United States Patent

Vogel

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[54] **STRUCTURE FOR THE CONTINUOUS CASTING OF METAL BARS**

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[21] Appl. No.: **73,376**

[52] **U.S. Cl.**......................................**164/278,** 164/87

[51] **Int. Cl.** **B22d 11/06**

[58] **Field of Search**..........................164/87, 276, 278

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[57] **ABSTRACT**

A structure for the continuous casting of metal bars, such as copper and aluminum, from hot molten metal. The structure includes a casting wheel which has a peripheral groove with a circumferential opening therein. A continuous-one-sided planar belt is provided for closing at least a portion of the circumferential opening so as to define a chamber for receiving the molten metal and for forming the continuous metal bar as the molten metal drops below its melting point. It is important that substantially the entire casting belt is in contact with the molten metal and the metal bar during the portion of the time that the belt is in contact with the casting wheel.

8 Claims, 5 Drawing Figures

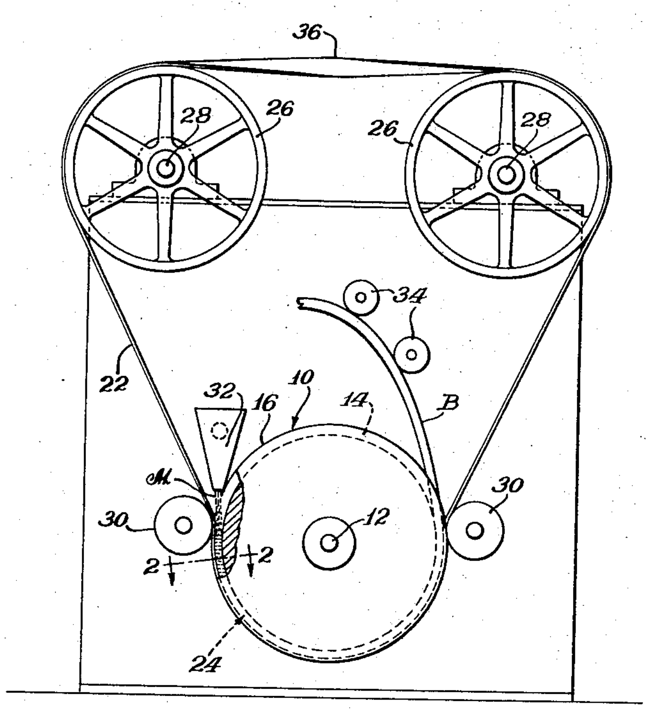


Fig.1.

