May 10, 1938. D. E. JONES 2,116,630

METHOD OF CASTING TUBULAR MEMBERS

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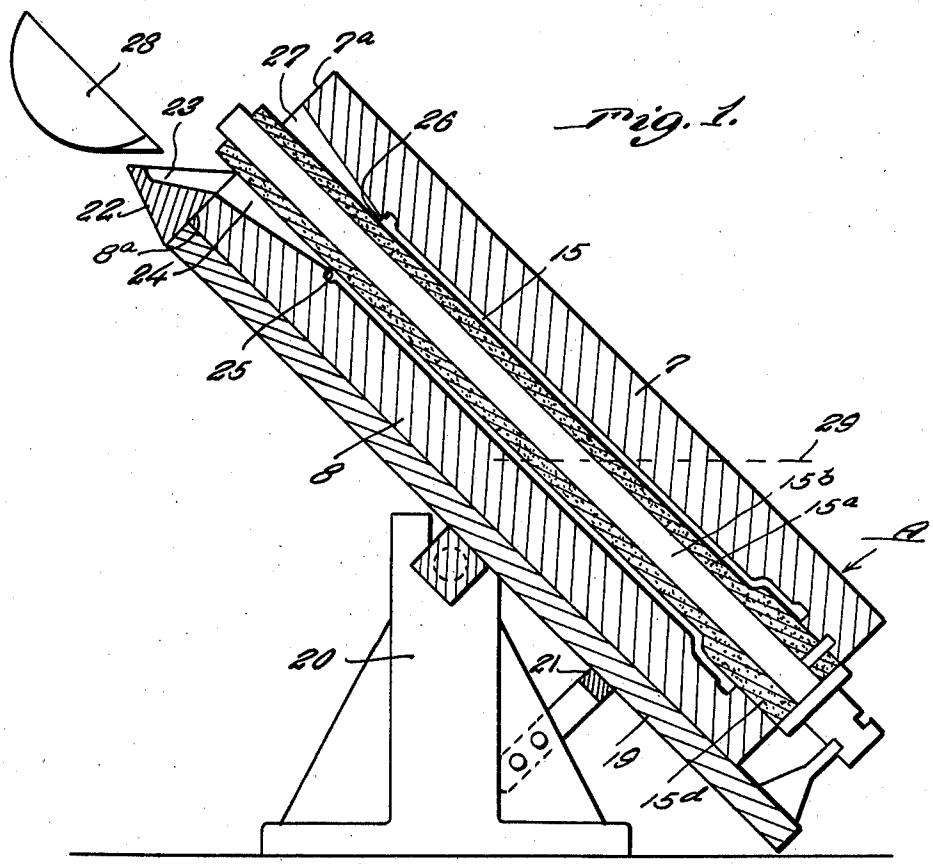


Fig. 1.

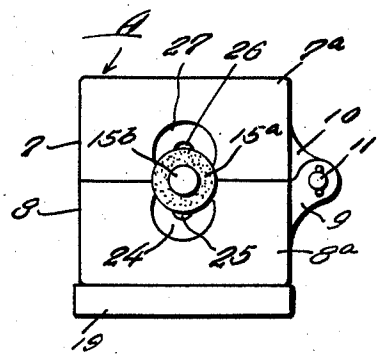


Fig. 2.

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Fig. 3.

