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(71) Applicant: **Aktiebolaget SKF**
S 415 50 Göteborg (SE)

(72) Inventor: **Anundsson, Jesper**
S-437 41 Lindome (SE)

(54) **Blocking element, roll line & continuous casting apparatus**

(57) Blocking element (25) for a roll mantle (28) of a roll line (20) of a continuous casting apparatus comprising a rotatable shaft (24) having a coolant line (30), whereby the roll mantle (28) is arranged to be supported on said rotatable shaft (24) in a rotationally fixed manner. The roll mantle (28) comprises at least one coolant channel (32) arranged to be in fluid communication with said coolant line (30), which coolant channel (32) has at least one fluid inlet (36) and at least one fluid outlet (42). The blocking element (25) is arranged to supply coolant to said at least one fluid inlet (36) and to receive coolant from said at least one coolant outlet (42).

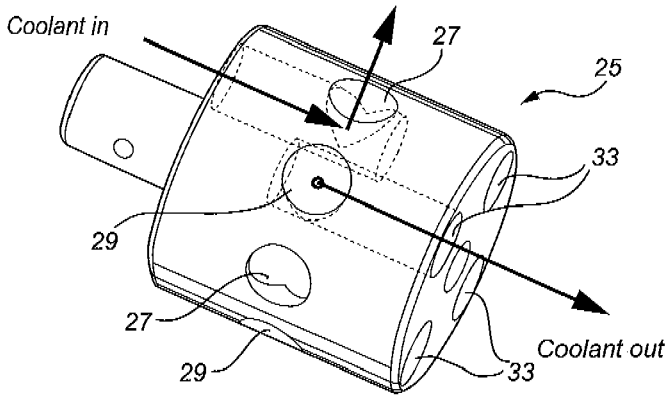

Fig. 10

EP 2 682 203 A2

Description

TECHNICAL FIELD

[0001] The present invention concerns a blocking element for a roll mantle of a roll line of a continuous casting apparatus comprising a rotatable shaft having a coolant line, whereby the blocking element is arranged to interrupt the flow of coolant in the coolant line in such a way that coolant passes into the roll mantle. The present invention also concerns a roll line comprising at least one such blocking element, and continuous casting apparatus comprising at least one such blocking element and/or at least one such roll line.

BACKGROUND OF THE INVENTION

[0002] In a continuous casting process molten metal flows from a ladle, through a tundish into a mould having water-cooled walls. Once in the mould, the molten metal solidifies against the water-cooled mould walls to form a solid shell. This shell containing the liquid metal, now called a strand, is withdrawn continuously from the bottom of the mould. The strand is supported by closely spaced, water-cooled roll lines which act to support the walls of the strand against the ferrostatic pressure of the still-solidifying liquid within the strand. To increase the rate of solidification, the strand is sprayed with large amounts of water. Finally, the strand is cut into predetermined lengths. The strand may then continue through additional roll lines and other mechanisms which flatten, roll or extrude the metal produce into its final shape.

[0003] The roll lines used in continuous casting plants are exposed to high thermal stresses, since the cast metal strands leave the mould at a temperature of over 900°C, in particular in the case of steel strands. Roll lines are therefore usually provided with internal cooling.

[0004] European patent application no. EP 1 646 463 relates to an internally cooled billet guiding roller for a continuous casting installation. The billet guiding roller comprises a central rotary shaft and at least one cylindrical roller tube (a "roll mantle") which is supported on said shaft in a rotationally fixed manner. Coolant channels located at a constant distance from the outer surface of the cylindrical roller tube, pass through the roller tube. The coolant passages are distributed uniformly in the interior of the cylindrical roller tube at, or near its periphery, and are formed by through bores. Coolant from a coolant line, which is arranged in the central rotary shaft, is supplied to the coolant passages at one end of the cylindrical roller tube, and returned from the coolant passages to the coolant line at the other end of the cylindrical roller tube via branch lines that extend radially through the cylindrical roller tube between the coolant passages and the coolant line. A number of blocking elements are inserted into the central coolant line to interrupt the flow of coolant in the continuous central coolant line in such a way that coolant passes into the individual roller tubes,

