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(54) **A COOLING ROLL**

KÜHLWALZE

ROULEAU DE REFROIDISSEMENT

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(56) References cited:
EP-A- 0 098 968 **EP-A- 0 428 464**
DE-A- 3 116 055 **DE-A- 3 839 110**
US-A- 4 019 846

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Description

This invention relates to a roll suitable for transferring heat between the roll and the material in contact with it. A particular, but not sole, application of the invention is to a roll suitable for use in a two-roll strip caster.

A strip caster usually consists of a pair of rolls, arranged side-by-side with their axes of rotation horizontal, and which are spaced apart to provide a gap between them. On the upper side of the rolls, the ends of the roll barrels can be provided with dams to form a space above the roll gap into which molten metal is poured. The rolls are usually liquid cooled to absorb heat from the molten metal which come into contact with them and form solidified skins which thicken as the rolls rotate. As the rolls are rotated they force the solidified skins of metal together and through the gap between the rolls to form a continuous metal strip.

In an effort to increase casting output, it is desirable to increase the speed of rotation of the rolls, but care has to be taken that the rolls absorb sufficient heat from the metal in contact with them to form two solidified skins whose total thickness is greater than the end product.

An object of the present invention is to provide an improved roll construction which permits greater throughput together with a stable roll design, which can readily be refurbished at the end of its useful life.

It is known from DE-3839110A for a cooling roll to comprise a rotatable arbor with an annular sleeve structure mounted on the arbor with a shrink fit interface between the outer peripheral surface of the arbor and the inner surface of the annular sleeve structure. The annular sleeve structure comprises an inner annular sleeve with an outer annular sleeve mounted on the inner annular sleeve with a shrink fit interface between them. In use, the sleeve structure is supplied with liquid coolant at the interface between the inner and outer sleeves to form a thermal barrier at the interface.

According to the present invention a cooling roll comprises

a rotatable arbor having a cylindrical surface;
an annular sleeve structure mounted on the arbor with a shrink fit interface between the cylindrical surface of the arbor and the inner surface of the annular sleeve structure;
channel means formed at the interface;
said arbor having ducts therein which are in communication with the exterior of the roll and said channel means;
said sleeve structure having internal passages for the flow of liquid coolant, said passages being in communication with the channel means;
said ducts, channel means and passages being arranged such that, in use, liquid coolant flows between the exterior of the roll and the passages by way of the channel means and the ducts to form a

thermal barrier in the sleeve structure;

characterised in that the sleeve structure comprises a single annular member and said thermal barrier is located between the outer peripheral surface of the sleeve structure and the interface.

The internal passages in the sleeve structure conveniently extend parallel to the longitudinal axis of the arbor. These passages may be formed by boring holes through the sleeve parallel to the longitudinal axis thereof. The passages connect with two annular channels, one in each of the end faces of the sleeve structure.

In order to absorb as much heat as possible from the molten material, it is necessary for the part of the roll which contacts the molten material to be of a high conductivity metal, such as steel, copper, or any of their alloys.

The surface of the high conductivity metal may be covered with a protective surface layer, which for example could be a stainless steel with good thermal fatigue properties or a nickel or nickel/chrome layer or a metal matrix composite layer such as tungsten carbide/cobalt alloy or chrome carbide/nickel-chrome composite.

At the end of its useful life the sleeve may be removed from the arbor by externally heating to expand the sleeve whilst omitting all sleeve cooling.

The sleeve could then be refurbished prior to re-assembly.

The sleeve serves as the roll barrel and, since an external force can be exerted upon it, there has to be a shrink fit between the sleeve and the arbor to prevent it rotating around the arbor.

In use, care has to be taken that the temperature of the sleeve relative to that of the arbor is not such that will cause differential expansion between the arbor and the sleeve so as to remove the interface joint between them. By arranging for a thermal barrier to be located between the outer surface of the sleeve and the interface between sleeve and the arbor, a limited minimum amount of the heat applied to the outer surface of the sleeve penetrates to the interface between the sleeve and the arbor. At the same time, the liquid cooled sleeve efficiently removes heat from the outer surface of the sleeve thereby permitting rapid cooling of the material which is in contact with it.

