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(54) **Roll mantle, roll line & continuous casting apparatus**

(57) 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. The roll mantle (28) comprises at least one coolant channel (32) arranged to be in fluid communication with said coolant line (30) and a first end region (ER1), a second end region (ER2) and a central region (CR) in between said first end region (ER1) and said second end region (ER2). The central region (CR) extends along at least 50% of the length (L) of said roll mantle (28), and the at least one coolant channel (32) comprises at least one coolant inlet (36) and/or at least one coolant outlet (42) located within said central region (CR) of the roll mantle (28).

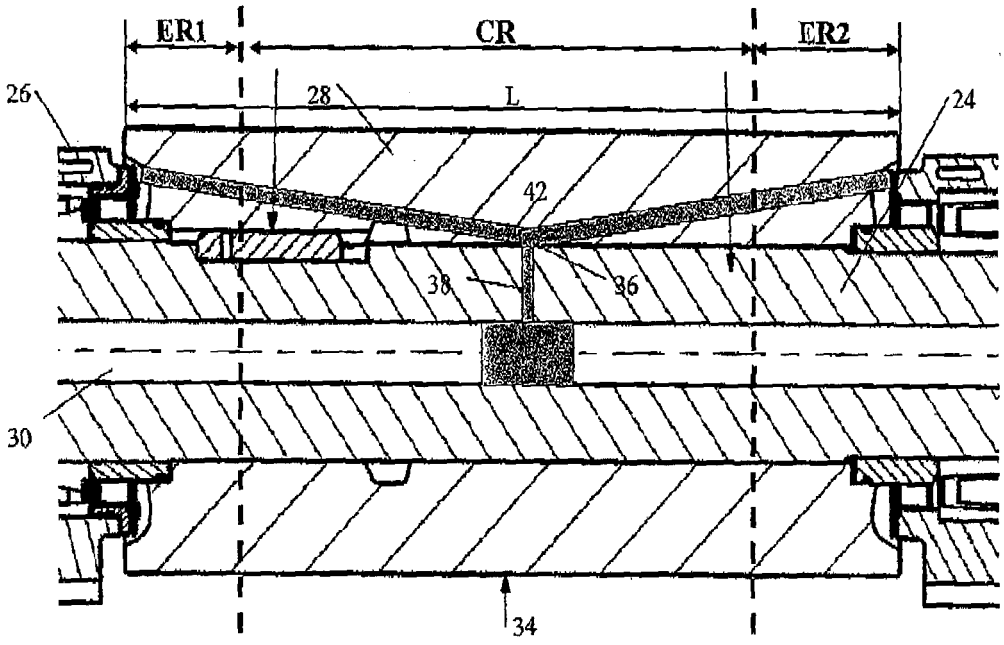

Fig. 3

EP 2 682 202 A2

Description

TECHNICAL FIELD

[0001] The present invention concerns a roll mantle for a roll line of a continuous casting apparatus, a roll line comprising at least one such roll mantle, and a continuous casting apparatus comprising at least one such roll mantle 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 This shell containing the liquid metal, now called a strand, is withdrawn continuously from the bottom of the mould, The strand is supported by closely spaced, water-cooled roll lines which act to support the walls of the strand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-solldifying 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.

SUMMARY OF THE INVENTION

[0005] An object of the invention is to provide an improved internally cooled roll mantle for 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.

[0006] This object is achieved by a roll mantle that comprises a first end region, a second end region and a central region in between the first end region and the second end region, whereby the central region extends along at least 50%, at least 60%, at least 70%, at least 80% or at least 90% of the length of the roll mantle, and whereby the at least one coolant channel comprises at least one coolant inlet and/or at least one coolant outlet located within the central region of the roll mantle, i.e. anywhere within the central region of the roll mantle and not at its ends or within its end regions.