SUMMARY OF THE INVENTION

[0005] An object of the invention is to provide an improved blocking element for a roll mantle of a roll line of a continuous casting apparatus comprising a rotatable shaft having a coolant line, whereby the roll mantle is arranged to be supported on the rotatable shaft in a rotationally fixed manner, and whereby the roll mantle comprises at least one coolant channel arranged to be in fluid communication with the coolant line, which coolant channel has at least one fluid inlet and at least one fluid outlet.

[0006] This object is achieved by a blocking element that is arranged to both supply coolant to the at least one fluid inlet and at the same time to receive coolant from the at least one coolant outlet.

[0007] Such a blocking element may be used to supply coolant to an internally cooled roll mantle and to receive coolant from the roll mantle and return it to the coolant line in the rotatable shaft. This means that the roll mantle's fluid inlet(s) and fluid outlet(s) may be positioned close together and the supply and return of coolant therefrom may be controlled by a single component.

[0008] Furthermore, roll mantles are subjected to extreme wear due to the high loads, high temperatures, high temperature variations, high humidity, high corrosion and high contamination during use. Using a blocking element according to the present invention allows at least one fluid inlet and/or at least one coolant outlet to be placed anywhere along the coolant line of a shaft. There will therefore be no exposed sealing means at the end regions of the roll mantle which ends regions are subjected to the high loads, high temperatures, high temperature variations, high humidity, high corrosion and high contamination. The fluid inlet(s) and/or coolant outlet(s) and any necessary sealing means will instead be located at a less loaded and relatively cool part of the roll mantle and shaft. The lifetime of sealing means around the fluid inlet(s) and/or coolant outlet(s) will therefore be extended and the sealing means will not therefore have to be replaced as frequently.

[0009] It should be noted that the expression "a rotatable shaft having a coolant line" is not necessarily intended to mean a rotatable shaft having a single coolant line. A rotatable shaft may be arranged to have any number of coolant lines.

[0010] According to an embodiment of the invention the at least one fluid inlet and the at least one fluid outlet are arranged at the same distance along the length of the roll mantle. The expression "length of the roll mantle" is intended to mean the length of the outer surface of the roll mantle, which outer surface is arranged to come into contact with cast metal strands during a continuous casting process.

[0011] A blocking element may for example be arranged at the centre of a roll mantle, i.e. half way between the ends of the roll mantle, which ends delimit the outer surface thereof, in cases where the roll mantle's fluid inlet(s) and/or coolant outlet(s) are located at the centre of

the roll mantle.

[0012] Sealing means may be provided between the rotatable shaft of the roll line and the at least one roll mantle. Rubber seals or 0-rings may for example be used to seal off the area between the rotatable shaft of the roll line and the at least one roll mantle.

[0013] According to another embodiment of the invention the blocking element constitutes a single component.

[0014] According to a further embodiment of the invention the blocking element comprises at least one coolant line-coolant supplying channel arranged at the perimeter of the blocking element to supply coolant from the coolant line to the at least one fluid inlet. The blocking element also comprises at least one coolant channel-coolant receiving channel at the perimeter of the blocking element to receive coolant from the at least one coolant outlet. According to an embodiment of the invention the blocking element comprises a plurality of coolant line-coolant supplying channels and a plurality of coolant channel-coolant receiving channels arranged alternately around the perimeter of the blocking element. According to an embodiment of the invention the blocking element may comprise at least one valve to control the amount of coolant flowing through the blocking element,

[0015] According to another embodiment of the invention the blocking element comprises locking means to lock it in position in a coolant line once it has been aligned with the coolant channel of a roll mantle and/or a coolant channel in a shaft.