The interference fit between the sleeve and the arbor provides a tensile stress in the sleeve which helps to negate the thermally induced compressive stresses.

In order that the invention may be more readily understood, it will now be described, by way of example only, with reference to the accompany drawings, in which:-

Figure 1 is a view, partly in section, of a cooling roll in accordance with the present invention; and
Figure 2 shows to an enlarged scale the part of the roll within the broken lines of Figure 1.

A roll suitable for use in a metal caster comprises an elongate arbor 1 having cylindrical portions 3 adjacent each end for receiving bearing assemblies (not shown). Substantially at the centre of the arbor there is a cylindrical surface 5 on to which an annular copper-alloy sleeve 7 is shrunk. At one end of the surface 5 there is an annular rib 9 which is integral with the arbor. An annular recess 10 is formed in the adjacent end wall 11 of the sleeve and a plurality of fitted bolts (not shown) extend through the rib into the sleeve 11 to provide additional securement for the sleeve on to the arbor. The recess 10 is closed off by an annular ring 12 which is secured to the rib 9 by a plurality of bolts 13.

An axial bore 15 extends into the arbor 1 from the non-drive end 16. A pair of annular channels 17A, 17B are formed in the surface 5 of the arbor beneath the sleeve 7. A plurality of radial bores 19 extend from the channel 17A to the bore 15 and, similarly, a plurality of radial bores 21 extend from the channel 17B to the bore 15. In the end face 11 of the sleeve 7, there is an annular channel 22 and a similar channel 23 is formed in the end wall of the opposite end of the sleeve. The two channels 22, 23 are connected by a multiplicity of passages 25 which extend between them in a direction substantially parallel to the longitudinal axis of the arbor 1. The passages 25 are spaced apart around the entire annular sleeve. In addition, the channel 22 is connected to the channel 17B by a bore 27 within the sleeve and, similarly, the channel 23 is connected to the channel 17A by an internal bore 28. The channels 22, 23 are closed off by cover plates 29 which may be of the same material as the sleeve 7 and fixed in position by any convenient means such as welding along lines 30.

A tube 34 with a central enlarged outer diameter and seal 35 is located within bore 15 and provides a barrier between two annular areas 17A and 17B one of which communicates with radial bores 19 and the other communicates with radial bores 21 for the passage of outgoing and incoming liquid coolant.

In use, liquid coolant, usually water, is passed along the space between the tube 34 the bore 15 and into each of the bores 19 where it flows to the channel 17A at the interface between the sleeve and the arbor. The water then flows along the bore 28 to the channel 23 extending around the adjacent end face of the sleeve.

From this channel, the water flows through the multiplicity of bores 25 to the channel 22 in the end face 11 of the sleeve.

The water flowing through the passageways 25 cools the adjacent parts of the sleeve and, consequently, a cooled zone extends around the sleeve in the vicinity of the passageways. This cooled zone serves as a barrier which reduces the flow of heat from the outer surface of the sleeve to the interface between the sleeve and the arbor, thus preventing the temperature of the sleeve in the vicinity of the interface with the arbor from rising to a level where the shrink fit interface between the sleeve and the arbor is destroyed. The cooled zone

serves to cool the outer surface of the sleeve thereby causing metal to solidify in contact with the surface.

From the channel 22 the water flows along the bore 27 to the annular channel 17B and then via the bores 21 to the annulus formed by the pipe and bore 15 on the opposite side of the seal 35 and through the tube 34. The coolant may be made to flow in the reverse route to that described previously. A rotary coupling (not shown) is coupled to the end 16 of the arbor to permit coolant to circulate through the roll as the roll is rotated.

