Dec. 20, 1932. F. W. HARBORD ET AL 1,891,813

MANUFACTURE OF METAL BILLETS, BARS, AND THE LIKE

Filed Oct. 23, 1929

Fig. 1.

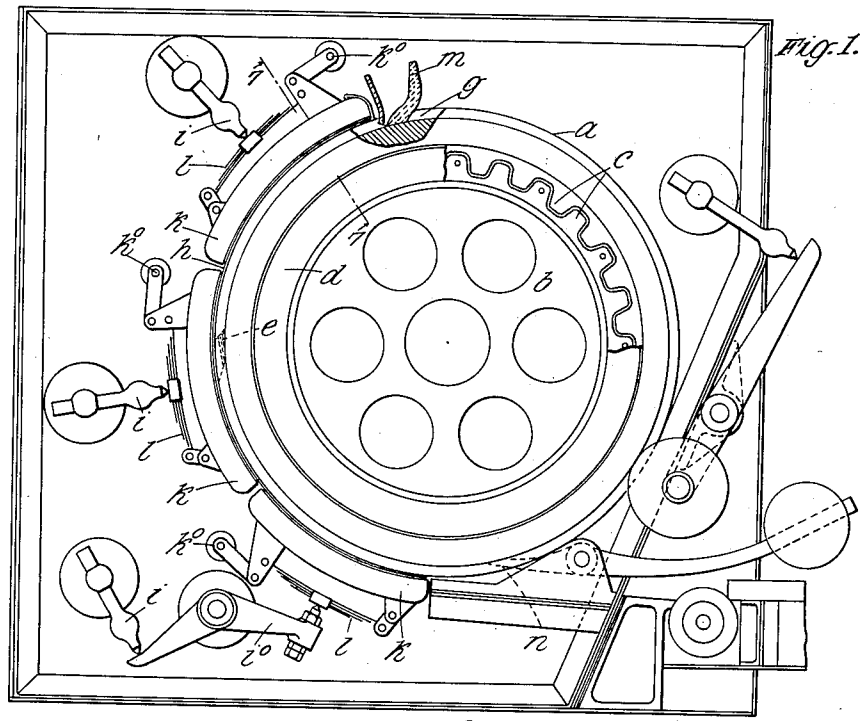


Fig. 2.

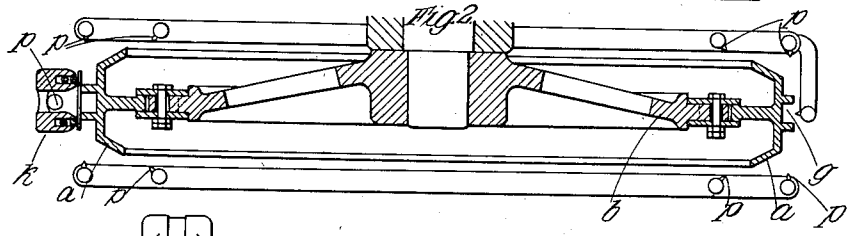


Fig. 3.

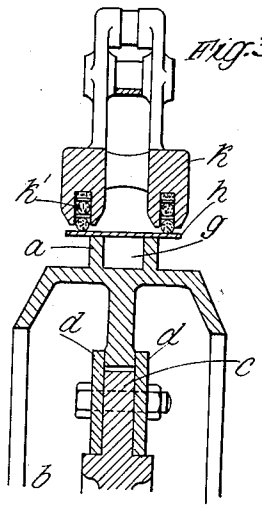
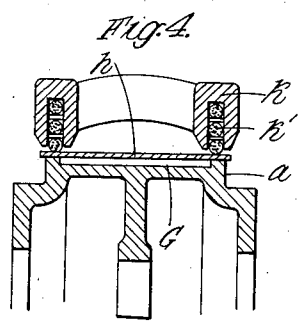


Fig. 4.



INVENTORS

Frank W. Harbord,

Vernon Harbord,

BY James L. Norris

ATTORNEY.

Patented Dec. 20, 1932 1,891,813

UNITED STATES PATENT OFFICE

FRANK WILLIAM HARBORD AND VERNON HARBORD, OF LONDON, ENGLAND

MANUFACTURE OF METAL BILLETS, BARS, AND THE LIKE

Application filed October 23, 1929, Serial No. 401,872, and in Great Britain November 14, 1928.

This invention relates to the production directly from molten metal of billets, bars, blooms, slabs or the like of metal generally, and particularly of iron or steel or steel alloys. The product will for convenience be hereinafter referred to as a billet, independently of the shape or relative dimensions of the cross section of the product.

The method employed for producing such billets or the like consists in closing the open face of a channel of appropriate cross section over part of its length to form a mould cavity, maintaining a substantially continuous relative longitudinal movement between the channel and the closure device, simultaneously maintaining a supply of molten metal to the mould cavity to keep the latter substantially filled, and automatically stripping the billet or the like from the channel soon after its emergence from the mould cavity and with or without previous consolidation of the billet while still within the channel.

