 is a vertical section through still another mold box.

SPECIFIC DESCRIPTION

In FIGS. 1–3, there is shown a system for the casting of metal (ferrous or nonferrous metal) in a single-flask mold. The apparatus comprises a carousel or turntable represented generally at 1 and comprising a hermetically sealed tubular support 3 mounted upon a base

plate 2 and supported thereon via struts 2a (FIG. 2). A bearing ring 4 is mounted on the upright 3 for rotation therearound and is supported by a ring 3a. The bearing ring 4 carries an annular disk 5 constituting the turntable which, therefore, is cantilevered at its central support. Struts 5a enable the turntable to support the mold flasks 7, here shown to be rectangular parallelepipeds, which are mounted pivotally between respective pairs of trunnions 6, the trunnions define pivoting axes C which lie along cords of the turntable 5. Moreover, these axes are located at a point sufficiently close to the edge so as to enable the flasks 7 to tilt over through an angle in excess of 90°, preferable through an angle close to or greater than 135° (see the dot-dash lines in FIG. 2). The tilting mechanism is represented generally at 8 and comprises a motor 8a mounted along the underside of the turntable 5 and having a drive sprocket 8b connected by a chain 8c with a driven sprocket 8d mounted on the flask 7 adjacent one of the trunnions 6. Consequently, operation of the reversible motor allows the flask to tilt or revert to its original horizontal position. Six such flasks are provided upon the turntable 5 in angularly equispaced relation so that the axes C, for example, may be considered to coincide approximately with a hexagon inscribed in the circular turntable. The turntable may be cut away at 5b parallel to each axis (FIG. 3) to facilitate tilting and can, therefore, have a generally hexagonal configuration.

As best seen in FIG. 2, the turntable drive comprises an electric motor 10 fixedly mounted on the post 3 and having a pinion shaft meshing with an annular toothed ring or rack 11 to rotate the disk 5. The control system for the motor 10 is represented generally at 100 and includes a time for intermittently driving the turntable and operating the motor 8 of each flask when it is positioned at the discharge station. The successive stations are represented generally at A, B, C, D, E and F.

It will be apparent that each of the mold boxes or flasks of the present invention is of the one-piece or nonseparable type in which the mold is destroyed upon removal of the cast object and the pattern is destroyed during the casting process. As shown in FIGS. 1–3, each flask is provided with an air-permeable wall 12 over at least the floor of the mold space, the air-permeable plate being preferably formed of a sintered metal (e.g., iron). The plate 12 divides the interior of the mold box or flask 7 into a casting chamber 13 and a gas plenum 14 which communicates via suitable ducts with a suction source and a source of fluid under pressure as best seen in FIGS. 2 and 3. These ducts include an inlet duct 15 extending through the right-hand trunnion in FIG. 3 and connected via a valve 21 to a source of fluid under pressure by a flexible hose or tube 18. The mouth of the duct is formed by the tube 17 and it extends into the chamber 14 to approximately the center of the flask. The flexible tube 18 is provided with a fitting for removably connecting it to the fixed connection fitting 19 (FIG. 2) of a solenoid type (electromagnetic) valve 22. The latter communicates via a recess 20 in the bearing ring 4 with apertures 30 of the post 3. The post 3 here serves as a compressed-air storage tank or accumulator and is connected to the compressor 101 by a fitting 28. To the extent that the bearing ring 4 serves to connect the inlet ducts 15 to the compressed-air source, it is a distributing head.

On the other side of each flask 7, there is provided an outlet duct generally represented at 16 and opening

into the space 14 beneath the perforated floor 12 of the casting cavity 13. This outlet 16 is connected via an electromagnetic valve 23 to a vent tube 24 open to the atmosphere, while an injector tube 25 also opens into duct 16 in the direction of venting. A valve 26 is provided in series with tube 25 and a flexible hose 27 which is connected to the compressed-air source 3, 20, etc. as described for hose 18. It will be apparent that, in accordance with the venturi-injector principles, a high-velocity flow of fluid through duct 25 induces a pressure drop in the annular space around tube 25 and, therefore, suction at line 16.

The interior 29 of the post 3 thus serves as a compressed-air accumulator for supplying the medium for aeration of the mold or compaction thereof. Ports 30 of the post 3 register with the respective recesses 20 of molds only in positions A and E, and in all other positions, except for those requiring air flow to induce suction, the ports 30 are blocked by the ring 4. Suction is generated in station C, as will appear hereinafter.

