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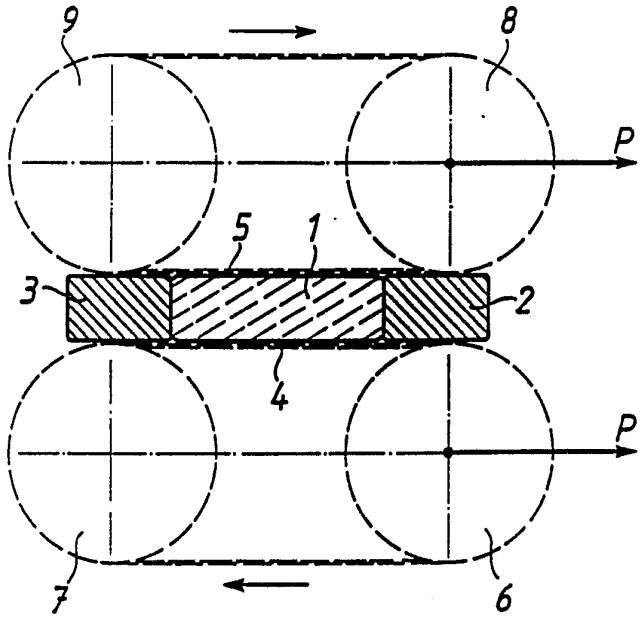
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(57) Abstract

The invention relates to a device for continuously strip-casting metals, metal alloys or steel in which melt is tapped into a casting section for continuous casting defined laterally by four side walls. The invention is characterised in that opposite pairs of the walls consist of cooling strips movable across, with or against the casting direction, running at a speed greatly in excess of the casting speed, abutting the casting strand, or indirectly abutting the casting strand via individual fixed plates of carbon containing material such as graphite or the like.

* See back of page

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Device for continuous casting

The present invention relates to a device for continuously casting metals, metal alloys or steel in which melt is tapped into a casting section for continuous casting, said section being defined laterally by four side walls.

Strand casting of flat metal bars has previously often been effected between plates of graphite or similar material, in which two of these are enclosed by cooled copper plates. (This applies, of course, to the wide sides.) One problem encountered with such casting has been that there is a risk of gaps occurring between the casting strand and the graphite plates, caused by shrinkage of the casting material. Gaps between the Cu plates and the graphite plates may also occur, due to the graphite plates being deformed by heat conducting.

The invention aims at solving these and other problems associated therewith and is characterised in that opposite pairs of walls consist of cooling strips movable across, with or against the casting direction, running at a speed greatly in excess of the casting speed, abutting the casting strand, or indirectly abutting the casting strand via individual fixed plates of carbon containing material such as graphite or the like.

The copper plate and the graphite plate in each of the wide side walls in the casting section of the casting machine can thus be replaced by only the cooling strip or a combination of graphite plate/cooling strip. Pressing the thin cooling strip against the casting strand so that the gaps are sealed and moving the cooling strip along at extremely high speed, ensures efficient cooling without the cooling strip being subjected to damaging heating.

The cooling strip is preferably arranged in a closed track running past the casting strand or graphite plate, with at least two rollers for each strip, at least one of the rollers per strip being in the form of a cooling roller through which a coolant such as water suitably flows. Several rollers per track are also possible, or even several cooling rollers per track. At least one roller per strip must be driven.

The strips may be coated with suitable lubricant, such as oil, or some form of insulating material. The strips prior to the casting zone may be coated with suitable lubricant and/or insulating layer and after the casting point may be cleaned by mechanical, hydraulic or pneumatic means, for instance. Suitable casting materials are copper, bronze and brass but aluminium and steel are also feasible. A casting speed of 120 m/h is possible, for instance, and a strip speed of 20 m/s.

As mentioned, the strip can be moved against, along or across the casting strand or at some other angle. The strip(s) may be tensioned at one or more of the cooling rollers, by hydraulic, pneumatic or mechanical tensioning means, for instance.

Casting may be performed horizontally, vertically or at an optional angle of inclination. "Across" shall here be taken to mean at either an angle of 90° or an acute angle to the vertical and/or horizontal plane.

