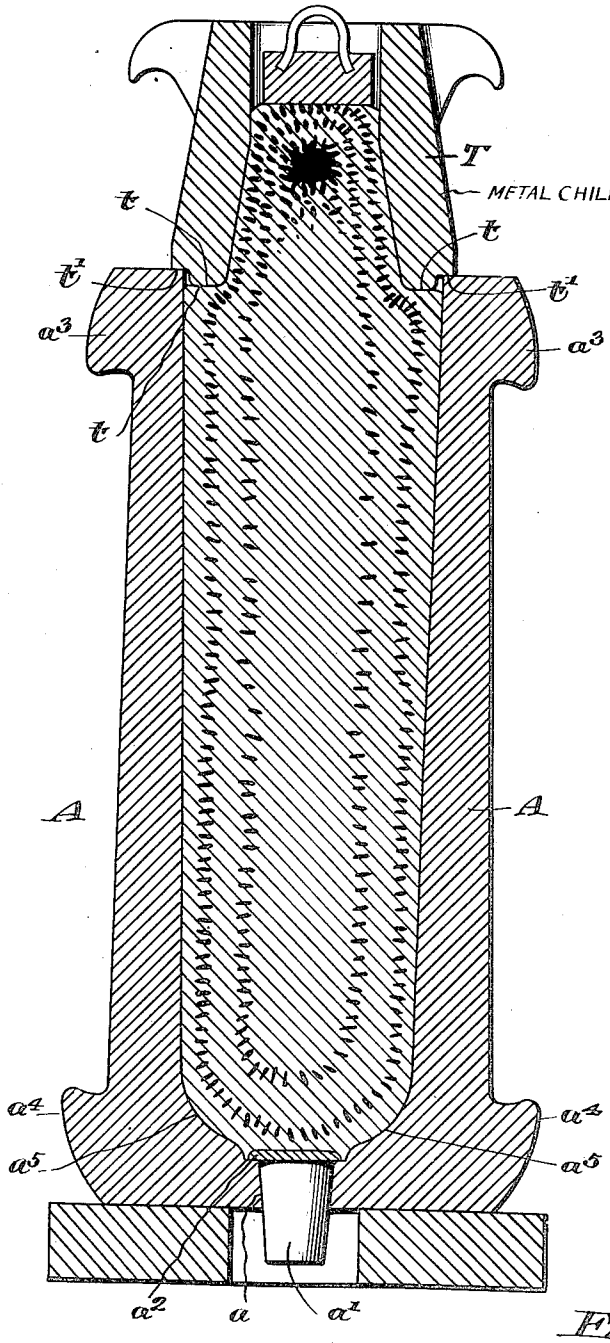
May 15, 1923. 1,455,197

E. GATHMANN

INGOT MOLD AND INGOT

Filed July 15, 1922



Inventor
Emil Gathmann
by his Attorneys
Baldwin & Wight

Patented May 15, 1923. 1,455,197

UNITED STATES PATENT OFFICE.

EMIL GATHMANN, OF BALTIMORE, MARYLAND.

INGOT MOLD AND INGOT.

Application filed July 15, 1922. Serial No. 575,312.

To all whom it may concern:

Be it known that I, EMIL GATHMANN, a citizen of the United States, residing in Baltimore city, State of Maryland, have invented certain new and useful Improvements in Ingot Molds and Ingots, of which the following is a specification.

This invention relates to the casting of ingots from effervescing or gassy steel and it involves certain improvements in the construction of the mold and in the method of manufacture.

The improved mold is illustrated in the accompanying drawings which show a vertical section of a metal ingot mold embodying my improvements.

