Nov. 30, 1943. J. A. BRADLEY 2,335,385

METAL CASTING

Filed Aug. 7, 1942

FIG. I.

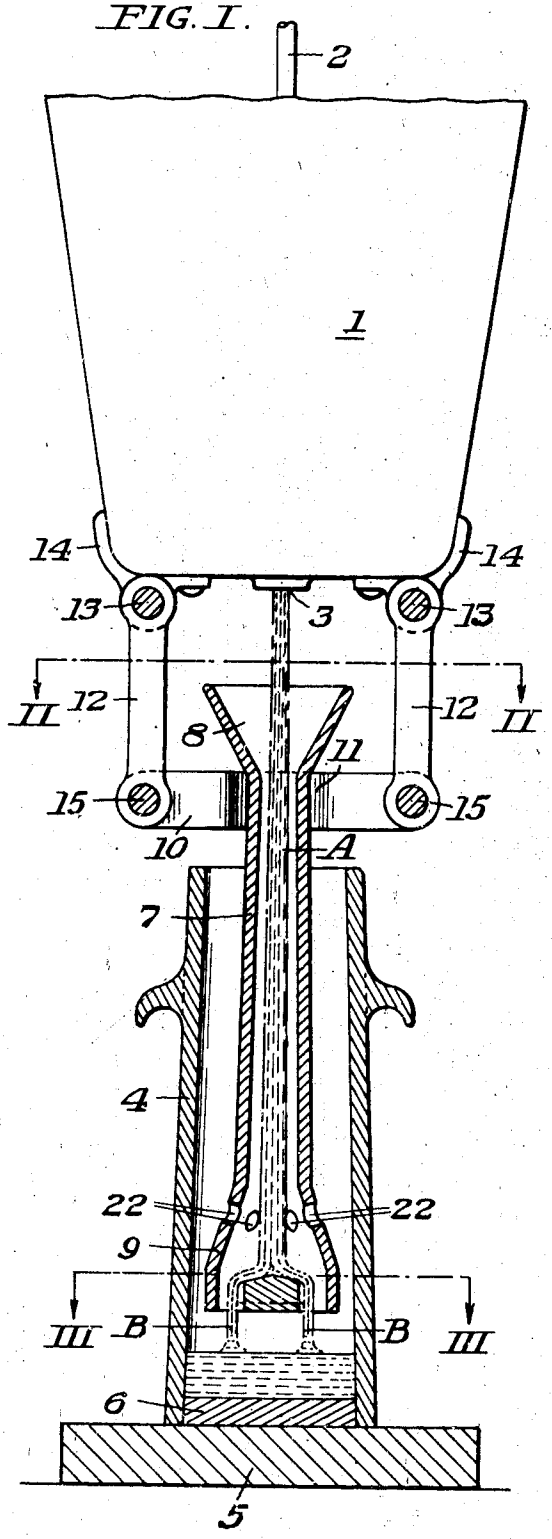



FIG. II.

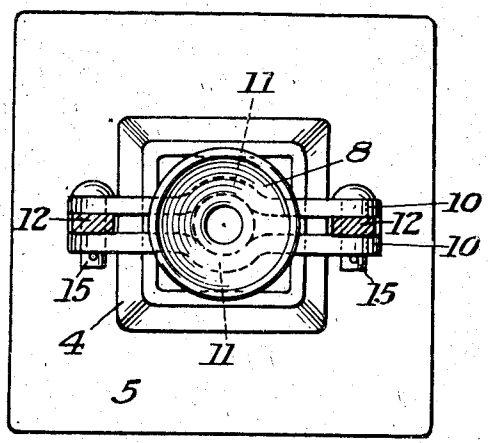



FIG. III.