An annular seal 33 is located at each end of and between the sleeve and the arbor to prevent leakage of coolant from between the arbor and the sleeve. These seals can be fitted after assembly of the sleeve which will aid maintenance in the event of failure as well as negate the requirement to assemble the seals prior to the shrink fitting of the sleeve 7 on to the arbor 1.

The sleeve can have a hard facing layer 31 on its outer periphery. This layer may comprise of chrome on nickel or stainless steel or a metal matrix composite such as tungsten carbide/cobalt alloy or chrome carbide/nickel-chrome composite. The barrel ends of sleeve 7 also can have similar hard facing layer 32.

Claims

1. A cooling roll comprising

a rotatable arbor (1) having a cylindrical surface;
 an annular sleeve structure (7) mounted on the arbor with a shrink fit interface between the cylindrical surface of the arbor and the inner surface of the annular sleeve structure;
 channel means (17a, 17b) formed at the interface;
 said arbor having ducts (15; 19, 21) therein which are in communication with the exterior of the roll and said channel means;
 said sleeve structure having internal passages (25) for the flow of liquid coolant, said passages being in communication with the channel means;
 said ducts, channel means and passages being arranged such that, in use, liquid coolant flows between the exterior of the roll and the passages by way of the channel means and the ducts to form a thermal barrier in the sleeve structure;

characterised in that the sleeve structure comprises a single annular member (7) and said thermal barrier is located between the outer peripheral surface of the sleeve structure and the interface.

2. A cooling roll as claimed in claim 1 characterised in that said passages extend in a direction substantially parallel to the longitudinal axis of the arbor and

connect with two annular channels (22), one in each of the end faces of the sleeve structure.

3. A roll as claimed in claim 1 or 2 in which the sleeve structure is of steel.
4. A roll as claimed in claim 1 or 2 in which the sleeve structure is of copper or copper alloy.
5. A roll as claimed in claim 3 or 4 in which the periphery of the sleeve structure is protected by a thermally tough material which is harder than the sleeve structure.
6. A roll as claimed in claim 5 in which the sleeve structure is protected by a layer of stainless steel.
7. A roll as claimed in claim 5 in which the sleeve structure is protected by a layer of nickel/chrome.
8. A roll as claimed in claim 5 in which the sleeve structure is protected by a metal matrix composite layer such as chrome carbide/nickel-chrome.
9. A roll as claimed in claim 5 in which the sleeve structure is protected by a layer of tungsten carbide/cobalt.

Patentansprüche

1. Kühlwalze enthaltend:

einen drehbaren Dorn (1), der eine zylindrische Oberfläche aufweist,
 eine ringförmige Hülsenstruktur (7), die auf dem Dorn über eine Schrumpfsitzübergangsfläche zwischen der zylindrischen Oberfläche des Dorns und der Innenoberfläche der ringförmigen Hülsenstruktur angebracht ist,
 Kanalmittel (17A, 17B), die an der Übergangsfläche ausgebildet sind, wobei der Dorn Leitungen (15; 19, 21) in seinem Inneren aufweist, die in Verbindung mit der Außenseite der Walze und den Kanalmitteln stehen,
 wobei die Hülsenstruktur innenliegende Durchgänge (25) für die Strömung des flüssigen Kühlmittels aufweist, die in Verbindung mit den Kanalmitteln stehen,
 wobei die Leitungen, die Kanalmittel und die Durchgänge in der Weise angeordnet sind, daß im Einsatz das flüssige Kühlmittel zwischen der Außenseite der Walze und den Durchgängen mittels der Kanalmittel und der Leitungen strömt, um eine thermische Barriere in der Hülsenstruktur zu bilden,
dadurch gekennzeichnet, daß die Hülsenstruktur ein einzelnes ringförmiges Element (7) aufweist und die thermische Barriere zwischen

der äußeren Umfangsoberfläche der Hülsenstruktur und der Übergangsfläche angeordnet ist.

