June 15, 1965 F. H. LE JEUNE 3,188,703

APPARATUS FOR LOW PRESSURE PERMANENT MOLD CASTING

Filed Aug. 8, 1962 3 Sheets-Sheet 1

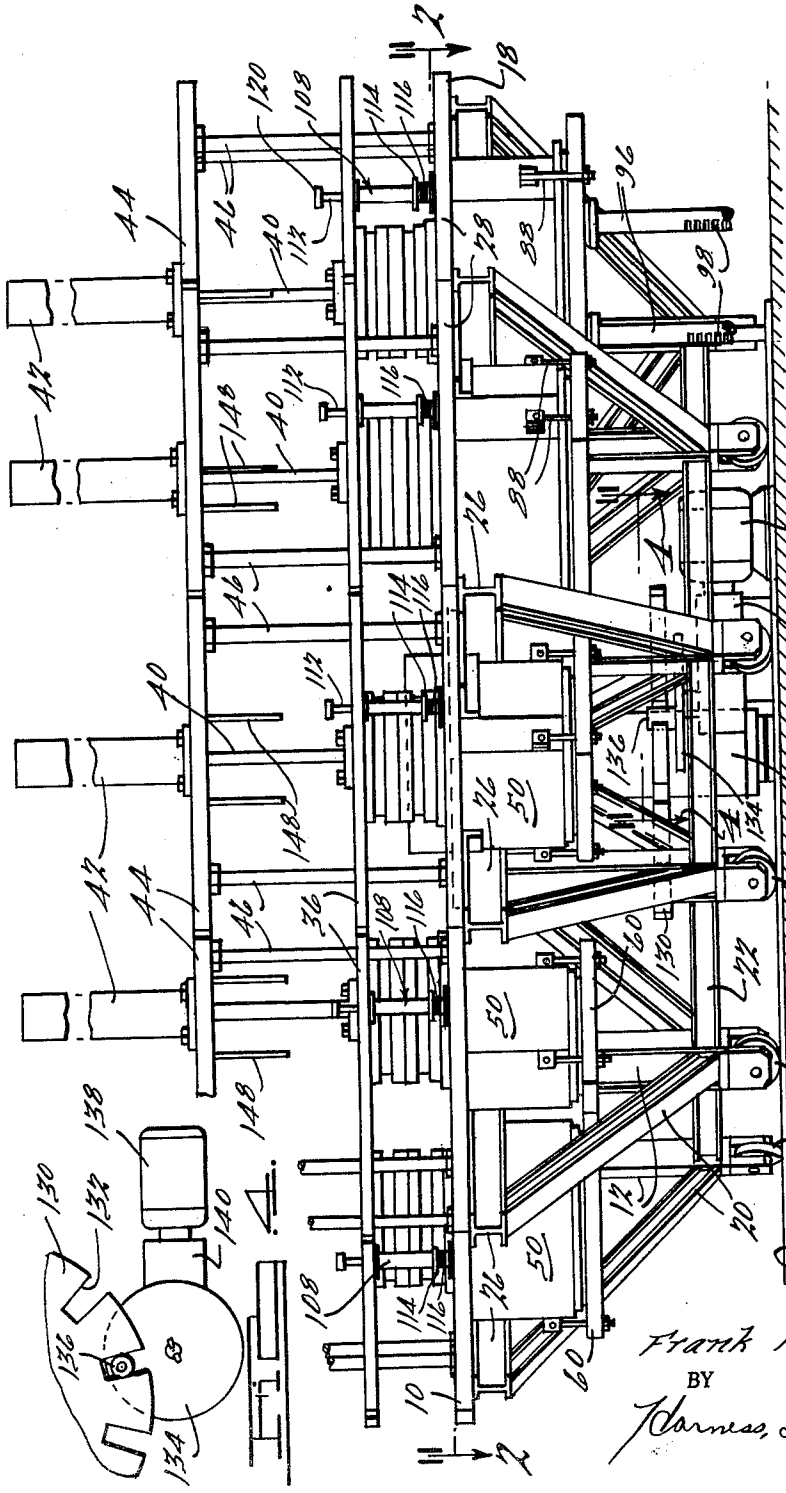


Fig. 1.

