March 26, 1963 A. BUNGEROTH ETAL 3,082,496

CONTINUOUS CASTING INGOT MOLD

Filed July 2, 1959 3 Sheets-Sheet 1

Fig. 1

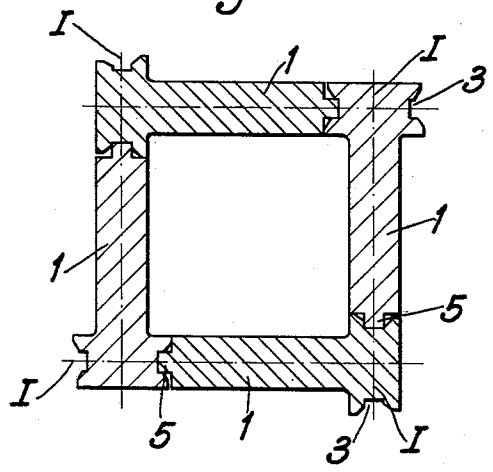
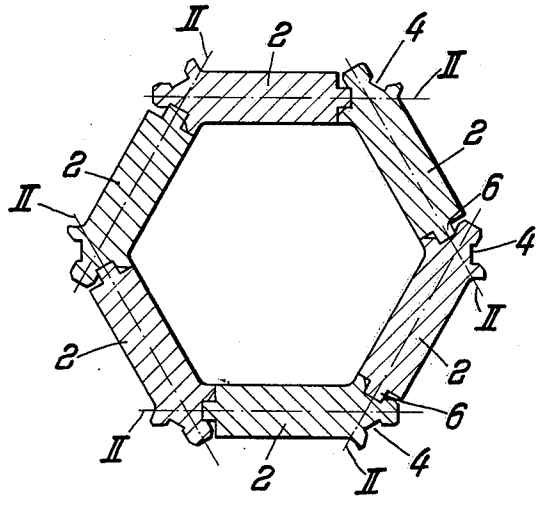


Fig. 2



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Filed July 2, 1959 3 Sheets-Sheet 2

Fig. 3

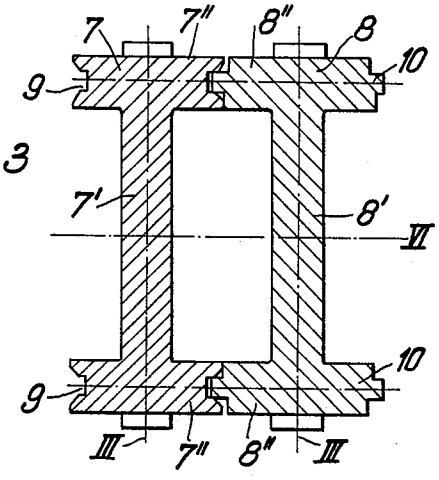


Fig. 4

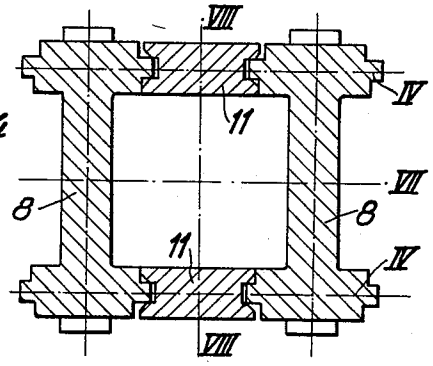
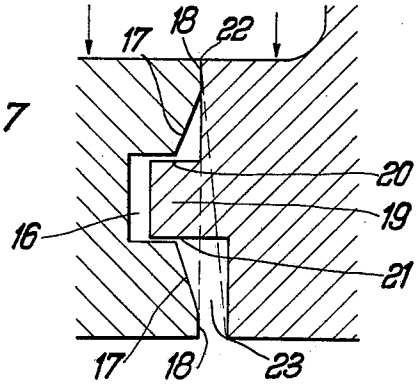


Fig. 7



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March 26, 1963 A. BUNGEROTH ETAL 3,082,496