[0007] 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. By arranging at least one coolant inlet and/or at least one coolant outlet within the central region of the roll mantle and not within the end regions of the roll mantle, there will 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 coolant 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 coolant inlet(s) and/or coolant outlet(s) will therefore be extended and the sealing means will not therefore have to be replaced as frequently

[0008] 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.

[0009] According to an embodiment of the invention the roll mantle comprises an outer surface and the at least one coolant channel is arranged at a non-constant distance from the outer surface of the roll mantle.

[0010] The expression "outer surface of the roll mantle" as used in this document is intended to mean the surface that is arranged to come into contact with cast metal strands during a continuous casting process. The expression "length of the roil mantle" is intended to mean the length of this outer surface.

[0011] If the roll mantle has a horizontal outer surface when in use, no horizontal coolant channels will have to be provided in the roll mantle, and coolant channels do not necessarily have to extend through the whole roll mantle, which may lead to less machining when manufacturing the roll mantle according to the present invention.

[0012] It should be noted that an entire coolant channel need not necessarily be machined in the roll mantle according to the present invention. A channel, hole or cavity may for example be machined in the roll mantle and then at least one coolant channel may be formed by providing

at least one partitioning means inside the machined channel, hole or cavity to form at least one coolant channel having at least one coolant inlet and at least one coolant outlet. The partitioning means may comprise metal or plastic or any suitable material in the form of a partitioning wall or structure.

[0013] According to another embodiment of the invention the at least one coolant inlet and/or the at least one coolant outlet is/are arranged at the centre of the roll mantle, i.e. half way between the ends of the roll mantle, which ends delimit the outer surface thereof.

[0014] According to a further embodiment of the invention the roll mantle has an inner surface, i.e. the surface that is arranged to be supported on the rotatable shaft of a roll line, and the at least one coolant channel is arranged to extend from the inner surface of the roll mantle towards the outer surface of the roll mantle.

[0015] According to an embodiment of the invention he at least one coolant channel is arranged to extend in a straight line towards the outer surface of the roll mantle, optionally at an angle to the outer surface.

[0016] The present invention also concerns a roll line for a continuous casting apparatus, which comprises at least one roll mantle according to any of the embodiments of the invention.

[0017] According to an embodiment of the invention sealing means are provided between the rotatable shaft of the roll line and the at least one roll mantle. Rubber seals or O-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.

[0018] The present invention further concerns continuous casting apparatus that comprises at least one roll mantle and/or at least one roll line any of the embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] 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 line according to an embodiment of the invention, and

Figures 3-9 show roll mantles according to embodiments of the invention.

[0020] 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

[0021] 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-solidifying 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.

[0022] 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).

[0023] 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.

[0024] 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 $Ø_0$ 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 $Ø_1$ which are arranged to be fixedly supported on the shaft 24.

[0025] 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.

[0026] Figure 3 is a cross section of a roll mantle 28 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 roll mantle comprises a first end region ER1, a second end region ER2 and a central region CR in between the first end region ER1 and the second end region

ER2, whereby the central region CR extends along about 70% of the length L of the outer surface 34 of the roll mantle 28 in the illustrated embodiment. The length L of a roll mantle 28 may be 400-800 mm.

[0027] The coolant channels 32 comprise at least one coolant inlet 36 and/or at least one fluid outlet 42 located within the central region CR of the roll mantle 28. In the illustrated embodiment the at least one coolant inlet 36 and/or the at least one coolant outlet 42 is/are arranged at the centre of the roll mantle 28. At least one coolant inlet 36 and/or the at least one coolant outlet 42 may however be arranged anywhere within the central region CR of the roll mantle 28, for example closer to the first end region ER1 than to the second end region ER2. Sealing means (not shown) may be provided between the rotatable shaft 24 and the roll mantle 28 to seal off the area around the coolant inlet 36 and/or coolant outlet 42.

[0028] The at least one coolant 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 coolant inlet 36 of the coolant channels 32 and the coolant line 30 may be provided in any suitable manner.