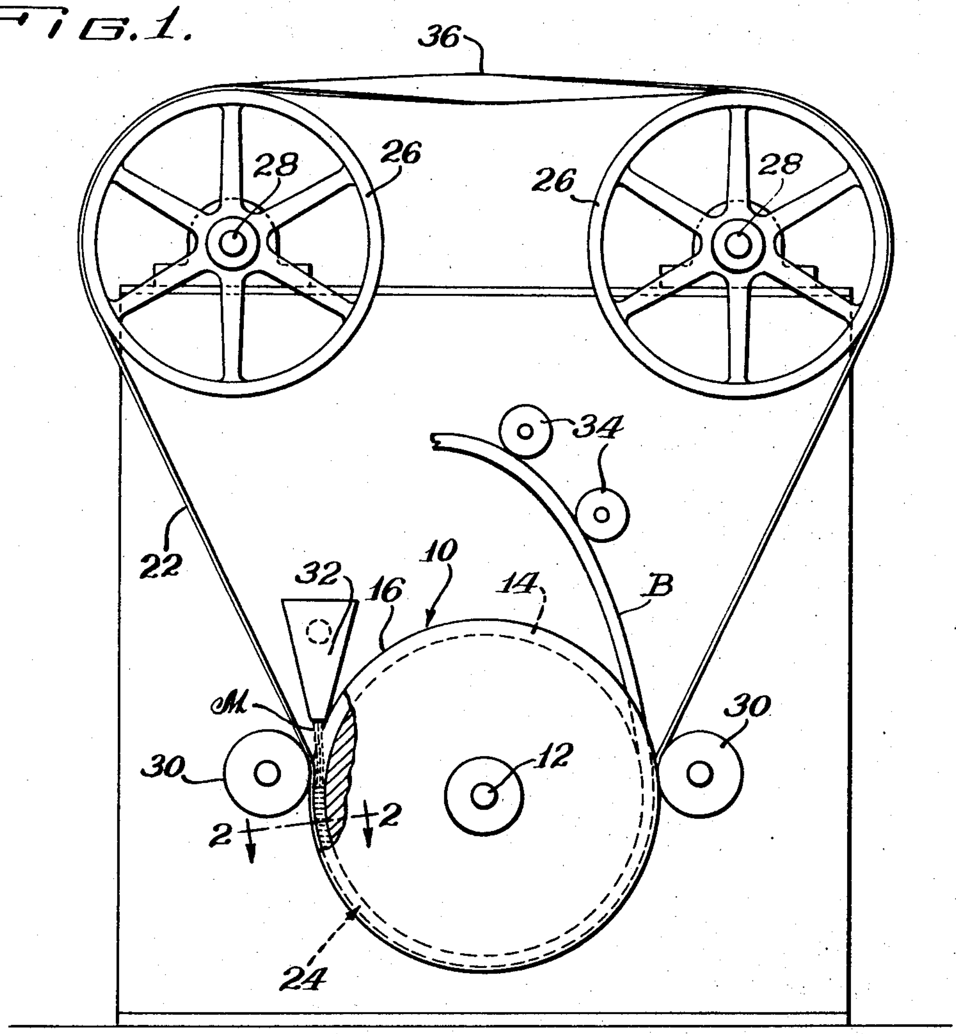


Fig.2.

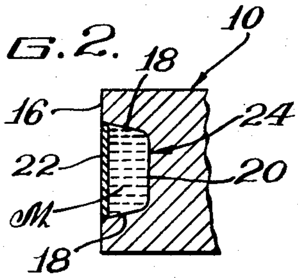


Fig.3.

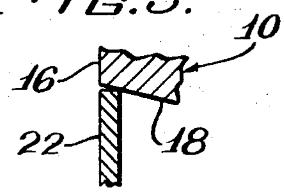


Fig.4.

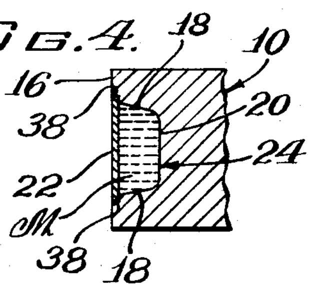
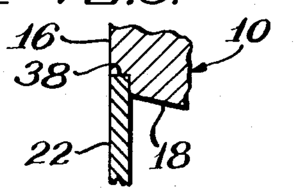


Fig.5.



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STRUCTURE FOR THE CONTINUOUS CASTING OF METAL BARS

BACKGROUND OF THE INVENTION, FIELD OF THE INVENTION AND DESCRIPTION OF THE PRIOR ART

This invention relates to an improved structure for the continuous casting of metals, such as copper and aluminum bars, wherein undesired distortions of the belt used in the casting process and the formation of metal fins on the cast bar are substantially avoided.

The continuous casting and rolling of metallic rod, such as copper and aluminum rod, has come into substantial use in recent years because of the greater economy such processes have over the older methods of rolling individual pre-cast wire bars to the desired sizes. Despite the known advantages of continuous casting and rolling of copper rod, for example, problems are nevertheless encountered with such continuous casting and rolling techniques.

One of the problems encountered with the continuous casting method is the formation of metal fins on the cast bar, prior to rolling. These fins comprise laterally projecting edges on the cast bar. Fins result from distortions of the continuous belt bearing against the periphery of the casting wheel during the casting process. The belt is designed to continuously engage the edges of the casting wheel adjacent the groove in the wheel so as to confine all of the copper or other metal product, in the molten state within the peripheral groove of the casting wheel. However, because of stresses, particularly thermal stresses imparted to the belt during the casting process, distortions occur in the belt, as a result of which, the belt no longer continuously engages the casting wheel. Thus, some of the molten metal escapes between the places of distortion on the belt and the casting wheel. This escaped metal then hardens and fins are formed. These fins must be removed from the cast bar before the bar passes to the rolling machine. The reason the fins are removed is that the rolling phase of the process cannot produce an acceptable, high quality rod when fins are initially present. The fins not only may damage the rolling equipment, but are likely to cause improperly formed rods.

Thermal stresses in the belt are also believed to cause short belt life, generally about five hours. Every time a new belt must be replaced, the entire casting and rolling operation is stopped. With high production rate equipment, as involved with continuous casting and rolling, even brief periods of down time are costly.

It is believed that the problem encountered with prior art designs is that the belts have marginal portions which are not heated to the high temperatures of the central portion of the belt which come into direct contact with the molten metal. In other words, the central portions of the belt reach extremely high temperatures while marginal portions are at significantly lower temperatures, thereby setting up the thermal stresses which ultimately result in belt distortion, fin formation, and shortened belt life.

