

June 19, 1956

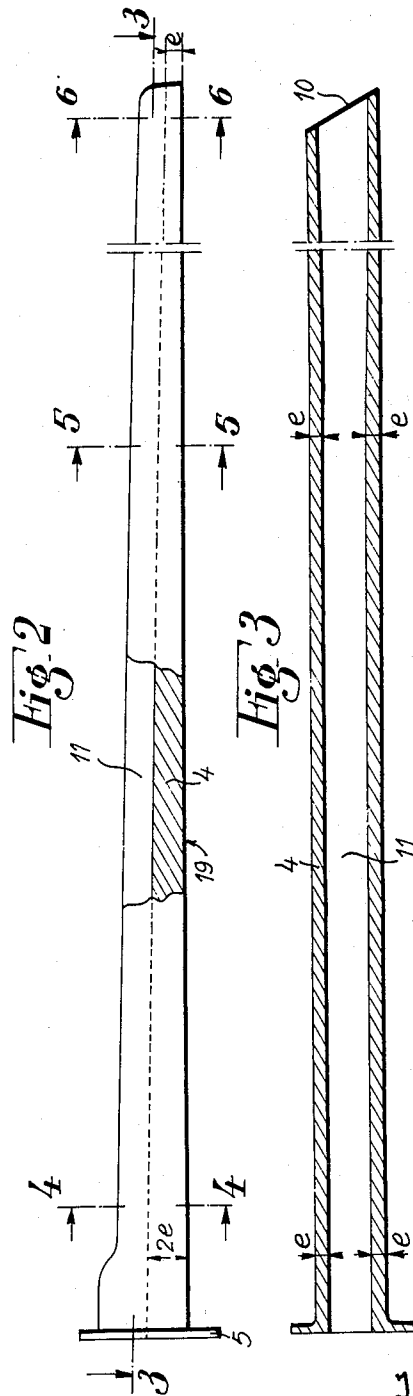
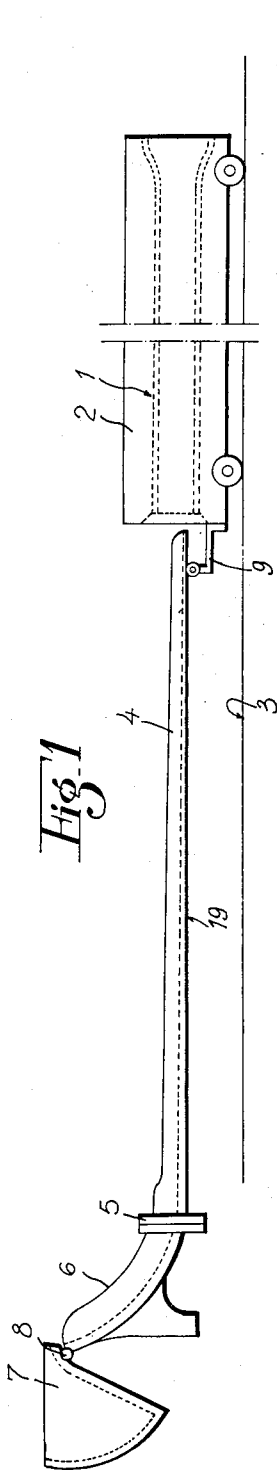
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2,750,639

FEED-TROUGH FOR CENTRIFUGAL CASTING MACHINE

Filed Jan. 5, 1953

2 Sheets-Sheet 1



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2,750,639

FEED-TROUGH FOR CENTRIFUGAL CASTING MACHINE

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Application January 5, 1953, Serial No. 329,535

Claims priority, application France January 10, 1952

5 Claims. (Cl. 22-79)

The present invention relates to feed-troughs for centrifugal casting machines.

In the manufacture of pipes and the like of, in particular, cast iron by the centrifugal casting process, it is known to employ machines having a rotative metal mold in which the molten metal is conducted by a trough that is inserted in the rotative mold, the trough and mold being subjected to a relative longitudinal translatory movement.

A centrifugal casting trough should satisfy the following requirements:

- (1) Its outer dimensions should be such that it can enter the mold.
- (2) Since its outer dimensions are thus determined, it should be light while being as rigid as possible.
- (3) It must not distort under the effect of expansions due to heat.

In general there is no need to be concerned over much with the possible deflection of the trough due to its weight and that of the metal it contains.

Generally speaking, the centrifugal casting machine includes at the rear a support on which the trough slides, which prevents excessive deflection of the latter when it is outside the mold and centers it in the opening of this mould. Then, when the whole of the trough is inside the mold the lower end of the trough (with respect to the direction of flow of the metal), which sags under the action of the weight of the iron, may rest in the mold and to this end is often provided with a rubbing ring in very hard metal. In any case, this deflection at the end of the trough does not exceed one or two centimetres and may be neglected for a trough of some length (six metres for example).