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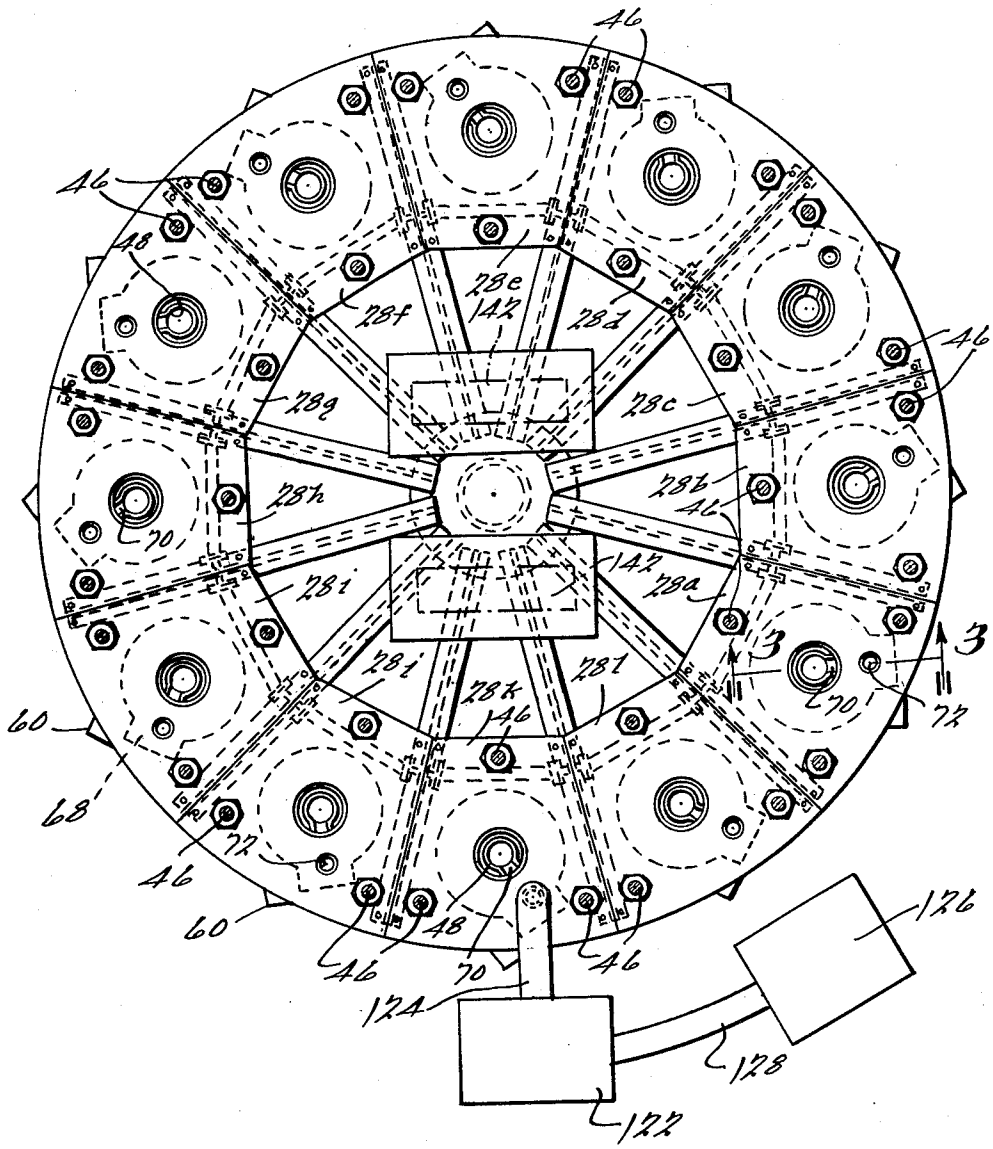


Fig. 2.