CONTINUOUS CASTING INGOT MOLD

Filed July 2, 1959 3 Sheets-Sheet 3

Fig. 5

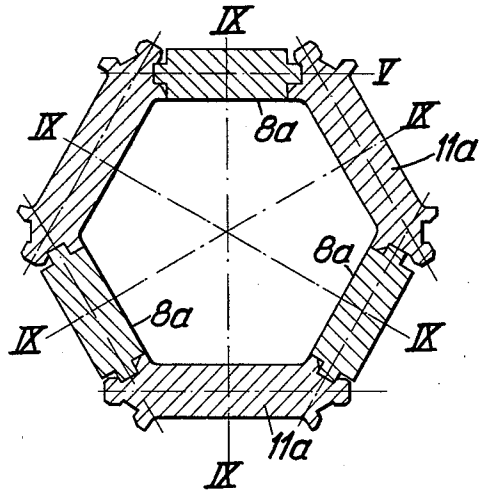
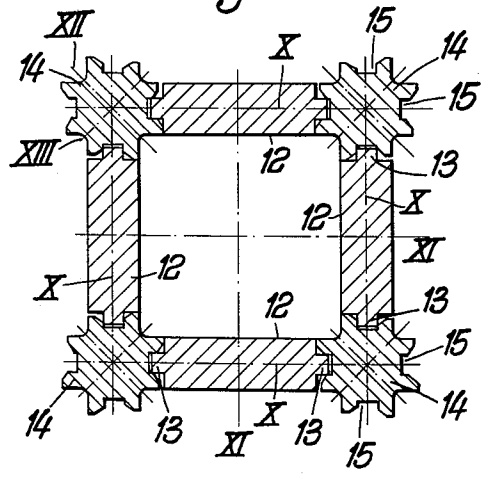


Fig. 6



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CONTINUOUS CASTING INGOT MOLD

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Claims priority, application Germany July 2, 1958
2 Claims. (Cl. 22—57.2)

This invention relates to continuous casting ingot molds and refers especially to improvements in such ingot molds comprising single exchangeable wall elements.

Ingot or chill molds being open above and below, such as being used for continuous casting of fusible metals, in particular when casting high-melting metals, such as steel, are subjected to extremely severe strain. These ingot molds are heated on their inner side with molten material, the temperature of which is in the case of steel of more than 1,500° C. (=2,732° F.), whereas its outer side is impacted by a coolant, in the majority of cases being water, the temperature of which is mostly below 50° (=122° F.). These high differences in temperatures are causing stresses producing warpings or deformations making the ingot molds unserviceable after a relatively short service life.

Therefore, continuous casting ingot molds have been already used in prior practice comprising individual walls, consisting of single wall elements which can be exchanged in order to avoid having to remove the unserviceable mold completely from operation. After time-consuming and difficult straightening work these elements or parts are indeed again usable, but nevertheless they are subjected to same deformations after a relatively short time.

The same conduct is shown also by thick-walled ingot molds, by walls and/or wall elements in which the coolant is made to circulate in borings.

Now, prior practice has observed that the warpings of the ingot mold walls or of parts thereof mentioned at the outset work out in the majority of cases in such a manner, that there are outwardly directed bulgings arising therefrom, showing their strongest effect over the full width of the plate and being less in the longitudinal direction. Owing to these bucklings the butt joints do of course open at the ingot mold inside, because of which reason the molten material has been soaking in, solidifying and obstructing carrying away the strand.

The general aim and object of the invention is to develop the connected individual wall elements or wall portions of a composed continuous casting ingot mold in such a manner that they can be reversed, to make them also capable of being turned over, and finally to make them interchangeable. A reversal, respectively an interchanging of the elements will e.g. result in inserting the originally outwardly directed bulgings toward the inside of the ingot mold. It has become evident that a plate, which has been inserted inversely with respect to its bulging or warpage, will not only automatically be straightened owing to the action of the likewise reversed temperature differential being active thereon, but, even beyond that, warpage will occur in the opposite direction. In this way, there is not only a time-consuming straightening work avoided and eliminated, but much more a considerable reduction of costs and economy of time will be attained as regards the necessity of repeated exchange of plates, which can be reversed time and time again rather than be replaced after comparatively short service life. Such a plate must at first overcome the existing curvature before being permitted to camber again toward the outside.

Moreover, it is ordinarily known that a certain wear is perceived within a course of time at the inside of continuous casting ingot molds, beginning and being the strongest within the range of the casting level and decreasing considerably toward the lower ingot mold end and is not discernible in molds constructed according to the present invention.

Due to the reversibility of the wall elements or wall portions of the ingot mold the heretofore lower end of the ingot mold wall may be now applied as the head end. In this manner the worn out range of the casting level is transferred into the lower range of the ingot mold, where, owing to the known shrinkage of the workpieces, it is not or, at the most, only slightly struck by the strand.

