United States Patent [19]

Moritz

[11] **3,726,336**

[45] **Apr. 10, 1973**

[54] **CONTINUOUS CASTING OF METALLIC ELEMENTS**

[75] Inventor: **Günther Moritz,** 11 Bonn-Bad Godesberg, Germany

[73] Assignee: **Vereinigte Aluminum-Werke Aktiengesellschaft,** Bonn, Germany

[22] Filed: **Nov. 16, 1970**

[21] Appl. No.: **89,802**

[30] **Foreign Application Priority Data**

Nov. 14, 1969 Germany ..... P 19 57 314.9
June 12, 1970 Germany ..... P 20 28 947.8
Nov. 12, 1968 Germany ..... P 18 08 418.9

[52] **U.S. Cl.** **164/283,** 164/89
[51] **Int. Cl.** **B22d 11/12**
[58] **Field of Search** 164/89, 126, 128, 164/283, 348, 64, 82, 144, 73, 268, 273, 281, 282

[56] **References Cited**

UNITED STATES PATENTS

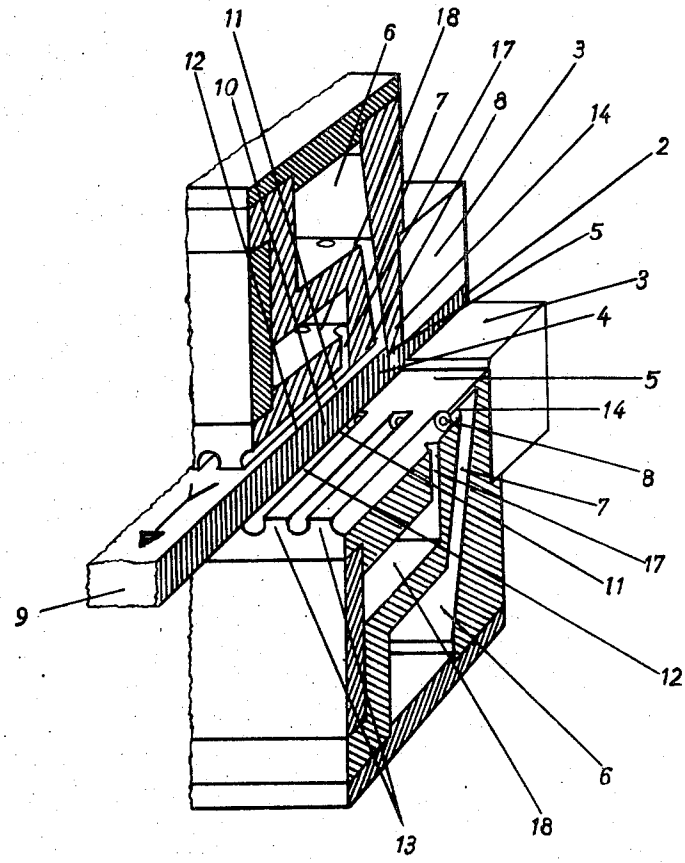
3,623,536	11/1971	Moritz	164/89
3,329,200	7/1967	Craig	164/73 X
3,451,465	6/1969	Moritz	164/73 X
3,381,741	5/1968	Gardner	164/73
3,460,609	8/1969	Olsson	164/73
3,455,369	7/1969	Craig	164/73
3,463,220	8/1969	Moritz	164/89 X
2,747,244	5/1956	Goss	164/268
3,286,309	11/1966	Brondyke	164/73
3,502,135	3/1970	Wertli	164/283 X
3,515,202	6/1970	Bick	164/89

Primary Examiner—J. Spencer Overholser
Assistant Examiner—John D. Brown
Attorney—Michael S. Striker

[57] **ABSTRACT**

A mold for continuous casting of metallic elements has an upright passage of constant cross-section intermediate an inlet and outlet thereof. Feed means feeds into the inlet a stream of molten metal so that the latter solidifies in the passage and advances therethrough as a metallic element of constant cross-section with circumferential clearance. Cooling means introduces into this clearance jets of water in such a manner as to indirectly cool the metallic element in an upstream portion of the clearance and to directly cool the element in a downstream portion of the clearance, and for producing in this clearance an underpressure sufficient to aspirate auxiliary fluids thereinto.