[0029] The coolant channels 32 are arranged at a non-constant distance from the outer surface 34 of the roll mantle 28 and extend in a straight line from the coolant inlet 36 to towards the outer surface 34 of the roll mantle 28 at an angle thereto. It should however be noted that the at least one coolant channel 32 does not necessarily have to extend in a straight line through the roll mantle 28.The at least one coolant channel 32 may for example extend in a curved line, or in the form of a spiral, zig-zag, regular or irregular pattern, or in any other suitable manner through the roll mantle 28.

[0030] Figure 4 shows a cut-away perspective view of an end region ER1 or ER2 a roll mantle 28 according to an embodiment of the invention 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. Coolant may therefore be arranged to flow through the end regions ER1 and/or ER2 of the roll mantle 28 but there is no coolant inlet or outlet within the end regions ER1 and ER2 of the roll mantle 28.

[0031] Figures 5 and 6 show how coolant may be arranged to flow though a roll mantle 28 according to an embodiment of the present invention. Coolant from a coolant line 30 in a rotatable shaft 24 may be made to flow (by means of pumps, valves and fluid distributors for example) 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 CR 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 be arranged around the inner surface 40 of the roll mantle 28 in the central region CR thereof.

[0032] According to an embodiment of the invention the coolant inlet 36 and the coolant outlet 42 are arranged adjacent to one another and preferably as close as possible. A coolant 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 coolant 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.

[0033] 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.

[0034] Figures 7-9 show how coolant may be arranged to flow though a roll mantle 28 according to another embodiment of the present invention. Coolant from a coolant line 30 in a rotatable shaft 24 may be made to flow (by means of pumps, valves and fluid distributors for example) into at least one fluid inlet 36 on the inner surface of the roll mantle 28. Coolant then flows along one or more 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 be arranged around the inner surface of the roll mantle 28. According to an embodiment of the invention the at least one coolant inlet 36 is arranged upstream of the at least one coolant outlet 42. The at least one coolant channel 32 may be arranged to extend at least partly around the roll mantle's circumference in any suitable manner.

[0035] 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.

[0036] 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 transport-

ing 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 roll mantle (28) comprises a first end region (ER1), a second end region (ER2) and a central region (CR) in between said first end region (ER1) and said second end region (ER2), whereby said central region (CR) extends along at least 50%, at least 60%, at least 70%, at least 80% or at least 90% of the length (L) of said roll mantle (28), and whereby said at least one coolant channel (32) comprises at least one coolant inlet (36) and/or at least one coolant outlet (42) located within said central region (CR) of the roll mantle (28).

2. Roll mantle (28) according to claim 1, **characterized in that** it comprises an outer surface (34) and each said at least one coolant channel (32) is arranged at a non-constant distance from the outer surface (34) of the roll mantle (28).

3. Roll mantle (28) according to claim 1 or 2, **characterized in that** said at least one coolant inlet (36) and/or said at least one coolant outlet (42) is/are arranged at the centre of said roll mantle (28).

4. Roll mantle (28) according to any of the preceding claims, **characterized in that** said roll mantle (28) has an inner surface (40) and said at least one coolant channel (32) is arranged to extend from the inner surface (40) of the roll mantle (28) towards the outer surface (34) of the roll mantle (28).

5. Roll mantle (28) according to any of the preceding claims, **characterized in that** said at least one coolant channel (32) is arranged to extend in a straight line towards the outer surface (34) of the roll mantle (28).

6. 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.

7. 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).

8. 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.

