

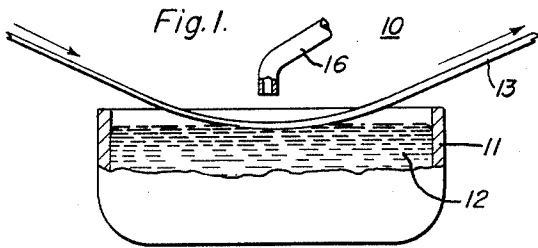
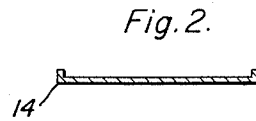
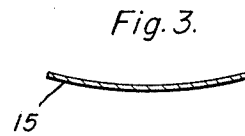
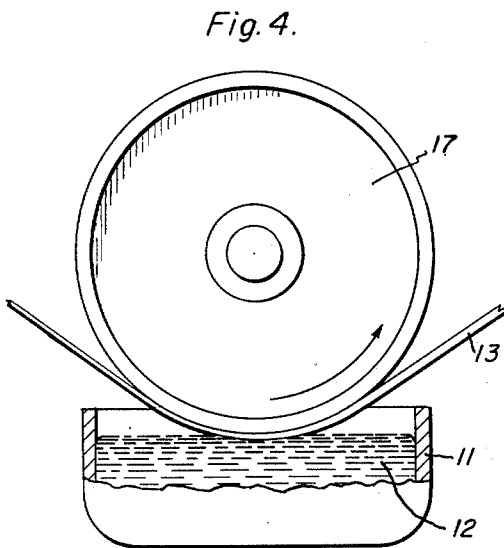
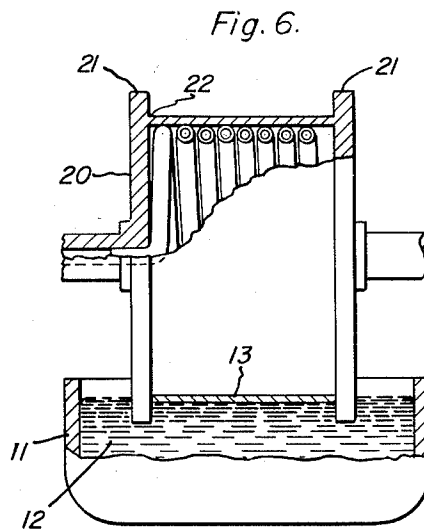
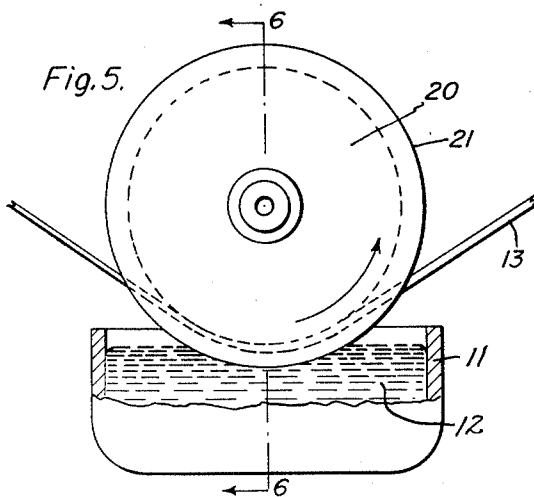
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FLOAT CASTING

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3,145,119

FLOAT CASTING

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1 Claim. (Cl. 117—114)

This invention relates to float casting and more particularly to an improved dip forming process which provides float casting.

"Dip forming" is a term generally applied, in the prior art, to describe a process, for example, where one metal in strip-like form is continuously passed through a molten bath of a same or dissimilar metal in order to have the molten metal accrete or adhere to the moving strip thereby increasing its dimensions. Float casting is casting or accreting of a molten metal on a metal strip form which is not submerged, but is in contact with the surface of a molten metal bath. The most important factors associated with a dip forming process, relate to the heat capacity of the metal strip in contact with the molten metal bath, the melting points of the different metals employed, and the degree or amount of melt which can be accreted on a given strip moving at a given rate of speed. For example, it is relatively simple at this stage to apply zinc or tin to a moving steel strip. This practice is more difficult when the metals to be employed are similar, i.e., for example, where a steel strip-like form is being passed through a molten bath of steel. Heretofore, because of the practicalities of the process, a preferred arrangement has been to have the strip enter the bath of molten metal from the bottom of the bath and proceed through the bath and out the top. While this arrangement is an improved process, it is understandable that it is quite difficult to provide proper inlet and sealing means in the bottom of a crucible containing molten metal to prevent leakage of the molten metal and at the same time prevent jamming of the input strip at the point of entry. Such an arrangement also does not lend itself to means for cooling or extracting heat from the strip-like form while proceeding through the bath so that the accretion of the molten metal bath on the strip may be controlled in order that more or less metal may be accreted. Such control heretofore primarily involved regulating the rate of speed or transit time of the strip-like form in the molten bath.

