July 7, 1970 A. J. WERTLI 3,519,062

APPARATUS FOR PRODUCING STRIP METAL BY CONTINUOUS CASTING

Filed Oct. 3, 1967 2 Sheets-Sheet 1

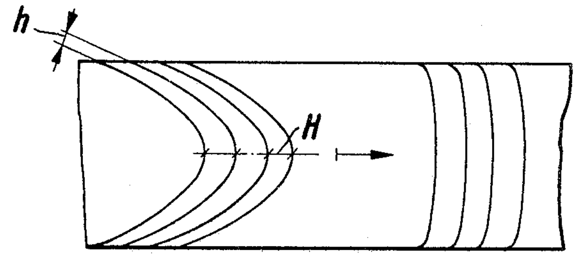

Fig. 1

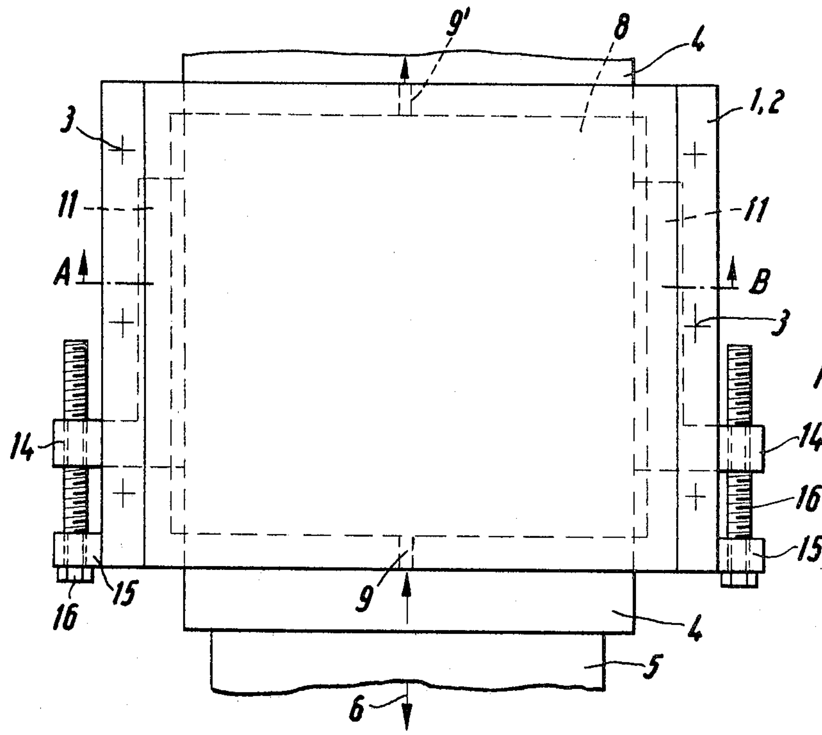

Fig. 2

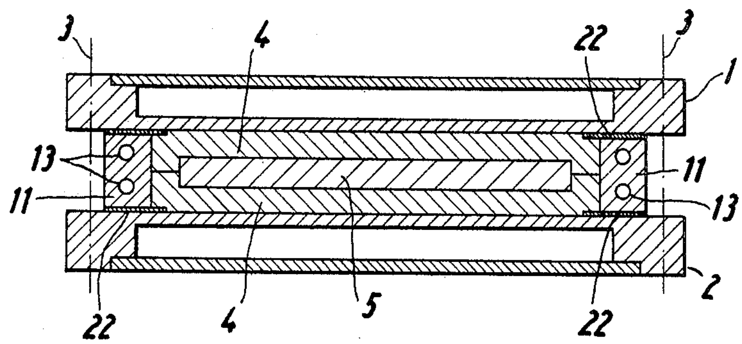

Fig. 3

Inventor:
ALFRED J. WERTLI
BY
Kenyon & Kenyon
ATTORNEYS

APPARATUS FOR PRODUCING STRIP METAL BY CONTINUOUS CASTING

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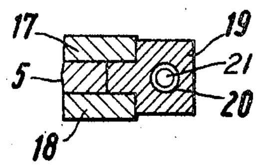