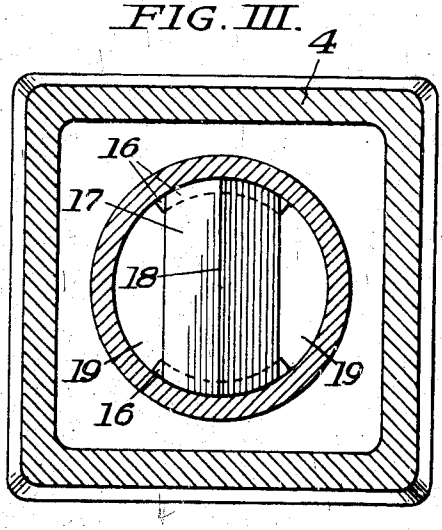
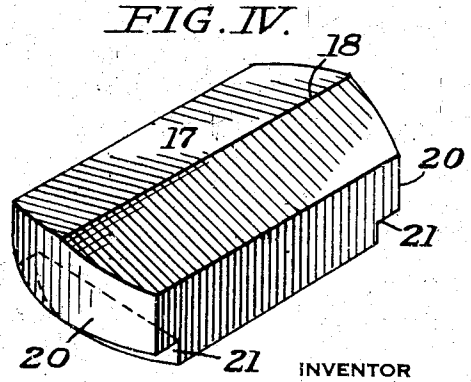



FIG. IV.




INVENTOR

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2,335,385

# UNITED STATES PATENT OFFICE

2,335,385

## METAL CASTING

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5 Claims. (Cl. 22—57)

This invention relates to the teeming of ingots and analogous metal castings.

In teeming ingots, and notably in teeming steel ingots, the inclusion of gas in the ingot metal presents a serious problem. If as is usual the molten steel which is teemed contains some residual gases produced in the steel-making process, such gases are carried into the ingot mold and are frequently entrapped in regions substantially below the upper surface of the ingot to form gas pockets and thus to create serious and persistent defects in the metal of the ingot. If the furnace heat is not so thoroughly "killed" in the furnace or in the pouring ladle that chemical action in the metal is wholly ended, such chemical action produces additional gas during the teeming. In any event, the jet of molten metal from the pouring ladle, falling a substantial distance from the ladle to the surface of the ingot metal, carries air with it below the surface of the ingot metal, thus introducing additional gas which may be unable to rise the entire distance to the surface of the ingot for escape before it is entrapped by solidification of the metal. As the ingot molds used in steel-making preponderantly and almost exclusively are hollow, vertically elongate bodies, gases carried below the surface of metal lying in a lower region of the mold must travel through an increasing depth of metal, in order to escape. A substantial volume of gas thus is frequently entrapped by solidification of the ingot.

It is the primary object of my invention to provide method and apparatus by means of which a major stream, or jet, of molten metal falling from the pouring ladle is violently broken-up close to the bottom surface of the mold cavity and the progressively rising surface level of the metal in the mold throughout the teeming of the ingot; by breaking-up the said major stream of the metal to dissipate the gases which it entrains, and dividing the said major stream of falling metal into a plurality of minor streams falling only a short distance to the receiving surface of the metal already in the mold cavity to avoid carrying air and other gases below that surface.

In the accompanying drawing, exemplary of a preferred embodiment of my invention insofar as the said invention sounds in apparatus, and exemplary of one form of apparatus usable in conducting the method of my invention:

Fig. I is a view partially in elevation and partially in vertical section in the plane of the section line I—I of Fig. II, showing a pouring ladle and structure associated with that ladle organized, and in process of utilization, to attain the above indicated object of my invention, the illustration of Fig. I being taken in the initial stages of the teeming operation with the metal standing at a low level in the cavity of the ingot mold.

Fig. II is a horizontal sectional view taken in the plane of the section line II—II of Fig. I, showing the ingot mold into which the metal is teemed, a tubular runner forming the primary apparatus element involved in my invention, and associated apparatus organized to connect the said primary apparatus element, or runner, with the pouring ladle.

Fig. III is a horizontal sectional view taken in the plane of the section line III—III of Fig. I through the ingot mold and through the runner, showing the structure adjacent the lower end of the runner.

Fig. IV is an isometric view showing an anvil member for mounting adjacent the lower end of the runner and forming an important structural element thereof, this anvil member being shown in assembly in Fig. III of the drawing.

In the drawing, reference numeral 1 designates a bottom-pour ladle, the stopper operating rod and teeming orifice of which are indicated respectively by reference numerals 2 and 3. As shown in Fig. I, the ladle is in pouring position with respect to a vertically elongate ingot mold 4 set on a stool 5 and having a bottom closure plate 6. So far the organization is conventional.