One type of continuous casting belt is shown, for example, in U.S. Pat. Nos. 3,411,565, 3,346,038, and 3,429,363. In each of these patents, the casting belt is substantially wider than the width of the casting groove of the casting wheel. As a result, the undesired thermal

stresses are set up in the belt because substantial marginal portions do not contact the hot metal and these marginal portions are not heated to the temperature of the central portion which does engage the molten metal. U.S. Pat. No. 3,429,363 does recognize the problem of thermal stresses in the casting belt, but the problem is solved in a way quite different from that taken here; the inventors there use a rather complex cooling arrangement for the belt. Another continuous casting belt arrangement is shown in U.S. Pat. No. 3,311,955 wherein the casting belt shown has a considerably less narrow marginal portion, but nevertheless the marginal portion is cooled by the cooling means provided in the casting wheel and is not in substantial contact with molten metal. As a result, the undesired thermal stresses still result.

An additional problem encountered in the prior art processes is that the casting belt is under constant tension in one direction so that the marginal portions of the belt are supported while the central portion over the groove is unsupported. The unsupported central belt portions, after a period of time, commonly distorts or bows inwardly, which has an adverse effect upon the life of the belt and upon the product formed. When the belt becomes distorted inwardly to any significant extent, the copper bar, for example, that is formed has an elongated central depression. Such a depression is undesired and sometimes even intolerable. During the rolling of the bar the inward depression is, in effect, folded upon itself which ultimately leads to an imperfect product with a central separation or continuous central elongated crack, which is unacceptable for high quality, rolled copper rod.

SUMMARY OF THE INVENTION

It is therefore an important object of this invention to provide an improved casting wheel and belt combination for a continuous casting structure wherein many of the disadvantages of such prior art equipment are substantially avoided.

It is also an object of this invention to provide an improved continuous casting wheel and belt combination wherein the formation of fins on the cast bar is substantially avoided.

It is a further object of this invention to provide an improved casting wheel and a belt combination for a continuous casting process wherein the life of the casting belt is substantially increased.

It is a further object of this invention to provide an improved continuous casting wheel and belt combination wherein inward bowing of the casting belt is substantially avoided.

It is a further object of this invention to overcome many of the disadvantages of prior art continuous casting wheel and belt combinations wherein the belt and casting wheel are constructed and arranged so that the casting belt is substantially in contact for its entire width with the molten metal and hot metal bar during the time of contact of the belt with the casting wheel so the marginal portions are heated to substantially the same temperature as the central portion of the belt.

It is still another object of this invention to provide improved casting wheel and belt combination for a continuous metal casting apparatus wherein the casting belt is formed as a continuous, one-sided belt strip so as to substantially avoid inward bowing of the belt during casting process.

Further purposes and objects of this invention will appear as the specification proceeds.

All of the foregoing objects are accomplished by providing a structure for the continuous casting of metal bars from hot molten metal wherein the structure comprises a rotatable casting wheel having a continuous peripheral groove with a continuous outer circumferential opening and a continuous one-sided belt for closing the width of the groove for at least a portion of the circumferential opening so as to define a chamber for receiving the molten metal and for forming a continuous metal bar as the molten metal drops below its melting point, substantially all of the belt being in contact with the molten metal and the metal bar so substantially the entire belt width is heated to the same temperatures.

BRIEF DESCRIPTION OF THE DRAWINGS

Particular embodiments of the present invention are illustrated in the accompanying drawings wherein:

FIG. 1 is a vertical, side elevational, schematic view of my improved continuous casting wheel and belt combination;

FIG. 2 is an enlarged cross-sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged detailed view of the embodiment of FIG. 2 showing the area of contact between the belt and the side wall of the groove of the continuous casting wheel;

FIG. 4 is a cross-sectional view, similar to FIG. 2, except showing an alternate embodiment of my invention; and

FIG. 5 is an enlarged detailed view of the embodiment of FIG. 4 showing the area of contact between the side wall of the groove of the casting wheel and the belt.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a continuous casting wheel, generally 10, for metal is shown in FIG. 1. The wheel 10 is secured to a drive shaft 12 which is rotatably driven at a selected rate of rotational speed by suitable drive means (not shown). The casting wheel 10, which is, for example, approximately 6 inches thick has a centrally located circumferential groove 14 in the outer cylindrical face 16 of the wheel 10. As shown in FIGS. 2 and 4, the groove 14 is defined by inwardly and downwardly tapering side walls 18, and a bottom wall 20, providing an opening for the groove 14, which is continuous with the outer face 16 of the wheel 10.