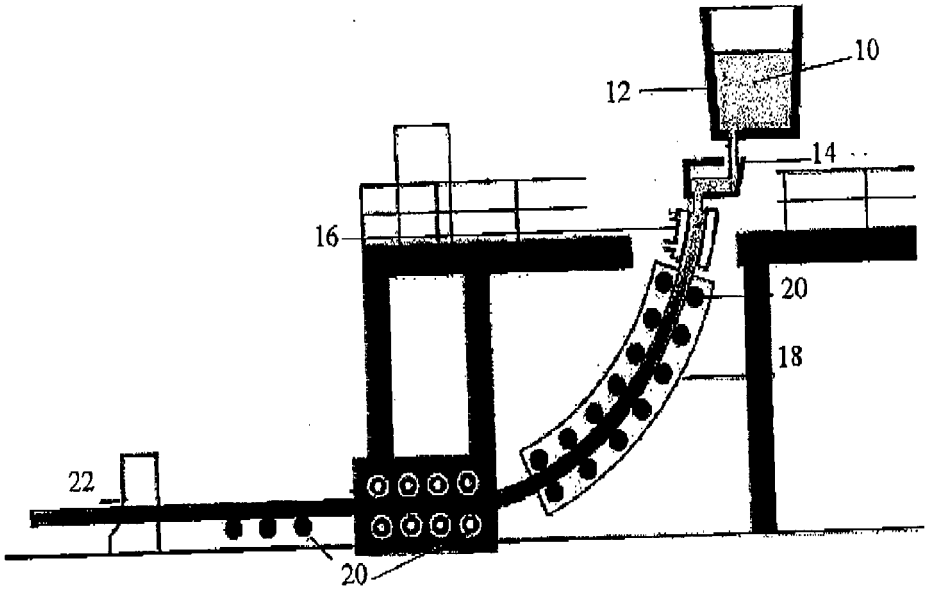

Fig. 1

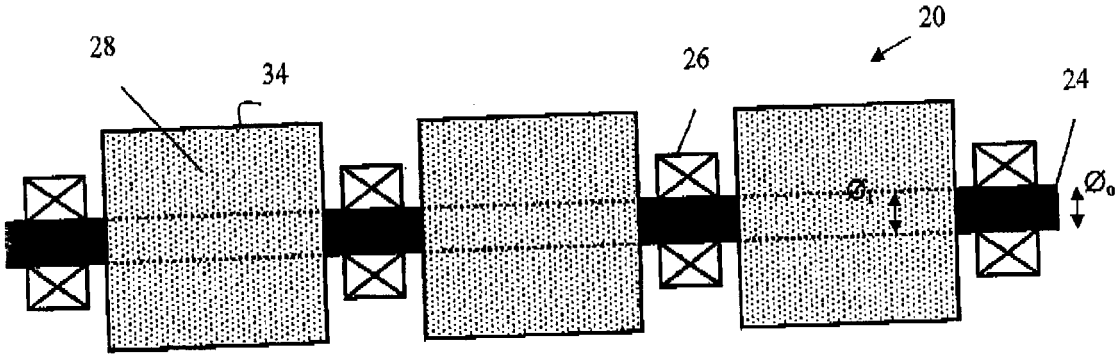

Fig. 2