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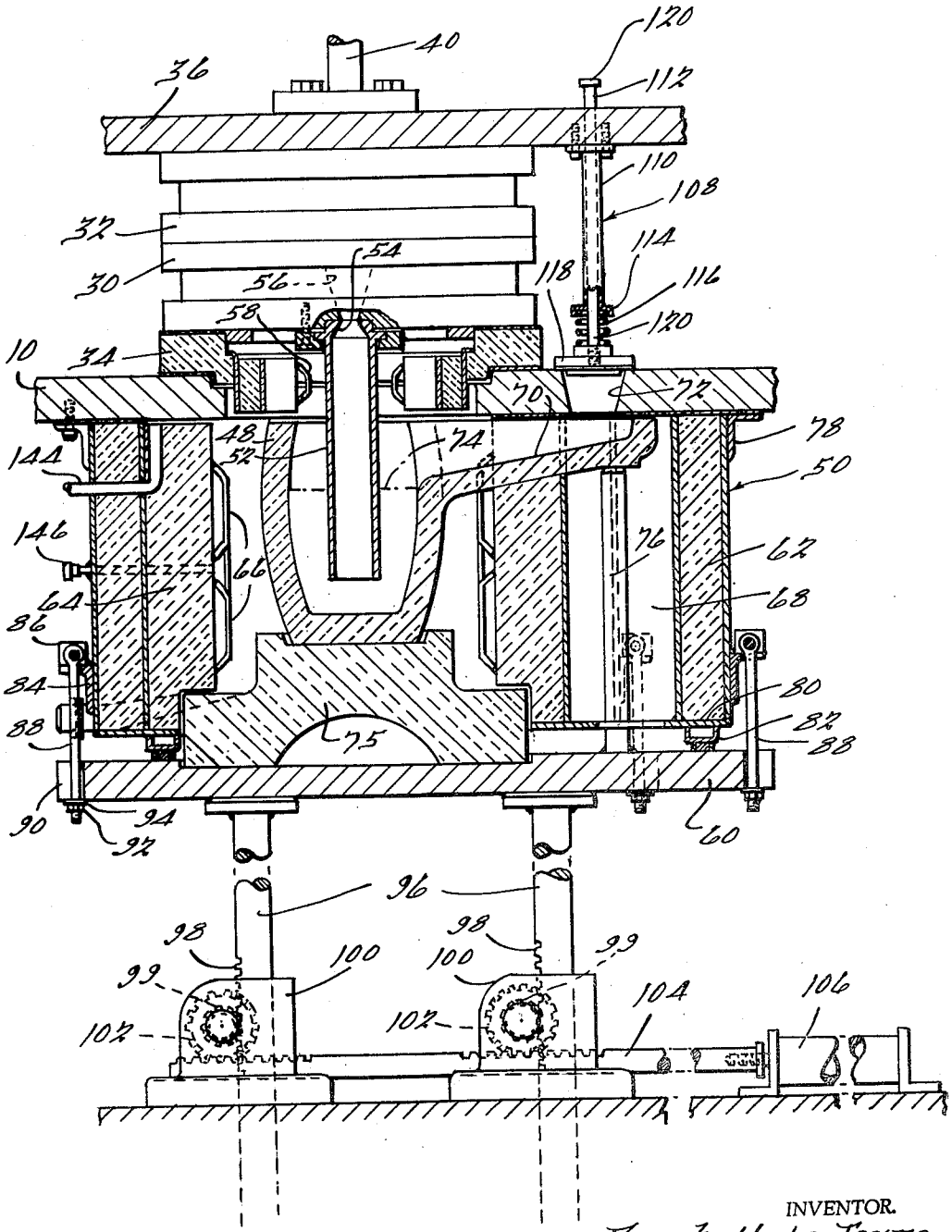


FIG. 3.