In accordance with my invention, steel or other metal flowing from the teeming opening 3 in the bottom of ladle 1 falls in a vertically free, and laterally confined, major stream, or jet, A to a point initially adjacent the bottom of the ingot mold, and adjacent the upper surface of the ingot metal as the metal rises in the mold; and at the end of its fall is violently broken up by causing it to strike an obstructing body, quietly to flow in a plurality of minor streams the remaining vertical distance to the receiving surface of the ingot mold or the metal standing therein. As the level of the ingot metal rises in the mold, the level in the ingot mold cavity at which point the major stream of flowing metal from the ladle is broken, is raised correspondingly. Desirably the height through which the major stream of metal falls is kept uniform to give uniformity in the action by which this stream is broken up, and gases dissipated from the metal of which it is composed.

Apparatus for producing this effect comprises an elongate tubular runner 7 of cast steel, cast

iron or other suitable material carried by the pouring ladle 1. Runner 7, which has a length approximating the height of the ingot mold, terminates upwardly in a funnel 8 and terminates downwardly in a distributor bell 9. The elongate bore of runner 7 is mounted in alignment with the teeming opening 3 of the ladle by structure which flexibly supports the runner from the ladle. Such structure comprises two horizontal arms 10 spaced slightly apart and bowed oppositely outward in a region 11 to provide between them a socket embracing the shank or body of the runner beneath its funnel 8. The horizontal arms 10 are suspended from the lower region of the ladle by two vertical arms 12, each of which is mounted on a pivot 13 carried by a bracket 14 on the ladle. Vertical arms 12 each lie between the two horizontal arms 10 adjacent their ends and have with them a pivotal connection 15.

The illustrated means for breaking up the major stream of metal before it is delivered from the runner is comprised in the distributor bell 9, which is formed as an enlargement of the tubular shank of the runner. Such means comprise a shoulder 16 divided into two segments, or lugs, projecting from the wall of the runner into the runner bore and spaced diametrically of the runner. This shoulder carries an obstruction in the form of an anvil member 17, which may be composed of cast iron, cast steel, copper, copper-coated iron or steel, or may be made of graphite or other suitable refractory material. The upper face of anvil member 17 slopes divergently downward from a central ridge 18 to openings 19 at the two sides of the anvil. The ends 20 of the anvil are shaped in accordance with the wall contour in the distributor bell and are chamfered along their lower edges at 21 to match the lugs composing the divided shelf or shoulder 16. In a region above that in which anvil member 17 is mounted, the runner wall has a plurality of vent holes 22 for the escape of gases. It will be noted that the space between the ends of the sections of shoulder or shelf 16 are wider than the width of anvil 17. The anvil may thus be inserted from the bottom of distributor bell 9 through this space and then turned to overlie the shoulder. It may be removed by converse manipulation.

I shall now describe the teeming method of my invention as conducted in the apparatus above described. First, pouring ladle 1 is brought into teeming position over the vertically extended cavity of ingot mold 4. The pouring ladle is then lowered into a position in which runner 7 extends downwardly into the ingot mold cavity so far that its lower end is closely adjacent the bottom of the cavity. It may be noted that so to position the runner requires that its length at least approximates the depth of the vertically elongate ingot mold cavity, and that any structure providing a substantial equivalent for the runner will be of corresponding length.

The teeming opening 3 of the ladle is then opened so that a stream of molten metal flows into the funnel 8 of the runner, and through the bore of the runner to discharge from distributor bell 9. This stream of molten metal, the major stream A, has a free vertical drop through the runner bore until it strikes the obstruction presented to it by the anvil member 17. The vertical distance through which this major stream A falls is so great, being at least as great as the depth of the ingot mold cavity, that the stream is broken up violently with consequent dissipation of the gases it entrains. These gases escape through vent holes 22 above the level at which the metal is delivered, and thus can escape without again contacting the ingot metal.

The major stream A having been broken up by striking the obstruction presented by anvil member 17, the metal of that stream falls, or flows in a plurality of minor streams B to the surface by which it is received. When utilizing the structure herein specifically disclosed, streams B are two in number, and issue through the openings 19 at the sides of the anvil member. At the beginning of a teeming operation, the bottom of the mold cavity is the receiving surface, and the two minor streams B, which are of lesser volume than the major stream A, and which fall a relatively short distance after their delivery from the runner are relatively so quiet that the splashing effect in the bottom of the mold cavity is negligible. As the metal begins to stand in a shallow pool at the bottom of the mold cavity, minor streams B falling on it do not agitate it so violently as to cause it to take up air or other gas which may be present.

