D. S. DE LAVAUD.

ROTARY CASTING.

APPLICATION FILED NOV. 14, 1919.

1,398,008.

Patented Nov. 22, 1921.

3 SHEETS—SHEET 1.

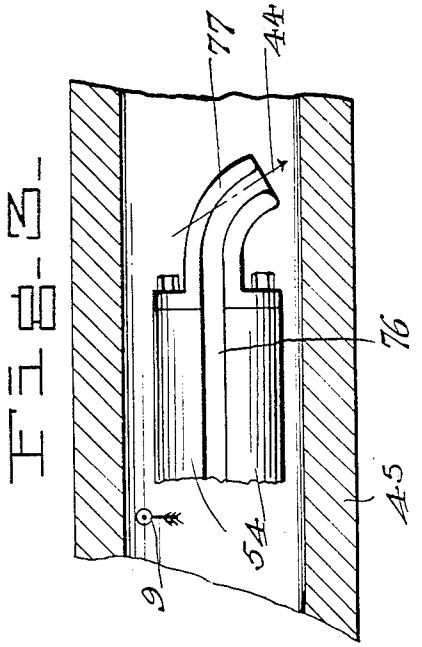


Fig. 3.

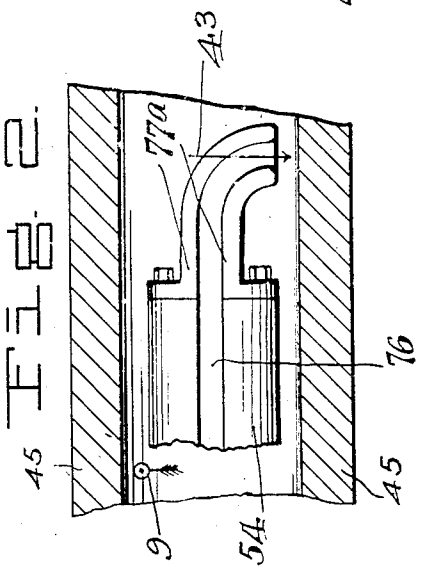


Fig. 2.

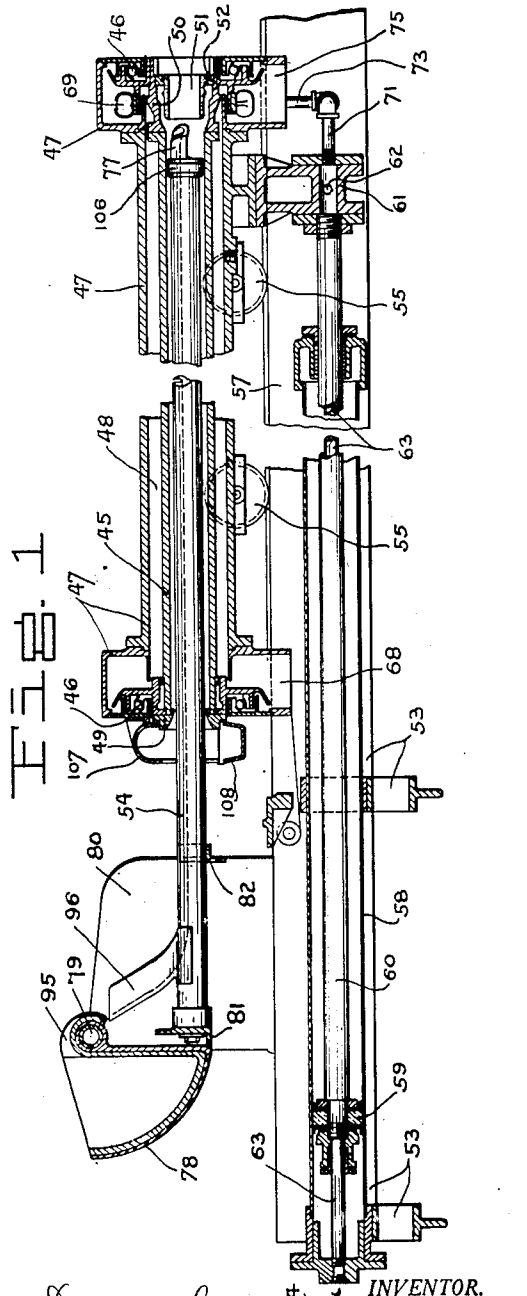


Fig. 1.

