A. F. CLARKE.

INGOT MOLD AND INGOT PRODUCED THEREBY.

APPLICATION FILED FEB. 21, 1913.

1,224,277. Patented May 1, 1917.

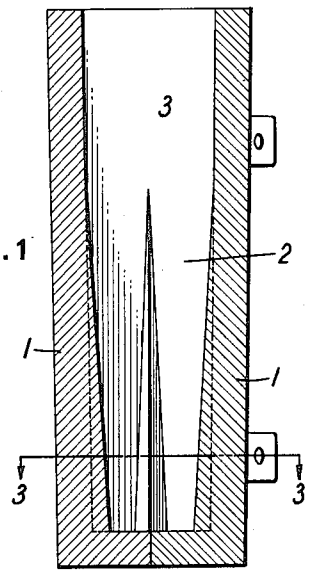


FIG. 1

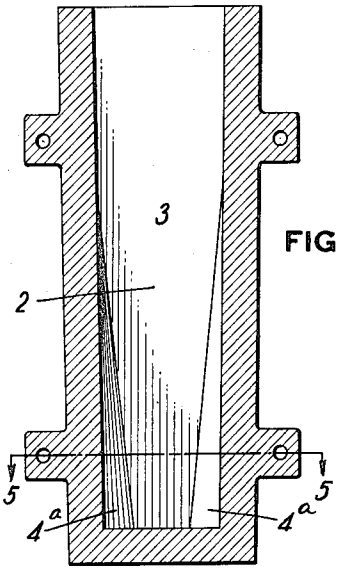


FIG. 4

FIG. 2

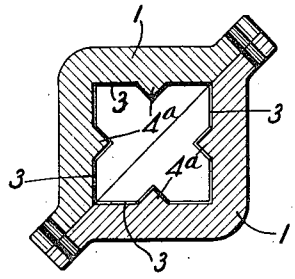
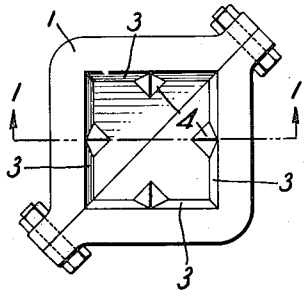


FIG. 3



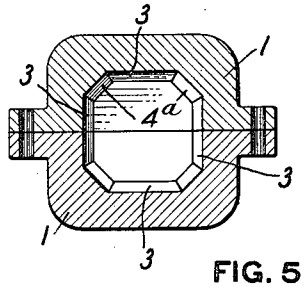


FIG. 5

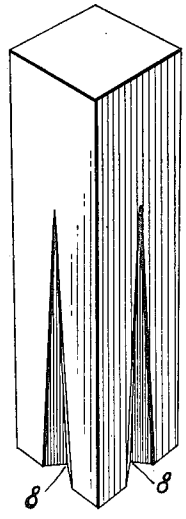
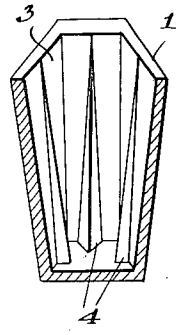


FIG. 6

FIG. 8.



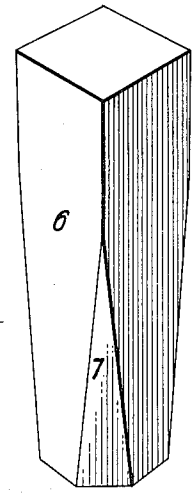


FIG. 7

WITNESSES

Chas. Lostterman

Elbert L. Hyde.

INVENTOR

Alexander Fielder Clarke

By F. H. Hewlett.

Attorney.

UNITED STATES PATENT OFFICE.

ALEXANDER FIELDER CLARKE, OF PITTSBURGH, PENNSYLVANIA.

INGOT-MOLD AND INGOT PRODUCED THEREBY.

1,224,277. Specification of Letters Patent. Patented May 1, 1917.

Application filed February 21, 1913. Serial No. 749,994.

To all whom it may concern:

Be it known that I, ALEXANDER FIELDER CLARKE, a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Ingot-Molds and Ingots Produced Thereby, of which the following is a specification.

This invention relates to the production of steel ingots and to the molds for casting the same. The object of the invention is to prevent "piping" of the ingots and also segregation of the impurities, and at the same time produce an ingot with practically parallel opposite side walls or surfaces, so that it will be safe in hammering, rolling or otherwise working it.