Buckling of the strip due to heat can thus be avoided. This is also achieved since momentary buckling due to high temperature at the casting point is rapidly counteracted by the gap caused by the buckling, which decreases the heat flow locally, thereby causing the temporary gap to disappear quickly.

The strip can be cleaned along its track, suitably after the casting point, either mechanically (by brushes, for instance), hydraulically (water) or pneumatically, for instance, so that it is clean upon passage of the casting point prior to renewed coating with oil, for instance.

The invention is exemplified in the accompanying drawings in which Figure 1 a shows the movement of the cooling strips across the casting direction and Figure 1 b their movement along the casting direction, according to the invention. Figure 2 shows a detail in the casting process and Figure 3 an alternative embodiment. Figure 4 illustrates the following calculation.

Figure 1 a shows cooling strips running transverse to a casting strand 1. The casting section is defined laterally by two sturdy plates 2, 3 (not included in the invention).

Two endless strips 4, 5 of steel, copper, brass, etc. are moved rapidly (f er han the casting speed) across the casting direction (see arrows), around rollers (6, 7 and 8, 9, respectively), at least one of the rollers in each track also being a cooling roller, cooled by circulating coolant. The strips 4, 5 either themselves, or together with a fixed graphite plate directly abutting the casting strand, form the side walls in the casting section. In the latter case the strip effects cooling due to its contact with the graphite plate, casting strand and plate. The strand is efficiently cooled through this rapid movement, as stated above. The casting direction is perpendicular to the direction of movement of the strip.

In Figure 1 b casting is performed vertically from a tundish 10. The unsolidified portion of the casting strand 12, (the sump) is shown at 11, and in this case the strips move either against or in the casting direction (see arrows 1, 2, respectively).

Figure 2 shows the sump 15 in the case of vertical casting, enclosed by the two cooling strips 16 and 17.

Figure 3 shows a tundish 18 and graphite plates 19, 20 located along the longitudinal sides of the strand 21 where actual solidification of the melt is to take place. The cooling strips 22 and 23 located outside and in contact with the graphite plates, move either in the same direction or opposite directions. The strips may be tensioned as shown in Figures 1 a and 1 b.

Figure 4 shows a part of a casting strand. Width B (m), thickness H (mm), length L (m) of the solidification (sump) zone, casting speed C m/h. q is latent heat kcal/kg. q_f = physical heat.

Heat emitted: $B \times H \times \gamma \times (q+q_f) \times C$ kcal/h

(γ = specific weight).

Heat absorbed:

Definitive thickness of cooling strip in mm	h
Definitive speed of cooling strip in m/s	v
Definitive width in m	B
Definitive specific weight (cooling strip)	γ(KB)
Definitive specific heat	c (KB)
Definitive temperative increase in ^{o}C	ΔT

Heat absorbed = $B \times h \times V \times 3600 \times \gamma_{KB} \times C_{(KB)} \times \Delta T \times 2$

$$H \times \gamma \times (q+q_f) = H \times V \times \gamma_{(KB)} \times C_{(KB)} \times 7200 \times \Delta T$$

$\gamma \quad \gamma_{KB}$ di $\qquad \Delta T = \frac{H \times C}{h \times V} \times \frac{(q + q_f)}{C_{KB} \times 7200}$

Heat flow (Q) $\qquad \frac{1}{k} = \frac{1}{\alpha_{(S-B)}} \times \frac{X \cdot 10^{-3}}{\lambda_M}$

$$Q = k \times B \times h \times (T_{SM} - T_{KB}) \times 2$$

k heat transmission coefficient kcal/$^{o}C \cdot m^{2} \cdot h$

x shell thickness (see Fig. 2) mm

$\alpha_{(K->B)}$ thermal exchange content of strand bar

λ_M coefficient of thermal conductivity in strand

$T_{SM} - T_{KB}$ temperature difference between strand and cooling strip

Cast quantity/h = $Q/(q+q_f)$

The usefulness of the invention is evident from the above. The invention can be varied in many ways within the scope of the following claims.

