Nov. 3, 1953 R. C. MYERS 2,657,440

CENTRIFUGAL CASTING APPARATUS

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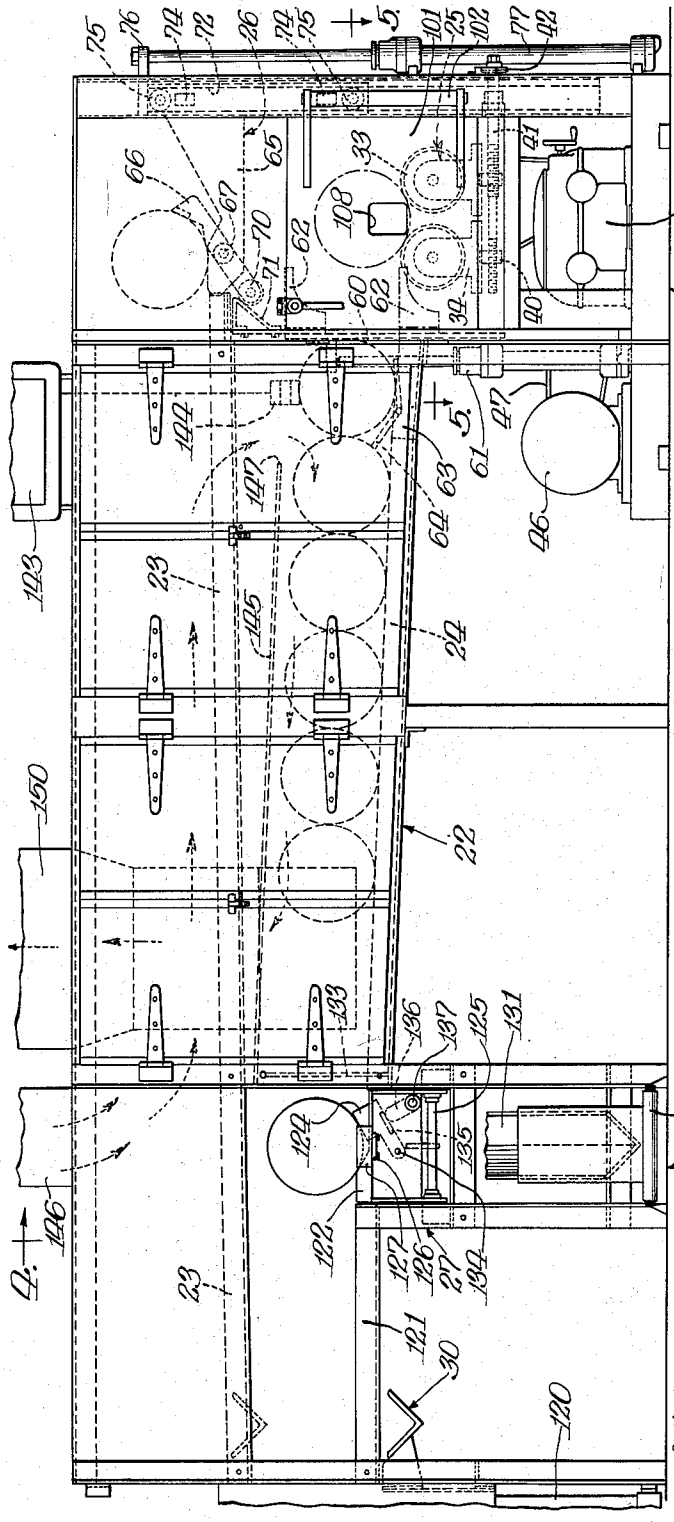


Fig. 1.

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CENTRIFUGAL CASTING APPARATUS

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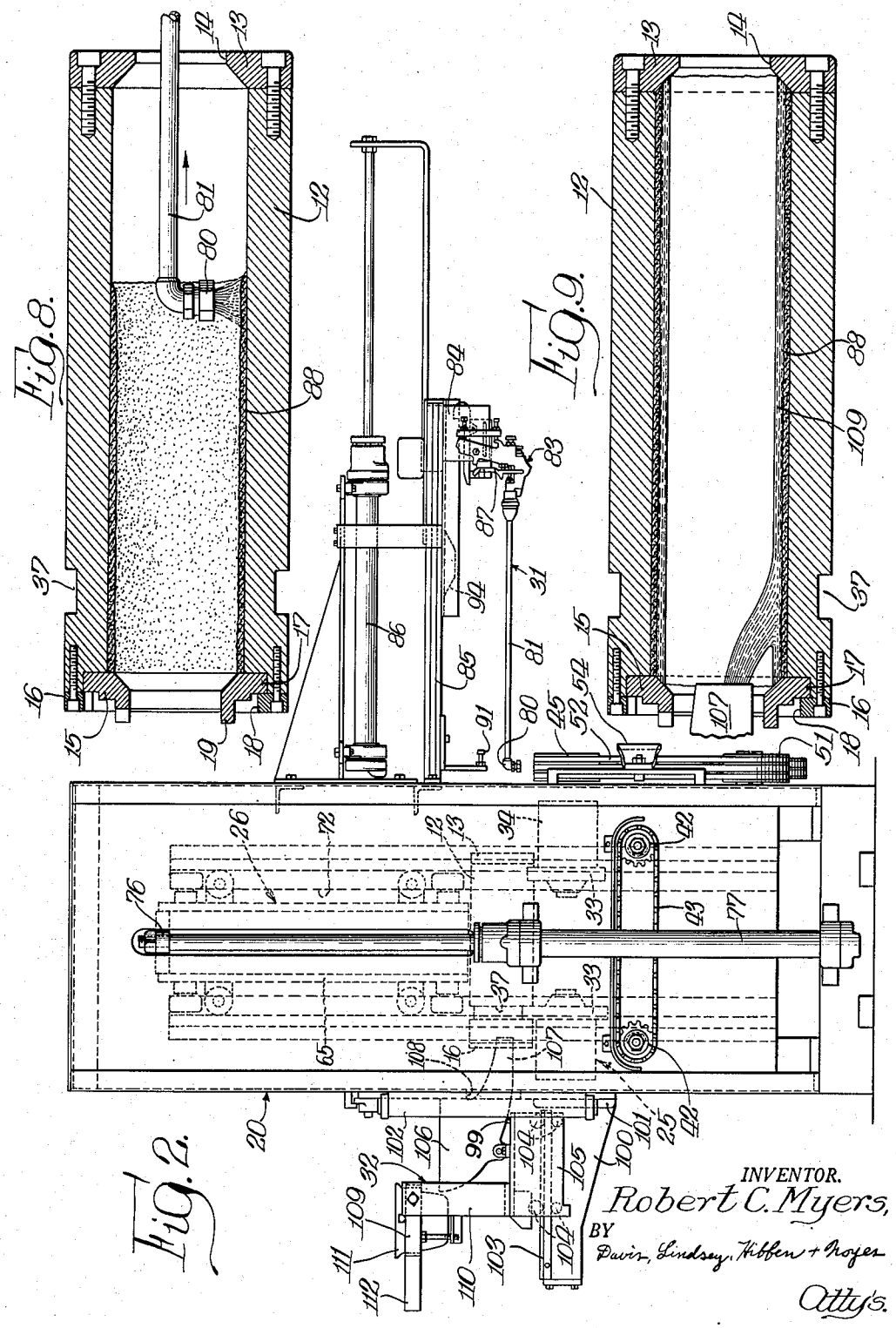


Fig. 8.