A continuous metallic strip or belt, generally 22, made of steel, for example, cooperates with the groove 14 of the wheel 10 to define a closed chamber 24. The belt 22, cooperating with the groove 14 to define the chamber 24, is in peripheral contact with the wheel 10 for a distance less than the entire circumference of the wheel, desirably a peripheral distance somewhat greater than 180°.

A pair of pulley members 26 are spaced upwardly of the casting wheel 10. Such pulleys may also be suitably arranged below the casting wheel. The pulleys 26 are idler pulleys and are rotatably mounted upon support shafts 28. The shafts 28 are each spaced above the wheel 10 and laterally of a vertical line passing upwardly from the drive shaft 12 of the casting wheel 10. The belt 22 engages the cylindrical faces of both of the pulleys 26 in addition to contact with the casting wheel 10. Tension applying members, such as roller members 30, bear against the outer face of the belt 22 generally where the belt 22 initially engages the outer periphery 16 of the wheel 10 and where the belt moves away from engagement with the peripheral face 16 of the casting wheel 10. The belt is maintained at a preselected tension by adjustment of the pulley mountings (not shown), so that the belt 22 positively engages the wheel 10 and pulleys 26. The tension applied to the belt 22 is to be sufficient to cause the belt 22 to seal the chamber 24 defined by the belt 22, and the groove 14 to avoid loss of molten metal therein during the casting process. The belt 22 is conventionally of steel while the casting wheel 10 is ordinarily made of copper. As viewed in FIG. 1, the casting wheel 10 rotates in a counterclockwise direction, and because of the positive engagement between the casting wheel 10 and the belt 22, the belt is driven in the same direction by the driven casting wheel 10.

The molten metal M is poured into the chamber 24 by pouring apparatus 32. The continuous casting techniques used herein are primarily useful in connection with the continuous casting of copper and aluminum. The molten metal M is poured into the chamber 24 where the belt 22 initially engages the cylindrical face 16 of the casting wheel 10. The metal is poured into the chamber 24 at a temperature above the melting point of the metal. The casting wheel 10 may be maintained at or cooled to a desired temperature by suitable cooling means such as cooling channels (not shown) in the wheel 10 so that the molten metal M solidifies in the chamber 24 shortly after the molten metal is poured therein. In this way, the solidified but ductile bar B is formed in the chamber 24 and passes out of the chamber 24 as the metal belt 22 departs from the face 16 of the casting wheel 10. Guide rollers 34 may be provided to engage the bar B while at elevated temperatures in a ductile condition. The bar B is then guided toward a series of rollers (not shown) on a rolling machine (not shown) which gradually reduce the cross-sectional area of the copper bar B to provide the copper or aluminum rod, which, for example, is used in making electrical wire strands.

The important aspects of my invention are found in the design of the belt 22 and in the combination of the belt 22 with the casting wheel 10. The first important aspect of the invention is that the belt 22 is formed as a continuous, one-sided belt or Mobius strip. A Mobius strip is formed by taking an elongated unjoined belt or strip, rotating one end 180°, and then joining the two ends together, as by welding. In the apparatus shown, the 180° turn used in forming the desired shape is shown at 36, at a point intermediate the two support pulleys 26. A Mobius strip is generally defined as a continuous one-sided strip. In effect, the 180° turn in the belt 22 permits both sides of a conventional belt to be effectively used as one continuous strip. In this way, the normal tendency of a belt of a conventional design to bow inwardly because tension is always applied from one direction is avoided because the 180° turn in the belt, to form the Mobius strip, effectively alternates the direction of tension of the belt bearing against the wheel **10**. Thus, the tendency of the belt to undesirably bow inwardly and form an inwardly depressed bar is substantially eliminated.

A further important aspect of the invention is the provision of a belt **22** which has a width substantially coextensive with the width of the groove in casting wheel **10**. In this way, the entire belt **22** is heated to and later cooled to substantially the same temperature for its entire width. This is in contrast to the prior art wherein marginal portions on a belt bore against the cylindrical face **16** of the wheel **10** and thus, were not heated to the temperature of the molten metal or bar. This created the undesirable thermal stresses which led to distortions of the belt and finally formation of fins. Additionally, such thermal stresses often led to early belt failure.

Referring to FIGS. **2** and **3**, with the walls **18** normally being tapered, the belt **22** is designed to be entirely in the groove **14** with its lateral edges bearing against the upper corners of the tapered walls **18** so as to substantially define a line contact seal therebetween.