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APPARATUS FOR LOW PRESSURE PERMANENT MOLD CASTING

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This invention relates to apparatus for casting metals by the low pressure process and particularly to an index machine supporting a plurality of permanent molds in which metal is cast by the low pressure process.

It is an object of the present invention to provide apparatus for casting metal in permanent molds by the low pressure process at relatively high production rates.

It is another object of the present invention to provide an index molding machine supporting a plurality of paired crucibles and molds, wherein means are provided for successively filling the crucibles, pneumatically sealing the furnaces in which the crucibles are located, feeding metal from the crucibles into the molds by air pressure and removing the cast parts from the molds.

It is another object of the present invention to provide apparatus of the above character having means for conveniently opening up the furnaces in which the crucibles are located for the purpose of performing maintenance on the crucibles or the heating elements within the furnaces.

It is still another object of the present invention to provide a machine of the above character in which the molten metal within the crucibles and the stalks leading from the crucibles to the molds is kept in a molten condition and at a relatively constant temperature and in which scum and other contaminant matter floating on the surface of the metal in the crucibles is not introduced into the molds.

It is still another object of the present invention to provide apparatus of the above character which is of rugged, sturdy construction, which may be relatively inexpensively fabricated for the volume of its productive capacity and which may be used for the mass production of castings by the low pressure permanent mold system in a highly convenient and inexpensive manner.

These and other objects of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a perspective view, with parts broken away, of apparatus embodying the principles of the present invention;

FIG. 2 is a reduced scale sectional view of the structure illustrated in FIG. 1, taken along the line 2—2 thereof;

FIG. 3 is an enlarged sectional view of the structure illustrated in FIG. 2, taken along the line 3—3 thereof; and

FIG. 4 is a sectional view of a portion of the structure illustrated in FIG. 1, taken along the line 4—4 thereof.

Referring now to the drawings, the apparatus of the present invention will be seen to include a large circular table or platform **10** having a plurality of depending legs **12** provided with rollers or wheels **14** at the ends thereof. The wheels **14** roll in a common circle over the surface of a floor **16** as the table **10** is rotated about its central vertical axis. The legs **12** are spaced radially inwardly from the outer periphery **18** of the table, while braces **20** extend from the lower ends of the legs **12** to the table outer periphery **18**. A plurality of cross members **22** interconnect the legs **12** to form the legs **12** and the table **10** into a rigid unitized structure. A central column **24**, connected to the table **10**, is journaled in the floor at its lower end to establish the axis of rotation of the table **10**. The table **10** includes a plurality of angularly spaced radially extending beams **26** secured to the column **24** at

their inner ends. An annular supporting surface is formed on the table **10** by a plurality of segmentally sector-shaped plates **28** resting on the beams **26** in side-by-side relation.

Each of the plates **28** defines a separate work station, as indicated at **28***a*, **28***b*, **28***c*, **28***d*, **28***e*, **28***f*, **28***g*, **28***h*, **28***i*, **28***j*, **28***k* and **28***l*. A pair of cooperating mold halves **30** and **32** are positioned at each of the work stations. The lower mold half **30** is supported on the adjacent plate **28** with an annular insulating pad **34** disposed therebetween. The upper mold half **32** is secured to a vertically movable plate **36** having a bracket **38** by which it is attached to a piston rod **40**. The piston rod **40** of each work station extends from and is operated by a hydraulic cylinder **42**. A separate cylinder **42** is provided for each work station and each cylinder **42** is carried on a separate support member **44** fastened to the upper ends of three spaced vertical rods **46**. The rods **46** pass through the plate **36** and form ways for guiding the vertical travel of the plate **36**, thus assuring the proper alignment of the upper mold half **32** with the lower mold half **30**. The upper mold half **32** is thereby adapted to be raised and lowered by its associated cylinder **42** for the purpose of opening the cavity defined by the mold halves **30** and **32** to remove a part cast therein.