Fig. 9.

Fig. 2.

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CENTRIFUGAL CASTING APPARATUS

Filed May 13, 1949 6 Sheets-Sheet 3

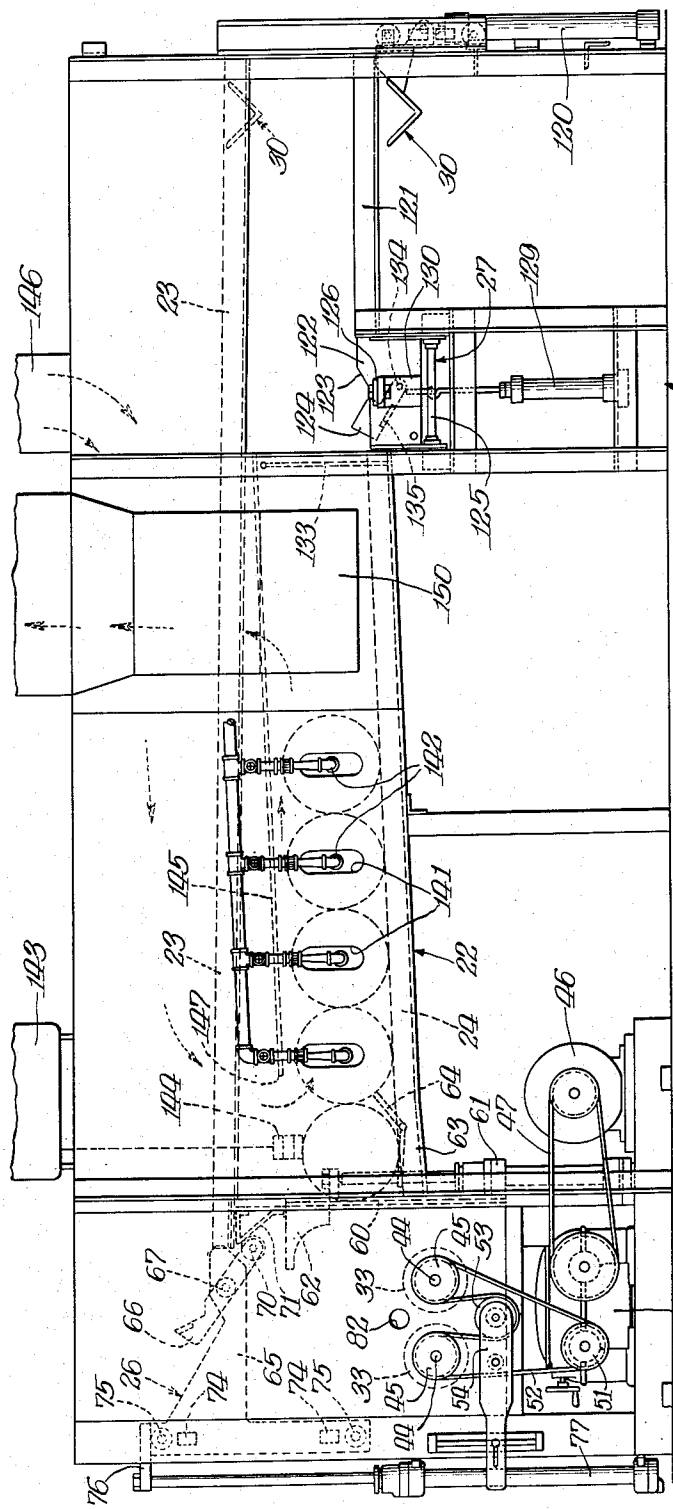


Fig. 3.

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CENTRIFUGAL CASTING APPARATUS

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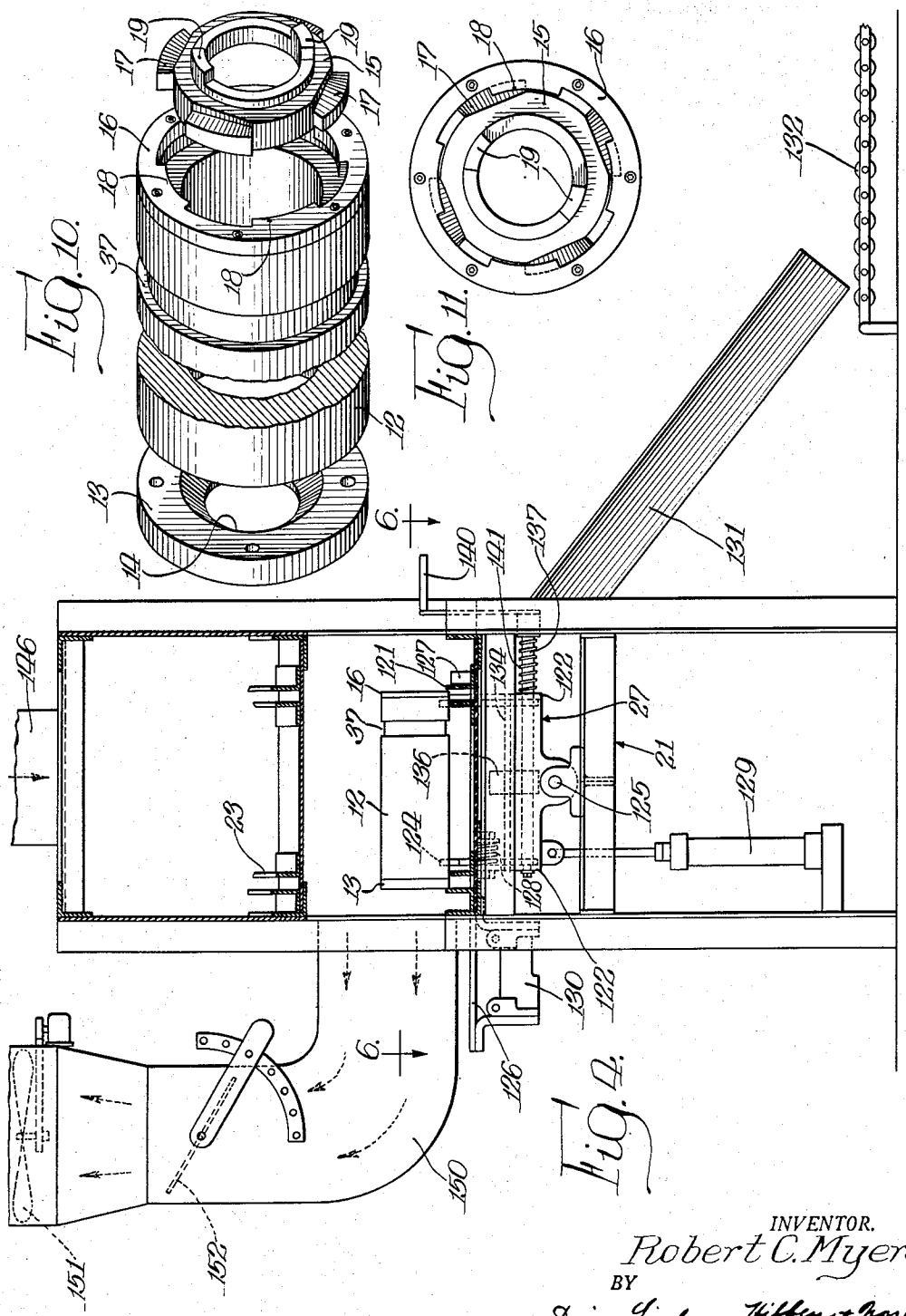


Fig. 10.