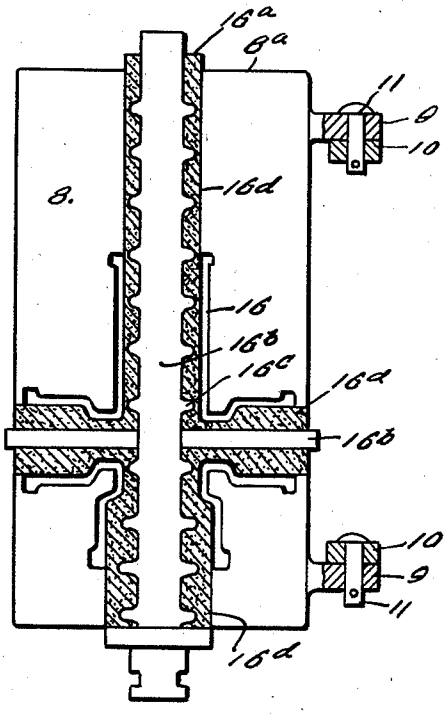
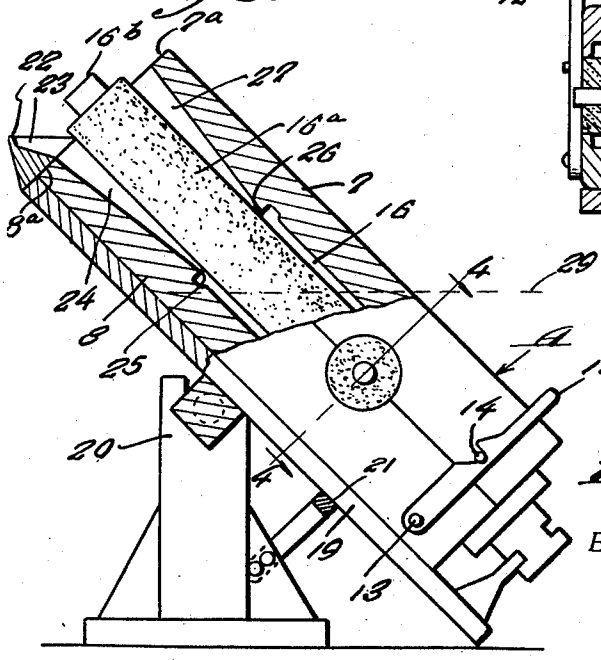


Fig. 5.



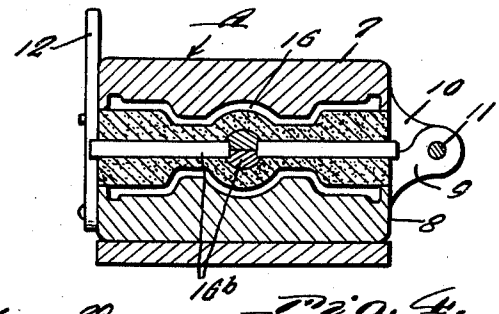


Fig. 4.

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METHOD OF CASTING TUBULAR MEMBERS

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Application August 29, 1936, Serial No. 98,592

4 Claims. (Cl. 22—209)

This invention relates to a method of casting tubular members such as soil pipe and fittings in molds.

The primary purpose of the present invention is to eliminate the risks and hazards accompanying the practice of pouring molten metal in cored molds so that it will strike the core in the mold cavity during its fall. In the practice where the core is situated in the path of the freely falling stream of metal, the sand will spall from the core where the stream of metal cuts it. It sometimes happens that all the sand will drop free of the metal arbor on which the sand core is formed because the falling stream of molten metal cuts the sand to a depth of the arbor. In the former case the sand spalls cause sand holes resulting in defective castings, and in the latter case develops a "drop-out" which destroys the casting. To overcome these defects the present invention aims to dispose the axis of the mold cavity at an angle to the freely falling stream of molten metal and introduce the molten metal at the lowest point at the upper end of the mold cavity so that the pouring stream will flow down the lowest line of the mold cavity to the lowest point of the mold without striking the core from which lowest point the metal fills in the mold cavity with the minimum of wash against the core. Should the core happen to spall or drop out in practicing the present invention the spalled sand will float on the top of rising column of metal in the mold cavity and collect in the gate or in the metal in the vent both of which are normal discards in foundry practice.