1 Claim, 2 Drawing Figures



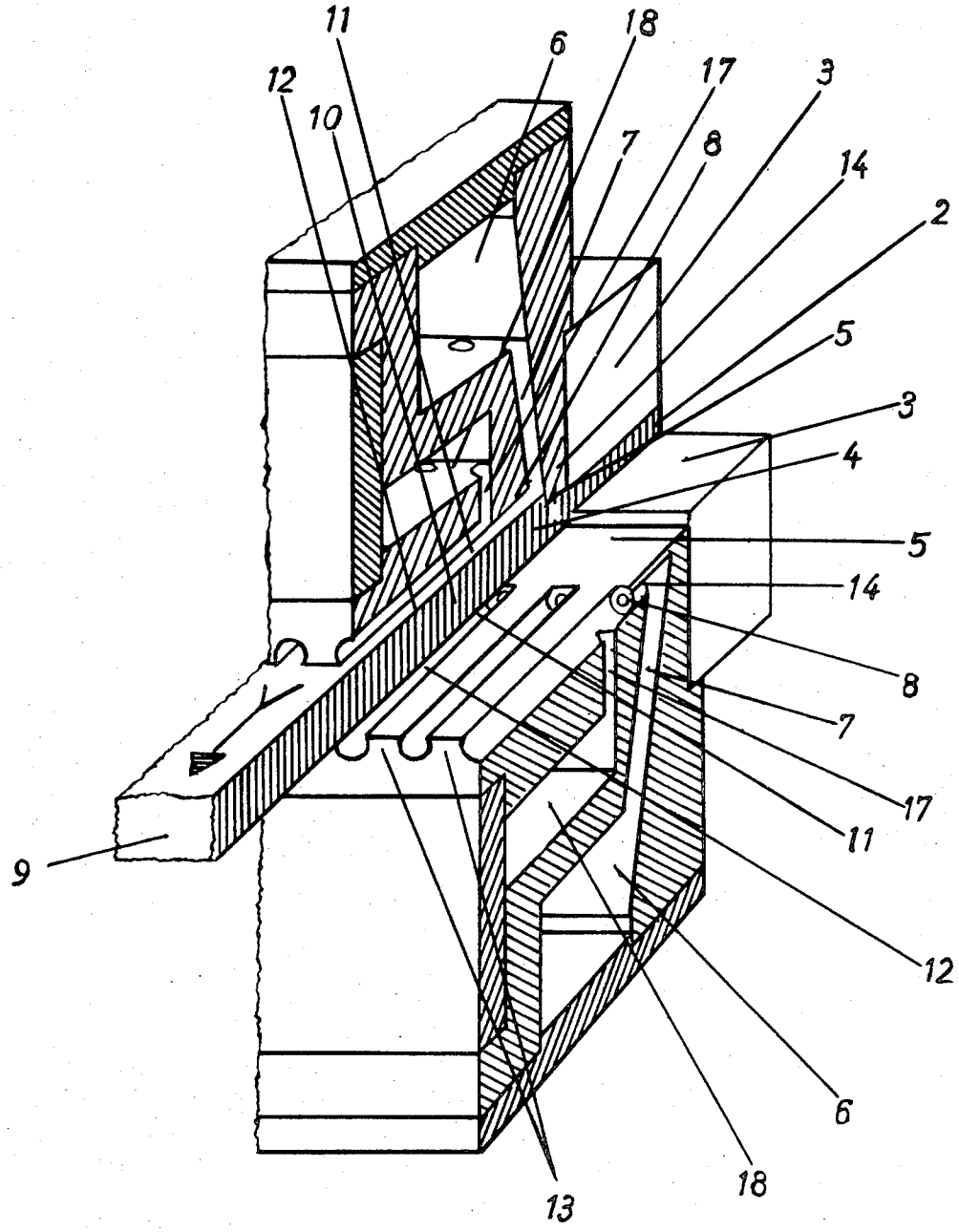


FIG. 1

INVENTOR
GUNTHER HORITZ
BY
ATTORNEY

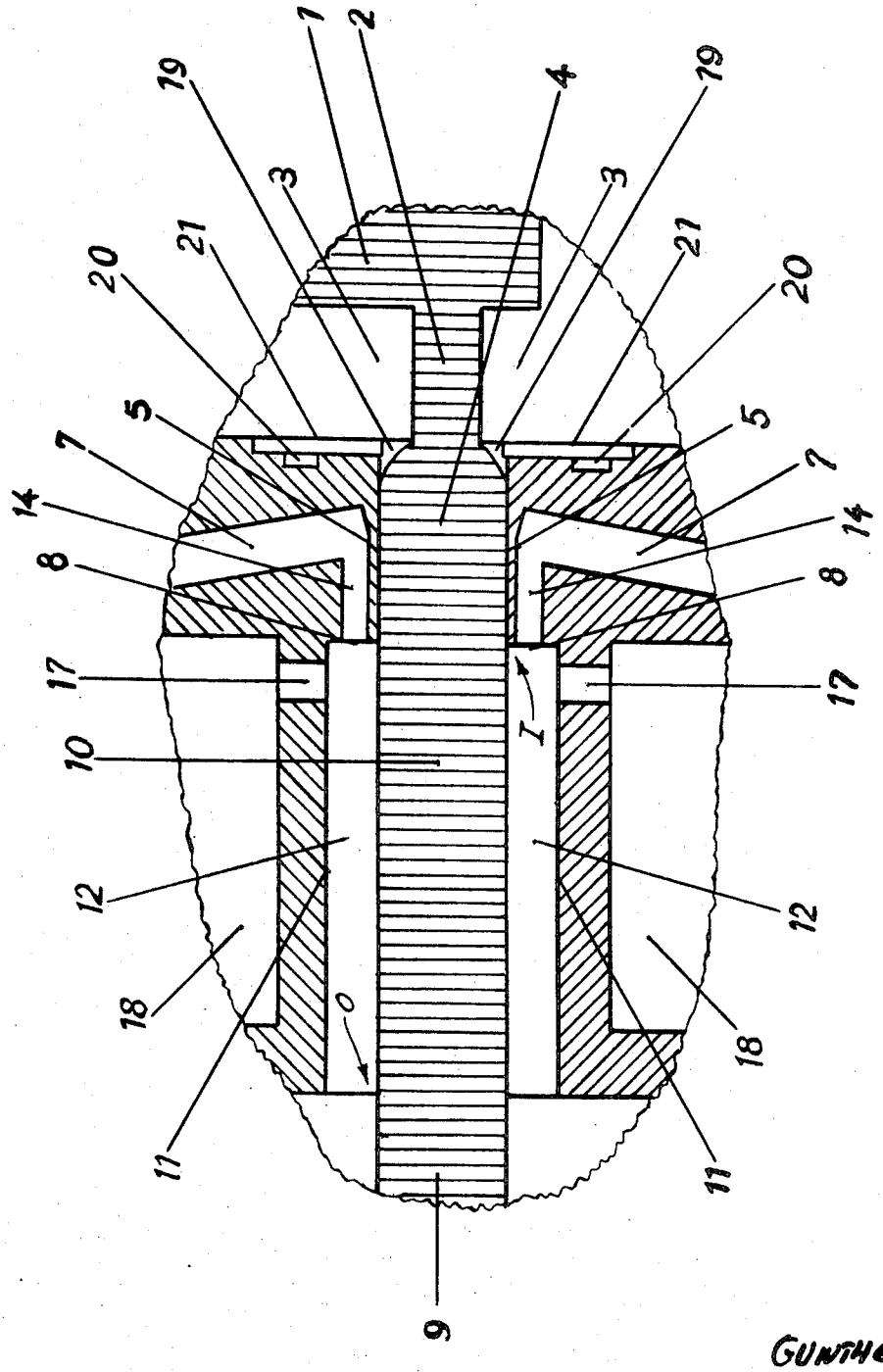


FIG. 2

INVENTOR

GUNTHER MORITZ

By. Thom I. Shipley

ATTORNEY

CONTINUOUS CASTING OF METALLIC ELEMENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

