July 19, 1927. 1,636,228

A. W. GRAY

CENTRIFUGAL CASTING OR COATING SYSTEM

Filed June 6, 1925 2 Sheets-Sheet 1

Fig. 1.

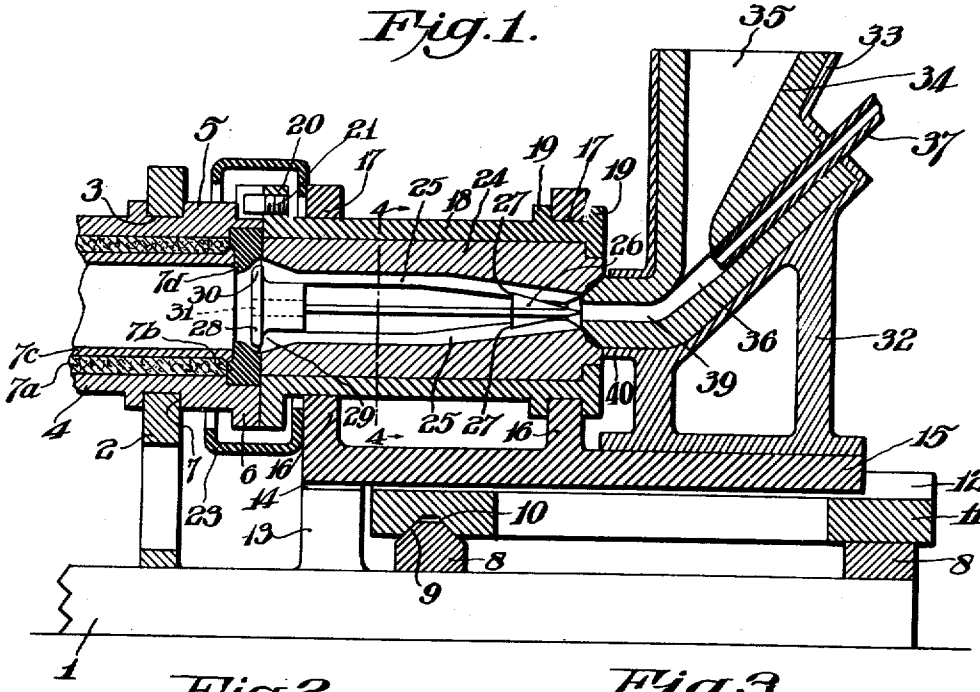


Fig. 2.

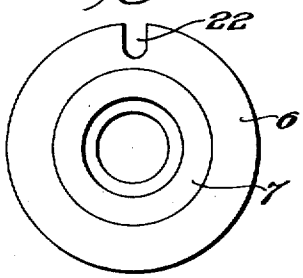


Fig. 3.

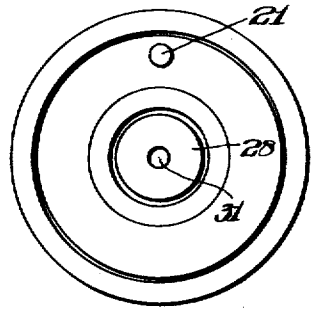


Fig. 4.

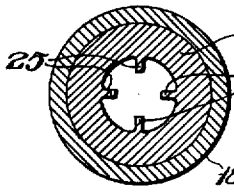
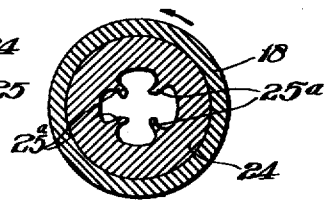


Fig. 5.



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Fig. 6.