In foundry practice venting the gas during the pouring operation has always been a source of annoyance and expense. Without proper vents gas pockets and blow holes appear as defects in the finished castings. The planning of the position of vents requires unusual skill to maintain the cost of foundry practice within the limits of market prices. Another object of the present invention is to promote proper venting. In pouring the members in accordance with the present invention all gas will accumulate at the highest point of the mold cavity from where it is vented with the minimum of expense thereby providing ideal conditions for venting.

Further objects of the present invention are to devise a method which enables uniform metal distribution and definite weight, contour and surface in the finished casting, that may be performed in the minimum of foundry space, which provides a commercially perfect casting, and that materially reduces manufacturing costs.

With the foregoing and other objects in view the invention consists of a novel arrangement of parts and sequence of steps as will more fully appear from the specification and illustrations in the accompanying drawings, but it is to be understood that changes, variations and modification may be resorted to without departing from the spirit of the claims hereunto appended.

In the drawings wherein like numerals indicate like parts throughout the several views:—

Figure 1 is a detailed vertical section through a straight pipe mold assembled for practicing the present invention.

Figure 2 is an end view of the mold in Figure 1, removed from the support and looking at the end through which the molten metal is poured with the pouring basin removed.

Figure 3 is a sectional plan taken on a plane between the lower or drag section and the upper or cope section of the mold shown in Figure 5 and looking at the upper face of the drag section.

Figure 4 is a detailed section taken on the plane of line 4—4 of Figure 5 and looking in the direction of the arrows.

Figure 5 is a side elevation partly broken away of an assembled mold wherein a cross fitting is ready for casting in accordance with the present invention.

In carrying out the method of the present invention the practice permits the use of permanent iron molds made in matching sections which may be separated from each other in any convenient way to assemble the mold for pouring and to remove the casting after pouring. It will be understood that the method is equally adapted for casting in sand molds and other related type of mold. I prefer to use permanent iron molds because it is recognized in the trade, that castings made in iron molds have smoother surfaces than those cast in sand molds, while uniformity of wall thickness and the weight of the casting can be controlled to a greater degree. Further, in carrying out the present invention green sand cores are used, and while dry sand cores may be used with favorable results it is the desire of all foundry practice to use green sand cores because they are cheaper. The objection to green sand cores is based on their tendency to spall and "drop out" in the mold during pouring, but in practicing the method of the present invention the likelihood of such action is rendered negligible. It follows then that the present invention permits the employment of two desirable factors in foundry practice the use of permanent sectional iron molds and green sand cores.

Although the method of the present invention is illustrated in connection with casting straight soil pipe and cross fittings in iron, the invention is adaptable for casting angular fittings and shapes other than cross shape and in any metal. In the case of casting cross-shaped fittings, as long as it is unnecessary to situate an arm or branch of the fitting in the path of the stream of molten metal flowing down the lowest line of the main or stem portion of the fitting, such fitting may be cast by the present invention. In casting angular fittings or bends by the present method the rate of pouring may be diminished as compared to pouring straight tubular members so as to permit the metal to flow around the corner of the bend without appreciable clogging at the angle. In casting all forms of the tubular members by the present invention, foundry practice developed by me, will permit the mold to be supported so that the stream of molten metal flowing down the line of the lowest part of the wall of the mold cavity will not impinge against the core until the lowest part of the mold cavity is reached.

In Figures 1 and 2 the method of the present invention is illustrated in connection with casting a straight soil pipe, while in Figures 3, 4 and 5 the method is illustrated in casting a cross-shaped fitting for soil pipe. In all of the views A indicates a permanent mold preferably made of cast iron which in the assembled form resembles a block that is sometimes rectangular and sometimes square in configuration depending on the character of members being cast in the mold. The mold A is made in sections which separate from each other in any convenient way to permit the mold to be assembled and the member cast therein knocked out with ease and dispatch. The two sections divide the mold body horizontally into the upper or cope section 7, and the lower or drag section 8. In the forms illustrated the one side of the drag section 8 has spaced lateral apertured hinge ears 9 which coact with like ears 10 on the cope section and in these ears are detachably seated the hinge pins 11 whereby the cope section may be swung on the hinge pin to open or closed position. In the closed position the mold sections may be locked together by the latch arm 12 pivoted at one end, as at 13, to the drag section 8 and engaging a keeper pin 14 on the cope section.