A related application was filed on Nov. 7, 1969 in my name and under the title "METHOD AND MOLD FOR CONTINUOUSLY CASTING METALLIC ELEMENTS"; it is copending under Ser. No. 874,794, now U.S. Pat. No. 3,623,536.

BACKGROUND OF THE INVENTION

The present invention relates to the continuous casting of metallic materials, and more specifically to a method of such casting and a mold for carrying out the method.

Continuous casting is carried out according to one aspect of the prior art by introducing molten metal into the upper open end of a mold passage which is vertically oriented. The molten metal undergoes cooling as it advances under the influence of gravity through the passage towards and outwardly beyond a lower open end of the passage. As it cools it solidifies and emerges as a metal element whose cross-sectional configuration corresponds to that of the mold passage.

The cooling is of course important and the prior art already provides for two types of cooling in one and the same mold, whereby the entering molten metal is cooled indirectly in the region of the upstream end of the passage and subsequently is cooled directly as it turns into a solified metal element, such direct cooling being effected downstream of the indirect cooling closer to the outlet end of the passage.

For various reasons it has been found that this prior-art approach is not satisfactory because it brings with it certain difficulties, including the possibility that the cooling water which directly contacts the outer surface of the solidified metal element might "back up" and rise into the region of the mold passage where only indirect cooling is desired.

For this reason my above-identified copending application provides for a mold for continuous casting of metallic elements, wherein the casting passage for the metal to be cast has a cross-section which first diverges and then converges in the direction from the upper open end to the lower open end of the passage. The cooling water conduits communicate with the passage in the convergent portion and are so arranged that in this portion they cool only the mold and thereby indirectly the solidified metal element. The water runs along the inner circumferential wall of the passage to the throat or narrowest part of the convergent-divergent cross-section and there contacts and consequently directly cools the advancing metallic element. The injection of water through the conduit into the convergent portion of the passage produces a venturi action and the resulting underpressure in the passage is utilized to draw air, a desired gas and/or lubricating fluid into the passage.

My approach as set forth in the above-identified copending application constitutes a real improvement over what is known from the art. However, it has been found in practical application that even in that way a "backing up" of the cooling water cannot be reliably prevented under all circumstances. This is true particularly if it is desired to obtain high casting speeds, for instance casting speeds in excess of 1 m/min. There is, therefore, still a need for further improvements and it is the general aim of the present invention to provide them.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the present invention to provide such improvements.

More particularly it is an object of the present invention to provide an improved mold for the continuous casting of metallic elements which is not possessed of the disadvantages set forth above.

A concomitant object of the invention is to provide such a mold which is uncomplicated in its construction.

In pursuance of the above objects, and others which will become apparent hereafter, one feature of the invention resides in a mold for continuous casting of metallic elements which, briefly stated, comprises wall means defining an upright passage having an inlet, an outlet and a constant cross-section intermediate said inlet and said outlet. Feed means is provided for feeding into the inlet a stream of molten metal for solidification and advancement as a metallic element of constant cross-section through this passage with circumferential clearance. Cooling means is provided for introducing into the clearance jets of water in such a manner as to indirectly cool the metallic element in an upstream portion of the clearance and to directly cool the element in a downstream portion of the clearance, and for producing in the clearance an underpressure sufficient to aspirate auxiliary fluids thereinto.