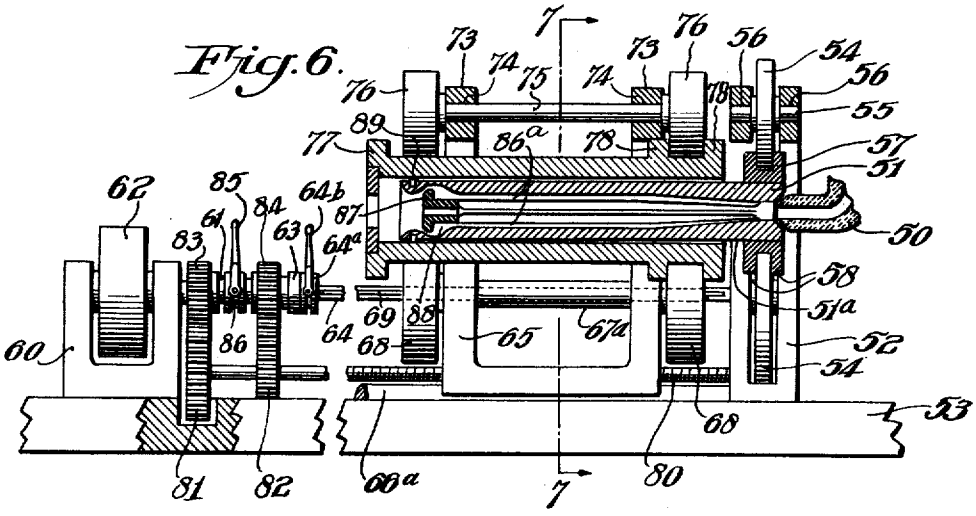
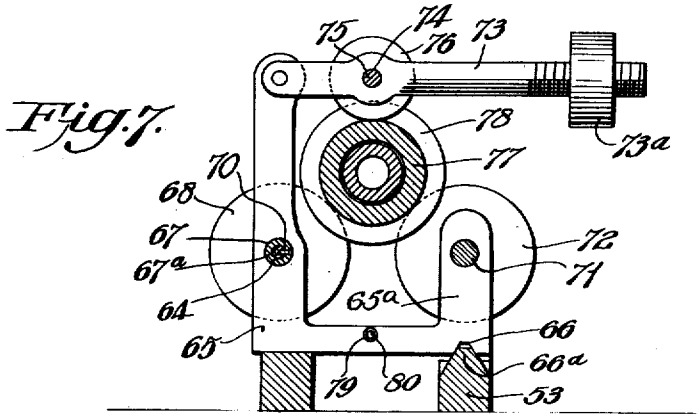


Fig. 7.



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UNITED STATES PATENT OFFICE.

ARTHUR W. GRAY, OF MILFORD, DELAWARE.

CENTRIFUGAL CASTING OR COATING SYSTEM.

Application filed June 6, 1925. Serial No. 35,301.

My invention relates to apparatus for centrifugally distributing molten or liquid material on the interior of a rotating surface, as a mold, or for coating, covering or spraying an object disposed interiorly of a mold or equivalent structure.

In accordance with my invention, any suitable molten or liquid material, as metal, glass, enamel, or the like prior to introduction into a rotating structure is caused to assume an angular velocity that may be smaller, greater, or substantially equal to the angular velocity of the rotating structure.

Further in accordance with my invention, any suitable molten or liquid material, as aforesaid, is initially introduced into a rotating container or conduit suitably arranged to cause the molten or liquid material quickly to assume substantially the same angular velocity as that of the container or conduit.

Further in accordance with my invention, the interior surface of a rotating container or conduit is provided with a longitudinally disposed rib or a plurality thereof for engagment with and a consequent propelling action on the molten or liquid material.

My invention resides in apparatus and features of construction of the character hereinafter described and claimed.

For an understanding of my invention and for an illustration of some of the various forms my apparatus may take, reference is to be had to the accompanying drawings, in which:

Figure 1 is a vertical longitudinal section of my improved casting machine.

Fig. 2 is an end view of the mold.

Fig. 3 is an end view of the conduit.

Fig. 4 is a transverse section of the conduit on the line 4—4 of Fig. 1.

Fig. 5 illustrates a modification of the arrangement shown by Fig. 4.

Fig. 6 is a vertical longitudinal section of a modified type of casting machine.

Fig. 7 is a transverse section on the line 7—7 of Fig. 6.