The major part A of the mold is of the well known Gathmann type shown in patents heretofore granted to me, of which my latest Patent No. 1,419,454 of June 13, 1922, may be taken as an example. Such molds are usually "big end up" molds constructed to cool the molten metal more quickly in the lower portion of the mold than in the upper portion thereof as by making the lower mold walls thicker and of greater heat absorbing quality. In such molds, in order to reduce piping, provision has been made to conserve the heat of the ingot at its upper end as by making the mold walls thinner at the top or by providing heat insulating means for the upper portion of the ingot. The part A is formed, as shown, with a bottom opening a closed by a plug a' and a sealing plate a^2 of the kind shown in my patent of June 13, 1922. The mold walls are rounded or necked in at a^5 as also shown in said patent. The part A of the mold is formed with lugs a^3, a^4 by means of which it may be lifted or supported while being raised or transported.

Instead of employing a top section of refractory material as heretofore to conserve the heat of the top portion of the ingot, I employ, according to my present invention, a metallic mold top portion T which is adapted to chill the upper part of the ingot by absorbing the heat therefrom for a purpose hereinafter described. This top portion is flanged at t to provide a part which extends to a slight distance into the lower mold section and a part t' which rests on the top of the mold section A, as shown in my patent No. 1,192,617 of July 25, 1916.

Molten steel, as it is teemed into the ingot forming mold, in so far as freedom from occluded gases is concerned, may be broadly separated into two kinds. These are generally known as effervescing or gassy steel and noneffervescing or deoxidized steel.

My present invention relates primarily to means for more efficiently producing ingots made of gassy or effervescing steel, i. e., steel containing a large volume of gases in solution due to the oxidation of the metal in the melting process carried on in Bessemer converters, open-hearth furnaces and similar melting apparatus, and where the steel has not been fully finished or deoxidized before it is poured into the mold.

During the cooling and solidification of the ingot in a mold, the contained gases are released as the cooler metal does not have the same absorptive or solvent power for the gases as it has when at a higher temperature and while being poured into the mold. As the ingot metal in the mold cools towards the critical line of solidification or so called freezing, the contained gases are released from solution with the metal and as the ingot metal becomes pasty or partially solidified these gases are entrapped in the body of the ingot metal within the mold and at times cause the metal to boil and if means are not provided to freeze over the open or free surface at the top of the ingot, the volume of the ingot would at times be materially enlarged by the formation of numerous blow holes or gas pockets of varying sizes principally within the zone of the outer skin of the solidifying or pasty ingot. It has, therefore, been the common practice to freeze over the upper exposed surface of the ingot when made of gassy steel at an early stage of solidification. Such freezing as previously practised has, however, not been sufficient to prevent a considerable increase in volume or a greater height or length of the solidifying ingot as the chilling action has heretofore been produced primarily on the horizontal upper surface of the ingot.

The kind of solidification of ingots made of gassy steel and of ingots made of well deoxidized steel is fundamentally different. In the gassy steel the ingot tends to increase in volume due to the formation of gas pockets or blow holes, which compensate for the natural shrinkage of the sounder portions of the steel in the ingot. Thus piping due to shrinkage is not a characteristic of this type of steel. In steel well deoxidized, a decrease in volume is effected amounting to from three to six per cent or more during

the process of solidification. This latter kind of solidification has been so controlled by casting the molten metal of this type in ingot molds of the kind shown, for instance, in my prior patent of June 13, 1922, that the pipe or discard is contained in the upper 3% to 8% of the ingot. From analyses of tests made by me it has been shown that a big end up mold, i. e., one with a larger cross section at the upper end, improves the quality of the ingot produced therein not only in thoroughly deoxidized steel but in the far larger tonnage field of ingots which are now being produced of gassy or effervescing steel. I have found, however, that a refractory shrink head for conserving the heat of the ingot at its upper portion, such as I have used when working with well deoxidized steel is not efficient in the production of ingots made of gassy steel. Therefore when working with gassy steel I have avoided conserving heat at the upper end of the ingot and instead provided means for chilling this portion of the ingot. The means preferably used for this purpose is what may be termed a "chill top". This is adapted to contain a greatly reduced section of the upper portion of the gassy steel ingot. The "chill top" referred to is illustrated in the drawings at T. It consists of a heavy heat absorbing mold portion having a chamber of materially contracted cross sectional volume or area relatively to the average cross section of the body of the ingot being formed, whereby the upper end of the ingot is chilled by the rapid absorption of its contained heat by the top mold section. In this way the upper portion of the ingot is made to solidify much more quickly than the body part thereof.