My present invention is based upon the surprising realization that I am able to obtain the desired venturi effect with the consequent aspiration of auxiliary fluids into the passage even if the passage is of constant cross-section, with the clearance between the inner surface of the passage and the outer surface of the cast element consequently also being of constant cross-section, while at the same time I obtain a substantial reduction of the danger that the cooling water might "back up" even if the casting speed exceeds 1 m/min.

This problem can be further mitigated in that the ejecting portion of the passages through which the cooling water is introduced into the clearance, that is the inner end portions of these passages, extend in parallelism with the elongation of the element which is being cast. When such a construction is utilized, then it is particularly advantageous to use the underpressure produced in the clearance not to aspirate air as one of the auxiliary fluids, but instead water or else a water-air mixture. This makes it possible to completely fill the entire clearance with cooling medium and to obtain an exceptionally good cooling of the outer surface of the advancing cast element.

It must be emphasized that quite surprisingly it was found that by resorting to the present invention the tendency of the cast element to form cracks or fissures, particularly at high speeds, is substantially reduced.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective fragmentary sectional view through a mold according to the present invention, the casting direction being indicated by the arrow; and

FIG. 2 is a fragmentary vertical section, taken in the casting direction through the mold shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing now the drawing in detail, that is FIGS. 1 and 2 thereof, it is pointed out that reference numeral 1 identifies a chamber accommodating molten metal which is to be cast in form of continuous metallic elements. Thus, chamber 1 may be considered as a feed means which serves to feed molten metal into the upstream open end of the casting passage of the mold, and it will be appreciated that suitable means (not illustrated because they do not form a part of the invention) serve to maintain the level of molten metal in the chamber 1 constant by supplying additional molten metal when needed.

As the drawing shows, the mold is of generally annular configuration and provided with a gap 2 in a cover plate 3 which separates the casting passage 4 of the mold from the chamber 1. The plate 3 consists of a heat-insulating material and the casting passage 4 is surrounded and defined by the water-cooled surface 5.

Reference numeral 6 identifies water chambers into which cooling water is introduced under pressure in suitable manner, for instance by pumps or the like which in themselves are not illustrated because they do not form a part of the present invention. The water leaves the chambers 6 through round-cross-section channels 7 and during its passage cools the surfaces 5 to thereupon issue from the openings 8 for direct cooling contact with the outer surfaces of the metal element 9.

As the molten metal enters through the gap 2 into the inlet portion 1 of passage 4, it will immediately solidify in the region of its outer surface due to the cooling effect of the surfaces 5. The metal in form of a now partially solidified metallic element 9 then continues to move out of the inlet portion 1 where it is indirectly cooled, into an intermediate portion 10 in which it is further cooled, but now directly by contact and the cooling medium, and then issues from outlet 0.

The drawing, particularly FIG. 2, clearly shows that a clearance 12 exists between the surface of the element 9 and the boundary surface 11 of the portion 10. This gap or clearance 12 surrounds the entire element 9 and is of constant cross-section over its entire longitudinal extension.

The cooling water issues under considerable pressure from the comparatively narrow openings 8 into the gap or clearance 12 of larger cross-sectional area, whereby I obtain the desired venturi effect producing an underpressure in the clearance 12. According to the illustrated embodiment, the clearance 12 is subdivided by a plurality of ribs 13 extending in the direction of movement of the element 9. However, these ribs need not be present and the invention will still remain operative. What is essential for the present invention is that the clearance 12 be of constant cross-section throughout its entire length whereby the surprising effect is produced that the backing-up of cooling water entering through the channel 7 is substantially reduced over what is known from the prior art, and in fact what is known from my previously identified copending application.

It will be seen particularly in FIG. 2 that in the embodiment illustrated the outlet portion 14 of the channels 7, that is the portion where the cooling water exits, is oriented in each case such as to be parallel with the direction of movement of the element 9, which serves to further reduce if not entirely eliminate the possibility that the cooling water can back up in the passage to the area where only indirect cooling is to be provided. It will be appreciated that if such backing up were to occur, that is if the cooling water would rise into the region of the mold passage where only indirect cooling is desired, the formation of steam within the mold would be inevitable with a final complete prevention of proper casting in that portion of the mold passage where only indirect cooling can be utilized.