Referring to Fig. 1, the base of my improved casting machine forms a support for a vertically extending standard 2 provided with an opening 3 receiving and rotatably supporting a suitable structure as a mold 4. Although but one standard and one end of the mold is shown, it is to be understood that the base supports another similar standard likewise provided with an opening for the reception and support of the mold. Adjacent one end, mold 4 is enlarged exteriorly as shown at 5 and is further enlarged at its extreme end to provide a depending flange 6. The enlarged portion 5 is provided with a circumferentially extending groove 7 for the reception of the standard 2, the shoulders formed by the groove resisting and preventing axial thrust of the mold in either direction. The standard at the far end of the base merely supports the mold 4 for rotative movement and is arranged to allow axial movement thereof in either direction. In this manner, free expansion and contraction of the mold is permitted without interfering with its rotation. As is well understood in the art, suitable anti-friction bearings (not shown) may be arranged between the contacting surfaces of the standards 2 and the mold 4.

On its inner surface, mold 4 may be provided with a suitable lining, as the sand or loam lining 7^a, placed in position by ordinary foundry methods. Or, a mixture of sand, clay, cement, and water known as "slurry" may be deposited centrifugally on the mold interior and subsequently hardened in any desired manner. Or, the lining may be omitted entirely and a chill mold of a type well known in the art may be utilized. If desired, one end of the mold may be partially closed by a ring 7^b which forms a wall for retaining one end of the casting 7^c during solidification. Ring 7^b may be provided with an inwardly extending portion 7^d for a purpose hereinafter described.

Disposed on the base 1 at right angles to the axis of rotation of the mold 4 are the guide members 8, one of which may have a V-section 9 for reception by the inclined recessed portion 10 of a frame 11 which is provided with a plurality of guide-ways 12. If desired, base 1 may be provided with a plurality of upwardly extending columns 13, one for each mold, and each provided with an additional guide-way 14 in horizontal alignment with the guide-ways 12 for a purpose hereinafter described.

Slidably disposed on the guide-ways 12 is a frame 15 having upwardly extending standards 16 provided with openings 17 receiving and rotatably supporting a casing 18. One standard 16 is received between flanges 19 formed adjacent one end of the casing 18, whereby axial movement of the

casing with respect to the frame 15 is prevented. As is well understood in the art, suitable anti-friction bearings (not shown) may be arranged between the contacting surfaces of the standards 16 and casing 18.

In accordance with my invention, rotative movement imparted to the casing 18 is in turn transmitted to the mold 4, or vice versa, in any desired manner, and as one arrangement for so doing, the casing 18 at the end remote from the flanges 19 may be provided with a flange 20 for the reception of a pin 21, or a plurality thereof, adapted to enter and be engaged by the sides of an open ended slot or hole 22, or a plurality thereof, formed in the flange 6 of the mold 4. For a purpose hereinafter described, a guard 23 may be disposed exteriorly of and partially surrounding the flanges 6 and 20.

The casing 18 may be provided with a suitable lining 24 as a refractory material when substances at high temperature such as molten metal are being cast. Casing 18 and its lining 24 form a conduit which may be conical to assist in impelling the molten or liquid material toward the mold and which further may be provided with one or more inwardly extending ribs 25 shown in Fig. 4 as extending radially thereof. If desired, ribs 25 may be bent laterally as shown in Fig. 5 and such bending may be continued until the free ends thereof contact with the inner surface of lining 24, whereby a number of substantially closed longitudinally extending tube-like passages are provided. It is to be understood that the rib structure or a portion thereof, whether extending radially or bent laterally, as aforesaid may be "rifled", i. e. bent spirally at any suitable pitch. Further, it is to be understood that the rib structure may be omitted entirely leaving the inner surface of the lining 24 substantially smooth. At times, it may be desirable to cause deflection of the entering stream of molten or liquid material toward the inner wall of the conduit in which case a cone 26 may be arranged within the lining 24 and secured to the rib structure 25 in any suitable manner as by recesses 27 formed therein and into which the cone is fitted.

If desired, adjacent the entrance of mold 4 a plug 28 may be fitted against enlarged portions 29 of ribs 25 and held in engagement therewith in any suitable manner. Flange 30 of the plug with the portion 7^a of ring 7^b forms a restricted, curved path so that floating impurities, or the like, in the molten material will be trapped and prevented from entering the mold. Plug 28 is provided with an opening 31 for a purpose hereinafter described.