As the level of the metal rises in the mold, the runner 7 necessarily is raised to hold its delivery end above the receiving surface of the metal standing in the mold to which the metal flowing in minor streams B is delivered. As the obstructing surface in the ingot mold cavity is lifted, the relatively great length of the elongate runner itself supplemented by a corresponding lifting of the pouring ladle, which is the source of the stream and by which the runner is carried preserves uniform the force with which the major stream strikes the obstruction in the runner and maintains the gas-dissipating effect of that action.

It thus appears that throughout the teeming operation the minor streams B in which the metal is delivered from the runner are approximately free of entrained gases. Even in the lower regions of the ingot mold, there minor streams fall but a short distance in being delivered to the receiving surface of the metal standing in the mold, and they are of a lesser cross-section than the major stream A. Throughout the entire teeming operation I therefore prevent the usual "jet effect" in which a stream of metal penetrates substantially below the surface of the metal standing in the mold, to carry air as well as other gases into that body of metal.

The foregoing description has described specifically the teeming of ingots. It is to be understood, however, that other castings vertically so elongate as to present problems directly analogous to those encountered in teeming ingots of usual form, advantageously may be teemed in accordance with my invention. In many instances my invention makes it possible to utilize "top-pouring" rather than "bottom-pouring" in casting bodies such as roughing rolls, blooming rolls and the like, which normally require bottom-pouring.

Numerous changes may be made in the exemplifications of my method as herein disclosed, both in the form and arrangement of the apparatus and the procedure of the method, in which my invention finds embodiment. Numerous modifications in the herein-disclosed embodi-

ments of my invention may therefore be made within the bounds of my invention as defined by the appended claims.

I claim as my invention:

1. For use conjointly with a vertically elongate metal-casting mold a runner for conducting molten metal into the mold formed as an elongate tubular body dimensioned cross-sectionally and longitudinally to extend into the mold cavity and with its upper end projecting above the mold to have a maximum downward reach to a position adjacent the bottom of the mold cavity, and a partial closure structure in the bore of the runner adjacent the lower end thereof and presenting to a major stream of metal falling through the runner an obstructing surface while leaving openings for delivery of metal of the major stream from the runner in a plurality of minor streams.

2. For use conjointly with a vertically elongate metal-casting mold a runner for conducting molten metal into the mold formed as an elongate tubular body dimensioned cross-sectionally and longitudinally to extend into the mold cavity and with its upper end projecting above the mold to have a maximum downward reach to a position adjacent the bottom of the mold cavity, and a partial closure structure removably mounted in the bore of the runner adjacent the lower end thereof and presenting to a major stream of metal falling through the running an obstructing surface while providing openings for delivering metal of the said major stream in a plurality of minor streams.

3. The herein described method of teeming molten metal into a vertically elongate metal-casting mold by causing the metal to fall from a source higher than the mold in a vertically free and laterally confined major stream to a level closely above a receiving surface in the mold cavity to which the metal is delivered, at such level breaking-up the said major stream with dissipation of entrained gases from the metal thereof, and delivering the metal from the said major stream in a plurality of minor streams to the said closely underlying receiving surface.

4. The herein described method of teeming molten metal into a vertically elongate metal-casting mold by causing the metal to fall from a source higher than the mold in a vertically free and laterally confined major stream to a level closely above a receiving surface in the mold cavity to which the metal is delivered, at such level breaking-up the said major stream by causing it to strike an obstructing body with dissipation of entrained gases from the metal thereof, and delivering the metal from the said major stream in a plurality of minor streams to the said closely underlying receiving surface.

5. The herein described method of teeming molten metal into a vertically elongate metal-casting mold by causing the metal to fall from a source higher than the mold in a vertically free and laterally confined major stream to a level closely above a receiving surface in the mold cavity to which the metal is delivered, at such level breaking-up the said major stream by causing it to strike an obstructing body with dissipation of entrained gases from the metal thereof, delivering the metal from the said major stream in a plurality of minor streams to the said closely underlying receiving surface, and as the said obstructing surface is lifted in the mold cavity in accommodation to the progressive rise in the receiving surface of the metal standing therein preserving uniform the force with which the said major stream strikes the obstructing body by raising equally the source from which the said major stream flows.

JAMES A. BRADLEY.