While I have shown the mold sections 7 and 8 hinged together to facilitate opening and closing the mold with ease and dispatch, it will be understood that the molds may be opened and closed in any manner adaptable to foundry practice. Other ways of locking the mold sections together may be used beside the latch arm 12 and the keeper pin 14 shown in the drawings.

The confronting faces of the cope and drag sections 7, 8 respectively are provided with a recess of predetermined configuration which when the mold sections are closed match each other to form the mold cavity 15 for straight soil pipe as shown in Figures 1 and 2, and the cruciform mold cavity 16 for the cross fitting as shown in Figures 3, 4 and 5. Supported in the cruciform cavity (as will presently appear) in Figures 3, 4 and 5 is a cruciform green sand core consisting of an outer layer of sand 16a packed and tamped to the proper outside configuration to firmly adhere to a central metal arbor bar 16b also of cruciform configuration, the latter being provided with lateral fins 16c to supply additional anchorage for the green sand. Green sand denotes sand in moist condition and having a property of being deformed as distinguished from the rigid cores produced by drying the sand cores in ovens prior to assembly in the mold cavity. A core is also mounted in the straight pipe mold cavity 15 in Figures 1 and 2 consisting of an outer layer of sand 15a anchored to a metal arbor bar 15b.

As is customary in foundry practice the ends of the mold cavity whether it be a straight or cruciform mold cavity 15 or 16 respectively, are the same size and conformably fit snugly about the end of the core. In the type shown in Figures 1 and 2 these tight fitting parts are shown at 15d, and in the cruciform type in Figures 3, 4 and 5 these tight fitting ends are indicated at 16d. These tight fitting end portions 15d and 16d prevent the molten metal from running out of the mold cavities 15 and 16 respectively which lie between. The tight fitting portions 15d and 16d secure the core fixed in the mold when the mold sections are in the locked relation shown in Figures 1, 2, 4 and 5. The intermediate portions of the cores are spaced from the mold cavity walls and in this space is poured grey iron in the molten state until the mold cavity is filled. When the metal chills it congeals against the mold cavity walls surrounding the core after which the mold sections are separated, the casting removed and the core is removed from the interior of the tubular member by breaking the sand away from the metal arbor.

The mold A is mounted on a platform 19 and the platform is supported on the frames or standards 20. In normal position the molds A are supported on a horizontal plane. The cores are assembled in the drag section 8 of the molds, in both forms of the application shown, while the mold is in the horizontal position. The cope section 7 is then closed and latched. Then the platform 19 carrying the closed mold is tilted to an angle where one end of the platform rests upon an abutment or stop 21 on the upright 20. The supporting arrangement holds the molds A in stationary position at an angle to the horizontal. In the form of the invention where the straight pipe is being cast, as in Figures 1 and 2, the axis of the mold cavity 15 is disposed at an angle to a horizontal plane and also at an angle to the path of a freely falling stream of molten metal. In the cross fitting illustrated in Figures 3, 4 and 5 the axis of the mold cavity 16 which forms the stem or main portion of this fitting is disposed at an angle to a horizontal plane and the opposed branches extend in a direction perpendicular to the main part or stem. The angle on which the axis of the mold cavity 15 and the stem or main part of the mold cavity 16 are disposed has given the best results at 45 degrees to a horizontal plane although it is within the contemplation of the invention to use any angle between the limits of 30 and 75 degrees should factors such as rate of pouring, adaptation to casting machines, and rigidity of cores warrant the change.