Mounted on frame 15 adjacent one end of the casing 18 is the nozzle structure 32 comprising a casing 33 enclosing suitable material 34 shaped to provide a funnel 35 and a passage 36, refractory material being preferable where materials having high temperatures are being cast. Passage 36 is provided with a pipe or similar member 37 both opening into a spout 39 disposed in the throat 40 of the casing. A heating flame or other suitable gas may be admitted through funnel 35 or pipe 37, preferably the latter, to heat the rotatable conduit or mold or to drive out the air and thereby prevent contamination of the material that is to be cast. Should the trap formed by plug 28 be closed, the heating or purifying gas may pass through hole 31 into the mold and there perform the desired function.

Pipe 37 also functions as a valve for closing the outlet of the funnel 35 thereby providing a bottom-pour hopper for the purpose of excluding slag, dross, or other impurities from passage 39.

The operation is as follows:

Assuming that the various parts are as illustrated in Fig. 1, rotary motion will be imparted either to the mold 4 or the casing 18, or to both if desired. Due to the frictional engagement of the parts and the pin and slot connection 21 and 22, the mold and casing 18 will rotate as a unit.

Molten material entering through the funnel 35 will pass downwardly and then through spout 39 and into the rotating conduit where it engages the deflecting cone 26 which throws it outwardly against the interior wall of the conduit. In passing to the other end of the conduit, the molten material quickly assumes substantially the same angular velocity as the conduit due partly to the fact that the ribs 25, or equivalent, tend to grip the same and prevent slippage with respect to the conduit walls. Thereafter, the now whirling stream of molten material escapes through the restricted passage between the abutments 7^a and 30 and rapidly revolving and with a cylindrical shape substantially the same as the mold, comes into engagement therewith at substantially the same angular velocity as that of the mold.

As soon as the casting is completed but while rotation is continuing, the conduit comprising casing 18 and lining 24 may be separated from the mold by movement along the guide-ways 12, whereupon liquid and impurities retained in the trap formed by plug 28 and adjacent parts of the mold and conduit will be thrown outwardly and caught by the guard 23, which, if desired, may be made in separate sections to facilitate cleaning.

At times, it may be desirable to utilize a single conduit for a plurality of molds, each rotatable on a separate spinning bench and arranged preferably side by side in a battery. When so arranged, the frame 11

carrying the conduit and associated funnel structure may be moved from mold to mold along the guide-ways 8 and when in position before an empty mold the axis of rotation of the conduit may be aligned with the axis of rotation of the mold by sliding the frame 15 along the short guide-way 14, a similar device being positioned on the base in front of each mold and functioning as a guide. However, it is to be understood that my invention is not to be limited to a mold and conduit constructed as separate units, but if desired, both mold and conduit may be constructed as one unitary structure.

It is to be understood that in casting long objects, it may be desirable to feed molten material into both ends of the mold, and under these circumstances, rotatable conduits and associated funnel structures of the type shown in Fig. 1 may be provided at each end of the mold.

Referring to Fig. 6, there is illustrated a casting machine especially suitable for making long pipe and includes a rotatable conduit inserted into a rotatable mold together with suitable apparatus for causing relative movement between the mold and conduit. In this machine a spout 50 for the introduction of molten or liquid material is shown as opening into a conduit 51, the material being supplied by any suitable structure, as a funnel and associated parts of the same general type as described aforesaid with respect to Fig. 1. Conduit 51 may be formed of any suitable material, such, for example, as was indicated with respect to the conduit 24 of Fig. 1, and includes a casing 51ª which may be supported for rotative movement in any desired manner as by a frame 52 fixed to base 53 carrying a suitable number of rolls 54, for instance three, spaced substantially equidistantly circumferentially about the casing 51ª. Each roll is suitably supported for rotative movement on a shaft 55 extending into oppositely disposed bearings 56. A journal 57 flanged at 58 is secured to casing 51ª and the outer peripheries of the several rolls extend into frictional engagement with the journal between the flanges. With this arrangement, rotative movement imparted to one of the rolls as hereinafter described causes the rotation of the conduit 51 and at the same time prevents longitudinal movement of the conduit with respect to base 53.