Claims

1. A device for continuously casting metals, metal alloys or steel in which melt is tapped into a casting section for continuous casting, said section being defined laterally by four side walls, **characterised** in that opposite pairs of walls consist of cooling strips movable across, with or against the casting direction, running at a speed greatly in excess of the casting speed, abutting the casting strand, or indirectly abutting the casting strand via individual fixed plates of carbon containing material such as graphite or the like.

2. A device as claimed in claim 1, in which the cooling strips are arranged to run towards the graphite plates, and that lubricant and/or insulating material may possibly be arranged to be supplied to the space between the graphite plates and cooling strips.

3. A device as claimed in claims 1-2, **characterised** in that pressure-generating members are arranged perpendicular to the strips, in opposition with the casting strand, influenced mechanically, hydraulically or pneumatically, intended to limit or eliminate any gaps between the cooling strips/graphite plates and casting strand.

4. A device as claimed in claims 1-2, **characterised** in that the cooling strips are arranged to run in a closed track past the casting zone and via two or more cooling rollers.

5. A device as claimed in claim 4, **characterised** in that each pair of strips can be tensioned by force being arranged to be applied on one roller each per strip.

6. A device as claimed in claims 1-5, **characterised** in that the strip is arranged to be cooled by the cooling rollers, or some of them, with the aid of coolant circulating therein.

7. A device as claimed in one or more of the preceding claims, **characterised** in that at least one roller per cooling strip is driven.

8. A device as claimed in one or more of the preceding claims, **characterised** in that the cooling strip(s) is/are corrugated as the end facing the casting strand and/or that the strip(s) is/are perforated.