More serious, however, is the effect of the expansions resulting from the rise in temperature which occurs when the molten metal flows through the channel of the trough.

To overcome the difficulties inherent in the expansions, a trough in steel is usually employed that has a channel which is provided along its entire length with short segments in metal or a refractory material. These segments prevent too great a distortion by curving that results from increase in temperature. In this arrangement the expansion only affects the short segments or elements and the difference in the elongation of the different fibres remains small so that due to the independence of the segments, the trough practically does not distort under the action of heat.

But apart from the fact that troughs having segments are relatively costly owing to the necessary machining of the trough and the short life of the segments, they possess another serious defect. They do not allow the trough to be rotated 180° about its longitudinal axis whereby the half-solidified strip of metal remaining in the bottom of the channel may be tipped out, unless these segments are secured to the trough with complicated devices which render still more difficult the replacement of these segments.

On the other hand, if the attached refractory segments

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are dispensed with to facilitate the turning over of the trough and a single-piece metal trough is used, there occur, due to the great differences in the heating of the extreme fibres of the trough, large differential expansions resulting from the great length of these fibres, which is in fact the length of the trough. These expansions either provoke an upward or downward curving of the trough when the end of the trough is free (which for troughs of six metres in length may constitute deflections of ten to twenty cm. or more at the trough end or they provoke considerable internal stresses which render such troughs absolutely useless when the distortions of the trough are limited by the mold in which it is disposed, firstly because they jam inside the mold and, secondly, because large variations in the molten metal supply during the pouring occur which result in irregularities in thickness of the pipe.

Further, when the trough curves upward, overflow could occur in the lower part of the channel.

The invention has for its object to provide an improved single-piece trough for a centrifugal casting machine for pipes and in particular pipes having a diameter between fifty and five hundred millimetres and a length anything up to six metres or more, this trough being practically free from any curving distortion due to heat and ensuring in consequence a regular flow or supply of the iron or other molten metal during the whole of the pouring period. This trough is, moreover, adapted to be used with a rotating device for its cleaning after pouring.

The invention has also for its object to provide a machine for centrifugal casting improved so as to make use of the aforementioned pouring trough.

The features and advantages of this invention will be apparent from the ensuing description and from the accompanying drawings, it being understood that the detailed description and drawings are merely illustrative of the invention.

In the drawings:

Fig. 1 is a view in side elevation of the general arrangement of a centrifugal casting machine improved in accordance with the invention.

Fig. 2 is a view in side elevation with a cut-away portion of a feed-trough in accordance with the invention.

Fig. 3 is a longitudinal section of this trough on line 3-3 of Fig. 2.

Figs. 4 to 6 are cross-sections of the trough on lines 4-4, 5-5, 6-6 respectively of Fig. 2, but to a larger scale.

Fig. 7 is a diagram showing the three cross-sections of Figs. 4 to 6 superposed.

In the construction shown in Fig. 1, the centrifugal casting machine for pipes, for example pipes having a diameter of the order of 100 mm. or more and a length of the order of six metres or more, comprises as known per se, a mold 1 rotatively mounted in a carriage 2 able to move longitudinally along rails 3 that may be horizontal or make a certain angle with the horizontal plane, these rails being then upwardly sloping from the right toward the left. During the pouring, the molten metal, for example molten casting iron, is poured into the mold 1 by a longitudinal pouring or feed-trough 4. This trough is fixed at its upstream end (relative to the direction of flow of the molten metal) by a flange 5 to a down runner 6 into which is progressively emptied the contents of a ladle 7 oscillable about a horizontal axis 8. The unit comprising the trough, the down runner and the ladle is mounted on a support (not shown).

The trough 4 rests at its downstream pouring end on a support 9 fixed to the carriage 2 with which the support moves during the longitudinal displacement of the carriage. The trough includes at its downstream end a pouring lip that may be, if desired, cut in the known manner on the bevel as shown at 10 in Fig. 3.

This trough has along its entire length a longitudinal channel 11.

The arrangement so far described is known in the art, but it differs from the known constructions by the features now about to be described.

Referring firstly to the trough 4, which is preferably in rough cast iron, the various cross-sections (Figs. 4 to 6) are inscribed, at least substantially within a circle C having a diameter at most equal to that of the mold in which the trough is adapted penetrate (see Fig. 4). Each of these cross-sections is defined externally, by two upper arcs of circles 12, connected by a small radius 13 to the channel 11 and, further, by a flat face 14 to a lower convex face 15.

