March 24, 1964 J. SAVAGE 3,125,786

CONSTRUCTION OF MOULDS USED FOR THE CONTINUOUS CASTING OF METALS

Filed April 2, 1963 2 Sheets-Sheet 1

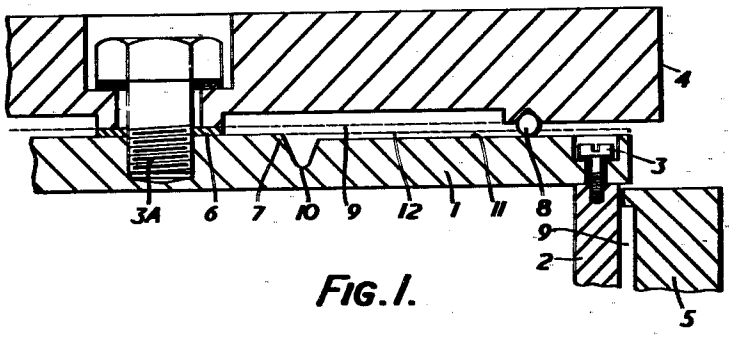


FIG. 1.

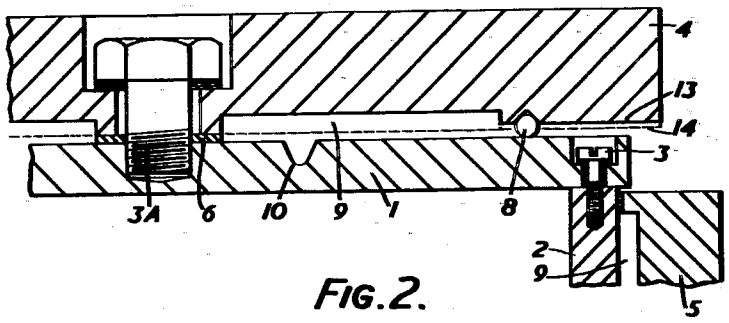


FIG. 2.

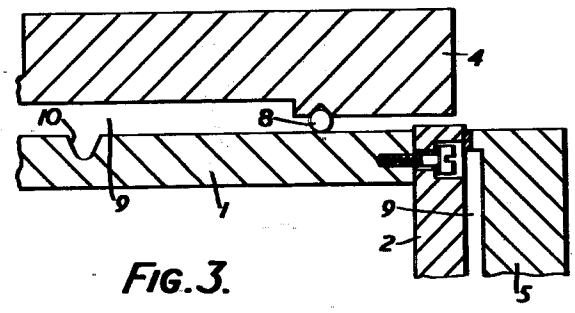


FIG. 3.

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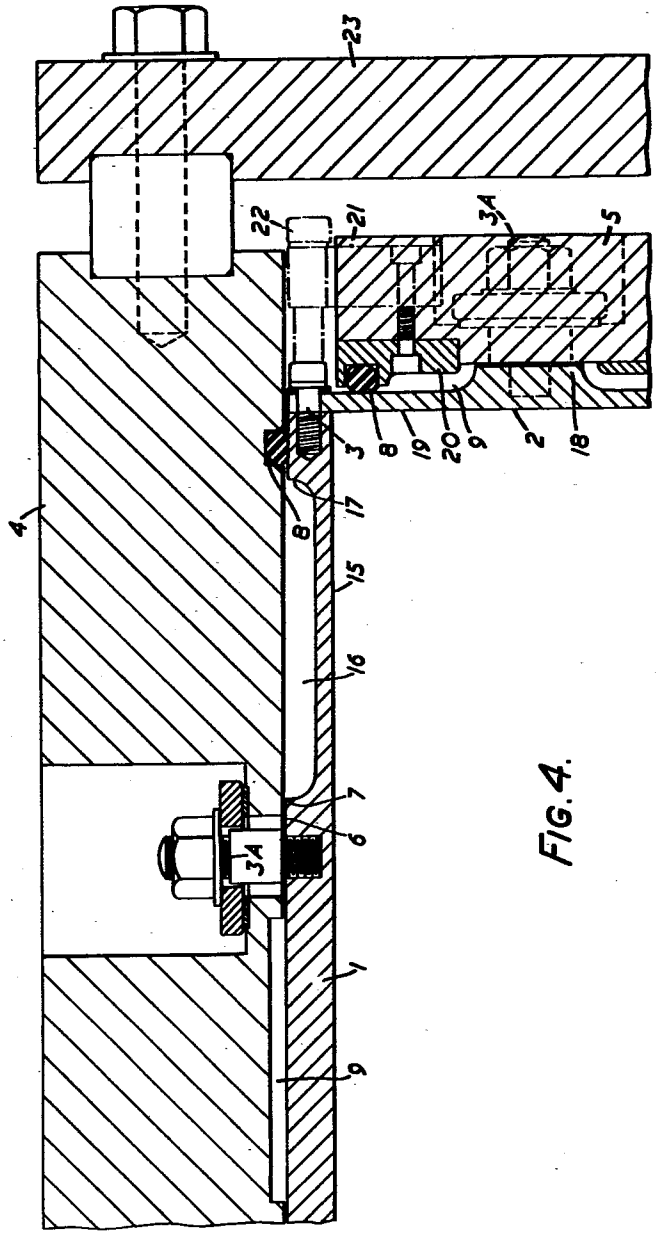