Accordingly, it is an object of this invention to provide an improved dip forming or float casting process.

It is another object of this invention to provide surface contact of a strip-like form in a dip forming process.

It is yet another object of this invention to provide cooling means for or increase the heat capacity of the strip while passing in contact with a molten metal bath.

It is again another object of this invention to provide an improved strip configuration to be passed in contact with a molten metal bath.

Briefly described, in one preferred embodiment of this invention, a strip-like form is passed into a molten metal bath in such a manner that the strip is not completely submerged in the bath and cooling means are applied to an exposed portion of the strip to control the accretion of molten metal.

This invention will be better understood when taken in connection with the following specification and the drawing in which:

FIG. 1 is a cross sectional and elevational view of one method and apparatus for practicing this invention;

FIG. 2 is one cross sectional configuration of the strip-like form employed in FIG. 1;

FIG. 3 is a further modification of a strip configuration to be employed in this invention;

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FIG. 4 is a schematic representation of solid contact cooling means;

FIG. 5 is a modification of the contact means of FIG. 4 utilized with a flat strip form; and

FIG. 6 is a frontal view of FIG. 5.

A dip forming process and apparatus is the subject of United States Patent No. 3,008,201, granted November 14, 1961, to Roland P. Carreker, Jr., and assigned to the assignee hereof. The subject of this copending application is included by reference herewith and the process employed therein is a preferred form of the process employed in this invention, and insofar as applicable, the various apparatuses disclosed are also employed in the practice of this invention. Briefly described, the Carreker application relates, in one form, to the passing of a wire or rod like element from the bottom of a furnace or crucible containing a molten metal bath, through proper sealing means, through the metal bath to exit from the top thereof to provide an increased cross sectional configuration of the element. Ordinarily, such a wire or rod is withdrawn from a suitable storage means, such as a reel or the like, and cleaned and straightened. Thereafter, the wire is passed into a vacuum entrance chamber which permits the rod to pass into the chamber but prevents the passage of atmosphere therewith. The rod then proceeds into an entrance port at the bottom of a crucible passing through the bath of molten material where the molten material accretes thereon increasing the rod cross sectional area appreciably.

Referring now to FIG. 1, there is disclosed an improved method and apparatus 10 utilized in this invention. FIG. 1 shows a suitable crucible or furnace 11 containing a bath of molten metal 12. It is understood that crucible 11 may be suitably connected to or employed as part of a furnace so that the level of the molten metal 12 therein may be maintained at a proper height during continuous operation. Since this invention is more particularly adaptable to the combination where the strip and the molten metal are of the same material, the description will proceed referring to, as one working example, a solid form steel strip 13 and a molten steel bath 12. The strip 13 originally may be provided in various forms such as those disclosed in FIGS. 1, 2 and 3, for example, in FIG. 1 as a flat strip, in FIG. 2 where the cross sectional configuration is that of a channel 14 or a flat strip having up-turned edges. Furthermore, such strip may take the configuration of FIG. 3 showing a more or less dished cross sectional configuration 15. It is contemplated that various configurations in addition to those as described may be suitably employed, there being the requirement that at least a part of such cross sectional configuration be adapted for exposure to cooling for the purposes as hereinafter described.

Referring again to FIG. 1 as strip 13 is withdrawn from a supply source (not shown), for example, from a reel, it is introduced into the molten metal bath 12. This introduction does not include complete submergence but only contemplates that the bottom of the strip in whole or in part is only partially submerged or in contact with the surface of the molten metal bath 12, or so that the molten metal does not flow into the concavity as described for FIGS. 2 and 3. Strip 13 may be withdrawn from the supply source as a flat strip and, prior to introduction to the bath 12, may be passed through suitable forming rolls to provide the cross sectional configuration of FIGS. 2 and 3. Ordinarily, as the strip is fed into contact with the molten metal, such contact is maintained over a suitable area or length of surface commensurate with the amount of metal to be accreted thereon and is thereafter withdrawn from contact with the molten metal. Strip 13 may be suitably supported between the supply source and the molten metal bath. After withdrawal from the

