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
3 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 of 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 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, each one of which is shown for simplicity. The leg of each T-shaped member extends between the plates 17 and 18. As shown, 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 there-in 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
2. a mold having a passage therein for the passage of molten metal therethrough,
3. 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
4. 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,
b. 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
c. 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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