Driving mechanism of any suitable character may be selected for imparting rotative movement to the conduit and combined rotative and axial movement to the mold. As shown, a bifurcated member 60 mounted on base 53 supports a main shaft 61 carrying a pulley 62 driven by a suitable source of power (not shown). Main shaft 61, provided with a clutch disk 63, receives and is freely rotatable around another shaft 64 having a corresponding clutch disk 64ª keyed thereto, whereby disk 64ª may move longitudinally with respect to shaft 64. By manipulating lever 64ᵇ, the two disks will be locked together, the result being that rotary movement from shaft 61 will be transmitted directly to shaft 64 and thence to one of the rolls 54 for rotating conduit 51.

A frame 65 movable axially along base 53, as hereinafter described, is grooved at 66 for the reception of a guiding rib 66ª on the base 53. Bearings 67 in frame 65 receive and rotatably support a hollow shaft 67ª to which a pair of drive rolls 68 are rigidly secured. A slot 69 in shaft 64 receives a key 70, or a plurality thereof, suitably secured to the rotatable structure comprising shaft 67ª and rolls 68. Rotatably mounted in suitable bearings in the front extension 65ª of frame 65 is the shaft 71 carrying a pair of rolls 72 corresponding with rolls 68.

A pair of arms 73 pivoted to an upper portion of frame 65 extend laterally of base 53, each providing a bearing 74 for receiving and rotatably supporting a shaft 75 carrying a pair of rolls 76 for exerting downward pressure on the mold to hold the same in frictional engagement with rolls 68 and 72, the pressure being derived in any suitable manner, as by weights 73ª adjustable on arms 73.

The mold 77, preferably of the type known in the art as a chill mold although provided, if desired, with any suitable lining, supports and guides the free end of conduit 51 and is provided adjacent one end with depending flanges 78 between which are received one each of the pairs of rolls 68, 72, and 76. The other and corresponding group of rolls receives and supports the mold adjacent its other end. In this manner, the mold is firmly secured to the frame 65 for axial movement therewith without interfering with its axial contraction and expansion. Furthermore, radial expansion of the mold does not interfere with its free rotation since each of the pressure rolls 76 is yieldingly held in engagement with the mold periphery.

Frame 65 and the structure carried thereby may be moved axially in either direction with respect to the base 53 in any suitable manner. As shown, the frame is provided with a threaded bore 79 for the reception of a threaded shaft 80 rotatably secured at one end to the frame 52. Adjacent its other end, shaft 80 is provided with gears 81 and 82 of any suitable diameter. Gears 83 and 84 freely rotatable on main shaft 61 may be alternately locked into engagement therewith as desired by manipulation of clutch lever 85 actuating clutch 86 keyed to the shaft but longitudinally slidable thereon. If the

clutch is engaged with gear 83 rotation will be imparted to threaded shaft 80 in one direction and the mold will be moved toward the left as shown in Fig. 6. Corresponding engagement of the clutch with gear 84 will rotate the threaded shaft in the reverse direction and move the mold in the opposite direction.

If desired, the mold may be moved at a greater speed in one direction, for instance, toward the right in Fig. 6. Any suitable mechanism may be provided for effecting this function as the intermediate gear 85 meshing with gears 82 and 84.

It is to be understood that the molten or liquid material is delivered from spout 50 into conduit 51 and distributed from the latter into the mold. Any suitable arrangement may be utilized for increasing the angular velocity of the material while in the conduit as the longitudinally extending ribs 86^a. It is likewise to be understood that the number of ribs may be varied to suit different conditions and that they may be modified as suggested in connection with Fig. 1, i. e. bent laterally, as desired, or rifled. Further, it is to be understood that, if desired, a cone or equivalent structure may be used to deflect the material into engagement with the inner surface of the conduit.