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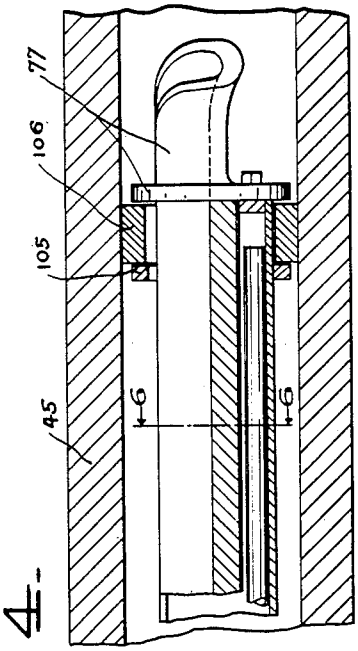
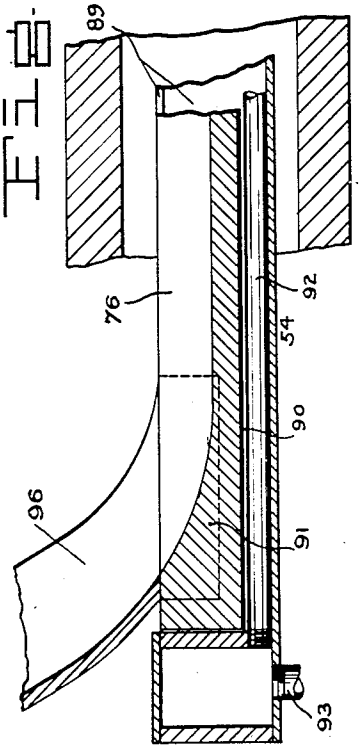


Fig. 4.



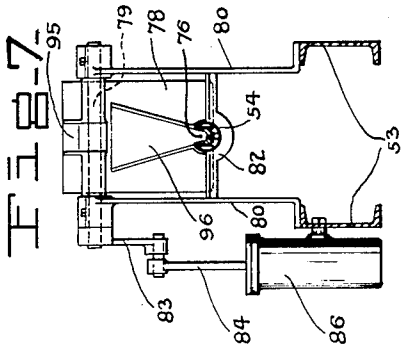


Fig. 7.

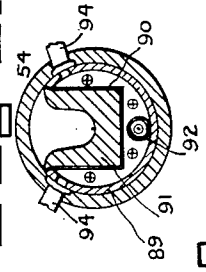


Fig. 6.

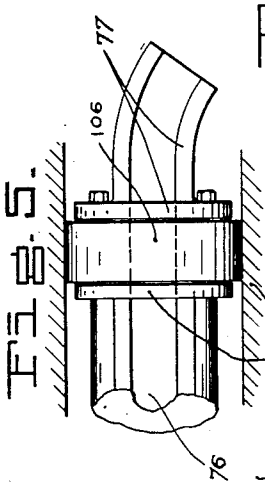


Fig. 5.

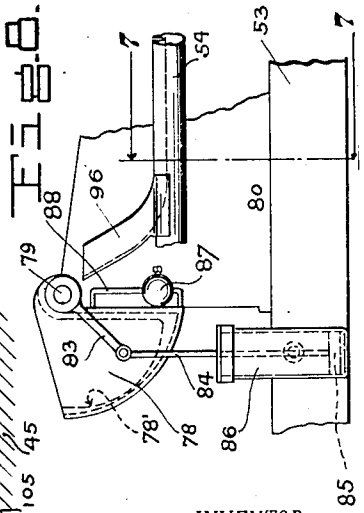


Fig. 8.

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3 SHEETS—SHEET 3.

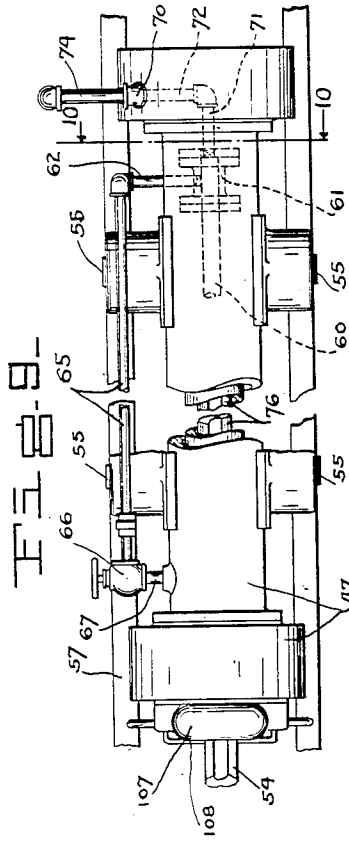


Fig. 9.

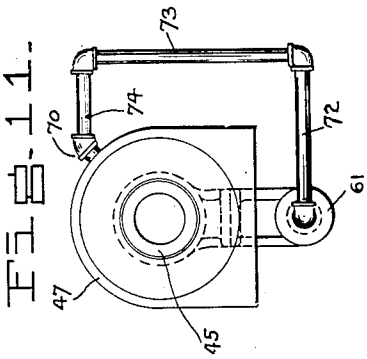


Fig. 11.