In the casting of steel ingots it frequently occurs that the ingot when cooled has one or more cavities or hollow spaces at its core or axis, due to the more rapid cooling of the outer metal and the formation of a solid outer shell or skin, so that the molten interior metal shrinks away from the center of the ingot and leaves the holes referred to. This action is known in the art as "piping." Attempts have been made to prevent "piping" by forming the mold tapering, or of smaller cross sectional area at the bottom than at the top, with the idea that the ingot will thus cool more rapidly at the bottom than at the top, so the upper strata of molten metal will sink to fill in the void and thus produce a solid ingot. While such molds do modify the "piping," it is found in practice that to secure any material effect in the reduction of "piping" the taper of the mold must be substantial and so that the ingot then produced has its opposite side walls or faces in planes at an appreciable angle to each other, making it difficult and dangerous to hammer the ingot, while, if the ingot is to be rolled, it is liable to stall the rolling mill, due to its increasing thickness from end to end. Moreover, although the ordinary tapered ingot mold modifies the "piping," it has no effect upon "segregation," or the collection of impurities of the steel in that portion of the metal last to solidify. Ingots cast in the ordinary tapered molds solidify from the outside toward the inside, even though the cross sectional area of the mold is appreciably smaller at one end than at the other, and for this reason segregation of impurities at the center of the ingot necessarily occurs.

My invention is designed to avoid the objectionable features of prior molds and produce a solid ingot free from "piping" and segregation, and of substantially homogeneous composition throughout, so that analyses of samples taken from different parts of the ingot will be substantially identical.

The invention comprises the construction and arrangement of parts hereinafter described and claimed.

In the drawings Figure 1 represents a longitudinal sectional view on the line 1—1, Fig. 2, through a mold embodying one form of the invention; Fig. 2 is a top or plan view of the same; Fig. 3 is a cross section of the same, taken on the line 3—3, Fig. 1, and showing a modification; Fig. 4 is a view corresponding to Fig. 1 and showing a modified form of the invention; Fig. 5 is a section on the line 5—5, Fig. 4; Figs. 6 and 7 are perspective views of ingots cast in the molds shown respectively in Figs. 1 and 4; and Fig. 8 is a sectional elevation, in perspective, of a modified form of mold.

The details of mechanical construction of my improved mold may be any of those commonly employed in the art and require no extended description. The mold may be formed of any suitable material, such as cast iron, or refractory material, and may be constructed of a single integral piece as in Fig. 8, or may be split or parted either diagonally, as shown in Fig. 2, or from side to side, as shown in Fig. 5. The mold shown in Fig. 1 comprises two halves or sections 1, of similar construction and locked or held together by any suitable or preferred arrangement of hoops, rings, latches, locks or levers. Said mold sections are formed to provide a mold chamber or cavity 2 which, in the case of a one-piece mold, as shown in Fig. 8, tapers slightly from the top to the bottom of the mold—that is, the distance across the mold at the top is slightly greater than at the bottom, so that the mold can be readily stripped from the cooled ingot. But in the case of a sectional mold, such as shown in Figs. 1 to 5, the mold cavity or chamber can be formed without any taper, as the mold sections can be separated to permit the removal of the ingot. The mold cavity or chamber 2 may be any shape in cross sec-

tion, either square or hexagonal, or any other shape having an even number of sides so that the mold sections will have pairs of oppositely disposed walls or faces.

The main portions of the oppositely disposed inner walls or surfaces 3 of the mold sections 1 are smooth or flat and in substantially parallel planes so that the solidified ingot has opposite flat, substantially parallel faces, whereby it can be supported properly upon the bed of the power hammer or table of the rolling mill, thereby permitting it to be readily and safely hammered or rolled, as will be readily understood.

To prevent "piping" and segregation, the side walls of the mold are provided with inwardly projecting wall portions 4, which may extend from the extreme top to the extreme bottom of the mold, as in Fig. 8, but preferably, and as shown in Figs. 1 and 7, extend from a point about two-thirds the height of the mold down to the extreme bottom end thereof. Said wall projections may be of any shape in cross section, but in any case gradually increase in cross sectional area from their tops to their bottoms, thus gradually decreasing the cross sectional area of the mold chamber or cavity from the upper end of the wall projections to the bottom of the mold. This causes more rapid cooling of metal in the bottom of the mold than at the top, with the result that there is maintained in the upper portion of the mold a quantity of fluid metal which gradually sinks as the metal in the bottom of the mold cools and fills up any void which may occur or be formed therein, and thus prevents "piping" at the core of the ingot.

The wall projections may be located wherever desired. In the form of mold shown in Fig. 4 said projections, marked 4^a, are located at the corners of the mold and are triangular in cross section so that the ingot produced thereby has opposite flat faces 6 formed by the side walls 3 of the mold and extending from top to bottom thereof, and corner faces 7, which are triangular in shape and are formed by the inwardly projecting wall projections 4^a, said faces 7 gradually increasing in width downwardly.