With the molds A disposed so that the axis of cavity 15 and the axis of the stem or main portion of cavity 16 is positioned at the preferred angle of 45 degrees relative to the path of freely falling molten metal, or to a horizontal plane, the grey iron in molten state is ready for introduction into the upper end of the mold. For this purpose a pouring basin 22 is detachably mounted on the upper or highest end 8a of the drag section 8. The sump 23 in the basin registers with a channel or runner 24 formed in

the upper face of the drag section 8. The runner 24 is segmental in cross section, extends axially of the mold cavity and diminishes in width and depth uniformly from its outer to its inner end where it registers with the small segmental port or gate 25. In the form of the invention explained in Figures 1 and 2 the gate 25 registers with the upper end of the mold cavity 15 and it will be seen that this gate 25 is in alignment with a vertical plane passing through the axis of the mold cavity 15. In the form of the invention disclosed in Figures 3, 4 and 5 it will be seen that gate 25 is in alignment with a vertical plane passing through the mold cavity 16 along the main part or stem of the cross fitting. It is further pointed out that molten metal passing through the gate 25 in both forms of the invention enters the lowest point of the upper end of the mold cavities 15 and 16 and is free to follow the line along the lowest points in the mold cavity walls underneath the core until it reaches the lowest point or bottom of the mold cavity from where the metal begins to fill the mold in a slowly rising column.

The present invention presents ideal venting conditions for gas generated in the pouring operation. For this purpose a port or vent opening 26 of segmental shape is made in the cope section 8 which vent opening registers with the highest point of the mold cavity 15 in the form of the invention explained in Figures 1 and 2, and although the vent opening 26 is situated at the highest point of the main part or stem of the mold cavity 16 in the form of the invention in Figures 3, 4 and 5, due to the angular disposition of the mold cavity 16, it will be seen that this vent is also at the highest point of the upper end of the mold cavity 16. The vent opening 26 registers with the inner end of the vent channel 27 formed on the inner face of the cope section 7. This vent channel is segmental in shape, opens out of the upper end 7a of the cope section 7, and diminishes uniformly in size from its open outer end to the vent opening 26. The vent opening is in alignment with a vertical plane passing through the axis of mold cavity 15, and is likewise aligned with a vertical plane passing through the axis of the main part or stem of the mold cavity 16.

During the pouring operation the molds remain stationary on the platform 19 and they are not moved until the molten metal has been chilled to a predetermined point. The molten grey iron metal is poured from the ladle 28 into the basin 22 from where the pouring stream passes through gate 25 into the mold cavity 15 or the mold cavity 16. In the form illustrated for straight pipe in Figures 1 and 2, the metal follows the lowest line of the mold cavity 15 until it reaches the bottom where the tight fitting portion 15d of the core closes the mold cavity from where the column of metal rises in the mold cavity 15 until the mold cavity is full. In pouring the form of the invention where the T-shaped fitting is shown in Figures 3, 4 and 5, the pouring stream enters the lowest point at the upper end of mold cavity 16, passes down the line of the lowest point of the main part or stem until it reaches the tight fitting part 16d of the core on the stem. From this point the column of metal fills the cavity 16 to a point where the lateral branches of the T-shaped fitting join the main part or stem and as the metal rises they are completely filled, after which the remaining or upper part of the stem is filled. It is pointed out that the pouring stream passing down the lowest part of the main part or stem of the T-shaped fitting in mold cavity 16 never reaches a cross-sectional area of such proportions that metal will enter the lateral branches until the column of metal rising in the lower portion of the stem reaches the joint of the branches. Since the vent opening 26 is at the highest point at the upper end of the mold cavity 15 in the straight pipe mold shown in Figures 1 and 2, and at the highest point of the main part or stem, which is above the highest point of the lateral branches in the molds for the cross-shaped fittings illustrated in Figures 3, 4 and 5, the one vent opening 26 for each type serves to release gas during the entire pouring operation. It will be seen that since the axis of the mold cavities 15 and 16 is disposed at an angle preferably at 45 degrees, the level of the rising column of metal will follow the plane indicated by the dotted line 29.