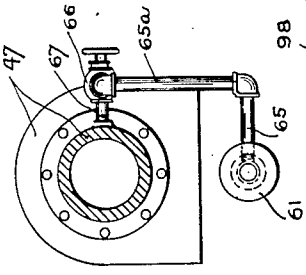


Fig. 10.

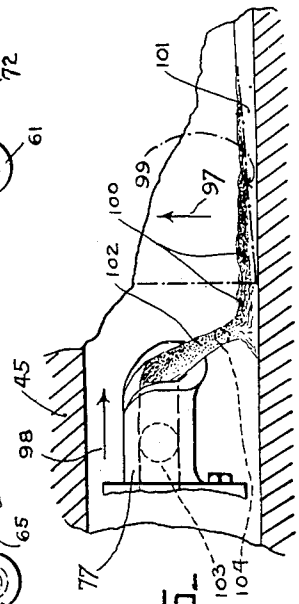


Fig. 15.

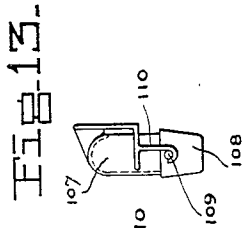


Fig. 13.

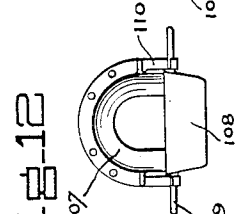


Fig. 12.

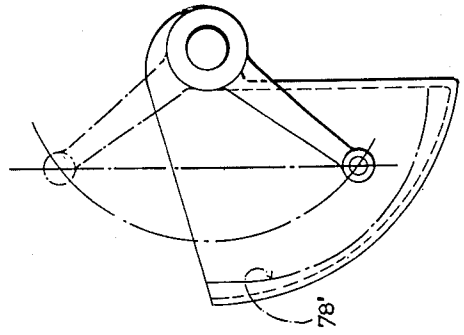


Fig. 14.

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BY Augustus M. Hamm ATTORNEYS.

UNITED STATES PATENT OFFICE.

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ROTARY CASTING.

1,398,008. Specification of Letters Patent. Patented Nov. 22, 1921.

Application filed November 14, 1919. Serial No. 338,010.

To all whom it may concern:

Be it known that I, DIMITRI SENSAUD DE LAVAUD, a citizen of the United States of Brazil, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Rotary Castings, of which the following is a specification.

This invention relates to the art of utilizing a rotary mold for the casting of hollow metallic articles, preferably partly centrifugally; the invention being particularly applicable to the casting of annular articles of considerable length as compared with their diameter.

The present invention involves a new process and a novel apparatus which may advantageously be used in carrying out such process, and involves improvements on and additional discoveries relative to, and constitutes a continuation in part of, the original discoveries in rotary casting described in my application, Serial No. 280,452, formerly copending herewith and since matured into U. S. Letters Patent No. 1,329,295; all whereby the said original discoveries may the better be taken advantage of and the herein indicated advantages be realized.

The invention will be more clearly understood from the following description, when taken in connection with the accompanying drawings, showing the preferred apparatus which may be used to facilitate carrying out the process of the present invention.

In these drawings,

Figure 1 is a vertical axial sectional view of the new apparatus, certain distributer parts being shown in elevation,—and wherein the discharge end of the distributer is constructed pursuant to the principles of Fig. 3;

Fig. 2 is an enlarged top plan view of the discharge end of a distributer constructed pursuant to the discoveries of my aforesaid application, Serial No. 280,452, of which this application is a continuation,—the part of the mold shown being assumed to be rotating in the direction of the upcoming arrow 9;

Fig. 3 is a view similar to Fig. 2,—the mold being assumed to be rotating in the same direction as the mold of Fig. 2,—but here the discharge end of a distributer is shown constructed pursuant to the later discoveries of the present invention;

Fig. 4 is a fragmentary view, showing on an enlarged scale certain of the parts shown in Fig. 1, with very many of the parts of the distributer shown in section;

Fig. 5 is a fragmentary view based on Fig. 4 and showing the actual construction of the discharge end of the distributer in top plan;

Fig. 6 is a transverse vertical section taken on line 6—6 of Fig. 4;

Fig. 7 is a transverse vertical section, taken on line 7—7 of Fig. 8;

Fig. 8 is a side elevation of a part of the apparatus shown in Fig. 1, with certain of the water circulating parts omitted;

Fig. 9 is a top plan view of the apparatus shown in Fig. 1, with the parts to the left of Fig. 1, that is, the parts shown in Figs. 7 and 8, omitted;

Fig. 10 is a transverse vertical section, taken on line 10—10 of Fig. 9;

Fig. 11 is an end elevation of the apparatus, looking to the left of Fig. 9;

Fig. 12 is a detail view, showing the hood and catch basin for receiving surplus metal at the end of the casting operation, which parts are also shown in Figs. 1 and 9;

Fig. 13 is a side elevation of the parts shown in Fig. 12;

Fig. 14 is an enlarged detail view, partially diagrammatic, showing certain of the parts of Fig 8; and

Fig. 15 is a view similar to Fig. 5, but showing the discharge end of the distributer in side elevation, and showing also the action of the metal on leaving the discharge end of the distributer and during formation of the cast article.