Referring to FIGS. **4** and **5**, alternatively, continuous steps or indentations **38** are provided along the upper edges of each of the side walls **18** as they intersect with the face **16** of the wheel **10**. The lateral edges of the belt **22** are received on these steps or indentations **38**. Although, in this embodiment, the entire belt is not in contact with the metal, there is only a minimal area, as **1/8** inch edges, not in contact with the hot metal so the belt is effectively heated entirely to the same temperature. Also, this embodiment has the advantage that the belt **22** is positively confined, and greater surface area is provided for positively sealing between the casting wheel **10** and the belt **22**.

It is seen that the foregoing described structure provides a combination casting wheel and belt arrangement which greatly avoids distortions of belt, fin formation and undesirable thermal fatigue. The turning of the belt 180° also avoids tensile stress, undesired belt bowing, and formation of a central depression on the cast product.

While in the foregoing there has been provided a detailed description of particular embodiments of the present invention, it is to be understood that all equivalents obvious to those having skill in the art are to be included within the scope of the invention as claimed.

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

1. A structure for the continuous casting of metal bars from hot molten metal, said structure comprising, in combination, a rotatable casting wheel having a continuous peripheral groove with a continuous outer circumferential opening, and a continuous belt defining a continuous one-sided strip for closing at least a circumferential portion of said circumferential opening for its entire width so as to define a chamber for receiving said molten metal and for forming a continuous metal bar as said molten metal drops below its melting point, substantially all of said belt being in contact with said molten metal and said metal bar.

2. The structure of claim **1** wherein said continuous belt comprises a Mobius strip.

3. The structure of claim **1** wherein said peripheral groove includes inwardly and downwardly tapering walls, and said continuous belt has its lateral edges bearing against the upper corners of said tapering walls.

4. The structure of claim **1** wherein said peripheral groove includes side walls having narrow indentations at its upper edges, said belt has lateral edges, and said lateral edges of said belt are positively received in said indentations.

5. A structure for the continuous casting of metal bars from molten metal, said structure, comprising, in combination, a rotatable casting wheel having a continuous peripheral groove therein, and a continuous one-sided belt for closing at least a circumferential portion of said opening for its entire width so as to define a chamber for receiving said molten metal and for forming a continuous metal bar as said molten metal falls below its melting point.

6. The structure of claim **5** wherein substantially all of said one-sided belt is in contact with said molten metal and said metal bar.

7. The structure of claim **5** wherein said continuous one-sided belt is a Mobius strip.

8. The structure of claim **5** wherein a pair of pulleys engage said continuous belt, said casting wheel engages said band in a position intermediate said pulleys, and said continuous one-sided strip has a 180° turn therein to define a Mobius strip at a position intermediate said pulleys.

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REEXAMINATION CERTIFICATE (780th)

United States Patent [19] [11] **B1 3,682,234**

Vogel [45] Certificate Issued **Nov. 10, 1987**

[54] **STRUCTURE FOR THE CONTINUOUS CASTING OF METAL BARS**

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[73] Assignee: **Essex International, Inc.**

Reexamination Request:
No. 90/000,874, Oct. 4, 1985

Reexamination Certificate for:

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Issued:	**Aug. 8, 1972**
Appl. No.:	**73,376**
Filed:	**Sep. 17, 1970**

[51] **Int. Cl.**⁴ **B22D 11/06**
[52] **U.S. Cl.** **164/433**
[58] **Field of Search** 164/481, 482, 479, 429, 164/431-434

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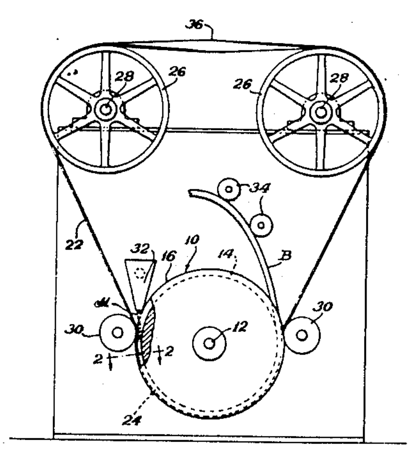
Primary Examiner—K. Y. Lin

[57] **ABSTRACT**

A structure for the continuous casting of metal bars, such as copper and aluminum, from hot molten metal. The structure includes a casting wheel which has a peripheral groove with a circumferential opening therein. A continuous-one-sided planar belt is provided for closing at least a portion of the circumferential opening so as to define a chamber for receiving the molten metal and for forming the continuous metal bar as the molten metal drops below its melting point. It is important that substantially the entire casting belt is in contact with the molten metal and the metal bar during the portion of the time that the belt is in contact with the casting wheel.



REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

AS A RESULT OF REEXAMINATION IT HAS BEEN DETERMINED THAT:

Claims **1–8** are cancelled.

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