[0016] The present invention also concerns a roll line comprising at least one blocking element according to any of the embodiments of the invention, and continuous casting apparatus comprising at least one blocking element and/or at least one roll line according to any of the embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will hereinafter be further explained by means of non-limiting examples with reference to the appended schematic figures where;

Figure 1 shows a continuous casting process,

Figure 2 shows a roll fine according to an embodiment of the invention,

Figures 3-6 show roll mantles containing a blocking element according to embodiments of the invention, and

Figures 7-10 show a blocking element according to an embodiment of the invention.

[0018] It should be noted that the drawings have not been drawn to scale and that the dimensions of certain features have been exaggerated for the sake of clarity.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] Figure 1 shows a continuous casting process in which molten metal 10 is tapped into a ladle 12. After undergoing any ladle treatments, such as alloying and degassing, and arriving at the correct temperature, molten metal 10 from the ladle 12 is transferred via a refractory shroud to a tundish 14. Metal is drained from the tundish 14 into the top of an open-base mould 16. The mould 16 is water-cooled to solidify the molten metal directly in contact with it. In the mould 16, a thin shell of metal next to the mould walls solidifies before the middle section, now called a strand, exits the base of the mould 16 into a cooling chamber 18; the bulk of metal within the walls of the strand is still molten. The strand is supported by closely spaced, water cooled roll lines 20 which act to support the walls of the strand against the ferrostatic pressure of the still-solidffying liquid within the strand. To increase the rate of solidification, the strand is sprayed with large amounts of water as it passes through the cooling chamber 18. Final solidification of the strand may take place after the strand has exited the cooling chamber 18.

[0020] In the illustrated embodiment the strand exits the mould 16 vertically (or on a near vertical curved path) and as it travels through the cooling chamber 18, the roll lines 20 gradually curve the strand towards the horizontal. (In a vertical casting machine, the strand stays vertical as it passes through the cooling chamber 18).

[0021] After exiting the cooling chamber 18, the strand passes through straightening roll lines (if cast on other than a vertical machine) and withdrawal roll lines. Finally, the strand is cut into predetermined lengths by mechanical shears or by travelling oxyacetylene torches 22 and either taken to a stockpile or the next forming process. In many cases the strand may continue through additional roll lines and other mechanisms which might flatten, roll or extrude the metal into its final shape.

[0022] Figure 2 shows a roll line 20 according to an embodiment of the present invention, namely a common shaft roll line 20. The roll line 20 comprises a shaft 24 having an outer diameter $Ø_o$ and supported by bearings 26 housed in bearing housings, and a plurality of roll mantles 28 for transporting a metal strand along the outer surface 34 thereof, having a corresponding inner diameter $Ø_i$ which are arranged to be fixedly supported on the shaft 24. Such a roll line 20 may comprise any number of blocking elements arranged in a coolant line 30 in the shaft 24.

[0023] It should be noted that a roll line 20 may comprise more components than those illustrated in the figures, such as mechanical couplings and optionally a lubrication system etc. However, only features of relevance to the present invention have been illustrated for the sake of clarity.

[0024] Figure 3 is a cross section of a roll mantle 28 comprising a blocking element 25 according to an embodiment of the present invention supported on a rotatable shaft 24 having a coolant line 30, whereby the roll

mantle 28 is arranged to be supported on the rotatable shaft 24 in a rotationally fixed manner. The roll mantle 28 comprises coolant channels 32 arranged to be in fluid communication with the coolant line 30. The length L of a roll mantle 28 may be 300-1000 mm.

[0025] The coolant channels 32 comprise at least one fluid inlet 36 and/or at least one fluid outlet 42 located at the centre of the roll mantle 28 in the illustrated embodiment. It should however be noted that at least one fluid inlet 36 and/or at least one fluid outlet 42 may be located anywhere along the length of the roll mantle 28, for example closer to an end of the roll mantle 28. Sealing means (not shown) may be provided between the rotatable shaft 24 and the roll mantle 28 to seal off the area around the fluid inlet 36 and/or coolant outlet 42.