Comparing first Figs. 2 and 3, different forms of discharge end for the distributer are shown. In both these constructions, as in the apparatus of Fig. 1 and Figs. 4 to 15, the mold, rotating in the direction of the upcoming arrow 9, is indicated at 45, and the distributer is indicated at 54. The axial canal of the distributer of all the figures is designated 76,—the end piece of the distributer of Fig. 2 being marked 77^a and the end piece of the distributer of Fig. 3 and also of the other figures being marked 77. The distinction between Figs. 2 and 3 resides in the indications and significances of the arrows 43 and 44, as will be described below, in a moment.

It should preliminarily, however, be ex-

plained here that the apparatus of my aforesaid application, Serial No. 280,452, involved, like the present apparatus (described in detail hereinbelow), the main features of a rotary mold, a metal distributer of the spout type adapted to project inside the mold and constructed and arranged for continuously discharging molten metal inside the mold, operating means for moving the distributer and mold relatively lengthwise of the mold, the discharge or spout end of the mold being so formed and arranged as to deliver the metal to the mold at one side only of the mold axis and in such wise as to lay the metal in the mold in successively deposited spirally related subdivisions, and movable feeding means, as a tilting reservoir, for delivering molten metal to the distributer adapted to be moved or tilted to vary the rate of delivery of molten metal to the distributer.

Now the construction of the discharge end of the distributer relative to the mold shown in Fig. 2 (which is approximately in accordance with the apparatus of my aforesaid application, Serial No. 280,452) is one which in practice has given fairly good results; but results inferior to those given by the use of the construction shown in Fig. 3, as will now appear.

It has just been stated that the discharge ends of the distributers of Figs. 2 and 3 differ chiefly in that the molten metal is discharged toward the mold 45 as indicated by the arrows 43 and 44. Of course the discharge piece of Fig. 3, as a result of its direction of discharge, has a greater radius of curvature, which is advantageous; but the distinction of main importance is that, while the stream discharged by the construction of Fig. 2 lies in a plane perpendicular to the axis of rotation of the mold 45, the stream discharged by the construction of Fig. 3 lies in a plane inclined relative to the perpendicular plane last mentioned and also relative to the vertical plane containing the axis of rotation of the mold. This construction of Fig. 3 as just described epitomizes one of the most important features, but however not the only feature of the present invention. In this connection, it may be explained that such new construction has successfully been employed to cast as good pipe as the pipe which have been cast with the apparatus disclosed in my aforesaid application, Serial No. 280,452, but also has been effective to overcome certain irregularities on the internal and external surfaces of the latter pipe. Of these irregularities on the internal and external surfaces of the pipe, the former are crustaceous or rubbled clusters of iron oxids or other impurities interspersed with half-globular protuberances of various diameters running up to perhaps $\frac{3}{32}''$, and the latter are overlapping striations of prematurely congealed metal somewhat resembling "cold shots" but actually being very superficial and a fraction of a millimeter in thickness. These internal irregularities are of course practically undesirable, as increasing the circulation friction of the pipe when later forming parts of pipe lines, and both the internal and external irregularities are commercially undesirable from the standpoint of the appearance of the pipe. By actual casting operations I have found that these internal and external irregularities may be always overcome if an apparatus is used in which the discharge end of the distributer is constructed pursuant to the principles of Fig. 3. And such a discharge end for the distributer is shown in the generally improved construction of Fig. 1, which will now be described.

Referring, then, to Fig. 1, and all its associated figures, the mold 45 is seen mounted for rotation on ball bearings 46. These ball bearings are preferably of the type shown in U. S. Letters Patent to me, No. 1,302,641, to avoid jamming of the parts when the mold expands radially at a greater rate than its journaling support, as occurs in practice; these ball bearings having their outer races secured to the mold and their inner races secured to the journaling support. This support is part of a jacket construction 47 providing an annular chamber 48 whereby the mold may be continuously water-cooled from end to end. At its left end the mold carries an annulus 49 which forms the end wall of the straight end of the pipe. At its right end the mold carries a shaped piece 50 for forming the external surface of the bell-end of the pipe and for removably holding a bell-core 51 and its carrier 52.