Fig. 11.

Fig. 12.

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CENTRIFUGAL CASTING APPARATUS

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Fig. 5.

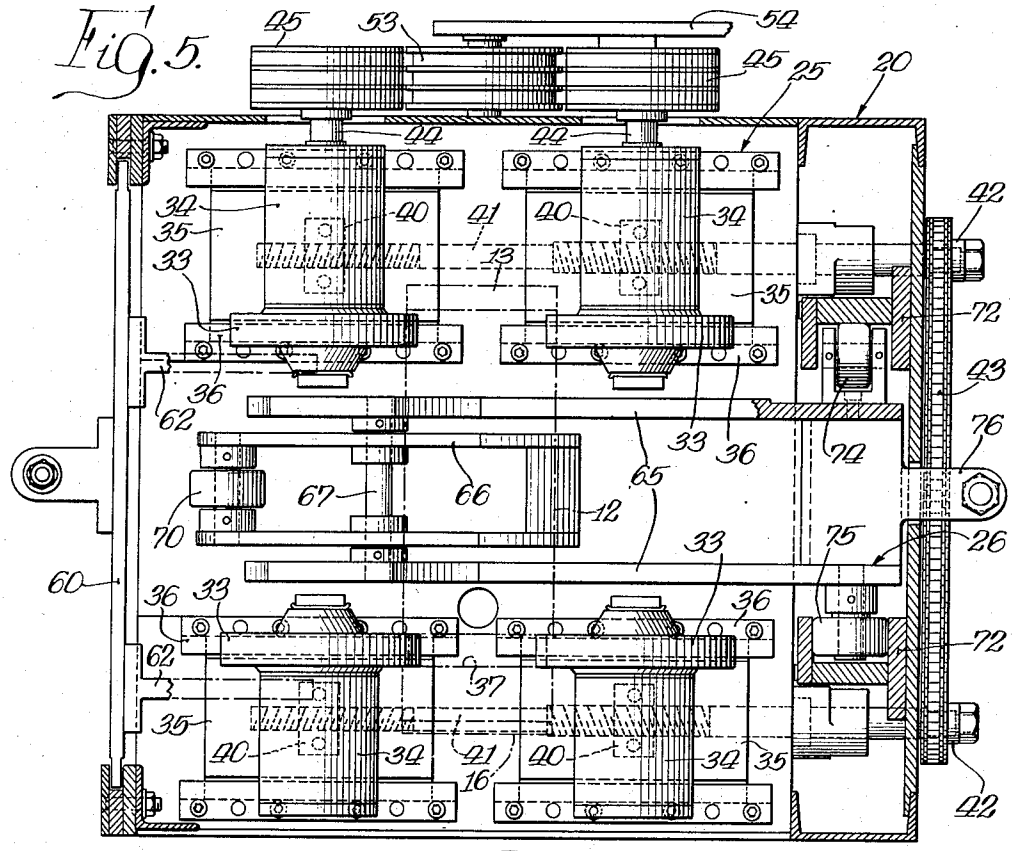
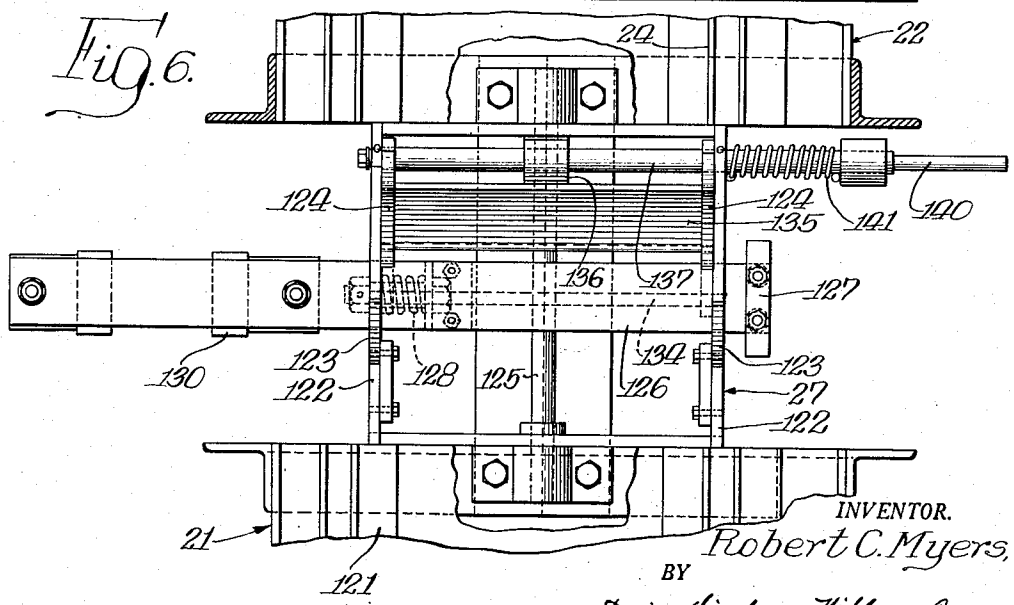


Fig. 6.