As may be seen in FIG. 3, a separate crucible **48** is supported beneath each of the mold halves **30** adjacent the underside of the associated plate **28**. Each crucible **48** is supported by and enclosed within its own thermally and pneumatically sealable enclosure or furnace, generally indicated at **50**. Depending from each of the bottom mold halves **30** is a hollow tubular stalk **52**, which extends into the subjacent crucible **48**. The interior of the upper end of the stalk **52** is tapered inwardly, as indicated at **54**. The stalk end **54** is in direct communication with the interior of its mold half **30** and particularly with a portion of the mold half **30** defining a sprue cavity **56**. As may be seen in FIG. 3, a heating coil **58** is supported by the annular pad **34** in a position closely spaced around the upper end of the stalk **52** to maintain metal within the stalk in a molten condition.

As further illustrated in FIG. 3, each of the furnaces **50** includes a bottom wall member **60** and an annular enclosing side wall **62**. The major portion of the side wall **62** is provided with a ceramic lining **64** for heat insulating purposes. In addition, the lining **64** serves to support heating coils **66**. As is indicated in FIG. 3, each of the furnaces **50** has an offset portion **68** which accommodates a spillway or mouth **70** of the crucible **48**. The spillway **70** is positioned immediately beneath an inlet opening **72** formed in the adjacent plate **28**. Thus, molten metal poured through the opening **72** will fall onto the spillway **70** and run downwardly into the crucible **48**. The height to which the crucible is normally filled is indicated by the line **74** and it will thus be seen that this level is substantially above the lower end of the stalk **52**.

The crucible **48** is relatively fragile and must be properly supported. For this purpose, a base **75**, resting on the bottom wall **60**, supports the bottom of the crucible. In addition, a supporting member **76** supports the spillway **70** of the crucible. As may be seen in FIG. 3, an annular bracket **78** of angle iron material is welded to the outer surface of the enclosing side wall **62** and is bolted to the underside of the table **10**. The annular furnace side wall **62** is formed with a metal bottom plate **80** to which is secured a continuous seal **82** adapted to sealingly engage the furnace bottom wall **60**. An angle iron **84** is also welded around the side wall adjacent the lower end thereof and is provided with several spaced brackets **86**, each of which pivotally supports a bolt **88** extendable through slots **90** in the furnace bottom wall **60**. Nuts **92** and washers **94** are positioned on the ends of the bolts **88** to

engage the undersurface of the furnace bottom wall 60 so that, upon tightening of the nuts 92, the furnace bottom wall 60 will be drawn upwardly tightly against the seal 82.

Means for lowering the bottom wall 60 of a selected one of the furnaces 50 is provided by a pair of spaced, vertically extending jacks 96 adapted to engage the underside of the bottom wall 60 of a furnace 50 disposed in vertical alignment therewith. The jacks 96 are provided with rack teeth 98, which mesh with a pair of pinions 99 supported for rotation about a fixed axis by journal blocks 100. The pinions 99 are co-rotatably associated with a pair of pinions 102 adapted to be rotated by a rack 104 which is reciprocable under the influence of a power cylinder 106. Thus, upon the horizontal reciprocation of the rack 104, the jacks 96 are raised and lowered. By disengaging its bolts 88 from the slots 90, the bottom wall 60 of a given furnace may be lowered by the jacks 96 for the purpose of cleaning or replacing the crucible 48, repairing or replacing insulation material, repairing or replacing a heating element, or performing any other desired maintenance.

A valve mechanism, generally indicated at 108, is carried by each of the plates 36 for closing the adjacent inlet opening 72 of its associated furnace 50. The valve mechanism 108 includes a guide tube 110 depending from the underside of its plate 36 and a valve stem 112 slidably extending through the tube 110. A flange 114 is formed on the lower end of the tube 110 and is engaged by one end of a spring 116 which bears at its other end against a valve element 118 secured to the lower end of the valve stem 112. When a plate 36 is raised by its cylinder 42, a head 120 on the upper end of its valve stem 112 will engage the upper surface of the plate 36 to raise the valve element 118 away from the opening 72. When the plate 36 is again lowered, the spring 116 will urge the valve element 118 against the surface of the plate 28 surrounding the opening 72 to seal the opening 72. In so doing, a "lost motion" relationship will occur between the valve stem 112 and the tube 110.