The invention consists in an apparatus for carrying into effect such a method of producing billets, and this apparatus comprises a rotatable disc or drum having formed in or attached to the periphery thereof a mold in the form of a ring having a channel of appropriate cross section having a stationary cover or closure device comprising a flexible metal strip extending over a part of the said channel and forming therewith a mold cavity, the said closure strip being yieldingly held in close contact with the face of the channel as by means of springs.

The mold channel is preferably formed in a ring which is not rigidly attached to the rotatable disc or drum but is mounted in floating relation therewith for a purpose hereinafter described, and both rotating mold and the fixed closure device are preferably water-cooled.

The closure device may consist of a strip of steel, heat-resisting alloy, copper or any metal of high melting point and is of sufficient flexibility to permit of its being pressed firmly along its whole length upon the face of the channel or groove of the rotating mold, as by means of a number of blocks of comparatively short length which are mounted so that they can be yieldingly pushed against the closure strip and thereby ensure a tight joint between the latter and the edges of the mold channel.

To ensure the metal gripping the moving mould, the inside of the mould may have ribs or grooves cast or cut in the surfaces of the mould, such ribs or grooves being so arranged that they do not interfere with the stripping of the billet from the mould or the maintenance of a good tight fit between the edges of the mould and the flexible strip closure device forming the top of the mould cavity.

The mold may be spirally arranged around the rotatable disc or drum, and in this case the drum or alternatively the mold closure device would be traversed along a guide parallel with the axis of the cylinder at an appropriate speed. In the latter case the closure device would not be absolutely fixed, but it would still be fixed in the sense that there would be no longitudinal, i. e. no rotational movement of the closure device, and would be separately supported to occupy a fixed angular position on the downwardly moving side of the rotating drum.

Obviously, the cylinder may have a plurality of grooves each provided with a mould closure device, or it may have one or more spiral grooves and in this case the mould or alternatively the closure device would be given an appropriate traversing movement parallel with the axis of the mould cylinder.

Alternatively, the continuous or circular mould may be arranged to rotate in a horizontal plane, or in a plane inclined slightly thereto, in which case the mould groove or cavity would be formed in or mounted upon the upper side of the circular plate or disc.

Further, although it is preferred that the movement of the moving portion or portions of the mould should be continuous, it is possible also to make such movement intermittent or step-by-step, provided the steps succeed each other with suitable rapidity.

In the accompanying drawings Fig. 1 is an end elevation of an annular or continuous apparatus embodying the invention; Fig. 2 is a horizontal section through Fig. 1; Fig. 3 is

a section, on an enlarged scale on the line 7—7, Fig. 1; and Fig. 4 is a section, similar to Fig. 2 of a modified form of mold for use in the apparatus shown in Fig. 1.

In the arrangement illustrated in Figs. 1, 2 and 3 the mould cavity *g* is formed in a metal ring *a* carried upon the periphery of a disc *b* which is mounted to revolve about a horizontal axis. The connection between the mould ring *a* and the disc *b* is made by means of teeth *c* engaging each other with only a slight freedom, so that the mould ring *a* "floats" on the periphery of the disc *b* to allow for differential expansion, being held in position by lateral retaining plates *d*, upon removing which the mould can be slid off and another one of the same or different section put in its place.

The refractorily lined casting pot *m* is suitably supported with its spout resting in the groove *g* of the mould ring to deliver the molten metal received from the casting ladle to the inlet end of the mould.

The top of the mould is closed by water-cooled blocks, or alternatively by a comparatively thin strip *h* of steel which is anchored at its forward end and is pressed against the edges of the mould cavity *g* by means of blocks *k* to form a closed joint and cover to the outer face of the mould cavity. The strip *h* and blocks *k* are freely water-cooled. As shown in the drawings the blocks *k* are pivotally mounted upon fixed fulcrums k^o and are urged towards the periphery of the mould by screws *i* or other suitable means, springs *l* being preferably interposed between the screws or other tightening device and the blocks *k*, and a compressible or elastic packing *k'* between the blocks *k* and the strip *h*.

To change the mould the blocks *k* are swung outwards upon their pivots k^o after the screws *i* have been swung clear. It will be noted that the screws *i* may engage directly with the springs *l* or through the medium of bellcrank levers such as i^o. When the blocks *k* are swung out of the way, the ring *a* may be removed from the disc *b* after removing one of the retaining plates *d*, and a different mould, such as the plate mould shown in Fig. 4, substituted.

The blocks and strip are stationary, only the cylinder moving, and they form—with the groove in the ring *a*—a closed mould over approximately half the periphery of the cylinder. The ring *a*, like the stationary blocks and strip, is also freely water-cooled, but no details of such cooling devices, apart from the water jets *p* indicated in Fig. 2, are shown in the drawings, as they are well understood.