[0026] The at least one fluid inlet 36 and the at least one coolant outlet 42 of the coolant channels 32 may be in fluid communication with the coolant line 30 via one or more radial channels 38 or non-radial channels in the rotatable shaft 24. It should however be noted that fluid communication between the fluid inlet 36 of the coolant channels 32 and the coolant line 30 may be provided in any suitable manner.

[0027] The coolant channels 32 may extend in any suitable manner through the roll mantle 28, such as in a straight line, a curved line, or in the form of a spiral, zigzag, regular or irregular pattern, longitudinally, radially or at an angle to the outer surface 34 of the roll mantle.

[0028] The blocking element 25 is constituted by a single component is arranged to supply coolant to the fluid inlet 36 and to receive coolant from the fluid outlet 42. In the illustrated embodiment the fluid inlet 36 and the fluid outlet 42 are arranged axially at the same distance along the length L of said roll mantle 28, at a short distance from one another, such as max. 20 cm, preferably max. 10 cm, max. 5cm, max. 2 cm, or max.1 cm from one another.

[0029] Figure 4 shows a cut-away perspective view of an end of a roll mantle 28 in which the outermost parts of the coolant channels 32 may be seen. When the roll mantle 28 is in use coolant will flow along a coolant channel 21 in a direction out of the plane of the paper towards part 32a of the coolant channel, and then in a direction along the plane of the paper to part 32b of the coolant channel, before it is returned via the coolant channel 21 in a direction into the plane of the paper to the coolant line 30 in the rotatable shaft 24.

[0030] Figures 5 and 6 show how coolant may be arranged to flow though a roll mantle 28. Coolant from a coolant line 30 in a rotatable shaft 24 may be made to flow, by means of a blocking element 25 according to the present invention, into a plurality of fluid inlets 32 that may be arranged around the inner surface 40 of the roll mantle 28 in the central region thereof. Coolant then flows along coolant channels 32 in the roll mantle 28 and is returned to the coolant line 30 in the rotatable shaft 24 via at least one fluid outlet 42 that may also be arranged around the inner surface 40 of the roll mantle 28 in the central region thereof.

[0031] According to an embodiment of the invention the fluid inlet 36 and the coolant outlet 42 are arranged adjacent to one another and preferably as close as possible. A fluid inlet 36 may for example be arranged at a distance from a coolant outlet 42 which is less than the maximum cross-sectional dimension of a coolant channel 32, for example less than the maximum diameter of a coolant channel 32 having a circular cross-section. The distance between a fluid inlet 36 and a coolant outlet 42 may for example be 0.5-10_0 mm to facilitate the supply of coolant thereto and the return of coolant therefrom respectively.

[0032] Figure 6 shows two coolant channels 32 arranged of the same size and shape; a roll mantle 28 according to the present invention may however be arranged to comprise any number of coolant channels 32, such as 1 to 12 coolant channels 32, each of any size or shape.

[0033] Figures 7 and 8 show a blocking element 25 according to an embodiment of the invention. The blocking element 25 comprises at least one coolant line-coolant supplying channel 27 arranged at the perimeter, i.e. the periphery if the blocking element 25 has a circular cross section. The at least one coolant line-coolant supplying channel 27 supplies coolant from the coolant line 30 in the rotatable shaft 24 to at least one fluid inlet 36 of a coolant channel 32 of a roll mantle 28. The blocking element 25 also comprises at least one coolant channel-coolant receiving channel 29 at the perimeter of the blocking element 25 to receive coolant from at least one coolant outlet 42 of a coolant channel 32 of a roll mantle 28.

[0034] Coolant from the coolant line 30 of the rotatable shaft 24 enters the blocking element 25 via holes 31 at one end of the blocking element 25. Coolant from the coolant channel(s) 32 of a roll mantle 28 leaves the blocking element 25 via holes 33 at the other end of the blocking element 25, as indicated by the arrows in figure 8. In the illustrated embodiment the coolant line-coolant supplying channels 27 and the coolant channel-coolant receiving channels 29 are provided alternately around the periphery of the blocking element 25. Such channels 27 and 29 may however be arranged in any suitable manner.