If necessary or desirable, a flanged plug 87 may be fitted against enlarged ends 88 of ribs 86^a and held in engagement therewith in any suitable manner. Adjacent the plug flange, conduit 51 may be increased in diameter whereby the molten material is caused to pass through a restricted, curved path so that floating impurities in the molten material will be trapped and prevented from entering the mold. If desired, a snap ring 89, or a plurality thereof, may be provided to scrape and clean the mold as the one moves with reference to the other.

The operation is as follows:

At the beginning of a casting or like operation, the mold will be positioned in its extreme position toward the right as shown in Fig. 6. With clutch disk 64^a locked to disk 63, shaft 64 will be in rotation and likewise the rolls 54 and 68 carried by the shaft, the rotative movement of the rolls being imparted respectively to the conduit and mold. Thereupon, after the molten or liquid material has begun to pour from spout 50 into conduit 51, clutch 86 will be thrown into engagement with gear 83. The material in passing through the conduit has its angular velocity increased by the ribs or like structure. Thereafter, the now whirling stream of molten material escapes through the restricted passage adjacent the flange of plug 87 and rapidly revolving and with a shape substantially the same as the mold comes into engagement therewith at substantially the same angular velocity as that of the mold. When clutch 86 was engaged with gear 83, rotary movement was imparted to threaded shaft 80, the result being that frame 65 carrying the rolls 68, 72, and 76 in turn carrying the mold 77 began its journey axially toward the left (Fig. 6). Due to the key and slot connection 69 and 70, this axial movement will not interfere with free rotative movement of the drive rolls 68.

When the mold has moved the desired distance toward the left (Fig. 6), a flow of molten or liquid material is discontinued, and at the proper time clutch 86 is thrown to its neutral position and disk 64^a is disengaged from disk 63. Thereafter, when the material being cast has hardened to a desired extent, arms 73 are raised in any desired manner and the mold removed. An empty mold may now be placed on rolls 68 and 72 and arms 73 lowered into the position shown in Fig. 7. Engagement of clutch 86 with gear 84 will cause reverse rotation of threaded shaft 80 whereupon the new mold will be caused to slide over the casing 51^a of the conduit into proper position for a new casting or like operation.

It is to be understood that the conduit and mold of Fig. 6 may be caused to rotate at the same or different angular velocities by properly choosing the diameters of the driving rolls and the portions of the mold and conduit engaged respectively by such rolls. Further, it is to be understood that in apparatus of the character disclosed in Fig. 1, the conduit and mold need not rotate at the same speed, for it is obvious that the driving or frictional engagement between the parts could be eliminated, and by using separate driving mechanisms respectively for the mold and conduit, their respective speeds of rotation could be varied as desired.

Briefly stated, my invention as described aforesaid, is effective in the production of various articles, and particularly pipe, that is free of the defects usually existing in such articles when produced by prior art centrifugal casting machinery. Since the angular velocity of the liquid material is substantially the same as that of the mold when it comes into contact therewith, and is of substantially the same shape as the mold, the heretofore well-known tendency of repeated dropping back and splashing of the metal into a pool at the bottom of the mold is obviated. This dropping and splashing increase greatly the surface of hot metal exposed to the atmosphere within the mold, augment the abrasion of the mold lining, if used, cause some of the falling metal to freeze as it drops, and stir into the molten frozen drops and impurities.

Moreover, when the liquid to be cast is fed into the mold in accordance with my invention, it is practical to rotate the mold at much higher speeds than has been the

practice heretofore. Increasing the speed of rotation assists in eliminating impurities suspended in the liquid. Also, by increasing the pressure under which the liquid solidifies, the increased angular velocity of the mold results in the production of sounder castings.

Although I have described several of the embodiments of my invention with some particularity, it is to be understood that such description is illustrative, and not limitive of my invention.

In the appended claims, it shall be understood that the term "gas" is employed in a generic sense to include a flame for warming the mold, or a gas of any kind (reducing, oxidizing or neutral) of any temperature to be passed through the conduit and the mold in the direction of flow for washing out the air and substituting an atmosphere of the kind desired.