Channels 17 are provided which communicate with the clearance 12 and which with their outer ends communicate with chambers 18. The chambers 18 may be connected — for instance by means of suitable non-illustrated valves — with the ambient atmosphere and/or with a source of water. Thus, it would be possible to supply the chambers 18 with air alone, with water alone, or with a mixture of both. Depending upon with what source of supply the chambers 18 are connected, air alone, water alone, or a water-air mixture can be aspirated through the channels 17 into the clearance 12, it being kept in mind that underpressure develops in the clearance 12 which causes such aspiration. These aspirated fluids are of course the "auxiliary fluids" mentioned earlier. By regulating the valves provided in conjunction with the chambers 18—and it is emphasized that these valves can be entirely conventional—the particular type or mixture of cooling medium as well as the pressure thereof as it exits into the clearance 12 from the channel 17, can be determined at the will of an operator, or it is also possible to automatize this function.

Particularly if water is admitted into the clearance 12 through the channels 17, the cooling effect upon the element 9 is vastly increased, and it comes as a considerable surprise that despite this increase the tendency of the cast element 9, particularly at high casting speeds, to form cracks or fissures is significantly reduced, thus increasing the quality of the element substantially.

Because the molten metal entering into the passage 4 does not fill the corner between the cover plate 3 and the surfaces 5, but instead forms a meniscus due to its surface tension, a hollow space 19 is formed. The surface of the element 9 does not usually provide for an air-tight closure with the surfaces 5, so that the underpressure in gap 12 can also prevail in the space 19 and accordingly can be utilized for aspirating into this space via oil channels 20 and inserts 21 of porous fire-resistant material, a lubricating medium such as oil or the like.

Naturally, it is also possible to utilize the underpressure to aspirate other types of auxiliary fluids from thos discussed above. For instance, a neutral or inert gas can be aspirated in this manner if so desired, or a gas having good heat-conducting properties. The use of an inert

gas may for instance serve to reduce or avoid the formation of oxides on the surface of the metallic element 9, while the use of a gas with good heat-conductive properties may be desirable in the event it is found necessary to make the indirect cooling of the cast solidified elements more effective.

Lubricating fluid supplied in the manner outlined above may be in liquid form or in vapor form. Because of the existing underpressure the lubricating fluid enters as a finely divided stream of particles which of course facilitates lubrication of the element 9. Naturally, the entry of the lubricating fluid can be regulated manually or automatically, just as the entry of fluids from the chambers 18.

The present invention is applicable to molds wherein the passage is vertically oriented, as well as to those wherein the passage is substantially horizontally oriented, both such types of molds being known to those skilled in the art. The invention thus resides not in the particular orientation of the casting passage with reference to the horizontal, but in those features which have been described above and are set forth in the appended claims, including of course the central concept of making the cross-section of the clearance constant.

The present invention is applicable not only to the casting of relatively thin elongated metallic elements, such as ribbons, rods, bars, wires or the like, but also to ingots or similar elements of larger cross-section.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a mold for continuous casting of metallic elements, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. A mold for the continuous casting of metallic elements, comprising

wall means defining a passage having an inlet portion, an outlet, and an intermediate portion of constant cross-section which is bounded at least at its lower side by tranversely spaced parallel ribs extending between said inlet portion and said outlet and which define between themselves gaps of constant cross-section which are open to said intermediate portion;

feed means for feeding into said inlet portion a stream of molten metal for solidification and advancement as a metallic element of constant cross-section through said intermediate portion in contact with said ribs;

cooling means, including cooling passages having first discharge openings communicating with said gaps in the region of said inlet portion and being oriented for introducing into said gaps jets of water which are directed towards said outlet; and

air channels having second discharge openings communicating with said gaps downstream of and in a different plane from said first discharge opening, so that the jets of water passing over said second discharge opening creates suction in said air channels.

* * * * *