[0035] Figure 9 shows a cut-away perspective view of a roll mantle 28 comprising a blocking element 25 according to an embodiment of the invention. The blocking element 25 is located in the coolant line 30 of the rotatable shaft 24 supporting the roll mantle 28 aligned with a radial coolant channel in the rotatable shaft 24 and at least one fluid inlet 32 in the roll mantle 28. Once a blocking element 25 has been aligned 25 it may be provided with locking means to lock the blocking element 25 in position in the coolant line 30.

[0036] Figure 10 shows how coolant in the coolant line 30 flows through a blocking element 25 according to an embodiment of the invention.

[0037] The roll mantles 28 in the illustrated embodiments have been shown as hollow cylinders having a

continuous and smooth outer surface 28a. It should however be noted that the at least one roll mantle 28 of a roll line 20 according to the present invention need not necessarily be a cylinder or of a symmetric shape of uniform cross section, and its outer surface need not necessarily be continuous or smooth, but may be of any shape, size and design depending on their function and/or location in a continuous casting plant.

[0038] Further modifications of the invention within the scope of the claims would be apparent to a skilled person. For example, even though the present invention concerns a roll mantle comprising at least one coolant channel that is arranged to be in fluid communication with a coolant line in a rotatable shaft when in use, the so-called coolant channels in the roll mantle may be utilized for any purpose, i.e. they are not only suitable for transporting coolant through at least part of the roll mantle.

Claims

1. Roll mantle (28) for a roll line (20) of a continuous casting apparatus comprising a rotatable shaft (24) having a coolant line (30), whereby the roll mantle (28) is arranged to be supported on said rotatable shaft (24) in a rotationally fixed manner, and whereby said roll mantle (28) comprises at least one coolant channel (32) arranged to be in fluid communication with said coolant line (30), **characterized in that** said at least one coolant channel (32) is arranged so that coolant in adjacent parts of said at least one coolant channel (32) flows in opposite directions when the roll mantle (28) is in use, whereby heat exchange between coolant in adjacent parts of said at least one coolant channel (32) is possible.

2. Roll mantle (28) according to claim 1 or 2, **characterized in that** said at least one coolant channel (32) is arranged to extend in a straight line, a curved line, a spiral, a zig-zag, regular or irregular pattern, longitudinally, radially or at an angle to the outer surface (34) of the roll mantle (28).

3. Roll mantle (28) according to claim 1 or 2, **characterized in that** it comprises two component parts (28a, 28b), whereby said at least one coolant channel (32) is formed on connecting said two component parts (28a, 28b).

4. Roll line (20) for a continuous casting apparatus, **characterized in that** said roll line (20) comprises at least one roll mantle (28) according to any of the preceding claims.

5. Roll line (20) according to claim 6, **characterized in that** sealing means are provided between said rotatable shaft (24) and said at least one roll mantle (28).

6. Continuous casting apparatus, **characterized in that** it comprises at least one roll mantle (28) according to any of claims 1-5 and/or at least one roll line (20) according to any of claims 6-7.

7. Blocking element (25) for a roll mantle (28) of a roll line (20) of a continuous casting apparatus comprising a rotatable shaft (24) having a coolant line (30), whereby the roll mantle (28) is arranged to be supported on said rotatable shaft (24) in a rotationally fixed manner, and whereby said roll mantle (28) comprises at least one coolant channel (32) arranged to be in fluid communication with said coolant line (30), which coolant channel (32) has at least one fluid inlet (36) and at least one fluid outlet (42), **characterized in that** said blocking element (25) is arranged to supply coolant to said at least one fluid inlet (36) and to receive coolant from said at least one coolant outlet (42).