Referring again to FIG. 1, it will be apparent that the apparatus also comprised a conveyor belt 35 for carrying away the cast article at the final station E, a vibrating pan 36 in which adhering mold sand is removed, and a table 37 upon which finishing steps are carried out. The finishing steps may include removal of sprues and the excess matter of vents and the like, descaling, cleaning, etc.

Angularly spaced from the article-processing line 35-37 is a conveyor belt 38 in which any additional casting medium (sand) is discharged, passed through a magnetic separator and delivered to a mixer in which moisture may be replenished and other components of the molding sand may be supplied so that the sand is suitable for reuse. A pair of vibrators 32 are provided on the walls of the mold to loosen or settle the mold material, as will be apparent hereinafter.

OPERATION

The turntable 5 is rotated in the clockwise sense (FIG. 1) and with the empty, upwardly open flask halted at station A, sand (molding medium) is dumped in a predetermined quantity into chamber 13. In this station, air is fed through inlet 15, 17 to chamber 14 and fluidizes the sand in chamber 13 to enable a thermally destructible pattern 31 of foam synthetic resin (foamed polystyrene) to be inserted into the fluid mass. The fluidization of the flask is carried out such that the motion of the particles is slightly turbulent and yet no substantial tendency to drive the particles out of the mold is maintained. Because of the fluidization of the molding medium, the pattern is easily seated in the mold space 13 without noticeable resistance.

At station B, the supply of compressed air is interrupted and vibrators 32 set in operation to vibrationally compact the mass around the pattern 31. An air-permeable foil, e.g., aluminum foil or a polyester film, is placed at 35 across the flask and has an aperture in the region of a casting funnel 34 which is mounted thereon. The casting funnel 34 registers with the sprue 31a of the pattern.

When the mold is advanced to station C, suction is applied beneath the wall 12 and a differential pressure is applied between the foil and the floor of the mold corresponding to the degree of pressure reduction. The higher atmospheric pressure further densifies or compacts the mold. As the fluidization pressure can be con-

trolled by valve 21, valve 26 permits control of the suction force which may be maintained during the casting step. The casting step is carried out at station C which is provided with a molten-metal ladle 102 as represented diagrammatically in FIG. 1. As the metal is cast into the funnel 34, it destroys the pattern 31 and fills the mold cavity formed by the destruction thereof. The gases evolved by the destruction of the porous polystyrene pattern are drawn off through the sand mass under suction.

At station D the cast body is permitted to cool and solidify and, upon advance of the flask to station E, the cast body may be removed from the sand mass. In this station, compressed air is again supplied to chamber 14 beneath the floor 12 to fluidize and loosen the sand to enable the casting body to be drawn out without effort. The casting flasks are displaced upon the conveyor belt 35 and are delivered to the vibrating pan 36 in which adhering sand is removed and are then treated on table 37 to remove excess metal as noted earlier. At station F, the flask 7 is tilted to dump the sand remaining in the flask on the conveyor belt 38. A magnetic separator recovers any metal from the sand, assuming that ferrous metals are cast. The recovered sand enters the mixer 40 and replenished sand may be returned by another belt (not shown) to station A.

In FIG. 4, there is shown a modified casting system utilizing the systems of the present invention. In this case, the endless transport means is a conveyor belt 41 for a number of flasks 7a of which only two have been shown in FIG. 4. Each of the flasks is mounted at 42 on a pair of pedestals and need not be tiltable on their supports since the molds are turned upside down at the discharge-end roll of the conveyor belt and returned in an inverted orientation to the starting side of the conveyor. At the starting side, of course, the flasks are turned upright once again.

The conveyor belt 41 is intermittently driven so that each flask passes through a number of stations, two of which are represented at G and H. Here again, each flask 7a is provided with an air-permeable floor 12a subdividing the flask into the casting space 13a and a plenum chamber 14a. A duct 43, provided with a seal 44 at its mouth, communicates with chamber 14a and extends downwardly from the conveyor belt. A base plate 45 carries a pair of vertical supports 46 on which a horizontal member (beam) 47 is vertically movable via antifriction rollers. A cylinder 51 is hinged at 50 to the base plate 45 and has a piston rod 52 articulated to the horizontal support beam 47 which admits of at least limited freedom of movement about an axis perpendicular to the axis of the cylinder 51. This permits self-centering of the system.