The transverse shape or form of the channel 11 of the trough is composed of, in each cross-section, two lateral, rectilinear, obliquely disposed lines 16, downwardly converging toward the vertical axis XX at about 10°. These two lines 16 are each connected, by a radiused portion 17 having its centre at O and a radius of about ten millimetres, to the portion 18 that is in the shape of an arc of a circle and is the concave bottom of the channel 11.

The shape of the trough and the thickness of its various portions are so determined that:

(1) In each cross-section the centre of gravity G^1 , G^2 , G^3 , of the total section corresponding to the wall of the trough coincides with the centre of gravity of the contour $a^1b^1c^1$, $a^2b^2c^2$ or $a^3b^3c^3$ of the portion of the channel 11 situated below a transverse horizontal line a^1c^1 , a^2c^2 , a^3c^3 that is situated at a constant distance 1 from the upper edge of the channel. The distance 1 may be between one half and one third of the total depth of the channel of the trough and is preferably of the order of one third for troughs adapted for the centrifugal casting of pipes of small diameter, for example less than a hundred mm., for which the outer dimensions of the trough are limited by the inside diameter of the mold and where in consequence the dimensions of the channel must be as large as possible to ensure the supply or flow of the casting iron necessary for the formation of the pipe. On the other hand, for pipes having a diameter greater than a hundred mm. for which the dimensions of the trough are materially less than the inside diameter of the mold, this height may be one half of the total height of the channel, as shown in the drawing.

(2) The width of the channel remains substantially constant along about two thirds of its length from the upstream end to the plane 5—5 (Fig. 2), then gradually increases over the last third while retaining the same shape. Thus the distance between the centres O of the two radiused portions 17 retains a substantially constant value d^1 up to plane 5—5 (Figs. 4 and 5) then increases up to the value d^2 (Fig. 6). Preferably d^2 is between 1.1 and 1.15 times d^1 .

(3) Relative to the longitudinal line 19 on the outer face of the base of the troughs 4 (which is parallel to the longitudinal axis of the mold 1), the bottom 18 of the channel 11 includes, starting from the upstream end and finishing at the pouring lip 10, a certain slope so that the thickness of the trough decreases progressively from a dimension $2e$ to a value substantially e from the upstream end to the downstream end of the trough (relative to the direction of flow of the metal) in the region of the bottom of the channel.

Under these conditions cross-sections such as those shown in Figs. 4 to 6 are obtained. These sections have been for purposes of comparison superposed in Fig. 7 in the form of contours IV, V and VI respectively in full lines, in dotted lines and in chain-dot lines. From this it is clear to see the gradual increase in the section of the channel from the upstream end to the pouring lip of the trough.

In the section through the plane 4—4 (Fig. 2) as shown in Fig. 4, the thickness of the trough is substantially constant over the full height of the side walls where it is e ,

then this thickness gradually increases up to a value substantially double, $2e$, in the bottom part of the trough.

In the section V, shown in Fig. 5, the side walls still have substantially the thickness e whereas the bottom has only a thickness of the order of $1.5e$.

Finally, in the section VI (see Fig. 6), the channel of the trough is enlarged, the side walls have a thickness slightly less than e whereas the bottom has a thickness no more than of the order of e .

The machine provided with the above described trough, is arranged so that the inclination of the mold 1 and the outer line 19 of the bottom of the trough 4 relative to the horizontal (the inclination may be nil, as represented) is such that, taking into account the pouring rate from the ladle 7, i. e. the latter's speed of oscillation about the axis 8, the level of the metal poured into the trough coincides, in each cross-section, substantially with the aforementioned lines a^1c^1 , a^2c^2 , a^3c^3 .

With the machine so arranged, it was found in the course of systematic trials that each fibre of the trough was headed directly by conduction from the surface wetted by the molten metal, the centre of gravity of this surface coinciding with the neutral fibre of the trough; all the fibres situated at equal distance from this neutral fibre were heated to the same temperature and underwent the same expansion.

In consequence, the expansion of the portion of the trough situated above the centre of gravity is equal to that situated below and the trough remains rectilinear and does not distort.

Further, it had been found that when the molten iron flowed in the channel, it cooled on contact with the channel walls and by radiation from its free surface along the length of the channel. In consequence, there is a difference between the temperature of the iron at the end 10 of the pouring trough and that of the down runner that might attain 20 to 50° C.

Now, the fluidity of the iron varies with temperature. It diminishes in particular rather rapidly as the point of solidification is neared. If the temperature of the pouring is far from the point of solidification, for example if it is 1300° C., this variation is small, but it becomes material if the pouring is effected at a temperature around 1200°–1250° C.