8. Blocking element (25) according to claim 1, **characterized in that** said at least one fluid inlet (36) and said at least one fluid outlet (42) are arranged at the same distance along the length (L) of said roll mantle (28).

9. Blocking element (25) according to claim 1 or 2, **characterized in that** it constitutes a single component.

10. Blocking element (25) according to any of the preceding claims, **characterized in that** it comprises at least one coolant line-coolant supplying channel (27) arranged at the perimeter of the blocking element (25) to supply coolant from said coolant line (30) to said at least one fluid inlet (36), and at least one coolant channel-coolant receiving channel (29) at the perimeter of the blocking element (25) to receive coolant from said at least one coolant outlet (42).

11. Blocking element (25) according to claim 4, **characterized in that** it comprises a plurality of coolant line-coolant supplying channels (27) and a plurality of coolant channel-coolant receiving channels (29) arranged alternately around the perimeter of the blocking element (25).

12. Blocking element (25) according to any of the preceding claims, **characterized in that** it comprises locking means to lock it in position in said coolant line (30).

13. Roll line (20), **characterized in that** it comprises at least one blocking element according to any of the preceding claims.

14. Continuous casting apparatus, **characterized in that** it comprises at least one blocking element (25)

according to any of claims 1-6 and/or at least one roll line (20) according to claim 7.