Positioned adjacent the table 10 is a holding furnace 122, from which molten metal is fed through a pouring spout 124 into the crucibles 48. A melting furnace 126 is also desirably located adjacent the holding furnace and is used for melting the particular alloy being used. A conduit 128 is provided for the direct flow of metal from the melting furnace 126 to the holding furnace 122. The pouring spout 124 of the holding furnace 122 is pivotally mounted, so that its pouring end may be moved between a position immediately above the opening 72 of an adjacent work station and a retracted position clear of the table 10, permitting the table 10 to be indexed to a new position.

Means for indexing the table 10 is illustrated as comprising a large Geneva gear 130 mounted on the column 24. The gear 130 has a plurality of circumferentially spaced, radially extending slots or openings 132. A rotary drive plate 134 is provided with an upstanding pin 136 adapted to enter the slots 132 successively upon the rotation of the plate 134. The spacing of the slots 132 and the circle of movement of the pin 136 are such that the pin 136 will leave one slot 132 and enter the next adjacent slot 132 during a given rotation thereof to incrementally rotate the gear 130 and thus the column 24 and table 10 to which it is fixed. The drive plate 134 is driven in rotation by a motor 138 through a gear reduction mechanism 140. There are twelve of the slots 132 and each corresponds in angular position to one of the work stations 28*a*, 28*b*, 28*c*, 28*d*, 28*e*, 28*f*, 28*g*, 28*h*, 28*i*, 28*j*, 28*k* and 28*l*. Thus, the motor 138 may be turned off during a period in which the pin 136 has left one of the slots 132 and prior to its reentry into a new slot 132 and, during this period, one of the work stations will be in a position adjacent the holding furnace 122. In such position, one of the work stations will also lie above the jacks 96.

Hydraulic power supply units for operating the power cylinders 42 are indicated generally at 142 as being mounted on the beams 26 inwardly of the plates 28. Electricity for operating the furnaces may be introduced from a suitable power supply source through a rotary electrical coupling (not shown) which may be positioned at the upper end of the column 24. Similarly, compressed air may be admitted to the rotary table 10 through a standard rotary coupling (not shown) also secured to the column 24. For sake of clarity, the hydraulic, pneumatic and electrical conduits or conductors have been omitted from the drawings. However, FIG. 3 shows a conduit 144 connected to each furnace, through which compressed air may be admitted to the interior of the furnace. A pressure relief valve 146 is provided as a safety measure, protecting against the build-up of excessive pressure in the furnace.

The operation of the apparatus of the present invention will be largely apparent from the foregoing description of the apparatus. Such operation is repeated sequentially at each work station. The plate 36 at a given work station is first raised, both to raise the upper mold half 32 and to open the opening 72 of the furnace. The interior of the mold is cleaned out and any inserts required to be placed therein are inserted in the mold. Thus, in the production of brake drums, a cast iron brake liner may be inserted in the lower mold half 30 for the casting of the drum about the liner. At a succeeding station, the crucible 48 is filled to the desired level by the introduction of molten metal through the opening 72 from the pouring spout 124 of the holding furnace 122. Next, the cylinder 42 of the work station is operated to lower the plate 36, thereby closing the mold and sealing the furnace. The interior of the furnace is then pressurized with compressed air admitted through the conduit 144. Various pressures may be utilized but pressures between 7 and 15 pounds per square inch are normal. The pressurization of the furnace is operable to cause molten metal within the crucible to flow up the stalk 52 to the interior of the mold. As is well known in the art of low pressure casting, the metal will solidify within the mold and any shrinkage resulting from the solidification is taken up by the continued feeding under pressure of metal into the mold. After the metal within the mold has been permitted to solidify, the air pressure in its furnace is exhausted and the plate 36 is again raised. At the upper limits of its movement, ejector pins 148 depending from the supporting members 44 may be utilized to assist in the removal of the parts from the mold. If the construction of the mold is such that the cast part will lift with the upper mold half 32, such ejector pins 148 may be used to strike ejector plugs (not shown) within the mold to eject the part from the mold. The mold is then cleaned out and readied for the time when it is next positioned adjacent the holding furnace 122. The operation is, of course, repeated in sequence at each work station. While one crucible is being refilled, molds at the other work stations are being filled through air pressure and the cast parts are solidifying.