Fig. 1a

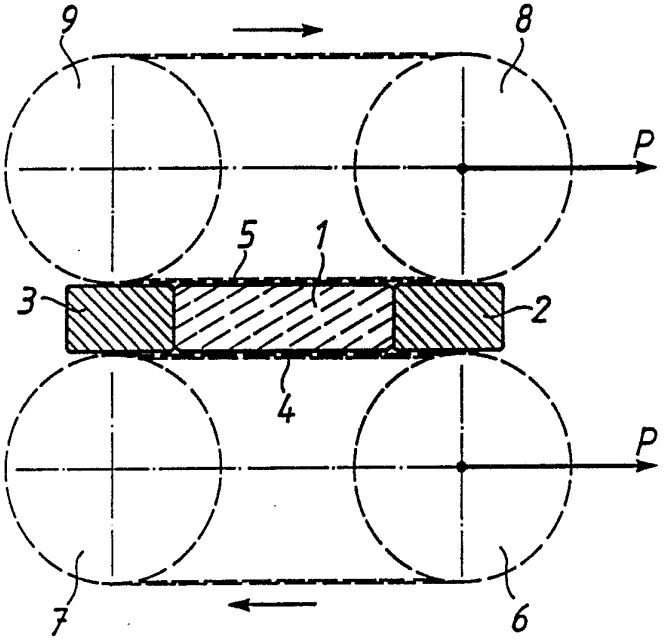


Fig. 1b

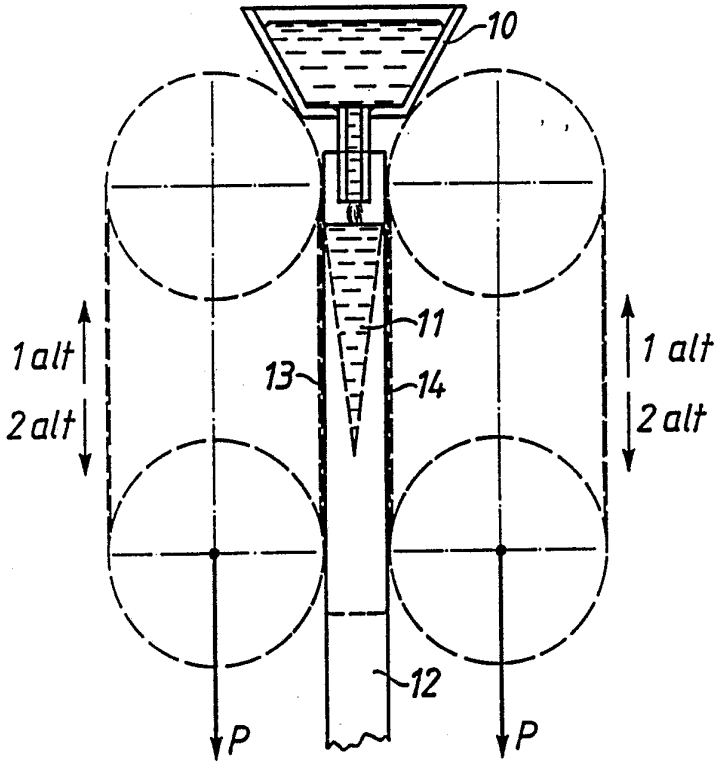


Fig. 2

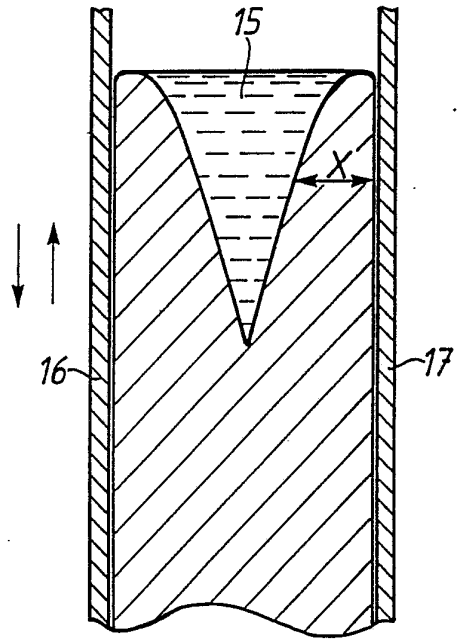


Fig. 3

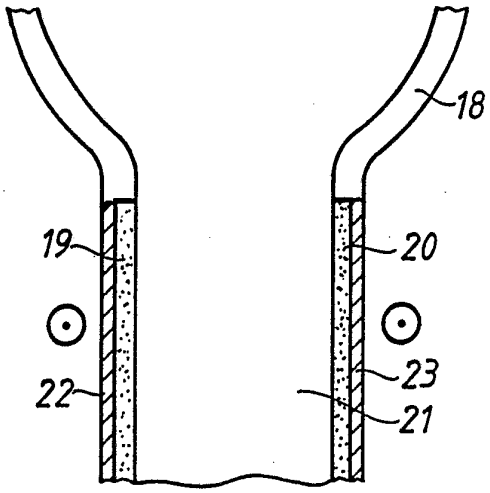
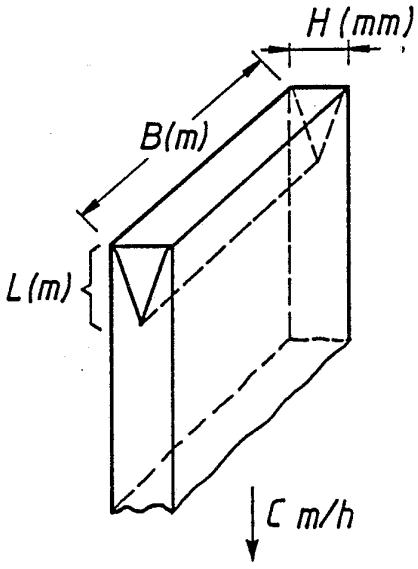


Fig. 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00625

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 22 D 11/04, 11/06, 11/14

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 22 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US, A, 2285740 (J.M. MERLE) 9 June 1942, see figure 1; claim 1 --	1
A	EP, A1, 0181566 (MANNESMANN AKTIENGESELLSCHAFT) 21 May 1986, see page 6, line 1 - line 19; figures 1-7 --	1
A	DE, C, 654005 (MASCHINENFABRIK AUGSBURG-NÜRNBERG A.G.) 8 December 1937, see the whole document --	1
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
24th January 1991	1991 -01- 30
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Ulf Nyström

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 90/00625

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-12-28
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2285740	42-06-09	NONE	
EP-A1- 0181566	86-05-21	DE-A-C- 3440236	86-05-22
		JP-A- 61123450	86-06-11
DE-C- 654005	37-12-08	NONE	
DE-C- 742180	43-11-24	NONE	