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CENTRIFUGAL CASTING APPARATUS

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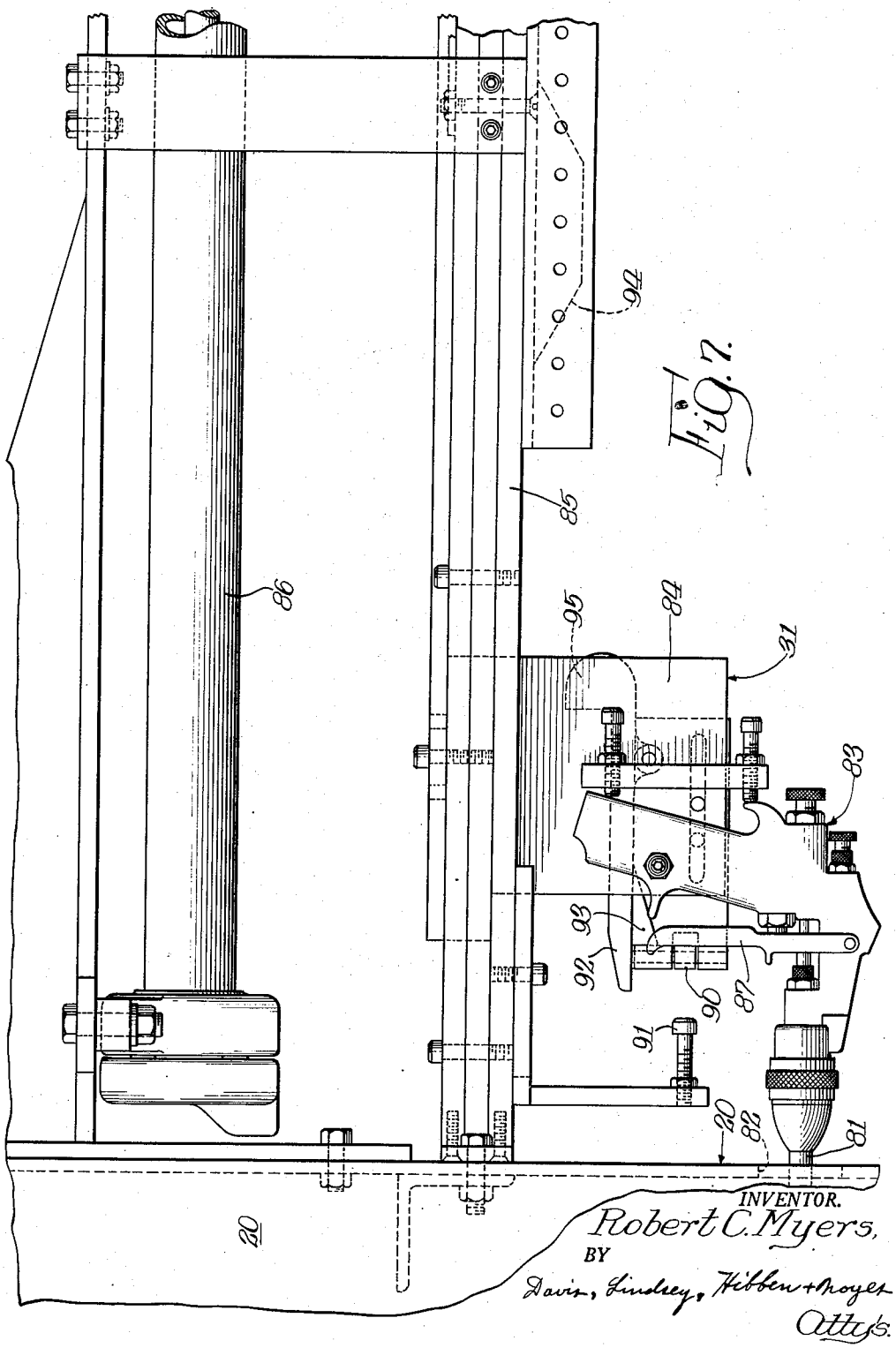


Fig. 7.

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UNITED STATES PATENT OFFICE

2,657,440

CENTRIFUGAL CASTING APPARATUS

Robert C. Myers, Cambridge City, Ind., assignor to Perfect Circle Corporation, Hagerstown, Ind., a corporation of Indiana

Application May 13, 1949, Serial No. 93,010

6 Claims. (Cl. 22—64)

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The invention relates generally to apparatus for making centrifugal castings and more particularly to such apparatus for making hollow cylindrical castings.

The general object of the invention is to provide novel centrifugal casting apparatus of the foregoing character, by which continuous manufacture of castings may be performed.

Another object is to provide novel centrifugal casting apparatus of the foregoing character, by which high quality castings may be made, and which provides for accurate control of the various factors resulting in the high quality.

A further object is to provide novel apparatus for making centrifugal castings, in which dies or molds are continuously moved through a circuit, at one point in which metal is poured into a die, and at a succeeding point the casting is removed from the die and the die returned to the first-mentioned point.

Still another object is to provide centrifugal casting apparatus which is constructed as a self-contained compact unit adapted to receive the molten metal for making a casting at one point and to discharge the casting at another point.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a front elevational view of the centrifugal casting apparatus embodying the features of the invention, with parts of the apparatus broken away.

Fig. 2 is an end elevational view of the right-hand end of the apparatus as shown in Fig. 1.

Fig. 3 is a rear elevational view of the apparatus, with parts thereof broken away.

Fig. 4 is a vertical sectional view taken substantially on the line 4—4 of Fig. 1.

Fig. 5 is an enlarged fragmentary horizontal sectional view taken substantially on the line 5—5 of Fig. 1.

Fig. 6 is an enlarged fragmentary horizontal sectional view taken substantially on the line 6—6 of Fig. 4.

Fig. 7 is an enlarged fragmentary elevational view of a portion of the apparatus shown in Fig. 2.

Fig. 8 is an enlarged longitudinal sectional view of one of the dies utilized in the apparatus and illustrating one of the steps in the process of casting.

Fig. 9 is a view similar to Fig. 8 but illustrating another step in the process of casting.

Fig. 10 is a perspective view of one of the dies illustrated in Figs. 8 and 9, with the parts thereof separated.

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Fig. 11 is an end view of the right-hand end of one of the dies as illustrated in Fig. 10.

The present apparatus is of the type in which the metal is cast in permanent cylindrical metal dies rotatably driven during the pouring of the molten metal to uniformly distribute the metal within the die and to maintain such distribution until the metal has solidified. The amount of metal poured into each die thus determines the thickness of the casting. During the casting of the metal, the die is protected from direct contact with the molten metal by an insulating coating placed on the interior of the die, prior to the pouring of the molten metal. Such insulating coating not only protects the die from the heat of the metal but also assists in controlling the cooling rate of the casting so that a desired metallurgical structure may be obtained in the casting. The coating also facilitates the ejection of the casting from the die after it has solidified and cooled to the desired extent.

For these broad purposes, the present apparatus comprises generally a casting section, an ejector section, and a storage section intermediate the other two sections. In the casting section, a die is placed on a rotary driving means for rapidly rotating the die to effect the centrifugal action. While the die is being so driven, a coating is placed on the interior of the die and thereafter molten metal is poured into the die in the desired quantity to form the casting. Spinning of the die is maintained during this procedure and continued thereafter until the casting has sufficiently solidified to maintain its shape, during which period the desired metallurgical structure is attained.

The die is then removed from the rotary driving means and passed through the intermediate storage section of the apparatus where the casting cools in a controlled manner to bring it to a suitable temperature for removal from the die. From the intermediate storage section, the die with the casting therein passes to the ejector section where the casting is removed from the die. After ejection of the casting, the empty die is then moved again into the storage section, where its temperature is brought to a desired point and it is held in readiness for admission to the casting section for making another casting. It is, of course, to be understood that while only one die is admitted to the casting section at any one time and only one die is permitted to enter the ejector section at one time, a series of dies is held in the storage section, some having castings therein which are cooling while others are empty and are

held in readiness for introduction to the casting section.