The results according to the invention are obtained by developing a continuous casting ingot mold comprising at least two wall portions wherein the profilated abutting ends of the wall elements being opposed at the parting lines between them are interlocking in such a manner that the cross section of the wall element is symmetrically developed with regard to its longitudinal axis. In accordance with another feature of the invention, the wall elements can be also symmetrically developed with regard to their transverse axes. If the wall elements are connected together by edge joints at the corners, the cross section of these edge bonds is likewise symmetrically provided with regard to their diagonal axes. Another fundamental concept of the invention consists in providing for continuous casting ingot molds, of the kind described heretofore, where the abutting ends of the mold forming or defining elements are closed at the inner wall of the ingot mold, but form a substantially wedge-like slit open toward the outside at the parting line of the joints. From such a slit being open toward the outside, the fact will result that even in the case of the strongest curvatures being still deemed as admissible for serviceable wall portions, a rigidly joined and closed butt joint will be left at the inner wall side of the ingot mold. This will be attained by chamfering one of the two profilated butt joints of the wall elements concerned over its full width in accordance with the maximum curvatures to be expected and deemed still permissible.

As the wall elements of composite ingot molds are often provided with groove-and-tongue-joint for easier attaining thereby a better holding together, the chamfering of the abutting ends must include these joints too, of course only insofar as the reversibility, capability of being turned over and/or interchangeability of the walls or wall elements will not be impaired. The specific development of the abutting ends being reciprocally provided with groove and tongue joints is therefore a substantial part of the present invention being described in the following with the aid of exemplified embodiments.

The accompanying drawings do represent a section of different embodiments of ingot molds made in accordance with the invention.

FIGS. 1 and 2 are cross-sectional views of a square, and a hexagonal ingot mold respectively, embodying the invention having wall elements symmetrically developed with respect to the longitudinal axes I and II thereof.

FIGS. 3, 4 and 5 show a flat type of ingot mold, a square ingot mold having so-called intermediate pieces, and a hexagonal ingot mold. In these molds the cross section of the wall elements is not only symmetrically developed with respect to their longitudinal axis III (FIG. 3), IV (FIG. 4) and V, but also with reference to transverse axes VI (FIG. 3), VII and VIII (FIG. 4) and IX (FIG. 5).

FIG. 6 illustrates an embodiment of a square ingot mold type having edge joints. The wall elements being symmetrical with reference to their longitudinal axes X and with reference to their transverse axes XI. The edge joints or bonds are symmetrical with reference to the diagonal axis XII and the axis XIII provided at a right

angle thereto. FIG. 7 is an enlarged cross-sectional view of the butt joint of two wall elements developed in accordance with the invention.

The ingot molds according to the FIGS. 1 and 2 are composed of matching portions or elements **1**, and **2** respectively. They are symmetrically developed with respect to their longitudinal axes I, and II respectively. where in this specification we speak of longitudinal axis, that axis which, seen in cross-section, is longest is meant. At the opposite abutting ends in the separating lines the elements are provided with grooves **3**, and **4** respectively, mating with tongues (projections) **5**, and **6** respectively. Such an arrangement facilitates the reversibility, capability of being turned over and/or the interchangeability of the elements. However, it will be apparent that all parts of an ingot mold must be turned over, reversed and/or interchanged one against the other at the same. This is nevertheless of subordinate importance, as we are always endeavouring to use as far as possible all walls, or wall elements in an equal state of warpage or wear and to apply them or to interchange same one against the other. The closed butt joint provided at the inner side of the ingot mold element in accordance with the invention is open toward the outside and substantially forms a wedge-like slit as is, of course, the case in all other assemblies of mold defining elements existing at any time.

The flat ingot mold type represented by FIG. 3 comprises two halves **7** and **8**. The webs **7'** and **8'** form the longitudinal sides of the ingot mold, whereas the narrow sides are formed by the flanges **7''** and **8''**. Whereas the flanges **7''** of the ingot mold **7** have grooves **9**, the flanges **8''** of the ingot mold halve **8** are provided with tongues (projections **10**. The grooves and flanges are intermesh when the ingot elements are assembled. This specific development of the abutting ends permits without any further ado and exchanging of both ingot mold halves against each other. In this way what was heretofore the inner wall becomes the outer wall, and what was heretofore the outer wall becomes the inner wall of the ingot mold. Because the ingot mold halves are in each case symmetrically developed around their longitudinal axes III and the transverse axes VI, both their being turned over as well as their reversal when remaining at the original ingot mold side become possible.