At the end of the mould cavity *g*, opposite to the casting pot, there is mounted a stripper *n* which is gravity or spring-urged to bear against the bottom of the mould cavity and to free the billet from the latter, after which the billet passes to a roller bed or equivalent conveyor. The mold cavity is freely water-cooled at a point or points in rear of the stripper. In starting, the mould cavity is blocked at a suitable point, as by means of a plug *e* of metal, fireclay or other suitable material, which plug is shaped to permit the stripper *n* to pass freely under it and thus displace it from the mould cavity as it passes over the stripper. The slide of the plug next to the molten metal may also be shaped so that the end of the billet is pried by the plug from the mould cavity when the stripper passes under the plug. If desired, small holes may be made in the plug, permitting the molten metal to flow into the plug itself, thereby keying the metal to the plug so that the latter is removed in one piece with the end of the billet.

The speed of revolution of the disc *b* and the rate of pouring the metal into the mould are so regulated that by the time the billet reaches a point just before it is engaged by the stripper it is sufficiently solidified to permit of its removal by the stripper from the mould cavity without bleeding, the billet being then carried away and cut to length by flying shears in the usual way.

Since the closure strip and mold do not move together, the closure strip acts in the manner of a brake band against the mold and the metal contained in the latter, necessitating sliding friction between the mold and the metal on the one hand and the closure strip on the other. This makes it possible to maintain the closure strip in much closer contact with the mold than would be possible if both the mold and the cover strip moved together and also prevents the formation of fins on the metal between the mold and the closure strip. Further, since the mold and the metal move together, the frictional action of the closure strip upon the metal, while such metal is in a semi-plastic state, serves to compress the metal in the mold to a certain extent by the dragging action of the metal against the closure strip.

Instead of having one mould on a cylinder, there may be two or more on the same cylinder, so that if one becomes too hot, casting can be continued from the same ladle into another mould on the cylinder.

Moreover, if it is found desirable to have a longer cooling time in the closed mould than is possible with a ring mould such as described, the mould may be spirally arranged on the periphery of the cylinder, thereby permitting the length of the mould to be extended completely round the cylinder or even further.

Having thus described the nature of the said invention and the best means we know of carrying the same into practical effect, we declare that what we claim is:—

1. An apparatus for producing metal bil-

lets, bars or the like directly from molten metal, comprising a ring member having a peripheral channel, a flexible metal strip member supported adjacent to and yieldingly overlying and in close contact with the periphery of said ring member for a portion of the length of said channel and forming with the latter a mold cavity, one of said members being stationary and the other being movable lengthwise of said channel, and a stripper mounted adjacent to and projecting into one end of said mold cavity whereby the solid portion of an ingot is removed from the channel.

2. An apparatus according to claim 1 including a rotatable disc which is loosely surrounded by the ring member to permit of expansion and contraction of the ring member relatively thereto and with which the ring member is rotatable.

3. An apparatus for producing metal billets, bars of the like directly from molten metal, comprising a rotatable disc member; a ring member surrounding said disc member and having a peripheral channel; interengaging means between said disc and ring members, said interengaging means permitting slight relative movement between said members to allow expansion and contraction of said ring member relatively to said disc member; a flexible metal strip overlying the periphery of said ring member for a portion of the circumference of the latter and forming with said channel a mold cavity; yieldable means holding said strip in close contact with the periphery of said ring member and against movement with the latter; and a stripper mounted adjacent to and projecting into one end of said mold cavity for removing the solid portion of an ingot from said cavity.

4. An apparatus for producing metal billets, bars or the like directly from molten metal, comprising a rotatable disc member; a ring member surrounding said disc member and having a peripheral channel; interengaging means between said disc and ring members, said interengaging means permitting slight relative movement between said members to allow expansion and contraction of said ring member relatively to said disc member; means detachably carried by one of said members and engageable with the other of said members to prevent removal of the ring member from the disc member but permitting slight axial movement of said members relatively to one another; a flexible metal strip overlying the periphery of said ring member for a portion of the circumference of the latter and forming with said channel a mold cavity; yieldable means holding said strip in close contact with the periphery of said ring member and against movement with the latter; and a stripper mounted adjacent to and projecting into one end of said mold cavity for removing the solid portion of an ingot from said cavity.

5. Apparatus according to claim 1 including a plurality of contiguous short blocks and yieldable means urging said blocks toward the flexible strip member to hold said member in close contact with the channeled periphery of the ring.

6. Apparatus according to claim 1 including a plurality of contiguous blocks means urging said blocks toward the outer face of the strip member, to hold the strip member in close contact with the channeled periphery of the ring member, and compressible packing between said blocks and the strip member.

In testimony whereof we have signed our names to this specification.

FRANK WILLIAM HARBORD.
VERNON HARBORD.