General description of the apparatus

The dies, as heretofore mentioned, are of a permanent character made of metal and are cylindrical in form. The construction of each die is such that, while both ends of the die are open, the openings are of smaller diameter than the inside diameter of the die so that, when the molten metal is poured into the die, the spinning movement holds the metal against the die, evenly distributed therein and none will run out the ends of the die. To permit removal of the solidified casting, one end of the die has a removable portion in the form of a cap, permitting the casting to be slid out of that end when the cap is removed.

In the particular form illustrated in the drawings, each die comprises a body **12** (see Figs. 8, 9, 10 and 11) which is cylindrical both interiorly and exteriorly throughout its length. One end of the body **12**, in this instance the rear end, is provided with a cap **13** permanently secured to the body as by screws, and having a central aperture **14**. The diameter of the aperture **14** is less than the inner diameter of the casting so that the molten metal will not run out the end of the die.

The other end of the body **12** is provided with a removable centrally apertured cap **15** held on the body by a retaining ring **16** rigidly secured to the body **12** as by screws. The cap **15** and retaining ring **16** are held together by means of segmental lugs **17** on the caps (see Figs. 10 and 11) engageable under segmental lugs **18** on the ring **16**. As is apparent, the lugs **17** may be disengaged from the lugs **18** by rotating the cap **15** relative to the ring **16** to permit removal of the cap. The cap **15** is also provided with a pair of lugs **19** on its face, which may be engaged by a suitable spanner wrench (not shown) for rotating the cap.

The apparatus, as illustrated in the drawings, is in the form of an elongated housing comprising a casting section, indicated generally at **20** (see Figs. 1, 2, 3 and 5), an ejector section, indicated generally at **21** (see Figs. 1, 3, 4 and 6) and an intermediate storage section, indicated generally at **22**. The housing comprising the three sections named is generally constructed of plate and angle members. In the intermediate section **22** are conveying means, herein shown, in the form of tracks which are slanted sufficiently to cause the dies to roll between the casting section **20** and the ejector section **21**, while in the latter two sections there are transfer devices in the form of elevators for shifting the dies. Thus, as shown in Figs. 1 and 3, an upper track **23** is provided for conveying the dies in one direction through the intermediate section **22**, while a lower track **24** is provided for conveying the dies in the opposite direction. The front face of the intermediate section **22** preferably comprises a series of hinged doors to permit access to the interior of the intermediate section when desired. In the casting section **20** is a die supporting and rotating means, indicated generally at **25** (see Figs. 1, 2 and 5) and positioned adjacent the lower track. Also mounted in the casting section **20** is an elevator **26** arranged to transfer dies between the die rotating means **25** and the upper track **23**. In the ejector section **21** is an ejector, indicated generally at **27** (see Figs. 1, 3, 4 and 6) for removing the castings from the dies, the ejector **27** being preferably mounted at the level of the lower track **24**. Also mounted in the ejector section **21** is an elevator, indicated generally at **30**, for moving the dies between the level of the ejector **27** and the upper track **23**.

Mounted on the casting section **20**, in the present instance at the rear side thereof, is a means, indicated generally at **31**, for applying a coating to the interior of the die (see Figs. 2 and 7), such coating being preferably in liquid form and, therefore, capable of being applied by means of a spray. The casting section also includes means, indicated generally at **32** (Fig. 2), for measuring and pouring a quantity of molten metal into a die positioned on the supporting and rotating means **25**.

The casting section 20

The die supporting and rotating means **25** located in the casting section **20** is in the form of sets of rollers **33** (see Figs. 1, 2, 3 and 5) adapted to support a die on the periphery thereof, as shown in Figs. 1 and 2, and rotatably driven to rotate the die. The rollers **33** are mounted in axially spaced pairs, as will be apparent from an inspection of Fig. 5, and are supported in bearings carried in roller supports **34**. The latter are provided with base portions **35** slidably mounted and guided on rails **36** rigidly secured in and forming a part of the housing structure of the casting section **20**. The slidable mounting of the base portions **35** is provided so that rollers of each pair may be adjusted toward and from each other to accommodate dies of different diameters, the die resting peripherally on the rollers. Preferably, the pair of rollers **33** at the front of the machine are slightly larger in diameter than the rollers at the rear of the machine so as to fit within a peripheral groove **37** (see Figs. 2 and 8) provided in the die to prevent endwise movement of the die relative to the rollers **33**.

Adjusting means is provided for shifting the rollers **33** of each pair toward and from each other, such adjusting means being arranged to adjust all four rollers simultaneously in equal amounts. To this end, the base portion **35** of each roller support **34** is provided with a downwardly extending lug **40** (see Fig. 5) having threaded engagement with a screw **41**. The threaded portions of each screw **41** are of opposite hand so as to effect adjustment of the rollers of each pair toward and from each other. The screws **41** of the two pairs of rollers extend to the exterior of the casting section **20** and on their outer ends are provided with sprockets **42** (see Figs. 2 and 5) connected by a chain **43** so that, by turning one sprocket, both screws **41** will be rotated and all four rollers **33** thus adjusted simultaneously.

The front pair of rollers **33**, in the present instance, are shown as merely idler rollers, while the rear pair of rollers **33** are adapted to be rotatably driven. To this end each rear roller **33** is mounted on a shaft **44** (see Fig. 5) extending rearwardly to the exterior of the casting section **21** and having a pulley **45** (see Figs. 3 and 5) mounted on the outer end of the shaft. A motor **46** is provided for driving the rollers **33** and is connected by a belt **47** to a driven pulley of a speed-reducing unit **50**. The speed-reducing unit **50** also has a drive pulley **51** connected by a belt **52** to the pulleys **45**. A belt tightening pulley **53** is preferably provided, the pulley **53** being mounted between and below the pulleys **45** and carried on a pivoted lever **54** adjustably secured to the rear wall of the casting section **20**.

The empty dies are adapted to be admitted one at a time to the casting section 20 and the latter is separated from the storage section 22 by a door 60 (see Figs. 1, 3 and 5). The door in the present instance is shown as being vertically movable and is adapted to be shifted by a hydraulic actuator 61 (see Figs. 1 and 3). By means of the actuator 61, the door 60 may be lowered when it is desired to admit a die from the storage section 22 to the casting section 20 for positioning on the rollers 33. While the apparatus could be arranged to store the empty dies on the upper track, in the present instance the empty dies are held on the lower track 24 in the storage section 22. Since the lower track 24 is shown as terminating at the door 60, a supporting means forming a continuation of the track 24 is provided to carry the die from the track over to the rollers 33. To this end, the door 60 is provided at its upper end with a pair of die supporting arms 62, which, when the door 60 is lowered, are at the same level as the adjacent end of the track 24, and which extend over to the rollers 33 to provide for movement of the dies from the tracks 24 to the rollers. The track 24 is preferably provided with an end portion 63 (see Figs. 1 and 3) which is more steeply inclined than the remainder of the track so that the end die will readily roll onto the arms 62 and thence onto the rollers 33. The remaining dies carried on the track 24 are held against rolling at this time by a detent 64.