Fig. 4

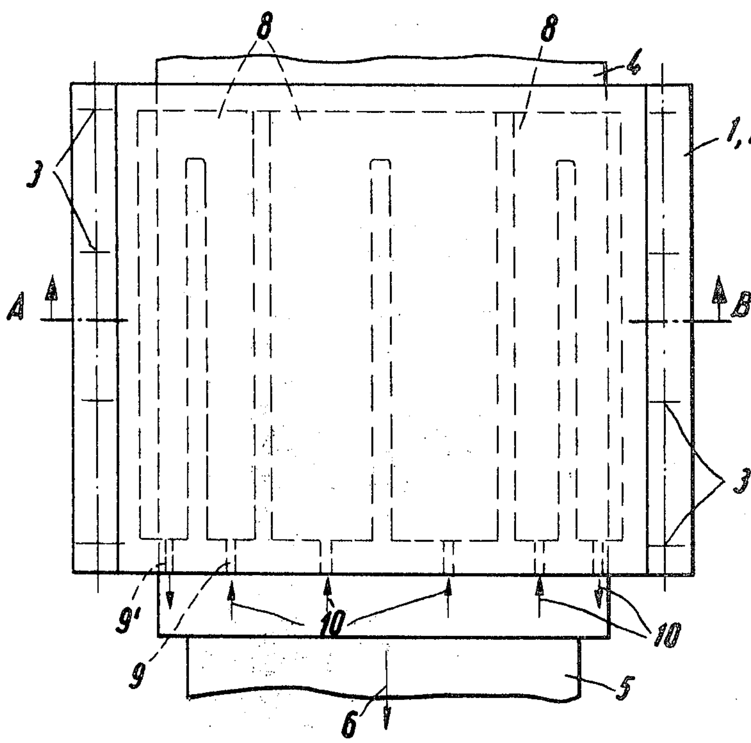

Fig. 5

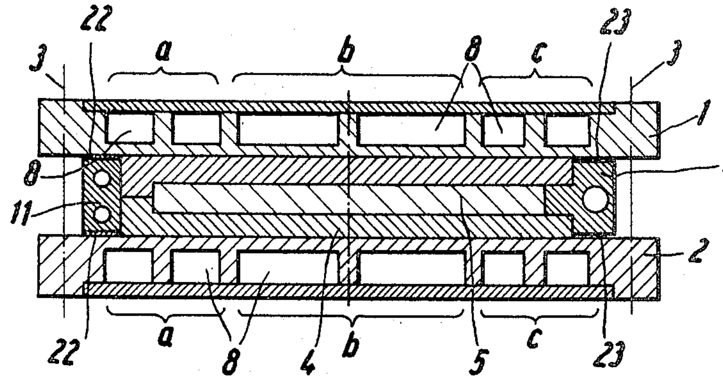

Fig. 6

Inventor:
ALFRED J. WERTLI

BY

Kenyon & Kenyon
ATTORNEYS

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APPARATUS FOR PRODUCING STRIP METAL BY CONTINUOUS CASTING

Alfred J. Wertli, Poststrasse 15, 8406 Winterthur, Switzerland

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U.S. Cl. 164—283 6 Claims

ABSTRACT OF THE DISCLOSURE

The mold is provided with a heating means adjacent the cooling device to heat the sides of a metal strip being cast through the mold. A uniform cooling of the strip is effected across the width of the strip due to the influence of the heat applied to the strip edges during cooling by the cooling device.

This invention relates to an apparatus and method for producing strip metal by continuous casting. More particularly, this invention relates to an apparatus and method wherein a molten metal or alloy is cooled into a solidified strip during passage through a mold.

Heretofore, the furnaces in which molten metals have been contained have been provided with molds for passage of the molten metal out of the furnace. These molds have generally been surrounded by cooling devices for the cooling of the molten metal passing through the mold in order to form a solidified metal strip. In many instances, these cooling devices have been formed in two parts, one of which extended across the upper surface of the mold while the other extended across the lower surface. Each part of such cooling devices have been provided with a separate flow of cooling medium such that each flow has cooled the entire width of the cast strip.

However, the strips which have been produced by these heretofore devices and methods, especially where the strips have been intermittently moved forward during casting, have had parabolic shaped lines formed on the upper and lower surfaces by solidification phenomena. Upon examination, such strips have been found to possess a heterogeneous structure in front of and behind each parabolic line. Further, the lines at the edges of the strip have had a considerably smaller spacing from one another than at the center of the strip such that the edges have had a practically continuous heterogeneous structure. This structure is unsuitable for further working, particularly by cold forming. Thus, in cold rolling of such strips with parabolic lines, cracks and fissures have frequently been formed in the strip edges.