What I claim is:

1. Apparatus of the character described comprising a rotatable conduit, means for passing a stream of molten or liquid material into said conduit, means for causing the material to assume substantially the same angular velocity as that of the conduit, and means for receiving the material from the conduit while in molten or liquid condition.

2. Apparatus of the character described comprising a rotatable conduit, means for passing a stream of molten or liquid material into said conduit, means comprised in said conduit, for causing the material to assume substantially the same angular velocity as that of the conduit, and means for receiving the material from the conduit while in molten or liquid condition.

3. Apparatus of the character described comprising a rotatable conduit, means for passing a stream of molten or liquid material into said conduit, means extending axially of the conduit and functioning independently of centrifugal action to increase the angular velocity of the material while in said conduit, and means for receiving the material from the conduit while in molten or liquid condition.

4. Apparatus of the character described comprising a rotatable conduit, means for passing a stream of molten or liquid material into said conduit, means for deflecting the material radially toward the inner surface of the conduit, means functioning independently of centrifugal action for increasing the angular velocity of the material while in said conduit, and means for receiving the material from the conduit while in molten or liquid condition.

5. Apparatus of the character described comprising an elongated rotating conduit, means for introducing a stream of molten or liquid material into said conduit, and means functioning independently of centrifugal action associated with said conduit for increasing the angular velocity of said material while in said conduit and in engagement with the inner surface thereof.

6. Apparatus of the character described comprising a rotating conduit, means for introducing a stream of molten or liquid material into said conduit, means independent of centrifugal action associated with said conduit for increasing the angular velocity of said material while in said conduit and in engagement with the inner surface thereof, said means comprising a rib disposed axially of the inner surface of the conduit, and means for receiving the material from the conduit while in molten or liquid condition.

7. Apparatus of the character described comprising a rotating conduit, means for introducing a stream of molten or liquid material into said conduit, a hook-shaped rib in said conduit disposed axially thereof for engaging said material to increase its angular velocity, and means for receiving the material from the conduit while in molten or liquid condition.

8. Apparatus of the character described comprising a rotating conduit whose interior surface comprises a series of axially extending passages, means for introducing a stream of molten or liquid material into said passages, and a rotatable mold receiving said material after passage through said conduit.

9. Apparatus of the character described comprising a rotating conduit providing a series of spiral passages extending axially of the interior thereof, means for introducing a stream of molten or liquid material into said passages, and a rotatable mold receiving said material after passage through said conduit.

10. Apparatus of the character described comprising a rotating conduit whose interior surface comprises a series of axially extending tube-like passages, means for introducing a stream of molten or liquid material into said passages, and a rotatable mold receiving said material after passage through said conduit.

11. Apparatus of the character described comprising a rotating conduit providing a series of spiral tube-like passages extending axially thereof, means for introducing a stream of molten or liquid material into said passages, and a rotatable mold receiving said material after passage through said conduit.

12. Apparatus of the character described comprising a rotating mold, and means for introducing a stream of molten or liquid material into said mold comprising a rotating conduit having an inner conical surface diverging in the direction of flow therethrough and having a radial rib extending inwardly and axially thereof.

13. Apparatus of the character described

comprising a rotating mold, means for introducing a stream of molten or liquid material into said mold comprising a rotating conduit having an inner conical surface diverging in the direction of flow therethrough, and means independent of centrifugal action associated with said conduit for increasing the angular velocity of said material while in said conduit and in engagement with the inner surface thereof.

14. Apparatus of the character described comprising a rotating mold, and means for introducing a stream of molten or liquid material into said mold comprising a rotating conduit having an inner conical surface diverging in the direction of flow therethrough, said conduit being provided with a series of axially extending passages on its inner surface.

15. Apparatus of the character described comprising a rotating mold, and means for introducing a stream of molten or liquid material into said mold comprising a rotating conduit having an inner conical surface diverging in the direction of flow therethrough, said conduit being provided with a series of axially extending spiral passages on its inner surface.

16. Apparatus of the character described comprising a conduit, means for introducing a stream of molten or liquid material into said conduit, means for deflecting said material toward the inner wall of said conduit, means for rotating said conduit at a speed sufficient to centrifugally retain the material in engagement with its interior surface, and a mold receiving the material from said conduit while in substantially tube-like form.