After the casting has been formed and sufficiently solidified to permit stopping rotation of the die, the latter is adapted to be lifted from the rollers 33 to the level of the upper track 23 and then shifted onto the upper track for movement to the ejector section. To this end, the elevator 26 is of such construction that it is movable into the space between the pairs of rollers 33 before a die is placed on the rollers. After the metal has been poured into the die and solidified, the elevator 26 is raised to carry the die with the casting therein to the level of the track 23, at which time a shifting device constituting part of the elevator 26 is provided for shifting the dies off the elevator and onto the track 23.

As shown in Figs. 1, 2, 3 and 5, the elevator comprises a horizontally extending arm 65 movable into the space between the pairs of rollers 33. The arm 65 is adapted to be lowered into position between the rollers 33 before a die is placed on the latter, and, when elevated, the arm 65 extends adjacent and at the level of the track 23. Mounted within the arm 65 is a member 66 pivotally supported intermediate its ends, as at 67, by the arm 65. At its left end, as shown in Figs. 1 and 5, the member 66 is provided with a roller 70 adapted to engage an angular stop member 71 provided within the casting section. As the arm 65 moves upwardly, the roller 70 contacts the stop member 71 and the member 66 is caused to swing about its pivotal support 67, so that its opposite end swings upwardly and shifts the die off the elevator, and onto the track 23.

The arm 65 is carried on a vertically extending frame structure provided with rollers operating in vertically extending guideways 72 provided on the interior of the end wall of the casting section 20. To provide for the various thrusts to which the arm 65 is subjected, there are four rollers 74, two on each side of the arm 65, which are mounted on axes extending parallel to the arm 65, and four rollers 75 mounted on axes extending transverse to the arm 65. The arm 65 is provided with a lug 76 extending through the end wall of the casting section, and exteriorly thereof is mounted a hydraulic actuator 77 connected to the lug 76. Thus by means of the actuator 77, the elevator arm 65 may be raised and lowered to lift the dies from the rollers 33 to a position adjacent the upper track 23. As the elevator reaches its upper position, the pivotally supported member 66 contacts the stop 71 to shift the die off the elevator and onto the track 23.

As heretofore mentioned, the casting section 20 also includes the means 31 for coating the interior of the die with an insulating composition. Such composition is preferably an aqueous mixture so that it readily may be sprayed, and includes a refractory material, such as silica flour, and a binder therefor, such as bentonite. The mixture is adapted to be sprayed under pressure onto the interior of the die to form a coating therein of substantially uniform thickness.

The coating applying means 31 comprises a spray nozzle 80 (see Figs. 2 and 8) mounted on the end of a pipe 81 and adapted to be inserted through aperture 14 in the cap 13 on the die and into the die and then moved endwise thereof to apply the spray to the interior surface of the die throughout the length thereof. Thus, the coating applying means 31 includes means for moving the spray longitudinally of the die and, in the present instance, this means also includes an automatic control for the spray. In the preferred form, the pipe 81 is adapted to extend through an aperture 82 in the rear wall of the casting section to position the nozzle 80 within the die. The pipe 81 extends from a spray gun, indicated generally at 83 (see Figs. 2 and 7) rigidly carried on a carriage 84. The carriage 84 is slidably mounted on a bracket 85 rigidly secured on the rear wall of the casting section 20 and extending rearwardly therefrom. The carriage 84 is connected to the movable member of a hydraulic actuator 86, also supported by the rear wall of the casting section.

The carriage 84, in the preferred arrangement, is adapted to be moved toward the rear wall of the casting section to move the nozzle 80 through the aperture 82 and into the die until it reaches the front end thereof. At that time, the trigger of the spray gun, indicated at 87, is adapted to be automatically actuated to its "on" position to start the spray. While the trigger remains in spraying position, the carriage 84 is moved rearwardly to move the spray lengthwise within the die, as illustrated in Fig. 8, to form a coating 88. At the point in the rearward travel of the carriage when the spray reaches the rear end of the die, automatic means is provided for shutting off the spray and the carriage 84 then continues its movement until the nozzle is withdrawn through the aperture 82 to the position shown in Fig. 2. To this end, the trigger 87 is adapted to be moved to its spraying position by a finger 90 pivotally mounted on the carriage 84. The trigger 87 is of the type that is spring-pressed to its "off" or non-spraying position, so that a positive force is required to actuate the finger 90. Such force is obtained by movement of the carriage 84, which brings the finger 90 into contact with an adjustable stop screw 91 extending from a portion of the carriage supporting bracket 85. When the stop screw 91 shifts the finger 90 to move the trigger to spraying position, a latch 92 pivotally mounted on the carriage 84 drops downwardly to position a lug 93 on the latch behind the finger 90 to hold it in such position. At this point, the carriage 84 starts to move outwardly

and the trigger 87 remains in spraying position during this period of movement.

Intermediate the ends of the carriage supporting bracket 85 is a cam 94 arranged to release the latch 92 from the finger 90 so that the trigger 87 may be returned to its non-spraying position under the influence of its spring. Thus, the latch 92 has, at its end opposite the lug 93, a curved, enlarged portion 95 adapted to be engaged by the cam 94 in the movement of the carriage 84. The cam 94 depresses the end 95 of the latch 92 to lift the lug 93 out of engagement with the finger 90. The spring actuation of the trigger 87 thereupon shifts the trigger to non-spraying position. This operation takes place at the time that the spray 89 has reached the rear end of the die. Movement of the carriage 84 continues beyond such point to move the spray rearwardly through the aperture 82 to an out-of-the-way non-operative position, as shown in Fig. 2.

The device 32 for measuring and pouring a predetermined quantity of molten metal into the die is preferably positioned at the front of the casting section 20. In the present instance, the device 32 comprises a bracket 100 (see Fig. 2) mounted on a door 101 pivotally supported for swinging movement on a vertical axis by a hinge 102. The bracket extends forwardly from the door 101, when the latter is in closed position, and has a guideway 103 engageable by rollers 104 supporting a carriage 105. The carriage 105 thus may be moved toward and from the door 101. Pivotally supported on the carriage, on a horizontal axis extending parallel to the door, is a pouring spout 106 having a nozzle 107 insertable through an aperture 108 (see Fig. 1) in the door 101 to permit the nozzle 107 to be inserted through the aperture in the cap 15 and into the front end of the die. By movement of the carriage 105, the nozzle 107 thus may be moved into the die for pouring purposes and thence moved away from the die to permit the latter to be moved from the supporting rollers 33. The pivotal mounting of pouring spout 106 permits adjustment of the nozzle 107 for dies of different diameters, and in this connection a stop screw 99 is mounted in the carriage 105 under the pouring spout 106 to hold it in its adjusted position. The carriage 105 also is provided with uprights 110 pivotally supporting a frame 109 in which a measuring ladle 111 is mounted. The ladle thus may be tilted to pour molten metal therefrom into the pouring spout 106. Preferably, the ladle 111 is balanced so that it normally rests in upright position and must be manually moved by means of a handle 112 formed on the frame 109, to pour the metal therefrom into the pouring spout 106.