Accordingly, it is an object of the invention to produce a substantially homogeneous structure across the width of a cast strip.

It is another object of the invention to reduce the solidification phenomena producing parabolic lines in continuously cast strips.

Briefly, the invention provides an apparatus and method by which a continuously cast strip is heated at the edges along at least part of the length of a cooling device forming the strip. This allows the solidification processes in the molten metal to proceed more uniformly so as to produce a homogeneous structure.

The strips obtained by the invention have good metallurgical properties. Instead of parabolic lines, the strips possess substantially straight lines extending at right angles to the direction of movement of the strip which lines are considerably shorter than the heretofore obtained parabolic lines.

The method of the invention is advantageously applicable to strips with a ratio of width to thickness of 6:1 and considerably extends the possibilities of manufacturing strips. Thus, strips can be manufactured by the method of the invention with width to thickness ratios of up to 70:1.

In one embodiment of the invention, the apparatus includes a cooling device having two plate-like hollow bodies each of which extends across one of the two broad sides of the produced strip and a prismatic heating member arranged in parallel relation to each of the two narrow sides of the strip for heating these narrow sides.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 diagrammatically illustrates a plan view of a length of continuously cast strip metal with parabolic solidification lines to the left half as formed by prior methods and substantially straight solidification lines to the right half as formed by the method of the invention;

FIG. 2 illustrates a plan view of an apparatus of the invention;

FIG. 3 illustrates a view taken on line A–B of FIG. 2;

FIG. 4 illustrates a fragmentary cross-sectional view of a modified apparatus of the invention;

FIG. 5 illustrates a plan view similar to FIG. 2 of another modified apparatus of the invention; and

FIG. 6 illustrates a cross-sectional view taken on line A–B of FIG. 5.

Referring to FIGS. 2 and 3, the cooling device consists of an upper part **1** and a lower part **2** which are in the form of plate-like hollow bodies and which are held together by bolts for example where indicated by broken lines **3**. A two part mold **4** of graphite is clamped between upper part **1** and lower part **2** to enclose a hollow space, the cross-section of which corresponds to that of the strip **5** to be cast. The mold **4**, at the end which protrudes from the cooling device **1, 2** (shown at the top of FIG. 2) is pressed against the wall of a furnace (not shown) containing the molten metal. In continuous casting, the molten metal flows into the cavity of the mold **4** in which, under the influence of the cooling device **1, 2**, it gradually solidifies into a strip **5** which is then moved forward continuously or intermittently in the direction indicated by arrow **6**.

The hollow space **8** of the upper part **1** of the cooling device has a flow of cooling medium passed therethrough. The flow enters at the aperture **9** and leaves at the aperture **9'**. The entry and exit of the flow of cooling medium in the lower part **2** is similarly arranged. The quantity of cooling medium flowing through hollow space **8** can be regulated by known means not further described.

Prismatic heating members **11** are provided between the upper part **1** and the lower part **2**, on each side of the mold **4** to extend over part of the length of the cooling device **1, 2**. The two heating members **11** each have two passages **13** therein through which a heating medium, e.g. oil at a suitable temperature, can be passed, the heating medium flowing in, for example, through the upper passage **13** and out through the lower passage **13**. The heating members **11** are mounted so as to be longitudinally adjustable. For this purpose each heating member has a lug **14** which has a threaded hole therethrough. At the lower end of the upper part **1** or lower part **2** in FIG. 2 a lug **15** is provided which has a hole of corresponding size in alignment to the threaded hole of lug **14**. A bolt **16** passes through the hole in lug **15** into the threaded hole of lug **14** and by this means the heating members can be moved parallel to the strip **5**. Heat insulating layers **22** are provided between the heating members **11** and the parts **1** and **2** which if necessary, and as shown in FIG. 3 can slightly overlap the edges of the mold **4**.

The flow of a heated medium through the heating members **11** during a casting operation influences the overall cooling of the strip across the whole width of the strip **5** so as to avoid an excessively rapid cooling of the edges of the strip. Thus, a more uniform withdrawal of heat across the width to the strip is obtained.