17. Apparatus of the character described comprising a rotating conduit, means for introducing a stream of molten or liquid material into said conduit, and means comprising a cone shaped member for deflecting said material toward the inner wall of said conduit.

18. Apparatus of the character described comprising a rotating conduit, means for introducing a stream of molten or liquid material into said conduit, rib structure in said conduit and extending axially thereof, and a deflecting cone supported by said rib structure.

19. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, and means adjacent the junction of said conduit and mold preventing passage of impurities into said mold.

20. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, a trap adjacent the junction of said conduit and mold, and means for separating the conduit and casing while continuing their rotation, whereby impurities collected by said trap will be thrown outwardly by centrifugal action.

21. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, a trap adjacent the junction of said conduit and mold, means for separating the conduit and casing while continuing their rotation, whereby impurities collected by said trap will be thrown outwardly by centrifugal action, and a guard partially surrounding the junction between said conduit and casing.

22. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit, means for feeding molten or liquid material to said conduit, and means for passing a gas through said conduit and into said mold.

23. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit, a member forming a trap provided with a longitudinal passage adjacent the junction of said conduit and mold, means for passing molten or liquid material into said conduit, around said member, and into the mold, and means for passing a gas into said conduit and through said passage into the mold should the passage around said member be closed.

24. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit whose interior surface forms a path converging in one direction, means for passing molten material through said conduit in said one direction, and means in the region of said converging passage of the conduit for preventing passage of impurities into said mold.

25. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit whose interior surface forms a path diverging and then converging in one direction, means for passing molten material through said conduit in said one direction, and means in the region of said diverging-converging passage of the conduit for preventing passage of impurities into said mold.

26. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, the path traversed by said material converging in the dircetion of flow in the region of juncture of said conduit and mold, and a trap in said region for preventing passage of impurities into said mold.

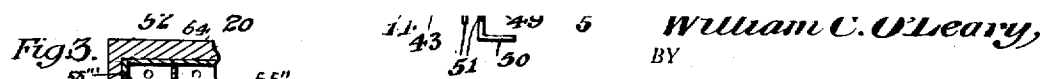
27. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, the path traversed by said material converging in the direction of

flow in the region of juncture of said conduit and mold, and a trap having a passage communicating with said mold and conduit for preventing passage of impurities into said mold.

28. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, the path traversed by said material diverging and then converging in the direction of flow in the region of juncture of said conduit and mold, and a trap in said region for preventing passage of impurities into said mold.

29. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, the path traversed by said material diverging and then converging in the direction of flow in the region of juncture of said conduit and mold, and a trap having a passage communicating with said mold and conduit for preventing passage of impurities into said mold.

ARTHUR W. GRAY.



flow in the region of juncture of said conduit and mold, and a trap having a passage communicating with said mold and conduit for preventing passage of impurities into said mold.

28. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, the path traversed by said material diverging and then converging in the direction of flow in the region of juncture of said conduit and mold, and a trap in said region for preventing passage of impurities into said mold.

29. Centrifugal casting apparatus comprising a rotating mold, a rotating conduit in axial alignment therewith, means for passing molten material through said conduit and into said mold, the path traversed by said material diverging and then converging in the direction of flow in the region of juncture of said conduit and mold, and a trap having a passage communicating with said mold and conduit for preventing passage of impurities into said mold.

ARTHUR W. GRAY.

Certificate of Correction.

Patent No. 1,636,228. Granted July 19, 1927, to ARTHUR W. GRAY.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 4, line 52, after the word "mold" strike out the comma and insert a period; same page, line 76, strike out the article "a", and line 126, after the word "molten" insert the word *metal;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of August, A. D. 1927.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.

Certificate of Correction.

Patent No. 1,636,228. Granted July 19, 1927, to

ARTHUR W. GRAY.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 4, line 52, after the word "mold" strike out the comma and insert a period; same page, line 76, strike out the article "a", and line 126, after the word "molten" insert the word *metal;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of August, A. D. 1927.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.