It will be seen that the apparatus of the present invention permits the leaving of a sizable "heel" of molten metal within each crucible 48 to stabilize the temperature within each furnace, yet each crucible is considerably smaller and less expensive to fabricate, heat and maintain than crucibles which have heretofore been used in casting by the low pressure process. Still, the oxides or other contaminant matter within each crucible 48 will float on the top of the metal within the crucible and, by virtue of the fact that the inlet of the stalk 52 is positioned beneath this level, such contaminants will not be introduced into the interior of the mold.

While it will be apparent that the preferred embodiment herein illustrated is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. Casting apparatus including a rotary table, a plurality of furnaces carried by said table in angularly spaced relation, a crucible in each of said furnaces, a plurality of molds carried by said table in paired relation to said furnaces, means connecting each of said molds to the crucible in the furnace to which it is paired, a stationary holding furnace, means for successively filling the furnaces on said table with molten metal from said holding furnace as said table is indexed, and means for pressurizing said furnaces.

2. The structure set forth in claim 1 including a plurality of lifting mechanisms on said table disposed one above each of said molds, each lifting mechanism being connected to an upper part of its adjacent mold for opening said molds to remove parts cast therein.

3. Casting apparatus including a rotary table, a plurality of furnaces depending from said table in angularly spaced relation, a crucible in each of said furnaces, a plurality of molds resting on said table and each being arranged in a position directly above one of said furnaces, means connecting each mold to the crucible of the furnace directly beneath it, means for pressurizing each of said furnaces, a stationary holding furnace, means for successively filling the furnaces on said table with molten metal from said holding furnace as said table is indexed, and closable inlet means on each of said furnaces through which metal may be poured into said crucibles.

4. The structure set forth in claim 3 in which each of the furnaces on said table is provided with a bottom wall on which its crucible rests and including means for disengaging each of said bottom walls from the remaining portion of said furnaces, and a stationary lowering mechanism adapted to support and lower the bottom wall of a furnace in juxtaposition thereto.

5. Casting apparatus including a rotary table, a plurality of furnaces carried by said table, a crucible in each of said furnaces, a plurality of molds disposed on said table, each in a position above one of said furnaces, a stalk

depending from each of said molds into the crucible of its adjacent furnace, means for pressurizing each of said furnaces to cause molten metal within the crucible thereof to flow upwardly through said stalks into the molds, and a stationary furnace adjacent the periphery of said table for filling the crucibles of the furnaces on said table.

6. The structure set forth in claim 5 including a heating element surrounding each of said stalks, and a plurality of heating elements in each of said furnaces to maintain metal in said stalks and said crucibles in a molten condition.

7. Casting apparatus including a rotary table, a plurality of furnaces carried by said table and each having an inlet opening at its upper end, a crucible in each of said furnaces, a plurality of molds on said table disposed one above each of said furnaces and connected to the crucible in its adjacent furnace, a separate lifting mechanism for each of said molds connected to an upper portion of one of said molds, valve means associated with each of said lifting mechanisms operable to automatically close the inlet opening of its adjacent furnace upon the lowering of said upper mold portion, means for pressurizing each of said furnaces, and a stationary furnace adjacent the periphery of said table for successively filling the crucibles carried by said table.

8. The structure set forth in claim 5 including means for incrementally advancing said table in rotation to successively move the furnaces carried by said table to a position adjacent said stationary furnace.

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