FIG. 4.

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CONSTRUCTION OF MOULDS USED FOR THE CONTINUOUS CASTING OF METALS

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Claims priority, application Great Britain Apr. 2, 1962
12 Claims. (Cl. 22—144)

This invention relates to moulds for use in the continuous casting of metals.

In carrying out the process well-known in the art as continuous casting, it has been suggested to use moulds comprising rectangular mould plates of copper or other suitable metal or alloy which are secured by suitable fixing means to rigid backing plates, which are normally of steel, water cooling passages being provided at the interface of the copper and steel plates.

The steel or other high melting point metal, which is solidifying in such moulds and is being continuously or intermittently withdrawn from the lower end of the mould, produces a high rate of heat flux through the copper wall. As a consequence, the temperature of the mould during the casting operation is raised to an extent where expansion of the mould plates introduces serious problems of construction. As it is convenient to fabricate such moulds from four single mould plates, which must be held in good contact at the corners, then expansion of the mould plates may give rise to small separations of these corner joints. In such a case, liquid metal may well enter into these joints, solidifying as a thin wafer or wedge, so seriously impairing the possibility of continued withdraw of the casting from the mould.

An object of the present invention is to provide a construction of the corner joints of such moulds which will permit the necessary expansion of the mould plates to take place without danger of these plates separating from each other at the corners of the mould.

According to the present invention, a continuous casting mould comprises four mould plates of rectangular profile held in contact at their edges to form an open ended mould space of rectangular cross-section, the mould plates being rigidly secured to rigid external backing plates and water-cooling passages being formed between the mould plates and their associated backing plates, and the marginal portions of each of at least one pair of opposite mould plates located adjacent to the corners of the mould and outside the connections of the mould plate to its backing plate are relieved on their rear surfaces in such a way as to increase the lateral flexibility of the said marginal portions under lateral stresses imposed on them by thermal expansion of the adjacent mould plates in contact with them, and clearances are provided between the relieved marginal portions and the associated backing plates.

According to a further feature of the invention, the rigid backing plates are not directly connected together at the corners of the mould, but are spaced from one another at the mould corners.

The relief of the marginal portions of the mould plates may take various forms. Thus each of the marginal portions may be formed with a groove in its rear surface extending parallel to its outer edge but spaced from the edge, for example located close to a connection of the mould plate to its backing plate.

Alternatively or in addition, the rear surface of each of the marginal portions may be relieved to a uniform depth over a major part of that surface, so that it is thinner than the remainder of the mould plate. The relieved area may extend up to the outer edge of the marginal portion, or it may terminate short of that edge

and form with the opposed surface of the backing plate one of the water-cooling passages.

The invention may be carried into practice in various ways, but four specific embodiments will now be described by way of example only with reference to the accompanying drawings whereof

FIGURE 1 is a diagrammatic sectional view of one corner of a rectangular mould,

FIGURES 2 and 3 are similar views of the corners of two modified embodiments, and

FIGURE 4, which constitutes a sectional view of one corner of another construction of rectangular mould.

The embodiment of FIGURE 1 comprises a rectangular mould formed by two flat copper side plates **1** and two flat copper end plates **2**, whereof the side plates **1** are wider than the end plates **2**. Each end plate is fixed between the two side plates by screws or other suitable jointing means **3**, which are provided to maintain intimate abutting contact at the interface between the mould plates **1** and **2** at the corner of the mould. A suitable water seal (not shown) is incorporated at each corner of the mould between the abutted plates **1** and **2** to prevent water leakage into the mould. During the operation of the continuous casting process, the temperatures of the mould plates **1** and **2** are of course increased considerably, resulting in expansion of these plates. The side plates **1** are rigidly secured to external backing plates **4** by means of bolted connections **3A** which are designed to permit the longitudinal sliding movement of each plate **1** relatively to the backing plate **4** arising out of the thermal expansion and contraction of the side plates. A thin gasket **6** is inserted between the side plate **1** and the backing plate **4**. The end plates **2** are similarly secured to rigid backing plates **5**. The expansion of the side mould plates **1** displaces the end mould plates **2** and their attached rigid steel backing plates **5**, but the side mould plates **1** are not constrained by the backing plates as a result of this expansion. This lack of constraint is achieved by keeping the steel backing plates **4** and **5** separate and spaced apart from one another at the corners of the mould, so that they can move relative to one another at the corners. It will be appreciated that if the backing plates **4** and **5** were connected for example in the form of a rigid rectangular outer box, the expansion of the mould plates **1** would be restrained.