Referring to FIG. 1, the strips produced by the above apparatus and method have no parabolic shaped solidification lines as indicated in the left half of the illustrated strip but rather possess substantially straight lines as indicated in the right half of the illustrated strip extending approximately at right angles to the direction of movement of the strip. Further, the straight lines have a more uniform spacing from each other than the parabolic shaped lines which have a considerably closer spacing *h* at the edges than the spacing H at the center of the strip.

Referring to FIG. 4, a modified mold consists of a top plate **17**, a bottom plate **18** and two side members **19** of T shape (only one of which is shown for simplicity). The leg of each T shaped member extends between the plates **17** and **18**. As above, the four parts of the mold can be made of graphite. The members **19** are each formed with a bore **20** extending therethrough to receive an electrical heating element **21** for allowing the members **19** to act as heating members. The heating elements **21** can be displaced in the bore **20** so that the edge portion of a strip **5** to be heated can be varied.

Referring to FIGS. 5 and 6, the upper part **1** and the lower part **2** of the cooling device are each divided into three zones, *a*, *b*, *c* in such a manner across the width of the strip **5** that the zones *a* and *c* lie above and beneath the strip edges while the zones *b* extend above and beneath the center of the strip. Each of the zones consists of a cooling chamber **8** which extends—approximately in U-shape—in the longitudinal direction of the strip. On each leg of the U-shaped cooling chamber **8**, bores **9** and **9'** for the feed and discharge of cooling medium are provided, the feed and discharge of the cooling medium being indicated by the arrows **10**. By this cooling device a differential cooling action across the width of the strip is achieved, for example, by adjusting the cooling medium flow in the three zones differently for which known means not further described can be provided. In this cooling device, the strip edges over at least a part of the length of the cooling device are heated for which purpose in the left half of FIG. 6 heating member **11** of FIG. 3 is provided while in the right half heating member **19** of FIG. 4 is used. The heat insulating layers **22** can slightly overlap the edges of the mold **4**. The air gaps **23** between the heating member **19** and cooling device **1**, **2**, can also continue between the mold and the cooling device or can be substituted by heat insulating layers.

The invention provides an apparatus and method which is capable of producing metal strips from molten metal which have a uniform structure and good metallurgical properties, especially for cold working.

Having thus described the invention, it is not intended that it be so limited as changes may be readily made therein without departing from the scope of the invention. Accordingly, it is intended that the foregoing Abstract of the Disclosure, and the subject matter contained herein be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An apparatus for solidifying molten metal into a continuously cast strip comprising

a mold having a passage therein for the passage of molten metal therethrough,

a cooling means for cooling the molten metal into a cast strip within said mold, said cooling means having a pair of plate-like hollow bodies disposed about said mold to extend across opposite broad surfaces of the cast strip, and

a heating means extending parallel to the narrow surfaces of the cast strip within said mold for heating the formed strip about the opposed narrow surfaces to effect a uniform solidification of said strip into a homogeneous structure, said heating means including a pair of prismatic heating members, each said member being disposed adjacent one of the narrow edge surfaces of the cast strip and including a bore therein for conducting a flow of heating medium therethrough.

2. An apparatus as set forth in claim **1** wherein each heating member abuts against a narrow side of said mold.

3. An apparatus as set forth in claim **1** wherein each heating member is longitudinally movably mounted with respect to said mold.

4. An apparatus as set forth in claim **1** wherein said heating means is incorporated in said mold.

5. An apparatus as set forth in claim **4** wherein said mold includes an opposed pair of plates, and said heating means includes a pair of opposed T shaped side members, each said T shaped side members having a leg disposed between said plates.

6. An apparatus for solidifying molten metal into a continuously cast strip comprising

a mold having a passage therein for the passage of molten metal therethrough,

a cooling means for cooling the molten metal into a cast strip within said mold, said cooling means having a pair of plate-like hollow bodies disposed about said mold to extend across opposite broad surfaces of the cast strip, and

a heating means extending parallel to the narrow surfaces of the cast strip within said mold for heating the formed strip about the opposed narrow surfaces to effect a uniform solidification of said strip into a homogeneous structure, said heating means including a pair of prismatic heating members, each said member being disposed between said hollow bodies adjacent one of the narrow edge surfaces of the cast strip and including an electrical heating element therein.

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J. SPENCER OVERHOLSER, Primary Examiner

R. S. ANNEAR, Assistant Examiner

U.S. Cl. X.R.

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