The jacket construction 47 is supported for axial sliding movement relative to a base construction 53 and the distributer 54 by means of four wheels 55 pivoted on the jacket construction and riding on rails 57 forming parts of the base construction 53.

The means for causing such sliding movement of the jacket construction 47, hereinafter called the mold-housing 47, comprises a cylinder 58 secured to the base construction 53 and having therein an annular piston 59 and an annular piston rod 60, the outer end of the rod being secured to a bracket 61 depending from the mold housing. Suitable means (not shown) are provided for at will admitting water to the left or to the right side of the piston to cause and control back and forth sliding movements of the mold housing.

Referring now to the means for water-cooling the mold, that is, for continuously maintaining a water circulation in the chamber 48, the bracket 61 is hollow and opens into annular piston rod 60 and into a conduit 62 (see Fig. 9). The water is fed con-

tinuously into the conduit 62 from the piston rod 60, the latter being fed by a conduit 63 surrounded slidingly by the piston 59 and the piston rod and secured at one end to base construction 53 as shown in Fig. 1 and open at the other end (not shown) inside the piston rod, so that when water is fed into said conduit 63, as indicated at 64, such water is delivered to the hollow bracket 61; irrespective of the movement or position of mold-housing 47. Conduit 62 leading away from the hollow bracket 61 communicates (see Figs. 9 and 10) with conduits 65 and 65ª leading to a valve 66 and thence to a short conduit 67 leading to the annular chamber 48 surrounding the mold. This water fills said chamber, preferably to maintain pressure as described in U. S. Letters Patent to me, No. 1,299,918, and overflows through a drain opening 68 (Fig. 1).

The mold is also rotated by water power, the means for the purpose including a Pelton wheel 69 fixed to the mold and operated (see Figs. 9 and 11) by a nozzle 70 communicating with hollow bracket 61 by way of conduits 71, 72, 73 and 74; the water discharging through drain-opening 75 (Fig. 1).

The canal 76 of the distributer 54 runs from end to end thereof and joins the canal in an end piece 77 acting as a discharge-spout, the distributer being fixedly mounted on the base construction at its end opposite the spout.

It will be noted that this discharge-spout is arranged to direct the stream of metal downwardly toward the mold, sidewise of the mold axis and substantially tangentially relative to the mold (as in Fig. 2), and also in a plane at an angle to a plane perpendicular to the mold axis (this latter feature being characteristic of the construction of Fig. 3 alone). As shown in Fig. 1, the free end of the spout may be bent down slightly.

Still referring in the main to Fig. 1 (but see also Figs. 7 and 8), the means for feeding metal continuously to the left end of the distributer includes a reservoir 78, having also the form of substantially a 90° segment of a cylinder and otherwise constructed similarly to the reservoir of the apparatus of my aforesaid application, Serial No. 280,452. This reservoir 78 is fixed on a pivot-shaft 79 journaled at the top of side standards 80 joined by cross-pieces 81 and 82 to which the adjacent end of the distributer is secured. The means for raising the reservoir 78 gradually is not here of the cog type, as heretofore suggested by me (in my aforesaid application, Serial No. 280,452), but comprises an arm 83 fixed on the pivot-shaft 79 and pivoted to the free end of a piston rod 84 of a hydraulically operated piston 85 working in a pivotally mounted cylinder 86. It is true that by this method of operating the reservoir, movement of piston 85 at a continuous rate of speed does not tilt the reservoir at a precisely uniform rate, since the free end of arm 83 swings through an arc when raising and lowering the reservoir between its limits of movement. The chord of this arc being vertical, as shown in Fig. 14, to which reference should also now be had, it follows that with the piston moving at a uniform speed, the reservoir first gradually increases its speed of tilt and then gradually decreases such speed, in passing from one extreme position to the other; but this trouble can easily be remedied by compensatingly shaping the refractory lining for the curved wall of the reservoir as indicated at 78′ in Figs. 8 and 14.

In order to compensate, also, for any tendency of the reservoir to tilt more and more rapidly as it is being emptied, due to the decreasing load on piston 85, an adjustable counterweight 87 (illustrated only in Fig. 10) may be provided and mounted on a bar 88 fixed to the reservoir so as to be vertically below pivot-shaft 79 when the reservoir is in its charge receiving position as shown.

In order to facilitate the making of long pipe (say 16′ x 14″), the distributer, since it is fixedly mounted only at one end and should have great rigidity from end to end, is desirably water-cooled around and below its canal 76; and for this purpose, may be water-cooled according to the water-cooling construction and principles described for the trough in U. S. Letters Patent to me, No. 1,276,038. For the making of pipe of comparatively small diameter, however, (say 12′ x 4″), a simpler, stiffer and remarkably efficient construction has been evolved, as shown in Figs. 4 and 6.