The foregoing construction of the casting section 20 thus provides for shifting a die from the lower track 24 onto the driving and supporting rollers 33 when the door 60 between the casting section and intermediate section is lowered. During such passage of the die, the arms 62 support the die in the space between the end portion 63 of the lower track 24 and the rollers 33. At the time that the die is placed on the rollers 33, the elevator 26 is in its lowered position with the arm 65 lying below the die and between the rollers. The motor 46 is then started to operate the rollers 33 and thus set the die into spinning motion about its axis.

When the die gets up to speed, the spraying means 31 is actuated to move the nozzle into the die to the front end thereof. When it reaches that point, the trigger 87 of the spray gun 83 is automatically actuated by the stop screw 91 to start the spray. The carriage 84 carrying the spray gun 83 is then moved rearwardly while the spray is operating to coat the interior of the die with the insulating composition, as illustrated in Fig. 8. The spinning movement of the die during this time, of course, holds the spraying composition against the interior surface of the die, and the heat of the die quickly dries the composition to leave the refractory coating 88 on the interior thereof. When the spray nozzle 89 reaches the rear end of the die, the trigger 87 is released by the cam 94 to stop the spray, the carriage 84, however, continuing its rearward movement to move the nozzle 89 to an inoperative position clear of the die.

At this point, the desired quantity of molten metal is carried from a nearby melting furnace and is poured into the ladle 111. The ladle 111 having a given capacity thus determines the amount of metal to be poured into the die and thereby ultimately determines the thickness of the casting. When the ladle 111 is filled to the desired point, the carriage 105 is moved forwardly to insert the nozzle 107 of the pouring spout 106 into the front end of the die, as shown in Fig. 9. The carriage 105 may, of course, be moved forwardly before the molten metal is poured into the ladle 111, if desired. The ladle 111 may then be tilted by the handle 112 to pour the molten metal from the ladle into the pouring spout 106 and thence into the die. The molten metal received from the nozzle 107 spreads evenly over the interior surface of the coating, as indicated at 108 in Fig. 9, and thus forms the casting, the spinning movement of the die, of course, maintaining the molten metal in a truly cylindrical shape until such time as the metal solidifies. After the metal is poured, the carriage 105 is moved away from the door 101 to remove the nozzle 107 from the die.

When the metal within the die has solidified sufficiently to maintain its shape, the motor 46 is stopped to stop rotation of the rollers 33. The elevator 26 is then actuated to lift the die off the rollers 33 and raise it to a position level with the upper track 23. As the elevator 26 approaches its upper position, the roller 70 on the end of the arm 66 contacts the stop member 71 to tilt the arm 66 and thus shift the die onto the track 23.

The ejector section 21

As heretofore mentioned, the dies with the castings therein are conveyed from the casting section 20 through the intermediate section 22, where cooling of the casting takes place, and then to the ejector section 21 for removal of the castings from the dies. To this end, the upper track 23 extends into the ejector section, as shown in Figs. 1 and 3, and when the casting has cooled sufficiently, a die with the casting therein is lowered by means of the elevator 30 from the track 23 and then moved to the ejector 27. As in the case of the elevator 26 in the casting section 20, the elevator 30 is actuated by a hydraulic actuator 120. When each die is thus lowered, it is placed on a short horizontal track 121, along which it may be rolled to the ejector 27.

The ejector 27 comprises generally V-shaped supports for the die adapted to receive the casting from the track section 121. After a die is placed on such V-shaped supports, the cap 15 is removed from the die and the supports are tilted so as to lower the front end of the die to

position the die with its axis at an angle. A vibrator mounted on the ejector then imparts vibrations to the die so that the casting will slide forwardly out of the die and into a trough for removal from the apparatus.

As shown in the drawings, the V-shaped supports for the die in the ejector comprise a pair of fixed plates 122 having slanting surfaces 123 (see Figs. 1, 3 and 6) forming one side of the V. The other side of the V is provided by a pair of movable plates 124. The fixed plates 122 constitute portions of a box-like frame in which the movable plates 124 are mounted. Such box-like frame is pivotally supported for tilting movement by a shaft 125 extending transversely to the axis of a die when positioned on the supports 122 and 124. The movement of the supports 122 and 124 on the shaft 125 provides for tilting the die so that the axis of the die extends forwardly and downwardly. Tilting movement of the frame is effected by a hydraulic actuator 129. Mounted in the box-like frame is a bar 126 lying directly under the die and having a block 127 at its forward end adapted to engage the lower portion of the front end of the die to hold the die against sliding movement when it is tilted. The bar 126 is slidably mounted in the box-like frame and a spring 128 is provided, tending to resiliently hold the bar in a fixed position relative to the frame. The bar 126 extends rearwardly from the box-like frame and at its rear end carries a vibrator 130. When the box-like frame is tilted to tilt the die, the vibrator 130 is operated to cause vibration of the die, the vibratory motion being imparted to the bar 126 carrying the block 127 at its front end and thus to the die. Since the die is held by the block 127 against sliding movement, the casting will gradually slide forward out of the die and will be received in a forwardly and downwardly directed trough 131 located at the front of the apparatus. Preferably, the trough 131 carries the finished casting to a conveyor 132, from which the finished castings may be removed.

After the casting has been removed from the die and the die is tipped back to a horizontal position, the cap 15 is replaced on the die and the latter is rolled off the ejector 27 and through a swinging door 133 opening into the intermediate section 22, the die then rolling onto the lower track 24 for storage until it is ready to be admitted to the casting section 20. To this end, the movable plates 124 of the ejector are pivotally supported by a shaft 134 carried by the plates 122. The plates 124 are normally held in a raised position, as shown in Figs. 1 and 3, to hold the die in position in the ejector 27. For this purpose, the plates 124 are connected by an intermediate plate 135, against which a holding cam 136 is positioned. The holding cam 136 is mounted on a shatf 137 adapted to be operated by a hand crank 140. A torsion spring 141 is mounted on the shaft 137 and tends to move the cam 136 to its upward position to hold the plates 124 in die-receiving position. However, by turning the crank 140, the cam 136 may be lowered, permitting the plates 124 to swing about the shaft 134 and thus lowered to a horizontal position so that the die may be rolled through the door 133 onto the track 24.

The storage section 22

One of the features of the invention is the control possible with the present apparatus of the cooling rate of the castings. By such control, the metallurgical structure of the metal may be determined, a feature which is particularly important if the metal being cast is gray cast iron. The rate of cooling of the cast metal, of course, determines the character of the metallurgical structure. The cooling depends upon a number of factors including the initial temperature of the molten metal, the insulating effect of the coating placed on the interior of the die, and the temperature of the die when introduced into the cast section 20. The initial temperature of the molten metal can, of course, be controlled at the melting furnace, and the insulating effect of the coating is dependent upon its composition and its characteristics when applied to the interior of the die. The initial temperature of the die before it is introduced into the casting section, however, can be controlled in the present apparatus. The rapidity with which heat is withdrawn from the casting after the dies and castings are moved into the storage section from the casting section is also controlled so that the casting is cooled sufficiently for withdrawal from the die in the ejector section.