2. Kühlwalze nach Anspruch 1, **dadurch gekennzeichnet**, daß sich die Durchgänge in eine Richtung im wesentlichen parallel zur Längsachse des Dornes erstrecken und mit zwei ringförmigen Kanälen (22) verbunden sind, von denen jeweils einer in den Endflächen der Hülsenstruktur vorgesehen ist.
3. Kühlwalze nach Anspruch 1 oder 2, bei der die Hülsenstruktur aus Stahl ist.
4. Kühlwalze nach Anspruch 1 oder 2, bei der die Hülsenstruktur aus Kupfer oder einer Kupferlegierung ist.
5. Kühlwalze nach Anspruch 3 oder 4, bei der die Umfangsoberfläche der Hülsenstruktur durch ein thermisch hartes Material geschützt ist, welches härter als die Hülsenstruktur ist.
6. Kühlwalze nach Anspruch 5, bei der die Hülsenstruktur durch eine Schicht aus rostfreiem Stahl geschützt ist.
7. Kühlwalze nach Anspruch 5, bei der die Hülsenstruktur durch eine Schicht aus Nickel/Chrom geschützt ist.
8. Kühlwalze nach Anspruch 5, bei der die Hülse durch eine Metall-Verbundwerkstoffschicht, wie beispielsweise Chromcarbid/Nickel-Chrom geschützt ist.
9. Kühlwalze nach Anspruch 5, bei der die Hülsenstruktur durch eine Schicht aus Wolframcarbid/Kobalt geschützt ist.

Revendications

1. Rouleau de refroidissement comprenant :

un mandrin rotatif (1) possédant une surface cylindrique ;
 une structure de manchon annulaire (7) montée sur le mandrin avec une interface à emmanchement à chaud entre la surface cylindrique du mandrin et la surface intérieure de la structure de manchon annulaire ;
 des moyens de canalisation (17a, 17b) formés à l'interface ;
 ledit mandrin renfermant des conduites (15 ; 19 ; 21) qui sont en communication avec l'extérieur du rouleau et lesdits moyens de canalisation ;

ladite structure de manchon possédant des passages internes (25) pour permettre l'écoulement du liquide de refroidissement, lesdits passages étant en communication avec les moyens de canalisation ;

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lesdites conduites, lesdits moyens de canalisation et passages étant agencés de telle sorte que, en utilisation, le liquide de refroidissement s'écoule entre l'extérieur du rouleau et les passages par l'intermédiaire des moyens de canalisation et des conduites pour former une barrière thermique dans la structure de manchon ;

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caractérisé en ce que la structure de manchon comprend un élément annulaire unique (7) et en ce que ladite barrière thermique est située entre la surface périphérique extérieure de la structure de manchon et l'interface.

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2. Rouleau de refroidissement selon la revendication 1, caractérisé en ce que lesdits passages s'étendent dans une direction sensiblement parallèle à l'axe longitudinal du mandrin et rejoignent deux canaux annulaires (22), un sur chacune des faces d'extrémité de la structure de manchon. 20
25
3. Rouleau selon la revendication 1 ou 2, dans lequel la structure de manchon est en acier.
4. Rouleau selon la revendication 1 ou 2, dans lequel la structure de manchon est en cuivre ou en alliage de cuivre. 30
5. Rouleau selon la revendication 3 ou 4, dans lequel la périphérie de la structure de manchon est protégée par un matériau thermiquement résistant qui est plus dur que la structure de manchon. 35
6. Rouleau selon la revendication 5, dans lequel la structure de manchon est protégée par une couche d'acier inoxydable. 40
7. Rouleau selon la revendication 5, dans lequel la structure de manchon est protégée par une couche de nickel/chrome. 45
8. Rouleau selon la revendication 5, dans lequel la structure de manchon est protégée par une couche composite à matrice métallique telle qu'une couche de carbure de chrome/nickel-chrome. 50
9. Rouleau selon la revendication 5, dans lequel la structure de manchon est protégée par une couche de carbure de tungstène/cobalt. 55