The permanent mould pipe or fittings are taken from the mold at yellow or bright orange color, when their outer surface has set or chilled, and before the elements in the metal have changed, with the interior still in partial solution which immediately starts an annealing action on the outer surface overcoming any possible chill. Further, the casting produced in a machined and polished iron mold have a perfectly smooth contour and finish just like the mold. When withdrawn from the mold with the outer surface set, the still molten interior of the casting starts to cool or set and expand against the rigid exterior, which exercises a counter pressure against the rigid exterior compressing the grain and rendering a fine structure, and materially increasing the tensile strength as compared to castings produced in sand molds.

I am aware that it is old in the prior patent art to pour ingots or solid castings from the highest end with the mold cavity at an angle to the falling stream of metal so the stream of metal will follow the lowest line of the wall of the mold cavity, but such procedure was to accomplish a different purpose. My problem was casting tubular not solid castings. In such practice it was to protect the bottom of the mold and prevent cutting, or to overcome segregation and piping or shrinking. However, in such practice the upper end of the mold was entirely open and presented the only feasible entrance through which to pour the metal and there were no cores to obstruct the pouring operation, nor was there any core to spall or drop out of the mold. In order to introduce the metal at the upper end of the mold in the present method, it was necessary to deviate from known foundry practice and modify either the customary mold or the core. Furthermore, the crux of the present invention resides in introducing the metal under the core so that the pouring stream will not impinge on and cut the sand from the core, a problem that never confronted the practice of casting ingots and solid castings.

I am also familiar with centrifugal methods of casting tubes where the molds are disposed at an angle. In this practice no core is used. It would be impossible to use a core because the pouring trough moves through the space ordinarily occupied by the core and the mold rotates. The present invention is accomplished by using stationary molds and overcomes the handicaps and pitfalls flowing from the use of cores.

Having described my invention what I claim is:—

1. A method of casting tubular members in a gas impervious stationary mold cavity having a core extending entirely through the mold cavity comprising disposing the mold cavity at an angle to the horizontal less than a right angle, introducing molten metal into the upper end of the mold cavity beneath the core through a pouring gate without changing the lateral direction of the pouring stream as it flows through the pouring gate, and venting the mold cavity through a separate passage above the core at the upper end of the mold cavity.

2. A method of casting tubular members in a gas impervious stationary mold cavity having a gas impervious core extending entirely through the mold cavity comprising forming the mold in which the mold cavity is made in separable parts, disposing the assembled mold with the mold cavity at an angle to the horizontal less than a right angle, introducing molten metal into the upper end of the mold cavity beneath the core through a single pouring gate without changing the lateral direction of the pouring stream as it flows through the pouring gate, and venting the mold cavity through a single separate passage above the core.

3. A method of casting tubular members comprising forming the mold cavity of gas impervious material in separable parts and with the mold cavity open at the ends, extending a gas impervious core entirely through the mold cavity with portions of the core sealing the open ends of the mold cavity, disposing the mold cavity at an angle to the horizontal less than a right angle, introducing molten metal into the upper end of the mold cavity beneath the core through a pouring gate without changing the lateral direction of the pouring stream as it flows through the pouring gate, and venting the mold cavity through a separate passage at the upper end of the mold cavity above the core.

4. A method of casting tubular iron members in a stationary separable gas impervious mold wherein a gas impervious sand core extends entirely through the mold cavity comprising disposing the stationary sand cored mold cavity at an angle to the horizontal less than a right angle, introducing molten iron into the lowest point of the upper end of the mold cavity beneath the sand core through a single pouring gate without changing the lateral direction of the pouring stream as it flows through the pouring gate, and venting the mold cavity through a separate passage at the highest point at the upper end of the mold cavity and above the core.

DONALD E. JONES.