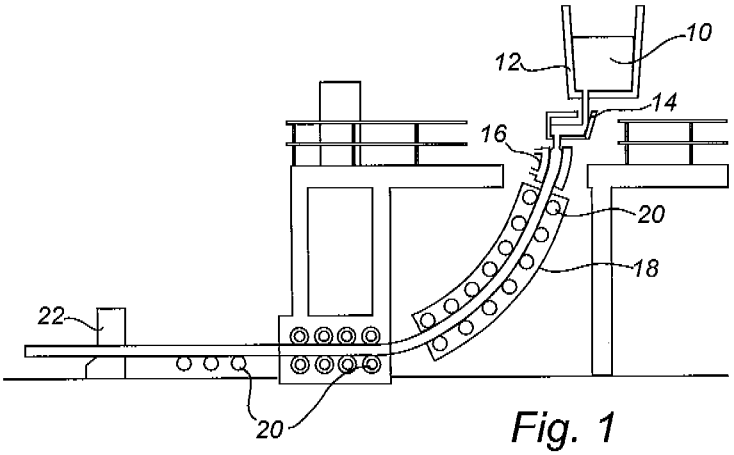

Fig. 1

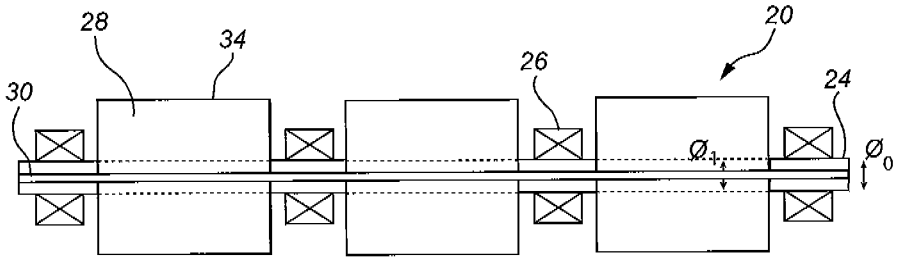

Fig. 2

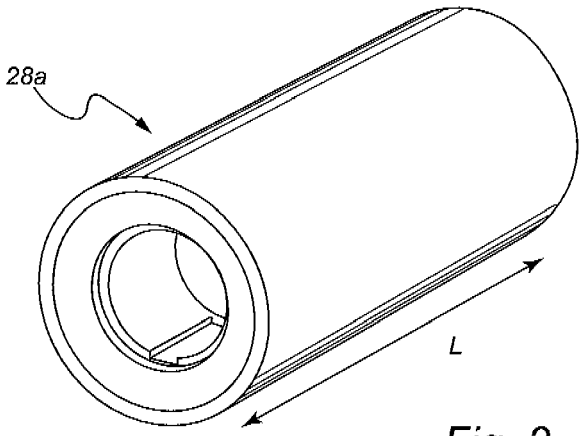

Fig. 3

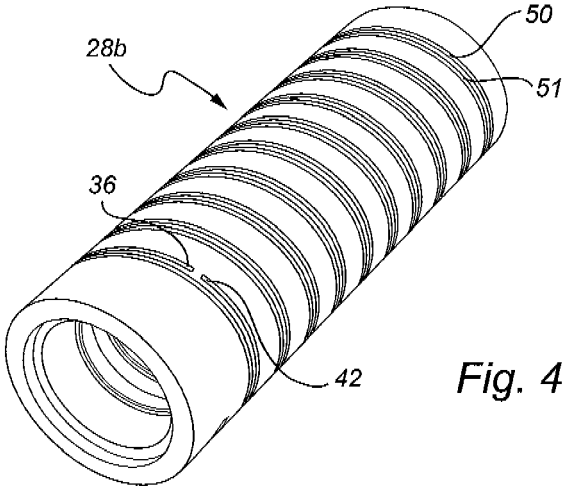

Fig. 4

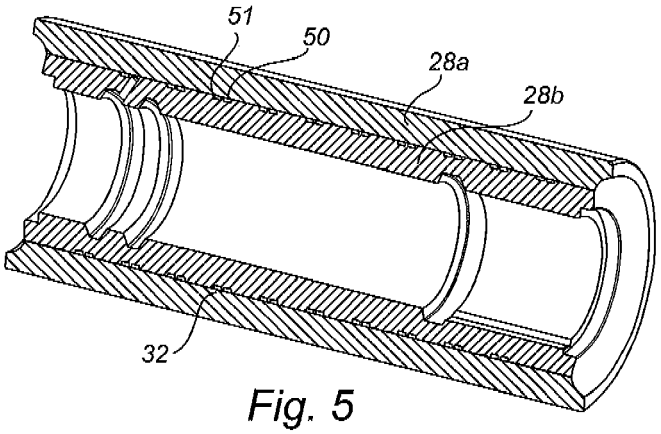

Fig. 5

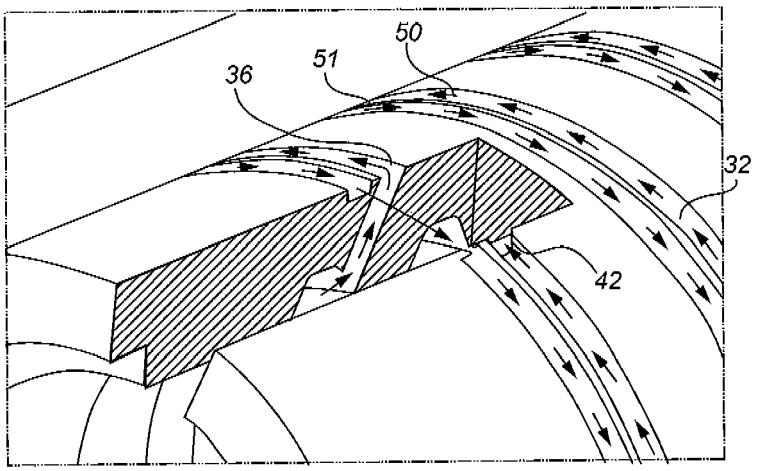