While the expansion of the side mould plates **1** can be easily accommodated by means of the backing plate construction described, the end mould plates **2** also expand, although by a smaller amount, as in a rectangular mould the dimension of each end plate **2** is smaller than that of each side plate **1**. It has been found that if each side plate **1** were simply attached to its backing plate **4** by the bolts **3A**, and if no other precautions were taken along the interface between the plates **1** and **4**, considerable constraint would be exerted by them on the end mould plates **2**, which might result in buckling of the end plates **2**. This might cause separation at the interface of the side and end mould plates **1** and **2**, which might be sufficient to permit liquid steel to enter the gap so produced. In order to prevent such constraint by the plates **1** and **4** against expansion of the end plates **2**, there is also provided a means by which the expansion of each end plate **2** can take place against a greatly diminished resisting force.

Thus the rear surface of the margin of the side mould plate **1** is spaced from the associated backing plate and is relieved from the point **7** to an extent indicated by the firm and dotted lines **11** and **12**, to reduce the thickness of the margin of the mould plate **1** by a small amount as compared with the central part of the plate, and a groove **10** is machined in the rear surface of the plate **1** parallel to its edge so as to produce a relieved neck of reduced

thickness and stiffness near the point 7. The groove 10 allows the marginal portion of the plate to flex more easily under the lateral forces applied to it by expansion of the adjacent end plate 2. A water seal 8 of suitable resilient material prevents any escape of cooling water from the channel 9 between the side mould plate and the backing plate 4. The clearance provided between the backing plate 4 and the relieved rear surface of the mould plate 1 in the region near the seal 8 is sufficiently large to permit very easy flexing of the narrow marginal portion of copper mould plate about the relieved neck produced by the groove 10, which is machined into the mould plate 1 so that there is only a very small restraint against the force of expansion of the end mould plate 2. It will be appreciated that while the groove provided in the mould plate 1 reduces restraint to flexing, it may in some cases be omitted, the relief of the thickness of the whole margin of the mould plate 1 being relied on to provide the required increase in flexibility.

In the second embodiment, shown in FIGURE 2, a similar effect is produced by maintaining a uniform thickness of the copper side mould plate 1 but providing the groove 10, and by reducing the thickness of the backing plate 4 in the region of the seal 8, as indicated by the firm and dotted lines 13 and 14, to provide the necessary increased clearance between plates 1 and 4 in the region of the seal 8.

In yet another embodiment, illustrated in FIGURE 3, an arrangement of the copper mould plates 1 and the backing plates 4 similar to that shown in FIGURE 2 is used, but each end plate 2 is fixed as shown in FIGURE 3 with its side face abutted against the edge of each side plate 1, so that it does not lie between the two side plates 1.

Alternatively, the embodiment of FIGURE 3 might be modified to incorporate an arrangement of the copper side mould plates 1 and backing plates 4 similar to that of FIGURE 1, each marginal portion of the plates 1 being both grooved at 10 and of reduced thickness, and the side plates 1 being positioned between the end plates 2 as shown in FIGURE 3.

In the fourth embodiment, illustrated in FIGURE 4, the marginal portion 15 of each of the side mould plates 1 is given increased flexibility by means of a wide relieved trough 16 which is machined out of its rear surface, the trough 16 extending from the point 7 nearly to the outer edge of the margin 15, from which edge it is separated by a land 17. The thickness of the margin 15 at the land 17 is slightly less than that of the unrelieved central portion of the side plate 1, and the land 17 engages the seal 8 and preserves the necessary clearance from the backing plate 4. Each side plate 1 lies in between the end plates 2 with its edges abutting the inner surfaces of the end plates, as shown in FIGURE 4, and is secured by means of the screws 3. The trough 16 consititutes one of the water-cooling passages, another of which is shown at 9.