At each end of the member or beam 47, there is provided a funnel-shaped connector 53 adapted to receive the fitting 43 aligned thereabove. A compressed-air line 50a communicates with the funnel 53 at the left-hand side of FIG. 4, while another compressed-air line opens via tube 25a into the outlet 16a of the other funnel 53 for venturi-injector generator of suction. A further funnel-shaped fitting 54 is provided on the beam 47 for providing electrical or pneumatic connection to a pair of vibrators 32a disposed at opposite sides of the flask 7a. The male connector is represented at 55.

At station G, the pattern 31a is introduced into the mold space 13a of the flask 7a while compressed-air is forced upwardly through the permeable plate 12a to

fluidize the sand in the flask. Connection is made with the flasks at stations G and H when the conveyor advances the flasks by an amount equal to the distance between these stations. Cylinder 51 shifts the beam 47 upwardly until the fittings 43 engage in funnels 53 and connector 55 is received in the socket 54. Also in station G, the vibrators 32a are energized after the compressed air supply is cut off to chamber 14a to densify the casting sand. The foil 33a and funnel 34a are then placed upon the mass of sand within the flask.

During this operation, a previously prepared flask at station 4 is brought under suction and the mass densified. While suction is maintained, the casting is carried out as previously described. Other stations may be used for the refluidization of the mass, for the removal of the casting and for the preparation of a fresh flask, or these operations may be carried out sequentially at the stations illustrated.

In FIG. 5, there is shown another form of mold flask according to the invention in which the flask 7b has a relatively large height by comparison to its horizontal dimensions. In this case, it has been found to be advantageous to extend the plenum chamber 14b around the sides of the cavity of 13b. In addition to the sintered bottom plate 12b therefore, lateral plates or walls 56b are provided with a spacing from the outer walls of the flask. The flask is connected to a pressure and/or suction source as described in connection with FIGS. 1-4.

Yet another embodiment of the flask has been shown in FIG. 6 in which the flask has a large horizontal cross-section. In this case, the plenum 14c is subdivided by partitions 57 into a plurality of compartments which may be pneumatically pressurized.

Yet another embodiment of the flask has been shown in FIG. 6 in which the flask has a large horizontal cross-section. In this case, the plenum 14c is subdivided by partitions 57 into a plurality of compartments which may be pneumatically pressurized or brought under suction individually and independently. This has the advantage that, where the casting is to have a shape requiring different degrees of suction or fluidization at different points, the compartments 14c may be selectively pressurized or subjected to suction accordingly. Here again, the means shown in FIGS. 1-4 for pneu-

matically pressurizing the mold or subjecting it to suction may be used.

I claim:

1. A casting apparatus, comprising:

- a plurality of mold flasks, each provided with at least one gas-permeable wall separating a casting chamber from a plenum chamber;
- a horizontal endless conveyor band for intermittently advancing said mold flasks along a closed transport path; and

means selectively communicating with said plenum chambers of said flasks at selected stations of advance of said flasks along said path for pressurizing said flasks to fluidize a mold-forming medium therein and for subjecting said flasks to suction to compact said medium about a platen, said means selectively communicating with said plenum chamber being so constructed and arranged as to alternately subject each of said flasks to pressurization and suction as said flasks are advanced along said path, said plenum chambers being provided with gas fittings, said means selectively communicating with said plenum chambers including mating fittings adjacent said path and engageable with the fittings of plenum chambers of flasks registering therewith, said mating fittings being mounted upon a support member; and

means for shifting said support member transversely to said path.

2. The apparatus defined in claim 1 wherein said mating fittings for pressurization of a plenum chamber and application of suction to a plenum chamber are mounted upon said support member jointly and are jointly shiftable thereon.

3. The apparatus defined in claim 1 wherein each of said mold flasks is upwardly open and said wall is an air-permeable horizontal plate in each flask separating said casting chamber above said plate from said plenum chamber below said plate.

4. The apparatus defined in claim 3, further comprising partitions subdividing said plenum chamber into a plurality of individual pressurizable compartments.

5. The apparatus defined in claim 3 wherein said plate is composed of sintered metal.

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