Fig. 6

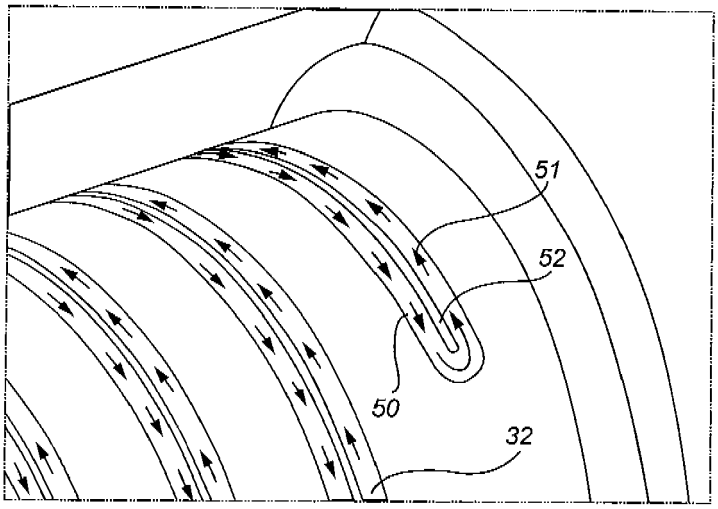

Fig. 7

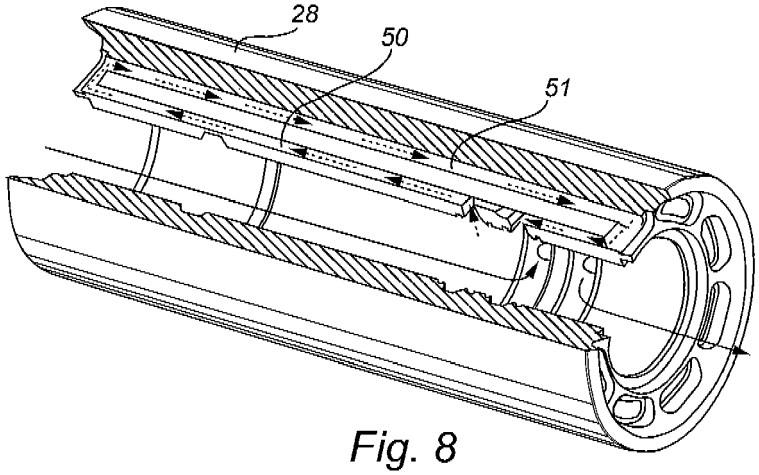

Fig. 8

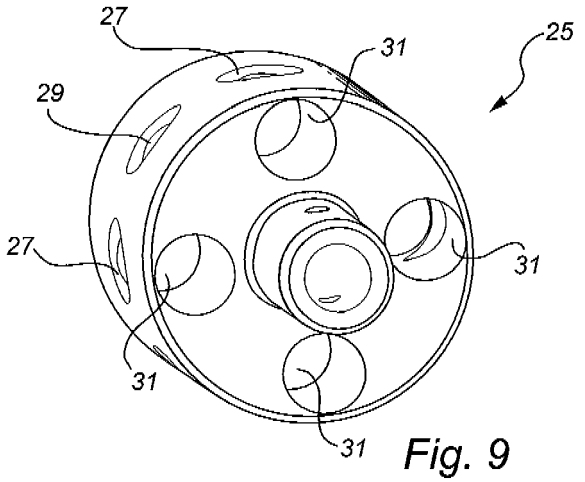

Fig. 9

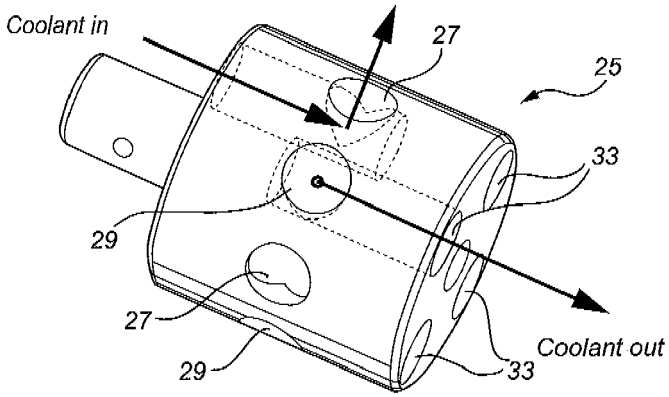

Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1646463 A **[0004]**