The top chill section shown is of such construction that it may be readily applied to or removed from a mold and does not involve complicated apparatus for moving it.

The rapid freezing or solidification of the top of the ingot prevents or at least greatly retards or reduces the swelling or enlargement of the ingot body and the consequent formation of numerous blow holes which cause such swelling in ingots made in the usual way.

Such blow holes as are formed in the ingot made in accordance with my invention are deep seated, i. e., located at a considerable distance from the surface of the side walls of the ingot. Actual tests have shown that most of the blow holes are contained in the top or upper portion of the ingot which has been chilled and frozen by the chill top section of the mold.

The so called big end up mold when fitted with my improved metallic mold top for chilling and rapidly solidifying the top and upper side portions of the ingot permits of the use of a much larger percentage than heretofore of the entire ingot for commercial purposes, such as sheet, bar, structural steel, and other steel products where the surface conditions are of primary importance. The entire body of an ingot formed in a mold having a chilling section of the kind shown in the drawings may be utilized with the exception of approximately one-half of one per cent or less discard at the bottom of the ingot and approximately one and a half to three per cent at the top of the ingot for steel product where surface is of primary consideration and uniformity of interior condition is not of great importance. The decrease in the top cross section of the ingot as also in the base portion as produced in my improved mold largely prevents or reduces the splitting of the ends of the ingot during the blooming or slabbing operations in the rolling mills.

In the ordinary flat bottom type of ingot mold from 2½% to 3% of the ingot is lost due to the so called "fish tailing" or "splitting" of the ends during rolling, but by providing the mold with a rounded bottom as shown and heretofore described and with a contracted top adapted to chill the top of the ingot, the total discard in the rolling process due to fish tailing or splitting is greatly reduced.

The drawings illustrate diagrammatically the appearance of the blow holes formed during solidification, and it will be observed that these are largely confined to the top part of the ingot within the chill section of the mold. The shape of the ingot ends formed as heretofore explained is such that relatively small crop at each end is required. The blow holes shown in the body of the ingot diagrammatically are not injurious, for product where surface is of primary importance.

It should be observed that in order to get the best results the cross sectional area of the upper portion of the mold chamber or chill head should be less than half the mean cross sectional area of the body of the chamber portion of the mold. The top portion of the mold or chill head should have its walls contracted to surround at least one-tenth of the length of the entire ingot and the walls of said top portion should be of greater weight and volume than the weight and volume of that portion of the ingot which is cast within it and the side walls defining the lower chamber portion should have a downwardly inclined inwardly extending necked-in contour to reduce the cross section at the bottom of the ingot.

I claim as my invention:

1. An ingot mold having a metallic heat absorbing top portion adapted to form the upper part of the ingot and to be removable from the main body of the mold and con-

structed to chill and thus quickly freeze the upper part of the ingot.

2. A big-end-up ingot mold having a metallic heat absorbing top portion adapted to form the upper part of the ingot and to chill and thus quickly freeze said upper portion.

3. A big-end-up metallic ingot mold having the walls of its lower portion constructed or equipped to promote the cooling of the lower part of the ingot, and having an all-metallic top part constructed to form the upper end of the ingot and to rapidly chill said upper part during solidification to thus assemble blow holes at the top of the ingot.

4. An ingot mold having a rounded bottom and rounded lower side walls adapted to rapidly cool the lower part of the ingot and having a top portion constructed to form the upper end of the ingot and to chill said upper end rapidly during solidification.

5. A metallic ingot mold provided with a necked-in or round bottom and having a vertical chamber, the cross sectional area of the upper portion of which is less than one-half of the mean cross sectional area of the body of the chamber.