The dies, when the apparatus is first started, are, of course, cold and would have a considerable chilling effect on the castings if the molten metal were poured into the dies at such temperature. It has been found, in correlating the die temperature to the other factors, that it is advantageous to have the dies, at the time of their introduction into the cast section 20, at a temperature ranging from 700° F. to 1000° F. To this end, the rear wall of the intermediate housing section is provided with a plurality of slots 141 (see Fig. 3) laterally spaced from each other a distance substantially equal to the diameter of the dies and positioned in the wall so that they are substantially concentric with the axes of the dies located on the lower track 24. Mounted on the rear wall of the housing are a plurality of gas burners, one being indicated at 142, for insertion through the slots 141 to provide a flame directed into the interior of each die to initially heat the die. The gas burners 142, of course, need only be used when the apparatus is first started up, since thereafter the heat remaining in the dies from the casting will be sufficient to maintain them at the desired temperature. To accurately determine the temperature of each die just before it enters the casting section 20, a temperature recorder 143 (see Figs. 1 and 3) is mounted on top of the storage section 22 and is provided with a temperature-sensitive element 144 which may be lowered to a position immediately over the die to record its temperature.

When the dies with the castings thereon are rolled off the elevator 26 onto the track 23, there is, of course, a large amount of heat left in the casting. To remove this heat and bring the casting to a temperature at which it is safe to remove it from the die, cool air is adapted to be circulated through the upper part of the storage section 22. To this end, the upper and lower portions of the storage section are separated by a partition 145 and an air intake 146 is mounted on the top of the housing, preferably adjacent the left end of the storage section 22, as viewed in Fig. 1. An air current entering through the intake 146 moves through the upper portion of the storage section to remove the heat from the castings.

This air current is also utilized to control the temperature of the empty dies before entering the casting section. To this end, the intermediate partition 145 is provided with an opening

147 at its right-hand end, as shown in Fig. 1, to permit the air to be drawn downwardly into the lower portion of the storage section where the empty dies are stored. Thus, the air will pass over the empty dies and bring them to the desired temperature for admission to the casting section. From the lower portion of the storage section below the partition 145, the air is withdrawn by a flue 150 (see Figs. 1, 3 and 4) which is provided with a fan 151 for producing a forced flow of air. In order to control the rate of cooling of the castings in the upper part of the storage section and to control the temperature of the empty dies in the lower part of the storage section, a damper 152 is mounted in the flue 150 so that the rate of flow of air may thereby be controlled.

Brief description of operation

From the foregoing, it will be apparent that empty dies are held in the lower portion of the storage section 22 ready for admission one at a time to the casting section 20. When a die is so admitted, it is placed in position on the rollers 33 and is rapidly rotated while first a spray coating is applied to the interior of the die by the nozzle 80, and thereafter molten metal is poured into the die by means of the pouring spout 106. The die is kept spinning long enough for the metal therein to solidify. The rollers 33 are then stopped and the elevator 26 lifts the die from the rollers up to the level of the upper track 23 and rolls the die onto such track. While the die is held on the upper track 123, the air current passing through the storage section 22 removes heat from the casting in a controlled manner.

Thereafter, each die with its casting is rolled from the storage section 22 into the ejector section 21 and is lowered by the elevator 30 for placing on the ejector 27. There the die is tilted and, at the same time, vibrated so that the casting slides out forwardly and into the trough 131. The die is then rolled from the ejector 27 into the lower part of the storage section 22, where its temperature is brought to the desired point for re-introduction into the casting section 20.

I claim:

1. Apparatus for making centrifugal castings, comprising an elongated casing, die rotating means in one end of said casing for supporting a die during pouring of the metal, an ejector in the other end of said casing for ejecting castings from the dies, a pair of tracks in said casing between said die rotating means and ejector, one above the other, with one track arranged for conveying dies with the castings therein from said die rotating means to the ejector, and the other track for conveying empty dies from the ejector to the die rotating means, a partition within said casing for enclosing the space about said other track, and means for circulating air through said space to control the temperature of the dies.

2. Apparatus for making centrifugal castings, comprising a casing having casting means, an ejector, and a pair of tracks generally paralleling each other for conveying dies between said casting means and said ejector, a partition in said casing between the pair of tracks and having an opening therethrough to separate the interior of the casing into two spaces, and an air impeller for moving air first through the space on one side of said partition to cool the dies with the castings therein, then through said opening and through the space on the other side of said partition to control the temperature of the empty dies.

3. Apparatus for making centrifugal castings, comprising a casing having casting means, an ejector, and a pair of tracks generally paralleling each other and positioned one above the other, the upper track being arranged to convey dies with the castings therein from said casting means to said ejector, and the lower track being arranged to convey empty dies from said ejector to said casting means, a partition extending between the tracks to provide upper and lower compartments in the casing for the respective tracks and having an opening therethrough, a pair of doors for closing off the lower compartment from the casting means and said ejector respectively, and an air impeler for drawing a current of air through the upper compartment to cool the dies with the castings therein, then through said opening and through the lower compartment to cool the empty dies to a uniform temperature before they enter the casting means.

4. Appartus for making centrifugal castings, comprising a casing having casting means, an ejector, and a pair of tracks generally paralleling each other and positioned one above the other, the upper track being arranged to convey dies with the castings therein from said casting means to said ejector, and the lower track being arranged to convey empty dies from said ejector to said casting means, a partition extending between the tracks to provide upper and lower compartments for the respective tracks and having an opening therethrough, a pair of doors for closing off the lower compartment from the casting means and ejector respectively, the upper compartment having an air inlet remote from said opening and the lower compartment having an air outlet remote from said opening, and an air impeller adjacent said air outlet for drawing a current of air through the two compartments to control the temperature of the dies.

5. Apparatus for making centrifugal castings, comprising a casing having casting means and an ejector spaced from each other, the portion of the casing therebetween having a partition dividing the interior into two compartments with an opening therebetween, one compartment having an air inlet and the other an air outlet, a pair of tracks in the respective compartments for conveying dies with the castings therein from the casting means to the ejector and empty dies from the ejector to the casting means, a flue connected to said air outlet, a fan in said flue for drawing a current of air through the two compartments to cool the dies with the castings therein, and a damper in said flue for controlling the rate of flow of said current to cool the empty dies to a predetermined temperature before entering the casting means.

6. Apparatus according to claim 1 wherein said other track is inclined downwardly toward said die rotating means, a door is slidably mounted for vertical movement in said casing adjacent said die rotating means and normally is held in its raised position extending across said other track, said door is adapted to be lowered to permit the leading die to roll onto said die rotating means and the remaining dies to roll toward said door, said other track has its end portion which supports said leading die more steeply inclined than the remainder of said other track to cause said leading die to roll onto said die rotating means, and a track member is movable, when the door is lowered, into position

to bridge the space between said end portion and said die rotating means.

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