In the square ingot mold according to FIG. 4 the wall elements **8** do conform with the wall elements **8** of FIG. 3. Between them wall elements **11** are provided, the abutting ends of which have grooves. Of course, grooves and tongues can also be alternately provided at the abutting ends of the wall elements. The ingot mold elements **8** are symmetrically developed with regard to the longitudinal axes IV and the transverse axis VII, and the wall elements **11** with regard to the longitudinal axes IV and the transverse axes VIII.

In FIG. 5 a hexagonal ingot mold is represented having wall elements **8*a*** showing tongues (projections) and wall elements **11*a*** showing grooves.

The wall elements concerned are in each case symmetrically developed with regard to their longitudinal axis V and with regard to their transverse axis IX.

The square ingot mold according to FIG. 6 comprises ingot mold elements **12** having tongues (projections) **13**. At the corners there are edge joints **14** provided. These are provided with grooves **15**. The wall elements **12** do show a symmetrical cross section with regard to the longitudinal axis X and with regard to the transverse axis XI. The edge joints concerned are in each symmetrically developed with regard to their diagonal axes XII and XIII. The axes XII coincide with the diagonals of the chill mold. FIG. 7 shows the butt joint of the two wall elemens being developed in accordance with the invention. The groove **16** is centrically arranged in a wall

element and changes at both sides into surfaces **17** being chamfered in relation to the wall surfaces toward the outside, ending in faces **18** following at a right angle to said wall surfaces. The abutting end of the one wall element developed in this manner is joined to the abutting end of the other wall element bearing the tongue **19** meshing the groove **16** with a certain clearance. Moreover, the tongue **19** has lateral surfaces **20**, **21** disposed to either side thereof of different lengths, i.e. one edge surface is closer to the edge surface of the tongue than is the other edge surface, the shorter one being turned toward the interior of the ingot mold, whereas the longer one is positioned toward the outside, thus enabling a closed butt joint **22** to be formed at the inner wall of the ingot mold and forming an open slit **23** toward the outside. From a curvature occurring in the direction of the indicating arrows (i.e. toward the outside—the direction being observed in the majority of cases) will result a much more better contact closing at the inner side of the ingot mold. This is true the more the curvature is driven toward the outside, up to the point where finally the surface **21** will join to the lateral surface of the groove **16**. Therefrom will arise a further hold for the coherence of the ingot mold elements. The slit **23** will in this way open farther toward the outside than represented by the drawing (initial position), a fact, however, which is of no importance.

What we claim is this:

1. A continuous ingot casting mold comprised of a mold body having an open bottom and top, said body being defined by a plurality of body-forming elements in abutting relationship, at least two of said elements being of identical cross-sectional configuration, said body-forming elements having mold defining surfaces and joint-defining edge surfaces, one joint-defining edge surface of each element having a groove therein disposed midway between said mold defining surfaces, the other joint-defining surface of each body-forming element having a tongue defined thereon to cooperate with the groove of an adjacent body-forming element, said elements being positioned one with respect to the other, such that the groove in the joint-defining surface of one element abuts against and engages the tongue on the joint-defining surface of an adjacent element, the joint-defining surfaces having a butt joint with the joint-defining surfaces in abutting relation at one side of the joint and spaced apart at the other side of said joint, whereby inward flexure of said body-forming elements due to thermal stress will maintain the joint-defining surfaces in tightly abutting relation at the inner portion of said joint.

2. A continuous casting mold according to claim 1 wherein each of said mold body-forming elements is of identical and symmetrical cross-sectional configuration and may be reversed end-for-end and edge-for-edge in forming the mold body.

References Cited in the file of this patent

UNITED STATES PATENTS

315,192	Walton	Apr. 7, 1885
954,368	Allison	Apr. 5, 1910
956,638	Hoffer	May 3, 1910
1,276,517	Gaiham	Aug. 20, 1918
1,773,732	Hines	Aug. 26, 1930
2,187,720	Williams	Jan. 23, 1940
2,428,660	Falk et al.	Oct. 7, 1947
2,835,940	Wieland	May 27, 1958
2,851,750	Schaaber	Sept. 16, 1958

FOREIGN PATENTS

1,029,973	France	June 9, 1953
453,970	Italy	May 17, 1949

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,082,496 March 26, 1963

Adolf Bungeroth et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 8, for "where" read -- Where --; line 17, after "same" insert -- time --; line 23, for "element" read -- elements --; line 33, strike out "are"; line 36, for "and" read -- an --; line 67, after "each" insert -- case --; line 71, for "elemens" read -- elements --.

Signed and sealed this 25th day of February 1964.

(SEAL)
Attest:
ERNEST W. SWIDER

Attesting Officer

EDWIN L. REYNOLDS
Acting Commissioner of Patents