6. A metallic ingot mold having a contracted upper chamber constructed to hasten the chill and thus freeze the upper portion of the molten liquid ingot more rapidly than the freezing of the body portion of the ingot, said mold chamber being provided with a necked-in or rounded bottom whereby both the top portion and the bottom portion of the ingot will be of less mean cross sectional area than the mean cross sectional area of the mold chamber.

7. An ingot mold having its top ingot forming chamber portion defined by metallic walls, said top portion having a mean cross section of less area than the mean cross sectional area of the vertical mold chamber, the said chamber being provided with a bottom or base portion having a rounded or a concavo-convex contour.

8. A metallic ingot mold provided with a concavo-convex bottom or base portion and having a metallic heat absorbing top portion inclosing a vertical chamber adapted to form the upper part of the ingot and constructed to chill and thus quickly freeze the vertical walls of the upper part of the ingot.

9. An ingot mold having its ingot forming chamber defined by heavy metallic heat absorbing walls, the top and also the bottom portion of the ingot chamber having an area of less horizontal cross section, as defined by the metallic heat absorbing walls, than that of the body portion of said chamber, and the side walls defining the lower chamber portion having a downward inwardly extending necked-in contour terminating in a substantially flat horizontal base portion.

10. An ingot mold having its ingot forming chamber defined by heavy metallic heat absorbing walls, the top and also the bottom portion of the ingot chamber having an area of less horizontal cross section as defined by the said metallic heat absorbing walls than that of the body portion of said chamber, and a separable base portion for closing the lower portion of the ingot chamber.

11. A vertically extending ingot mold having substantially its entire ingot forming chamber defined by heavy metallic heat absorbing walls, the upper as also the lower portions or sections of said chamber having a necked-in contour, whereby an ingot formed in said chamber will have its top and bottom ends of less horizontal cross section than the body of the ingot.

12. A mold for forming and rapidly chilling ingots which are made of a gassy or partially deoxidized molten metal, the said mold being characterized by having its vertically extending and also its bottom wall portions defining the mold chamber constructed of heavy metallic heat absorbing material, the upper and lower sections of said chamber having a mean horizontal cross sectional area considerably less than that of the body portion of said chamber.

13. An ingot cast in a chill mold throughout its length and having a top and bottom portion of less horizontal cross sectional area than that of the intermediate body portion of the ingot, the base surface portion being substantially flat and merging into the lower portion of the ingot by means of a necked-in contour.

14. An ingot produced from a gassy or partially deoxidized molten metal cast in a chill mold throughout its vertical length, having a top and bottom portion of materially less horizontal cross sectional area than that of the intermediate body portion of the ingot, the base of the bottom portion of the ingot being formed or defined by a relatively thin flat metallic plate, which is welded or attached to the said base by the casting of the said ingot.

15. An ingot produced from gassy or partially deoxidized molten metal having its lower, its body and its vertically extending top portions formed in an ingot mold chamber defined by heat absorbing metallic walls, the lower and the top portions of said ingot having an area of less horizontal cross section than that of the body portion of the ingot and the side walls defining the lower portion of the ingot having a downward inwardly extending necked-in contour terminating in a horizontally disposed substantially flat bottom or base portion.

16. The hereindescribed method of molding a gassy or semi-deoxidized molten metal into steel ingot shapes whereby longitudinal

splitting or fishtailing of the upper and lower end portions of the ingot during its blooming or slabbing in the rolling mill is reduced, which consists in accelerating the solidification of the upper and lower ingot portions by means of upper and lower heavy chambered chills each of which is of less cross sectional area than the middle portion of the mold chamber thereby molding the said upper and lower portions of the ingot in said chill with less mean cross sectional area and less transverse dimensions than that of the body of the ingot.

In testimony whereof, I have hereunto subscribed my name.

EMIL GATHMANN.