Referring to Figs. 4 and 6, then, such water-cooling for the distributer includes a tubular outer member 89 slotted at its top along its length to provide for the welding or brazing in place, against the side edges of the slot, of the upper edges of a rectangularly bent basket 90 as shown; the basket and slot running practically the entire length of the distributer. The basket is preferably bent up from a piece of thin sheet metal. In the basket is set a shaped member 91 (which may be unitary as shown or formed of several sections) providing the canal 76. Between the basket 90 and the tubular outer member 89 is provided a water-jacket chamber substantially U-shaped in cross-section. In the lower part of the chamber below the basket, a conduit 92 runs the length of the chamber, one end of the conduit receiving the cooling water from an inlet conduit 93 and the other end of the conduit 92 being open adjacent to the discharge end of the distributer. Outlets for the cooling water may be provided as indicated at 94 in Fig. 6.

In order to deliver molten metal from the reservoir 78 to the distributer at the high

velocity I have found desirable, while at the same time avoiding the necessity for inclining the entire machine downwardly toward the discharge end of the distributer (although for that purpose, or to increase the effect, such inclination may be resorted to), the pouring channel 95 of the reservoir is elevated above the receiving end of the distributer and a chute 96 is mounted on the distributer in position to receive the metal discharged from the reservoir and lead the same in an unbroken stream to enter and flow through the canal 76 at a substantially constant stream-cross-section while the mold is being rotated and moved axially; to this end the chute being preferably of gradually decreasing width as it approaches the distributer.

The floor of the chute 96 is preferably straight near its top, thereafter merging into a curve blending into a curved floor-part of the canal 76 at the receiving end of the distributer, as shown in Fig. 4.

In this regard, I have discovered that while lining the reservoir 78 with refractory material is desirable as described in connection with Fig. 1, entirely satisfactory results are obtained when the metal-guiding surfaces of the chute 96 and distributer 54 are of cast iron, coated with ordinary blackwash or blackwash plus an admixture of powdered carborundum.

Referring now to Fig. 15, let us examine the result of designing and inclining the discharge-spout of the distributer as shown and described in connection with Fig. 3. Now with the discharge-spout at the bell-end of the mold, at the commencement of the casting of a pipe, the mold-housing 47 is stationary, the mold rotating in the direction of the arrow 97. As soon as the bell is formed, however, the relative movement between the mold-housing and the distributer commences, the piston 59 being actuated for the purpose; the feeding of metal of course continuing uniformly until the mold-housing has traveled far enough in the direction of the arrow 98 to dispose the discharge-spout to left of the left end of the mold and consequently to finish the pipe. During this movement of the bell-end of the mold away from the discharge-spout of the distributer, the pipe is continuously built up by the deposit of new metal in the mold at each instant somewhat as indicated by the dot-and-dash line 99. That is, most of the metal piles up toward the bell-end of the pipe and away from the discharge-spout, which in turn means that most of the metal piles up on the hot metal already deposited in the pipe and so does not prematurely congeal against the water-cooled, chill mold to form the superficial external striations above mentioned. Therefore the external surface of the pipe is made very smooth, almost glassy. Again, by inclining the discharge-spout thus at an oblique angle to a plane perpendicular to the axis of the mold, the metal is delivered in such a way that of the new metal 100 at any instant being delivered to the mold, the most oxidized part is deposited and remains on top of the just previously deposited metal 101; the purest part of the metal stream 102, that is, the part which was running along the bottom of the canal 76 of the distributer, alone coming in contact with the mold. Such iron oxids and other impurities as had entered into the constitution of the pipe, are deposited within or on the hot metal previously deposited; and the internal clusters of crustaceous or rubbled irregularities disappear. In order to make this point very clear, the stream 102 and the metal 100 as shown in Fig. 23 are stippled, in such a way that the more dense the stippling the more impure the metal. The half-round protuberances above referred to have also been found to be avoided by using an apparatus constructed like that of Fig. 11, the spout inclination described being largely responsible, since most of the latest metal 102 impinges against the hot mass of previously deposited metal 100 and whirls along the latter in a spiral path of constantly decreasing diameter as the particles of the metal 102 approach the congealing point. In this way, no doubt added to by the velocity of the stream 102, which velocity is increased by the presence of chute 96, the creation of a storm of flying particles of molten metal in the vicinity of the stream 102 is prevented—the creation of which particles, it has been found, being responsible for the half-round protuberances found on the interior of the pipe when using the apparatus of Fig. 1, as these particles partially congeal before coming to rest against the inner surface of the pipe being formed, which pipe is also in the meantime partially congealed. Very good results have been obtained when such velocity is extremely high, especially with the parts so arranged, that, as has been discovered in practice, the stream 102 becomes as much reduced in cross-section in comparison with the cross-section of its feeding stream running along the canal 76 of the distributer, as would be indicated by the relative sizes of the broken-line circles 103 and 104; the former indicating the approximate cross-sectional area of the stream 102 and the latter indicating the approximate cross-sectional area of the stream in the canal.