For a given supply rate the decrease in fluidity provokes, with a constant slope, a decrease in the speed of flow. In known troughs whose cross-sections are constant this decrease in speed causes a gradual rise in the level of the flow. If the level of the iron at the start of the trough is established at the height resulting from the slope of the trough and the chosen supply rate, this height increases as the pouring lip is approached. This occurs especially in the lower part of the trough. An even more intense cooling of the iron takes place due to the increase in the surface of contact with the walls of the trough resulting in a new decrease in the fluidity followed by a new rise in the level.

In a trough of this known kind having a constant section such a phenomenon is unstable, no equilibrium is achieved and overflow is possible in the mid-part of the trough when, due to its rise, the level of the iron reaches and passes the upper edge of the channel. Note that this defect may be made much worse by the trough's tendency to curve owing to unequal heating and due to expansion of the longitudinal fibres, as described above.

Due to the increase in section of the channel according to the invention resulting in the widening of the extremity and the increase in the depth of the channel, these defects are avoided. The increased depth and width of the channel provide the iron with a larger flow section as the iron becomes less fluid and the level of the free flow does not rise but remains at a constant distance from the upper edges of the channel. Owing to this, the centre of gravity of the perimeter of the channel wetted by the molten metal and the centre of gravity of the

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cross-section of the trough remain coincident which restrains any bending of the neutral axis of the trough.

It should be noted that according to the invention the trough conserves within certain limits the ability to distort so that it may always be in the working condition in which the centres of gravity coincide. For instance, supposing that for some reason the level of the liquid iron lowers in the channel, the centre of gravity of the wetted perimeter drops below that of the cross-section of the trough. The trough is then heated more toward the base than toward the top and it has a tendency to curve upwardly thereby decreasing the pouring slope and in consequence the rate of discharge which forces the level of the iron to rise. On the other hand, if the level of the iron exceeds the predetermined mean level, the centre of gravity of the wetted perimeter passes above that of the trough and as the latter is heated more at the top than at the bottom it tends to curve downwardly thereby increasing the pouring slope and, in consequence, the rate of discharge which tends to return the level of the iron to the predetermined height.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. Single piece elongated pouring trough for flowing and feeding molten metal into a centrifugal casting machine for centrifugally casting pipes and the like metallic pieces, said trough comprising: a wall defined by a transverse downstream end surface and a transverse upstream end surface and by two longitudinal wall surfaces, and by a pouring lip at said downstream end surface; the first one of said longitudinal wall surfaces being external, convex, and having a cylindro-prismatic profile; the second of said wall surfaces being internal and concave; said second wall surface forming a longitudinal channel for feeding and pouring molten metal, said channel extending over the entire length of said trough from said upstream transverse end surface to said downstream transverse end surface; said internal and external longitudinal wall surfaces defining U-shaped transverse sections of the trough at each transverse plane of said trough; each of said U-shaped sections being inscribed substantially in circles having the same radius; said wall comprising a bottom portion, side portions and upper longitudinal rims; the thickness of said wall decreasing progressively from said upstream end surface to said downstream end sur-

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face; whereby the transverse cross-sections of said channel increase progressively from said upstream end surface to said downstream end surface; in each transverse plane of said trough, the area of the total cross-section of said wall having its center of gravity coinciding substantially with the center of gravity of the geometrical surface defined, in each said transverse plane, by a transverse line which, at all said transverse planes from said upstream end to said downstream end and at all transverse cross-sections of said channel, remains at a constant distance from said upper longitudinal rims, and by the portion below said transverse line of the contour of said internal wall surface in the corresponding transverse plane; said distance being comprised between a ratio of one-half and a ratio of one-third of the height of said channel, said ratio decreasing as said transverse cross-sections of said channel increase.

2. Pouring trough as claimed in claim 1, in which the width of said channel increases over about one-third of the length of said trough, measured on the downstream part thereof from said pouring lip.

3. Pouring trough as claimed in claim 2, in which said width of said channel increases by 13% overall.

4. Pouring trough as claimed in claim 1, in which the thickness of said wall between the bottom of said channel and the bottom of said trough decreases progressively and longitudinally of said trough from said upstream end to said downstream end.

5. Pouring trough as claimed in claim 1, in which the cross-sectional area of said channel in each said transverse planes has a substantially trapezoidal peripheral shape, flared towards said upper edges and comprising two side-wall rectilinear portions converging downwardly at an angle of about 10 degrees toward the vertical axis of symmetry of said trough, said channel having a concave bottom connected with said side-wall portions by curved portions having a small radius of curvature.

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