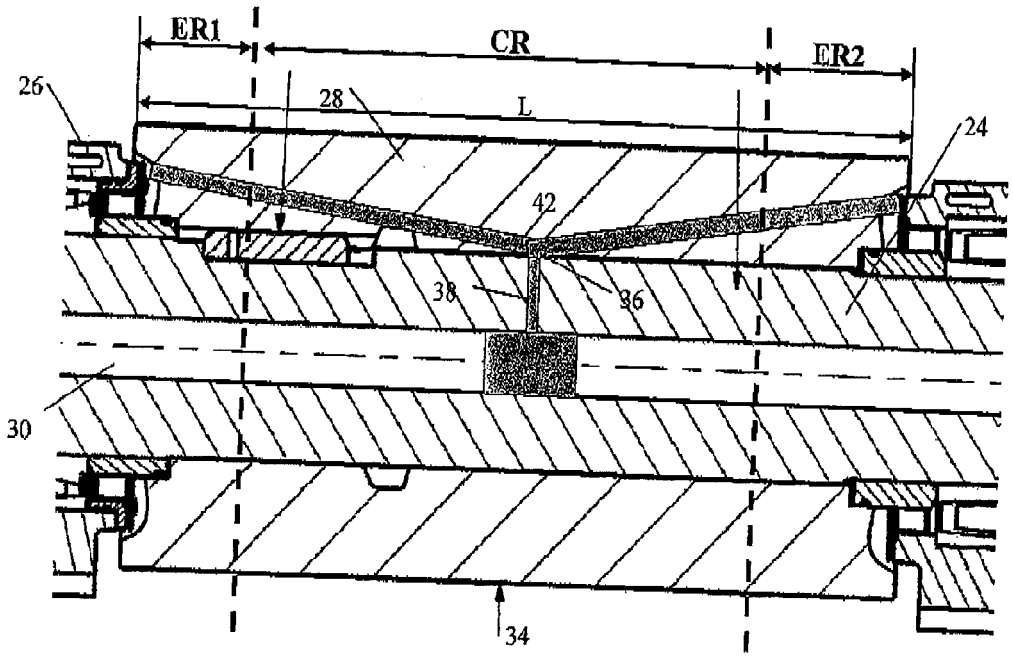

Fig. 3

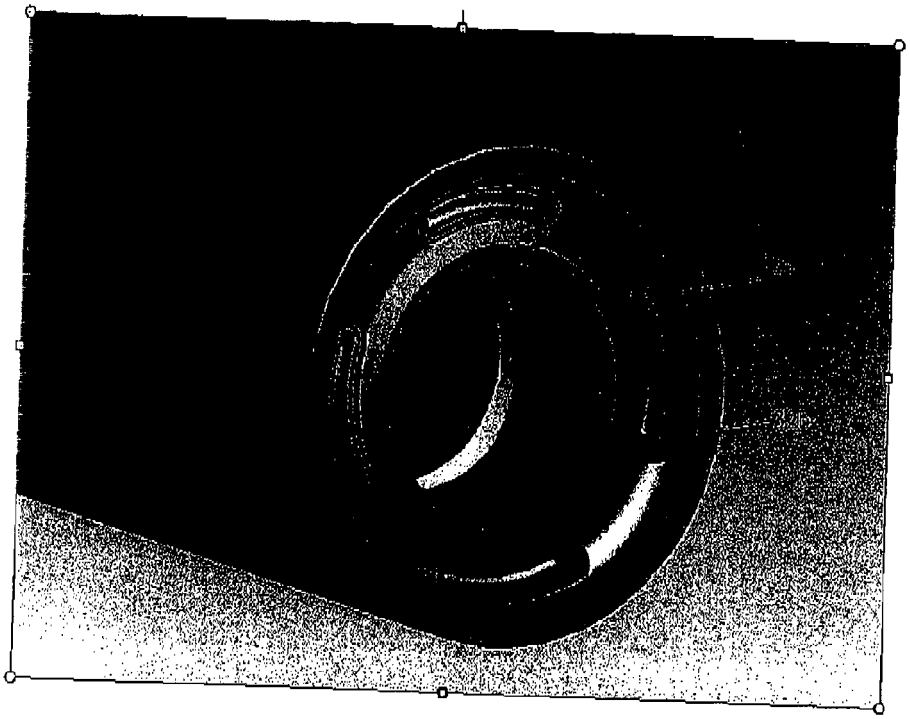

Fig. 4