In the mold shown in Fig. 1 the wall projections 4 are in the form of ribs and project inwardly from the opposite side walls or faces 3, and are located midway between the corners of the mold. Said projections 4 may be of any shape in cross section and are illustrated as triangular. They gradually increase in cross sectional area from a point about two-thirds the height of the mold to the bottom thereof. These projections not only reduce the cross sectional area of the mold cavity at the bottom, but also project so appreciably into the mold cavity or space that they permit the metal along the center or axis of the ingot to cool practically at the same rate as the metal on the exterior thereof. In the solidified ingot cast in this mold (Fig. 6) the side walls or faces are provided with reëntrant angles, marked "8", formed by the riblike wall projections 4. If, as is usual, the mold itself is made of cast iron, which is a good conductor of heat, the greater thickness of metal between the central portion of the ingot and the outside of the mold near the bottom thereof conducts the heat away on all sides from the center of the ingot at more nearly the same rate as from the corners thereof than with prior molds, so that the rate of cooling and solidification of the metal in different portions of the mold cavity is more nearly the same. This prevents the collection and concentration of the impurities in a limited amount of the molten metal, so that the solidified ingot is practically homogeneous in composition and analyses of different portions thereof will be identical.

It will of course be understood that as the metal of the ingot cools it shrinks and very gradually lowers in the mold so that there may be a slight cup or depression in the upper end of the ingot, as illustrated. This part of the ingot will be cropped off, as is usual.

The mold described is of simple construction and can be used in the same manner as other molds in common use. It practically completely prevents "piping" and segregation and secures a solid ingot of homogeneous composition. At the same time the reduction in cross sectional area of the bottom of the mold cavity secured by the provision of the wall projections or ribs does not modify the shape of the ingot to such extent as to make it unsuitable for hammering or rolling. The finished ingot has opposite flat faces in parallel or substantially parallel planes and extending from end to end thereof, so that it can be handled easily and just as safely as ordinary ingots.

What I claim is:—

1. An ingot mold having a chamber or cavity provided with opposite side walls extending in straight lines from end to end thereof, said walls being in substantially parallel planes and all the walls being of substantially the same width, the cross sectional area of said chamber or cavity being materially greater at one end of said mold than at the other.

2. An ingot mold having a chamber or cavity provided with opposite side walls extending in straight lines from end to end thereof, said walls being in substantially parallel planes and all of said walls being of substantially the same width, the cross sectional area of said chamber or cavity de-

creasing gradually toward one end of the mold and being materially less at one end than at the other.

3. An ingot mold having a chamber or cavity provided with opposite side walls in substantially parallel planes and extending from end to end of said mold, said mold walls being provided with portions projecting inwardly into said chamber, said projecting portions being of gradually increasing cross sectional area from one end to the other.

4. An ingot mold having a chamber or cavity therein provided with opposite side walls in substantially parallel planes and extending from end to end of said mold, said walls between the mold corners being provided with inwardly projecting ribs, said ribs being of materially greater cross sectional area at one end than at the other and thereby varying the cross sectional area of the chamber or cavity in said mold.

5. An ingot mold having a chamber or cavity provided with opposite side walls in substantially parallel planes and extending from end to end of said mold, said walls between the mold corners being provided with inwardly projecting ribs extending from a point near one end of said mold to the other end thereof, said ribs being of materially greater cross sectional area at one end than at the other and thereby varying the cross sectional area of the mold chamber or cavity.

6. An ingot having two of its opposite sides approximately straight and equi-distant from the vertical central axis of the ingot at its upper and lower portions and two intervening sides inclined and converging toward the ingot bottom.

7. A metallic mold in which the mold cavity has some of its sides approximately straight and parallel while others are relatively tapered or inclined from the upper portion of the mold downwardly toward the bottom thereof.

8. A metallic mold in which the mold cavity has some of its sides approximately straight and parallel while others are relatively tapered or inclined from the upper portion of the mold downwardly toward the bottom thereof, said mold cavity being of greater cross section at top than at bottom and the walls of said mold being made to absorb heat more rapidly at its lower portion than at its upper portion.

9. A metallic mold in which the mold cavity has some of its sides approximately straight and parallel while others are relatively tapered or inclined from the upper portion of the mold downwardly toward the bottom thereof, the walls on diametrically opposite sides of the mold cavity at the lower portion of the mold being thicker than the remaining or intervening walls.

In testimony whereof I have hereunto set my hand.

ALEXANDER FIELDER CLARKE.

Witnesses:
ELBERT L. HYDE,
WILLIAM P. LARKIN.