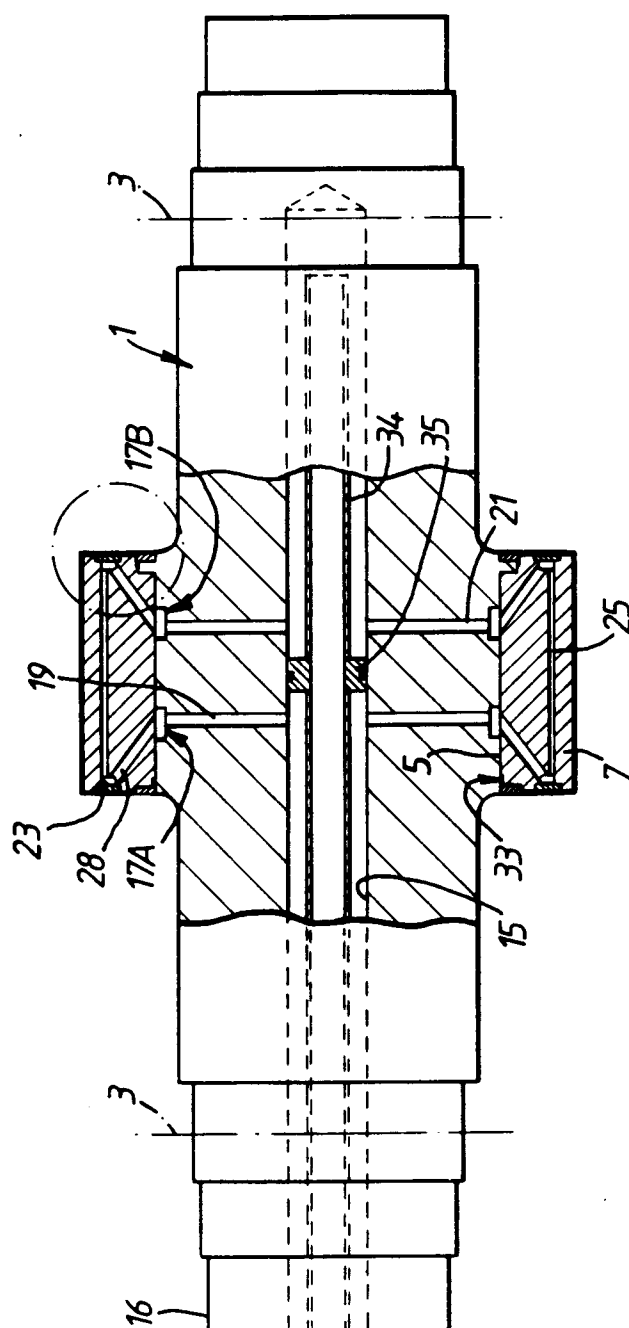


Fig. 1.

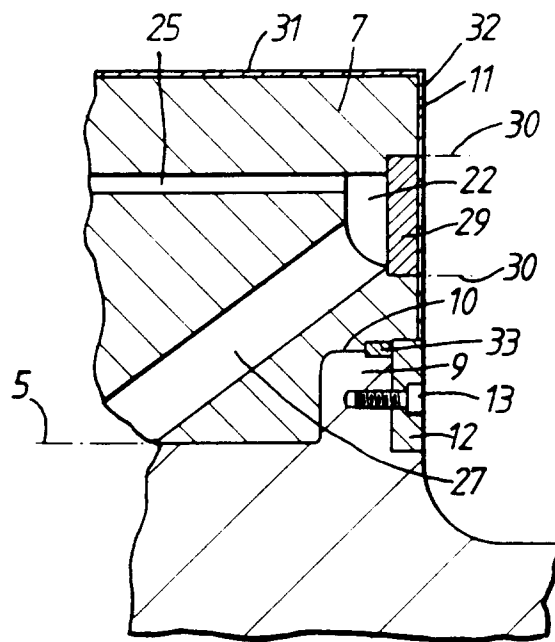


Fig.2.