In this case each end plate 2 is of reduced thickness over its whole area except at the rearwardly protuberant zones 18 which are tapped to receive the connectors 3A, so that the flexibility of the whole end plate 2 is enhanced. The thin marginal portions 19 of the end plates are sufficiently flexible to accommodate the differences in the thermal expansion of the side plates 1 between the top and bottom of the mould, these differences causing the marginal area of each end plate to take up a slightly curved shape. The backing plates 5 carry locating strips 20 which control the clearances from the end plate margins 19 and which locate the seals 8. Water-cooling passages 9 are provided as before between the end plates 2 and their backing plates 5.

Cantilever strips 21 are secured in recesses in the edges of the backing plates 2. A number of the short screws 3 are replaced by extended studs 22 which, in addition to holding the side and end plates together, engage in the cantilever slotted strips 21, thus preventing the marginal portion 19 of the end plate 2 being forced away from its associated backing plate 5 by the pressure of coolant in the cooling passage 9.

The two backing plates 4 associated with the side plates 1 are rigidly joined together by means of a yoke 23 at each end of the mould, but it will be noted that the end backing plates 5 are not connected to the yokes 23 and are spaced from the side backing plates 4.

From the foregoing it will be appreciated that the methods of construction proposed overcome the serious objections to methods in current use by now providing for very easy flexing movement of the copper side plates of the mould, this flexing arising from the expansion of the end plates, and without any danger of a gap being produced at the interface of these side and end plates.

It will be appreciated that in a further form of the invention the end plates of the mould may also be relieved in the same manner as the side plates shown in FIGURES 1, 2 or 3 in order to obtain easy flexing due to thermal expansion of both the side and end plates near the corners of the mould.

Furthermore, the relieved marginal portions of each side or end plate may each be formed with two spaced grooves each similar to the groove 10 of FIGURES 1, 2 or 3, one groove being located close to the connections 3A as in the case of the groove 10 and the second groove being located close to and on the inner side of the water seal 8. This enables the marginal portion of the plate to undergo a double deflection, bending in opposite angular directions at the necks of the two grooves, and thereby to maintain a squarely-abutted point between the two adjacent plates at each corner of the mould.

It will also be understood that, while the invention has been described with particular reference to the construction of rectangular moulds for use in the continuous casting of steel, the invention may equally well be applied to the construction of moulds having a substantially square cross-section or for moulds made from materials other than copper; and that either rectangular or square moulds constructed according to the invention may be used in the continuous casting of metals other than steel.

What I claim as my invention and desire to secure by Letters Patent is:

1. A continuous casting mould which comprises four mould plates of rectangular profile held in contact at their edges to form an open-ended mould space of rectangular cross-section, the mould plates being rigidly secured to rigid external backing plates and water-cooling passages being formed between the mould plates and their associated backing plates, and in which the marginal portions of each of at least one pair of opposite mould plates located adjacent to the corners of the mould and outside the connections of the mould plate to its backing plate are relieved on their rear surfaces in such a way as to increase the lateral flexibility of the said marginal portions under lateral stresses imposed by thermal expansion of the adjacent mould plates in contact with them, and clearances are provided between the relieved marginal portions and the associated backing plates.

2. A mould as claimed in claim 1 in which the backing plates of adjacent mould plates are spaced from one another at the corners of the mould.

3. A mould as claimed in claim 1 in which each of said relieved marginal portions of the mould plates is formed with a groove in its rear surface extending parallel to the outer edge of the marginal portions but spaced from the said outer edge.

4. A mould as claimed in claim 3 in which each groove is located adjacent to a connection of the mould plate to its backing plate.

5. A mould as claimed in claim 1 in which the rear surface of each of the said marginal portions is relieved to a uniform depth over a major part of the said surface.

6. A mould as claimed in claim 5 in which the re-

lieved area extends to the outer edge of the marginal portion.

7. A mould as claimed in claim 5 in which the relieved area terminates short of the outer edge of the marginal portion and forms a water-cooling passage.

8. A mould as claimed in claim 1 in which the relieved mould plates constitute side plates which are wider than other two plates, referred to as end plates.

9. A mould as claimed in claim 8 in which the end plates are located between and with their edges in abutted relationship with the inner surfaces of the marginal portions of the side plates.

10. A mould as claimed in claim 9 in which the marginal portions of the end plates are similarly relieved.

11. A mould as claimed in claim 8 in which the side

plates are located between and with their edges in abutted relationship with the inner surfaces of the margins of the end plate.

12. A mould as claimed in claim 11 in which the thickness of each end plate over the major part of its area except at the connections to the associated backing plate is less than the thickness of the unrelieved parts of the side plates.

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