bath, strip 13 may be further subjected to forming operations, reworked by rolling processes, cut into sections or rolled for reel storage. Since it has been described that one of the more important problems associated with dip forming is that a proper difference in heat capacity be employed, regulation thereof may be had in accordance with this invention by cooling means or heat sink. Since the top surface of the metal strip is not submerged, it may be subjected to cooling by being exposed to gases, liquids or solids as contact cooling means. Directed nozzles 16 may be employed to direct streams of cooling air adjacent the exposed surface of strip 13 to satisfactorily control cooling. A liquid coolant such as water or an atomized spray may also be employed with the coolant evaporating on contact with strip 13 to attain the beneficial effect of vaporization. In the embodiments of FIGS. 2 and 3, strip 13 is formed with a concavity which facilitates other forms of cooling. For example, a fluid medium may be contained within the concavity and introduced at one position and withdrawn from another. A granular or finely divided solid medium may be employed in the same manner, i.e., by being introduced before or during contact of the strip with the bath and withdrawal thereafter. Such a solid may, of course, melt or sublime.

Ordinarily, it is preferred that cooling be localized, i.e., that it be provided during contact of the strip with the metal bath. Such a cooling means provides in the first instance, a much larger amount of metal to be accreted and an extended period of time where the strip is in contact with the molten metal. By this means, it has been discovered that a higher pick-up ratio of the molten metal is possible than obtained in conventional dip forming where the rod or strip is passed completely through the metal bath. Furthermore, the difficult bottom entry and sealing problems have been eliminated and metal pick-up or casting takes place horizontally.

In the practice of this invention, the melt must be in a clean condition, that is, that there should be no heavy slag present. This requires the molten metal to also be clean, and of good purity. Accordingly, it is preferred to maintain the bath in a vacuum, inert or reducing atmosphere, and therefore the cooling means should be correlated with the type of atmosphere present or so chosen and arranged so that each purpose is obtained.

Where it is not practical to provide fluid or finely divided solid cooling, a direct contact type of cooling may be employed. Referring now to FIG. 4, there is illustrated a wheel or drum 17 which engages strip 13. Wheel 17, of a ceramic or metallic material, for example, a hollow copper wheel, is suitably internally cooled and rotates together with strip 13 to provide effective cooling of the strip by direct mechanical surface contact. Cooling of wheel 17 may take the form of simple radiation because of its large surface area. In FIG. 6, wheel 17 is provided with internal liquid cooling by admitting fluid through one side of the wheel to be circulated therein, for example, through coils 18 and withdrawn from the other side. A hollow shaft or axle 19 may serve as fluid coolant entry and exit means.

As an example of one practice of this invention, a solid copper drum of about 10 inches diameter and 1 inch thickness was employed in float casting of steel. A thin

steel strip was placed about the circumference of the wheel and the strip and wheel positioned in a molten steel bath similar to FIG. 4. The wheel was rotated in the bath and then removed. The amount of molten steel accreting on the strip was greater than that which would be obtained without the heat sink wheel.

A further modification of the wheel form of cooling is disclosed in FIGS. 5 and 6. In FIGS. 5 and 6, wheel 20 is particularly adapted for flat strips 13. Wheel 20 is formed with or includes a pair of flange plates 21 which provides the periphery with a channel configuration. As can be seen in FIGS. 5 and 6, the channel 22 contains the strip 13 so that surface contact is maintained between the strip and the wheel periphery without introduction of the melt therebetween, and the width dimension is unchanged.

In the operation of this system, cooling while in contact with the bath is regulated so that maximum pick-up of the molten metal is attained. This pick-up or accretion is by far larger than that obtained without cooling and the cooling imparts a greater strength to the strip when emerging from the bath. Accretion of the melt on the surfaces of wheel 17 is prevented or minimized by proper choice of wheel materials, treatment of wheel surfaces, or protection thereof. It has been found, for example, that the use of zircon deters accretion of molten steel. Accordingly, as in FIG. 6, the flanges 21 may be made of zircon. The channel configuration of FIG. 2 may be employed so that the channel legs protect the drum. After the strip passes from the bath, it is again passed between a pair of rolls for further working, forming, or sizing.

While a specific method and apparatus in accordance with this invention has been shown and described, it is not desired that the invention be limited to the particular description nor to the particular configurations illustrated, and it is intended by the appended claim to cover all modifications within the spirit and scope of this invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

The continuous float casting method which comprises the steps of providing a body of molten casting metal, running an elongated strip continuously past the said metal body, deflecting the strip downwardly toward the molten metal body and thereby contacting the under side of successive portions of the strip with the molten metal while at the same time maintaining the upper surface of said successive portions of the strip above and out of contact with the said molten metal, deflecting the strip upwardly away from the said molten metal body so that said successive portions of the strip coated only on one side are removed from contact with the molten metal body and controlling the amount of metal accretion on the strip by contacting the upper surface of said successive portions of the strip with cooling means at a temperature substantially below the temperature of the molten metal.

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