Hereinabove, in discussing and explaining the preferable arrangement for water-cooling the distributer as shown in Figs. 4 and 6, it was explained that such water-cooling was desirable for pipes of comparatively

small diameter, as 4″; it of course being clear that the smaller the diameter of the pipe the smaller the outside permissible diameter of the distributer in that part of the latter within the mold at any time during the casting operation.

In order, however, to give added security to the discharge end of the distributer when even smaller pipe is to be made, as say pipe of only 2″ diameter, there is provided a supporting means for the end of the distributer adjacent to the discharge-spout which is characterized by the fact that that end of the distributer is actually supported by the mold—an advantage permitted chiefly because of the construction of the discharge-spout just described, resulting in the discharge of most of the metal at any instant being delivered by the discharge-spout, away from the discharge-spout—yet not supported by the mold in such a way as to interfere with the constant rotation of the mold at the desired speed. In other words, the discharge end of the distributer is in fact supported by the mold but is not in direct contact with the mold. Such supporting means includes a pair of collars fixed on the distributer as shown in Figs. 4 and 5, one of which collars is formed as a part of the discharge-spout 77 and the other of which, 105, is fixed on the distributer, said supporting means further including a loose annulus or roller 106, interposed between the two collars and adapted to revolve freely relative to the distributer, during the entire casting operation.

Referring to Figs. 12 and 13, the following parts are provided to avoid centrifugal dispersion beyond the bounds of the apparatus, of molten metal accidentally issuing from the discharge-spout, when the mold-housing 47 of Figs. 1 and 9 is at the extreme limit of its travel to the right and the pipe is finished and the discharge-spout is to the left of the left-end of the mold. These parts are a hood 107 permanently bolted to the mold-housing, and a catch-basin 108 having handles 109 whereby the catch-basin may be detachably suspended from dependent hooks 110 fixed on the hood.

In closing this specification, it should be pointed out that the distributer of any embodiment need not be substantially coaxial with the mold, and if placed eccentric, a curved or bent discharge-spout may even be dispensed with since then obviously, the metal will be delivered sidewisely of the mold-axis pursuant to the invention. Also, attention should be directed to the fact that the process and apparatus of the present invention are not to be limited to casting where the mold is on a particular axis, as horizontal or substantially horizontal as illustrated; but, on the contrary, the invention may be carried out with the mold and distributer on substantially vertical axes—provided the distributer and other parts above the discharge-spout are suitably designed.

I claim:

1. The process of casting an annular metallic article in a rotary mold, which consists in laying the metal in the mold in successively deposited spirally related subdivisions while guiding the flow of the metal adjacent to the mold to cause the metal to flow tangentially toward the mold only at one side thereof at an angle to the mold axis and at an angle to a plane perpendicular to the mold axis.

2. The process defined in claim 1, wherein such line of flow is directed toward the end of the article to be formed at the commencement of the casting.

3. The process defined in claim 1, wherein such line of flow is directed toward the end of the article to be first formed and such direction of flow is maintained throughout the casting of the article.

4. The process defined in claim 1, wherein the last-mentioned angle is more than 10 degrees.

5. The process defined in claim 3, wherein the last-mentioned angle is more than 10 degrees.

6. The process of casting an annular metallic article in a rotary mold, which consists in laying the metal in the mold in successively deposited spirally related subdivisions while guiding the flow of the metal adjacent to the mold to cause the metal to approach the mold in a path at one side of the mold axis and at an oblique angle to the mold axis.

7. The process of casting an annular metallic article in a rotary mold on an axis nearer the horizontal than the vertical, which consists in laying the metal in the mold in successively deposited spirally related subdivisions while guiding the flow of the metal adjacent to the mold to cause the metal to approach the mold in a descending path intermediate a vertical plane containing the axis of the mold and a plane perpendicular to said axis.

8. The process of casting an annular metallic article in a rotary mold, which consists in laying the metal in the mold in successively deposited spirally related subdivisions while guiding the metal adjacent to the mold to cause the metal to flow against the mold in a substantially solid stream at such a speed, and at such an inclination of stream flow relative to the inner periphery of the mold and its direction of rotation, that the velocity of the stream as it impinges against the mold is great enough to insure that practically all the metal at any instant being delivered to the mold is flung against the mold and travels under its own momentum with the mold's inner periphery

at least until the combined effect of centrifugal force and inter-molecular friction within said metal functions to maintain said metal fixed relative to previously deposited metal, which consists further during the casting of such article in continuously supplying molten metal to maintain said flow substantially uniform at all times, which consists further in maintaining said supply by guiding and confining said metal in a descending preliminary flow running from a point a considerable height above the point where the metal is delivered to the mold, and which consists further in holding said descending flow to continuously decreasing width as it descends to maintain its cross-section uniform at all points along its length at all times during the continuous supply of the metal at a uniform rate to the upper end of said descending flow.

9. In a rotary casting machine, the combination of a rotary mold, a distributer adapted to project inside the mold and constructed and arranged for continuously discharging inside the mold molten metal supplied to the distributer, said distributer adjacent its discharge end portion being entirely out of sliding contact with any part of the inner periphery of the mold, and operating means for moving the distributer and mold relatively lengthwise of the mold, there being provided an annular member sleeved rotatively on the distributer intermediate its ends and interposed between the distributer and the mold.

10. In a rotary casting machine, the combination of a rotary mold, a distributer adapted to project inside the mold and constructed and arranged for continuously discharging inside the mold molten metal supplied to the distributer, said distributer at its discharge end having an outlet passage at one side of the mold axis for discharging the metal in a stream to one side of said axis, the distributer between its discharge and supply ends being elongated and provided with an elongated guiding and confining passage, and means for water-cooling said passage at all times during the casting.

11. The casting machine defined in claim 10, wherein said passage is of uniform cross-section from end to end, and said cooling means is formed and arranged to cool said passage substantially uniformly from end to end.

12. In a rotary casting machine, the combination of a rotary mold, a distributer adapted to project inside the mold and constructed and arranged for continuously discharging inside the mold molten metal supplied to the distributer, said distributer at its discharge end having an outlet passage at one side of the mold axis for discharging the metal in a stream to one side of said axis, and operating means for moving the distributer and mold relatively lengthwise of the mold, said discharge passage being in top plan substantially at an oblique angle to the axis of the mold.

13. In a rotary casting machine, the combination of a rotary mold, a distributer adapted to project inside the mold and constructed and arranged for continuously discharging inside the mold molten metal supplied to the distributer, said distributer at its discharge end having an outlet passage at one side of the mold axis for discharging the metal in a stream to one side of said axis, and operating means for moving the distributer and mold relatively lengthwise of the mold, said discharge passage being also so formed and arranged as to discharge the metal in a constricted stream directed at an oblique angle relative to a plane transverse of the mold axis and inclined toward the first-formed end of the article to be cast.

14. The casting machine defined in claim 12, wherein said discharge passage is also so formed and arranged as to discharge the metal in a constricted stream directed at an oblique angle relative to a plane transverse to the mold axis and inclined toward the first-formed end of the article to be cast.

15. The casting machine defined in claim 13, wherein said discharge passage is also so formed and arranged as to discharge the metal in a constricted stream directed at an oblique angle relative to a plane transverse to the mold axis and inclined toward the first-formed end of the article to be cast.

16. The casting machine defined in claim 12, wherein the distributer between its discharge and supply ends is elongated and provided with an elongated guiding and confining passage in the nature of a canal and merging into said discharge passage, such canal being of substantially the same cross-section from end to end, and wherein the distributer is also provided with a descending supply passage for the canal, said discharge and supply passages and the canal being so inclined and disposed and of such cross-sections relative to each other that with metal continuously supplied at a uniform rate to the upper end of said supply passage the cross-section of the metal flow at the point of merging of the supply passage and canal is not in excess of the cross-section of the canal and the discharge passage at any point along either and the velocity of flow of the metal at the last-mentioned point is substantially the same (that is, the same, less friction) as such velocity at the discharge end of the discharge passage.

17. In a rotary casting machine, the combination of a rotary mold, a distributer adapted to project inside the mold and constructed and arranged for continuously discharging inside the mold molten metal supplied to the distributer, said distributer at

its discharge end having an outlet passage at one side of the mold axis for discharging the metal in a stream to one side of said axis, the discharge end of the distributer being so shaped and disposed relative to the shape and disposition of the other metal guiding parts of the distributer, and so located relative to the axis of the mold, that subdivisions of the metal in the stream discharged beyond the distributer continuously move angularly relative to other subdivisions of the metal in the part of the last-mentioned stream continuously presenting itself to the inner periphery of the mold, so that the stream continuously first congeals against the mold in that portion of the stream constituted by metal least theretofore subjected to atmospheric exposure during the passage of the stream within the limits of the distributer.

Signed at New York, in the county of New York and State of New York, this 23rd day of October, A. D. 1919.

DIMITRI SENSAUD DE LAVAUD.