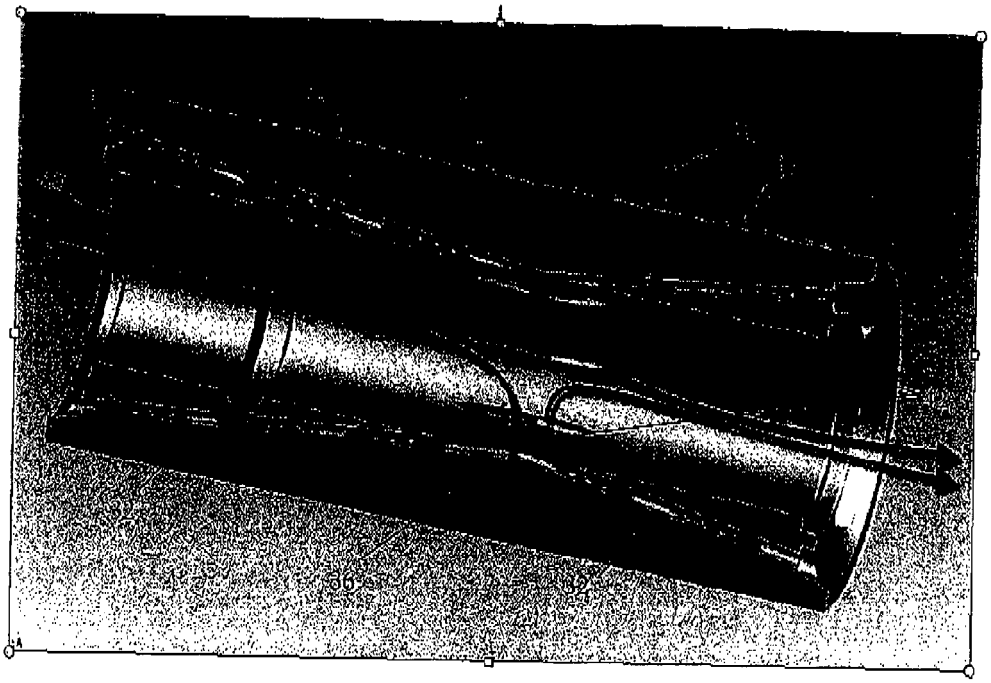

Fig. 5

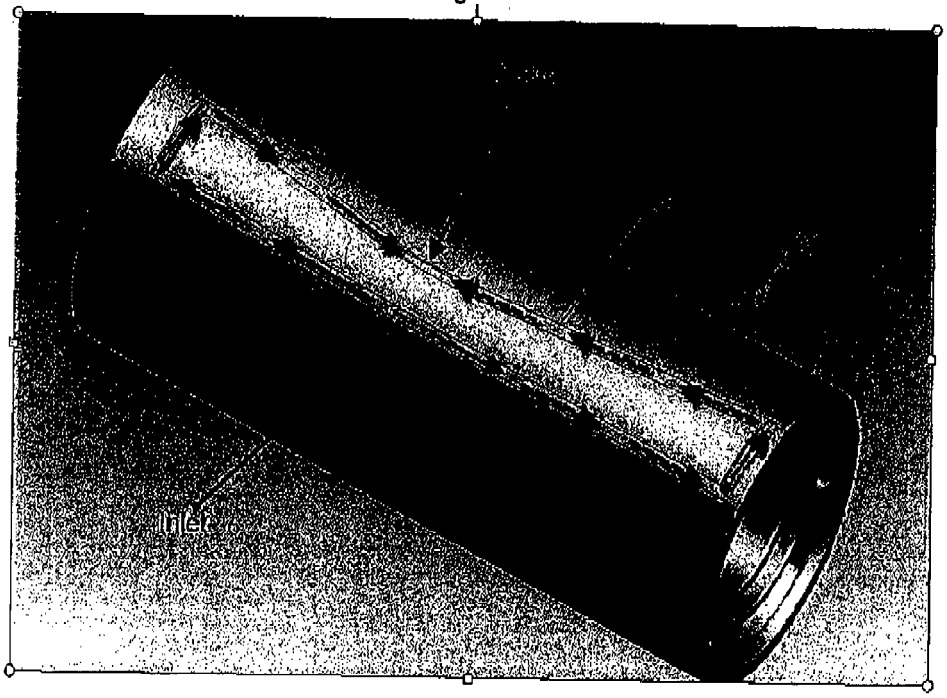

Fig. 6

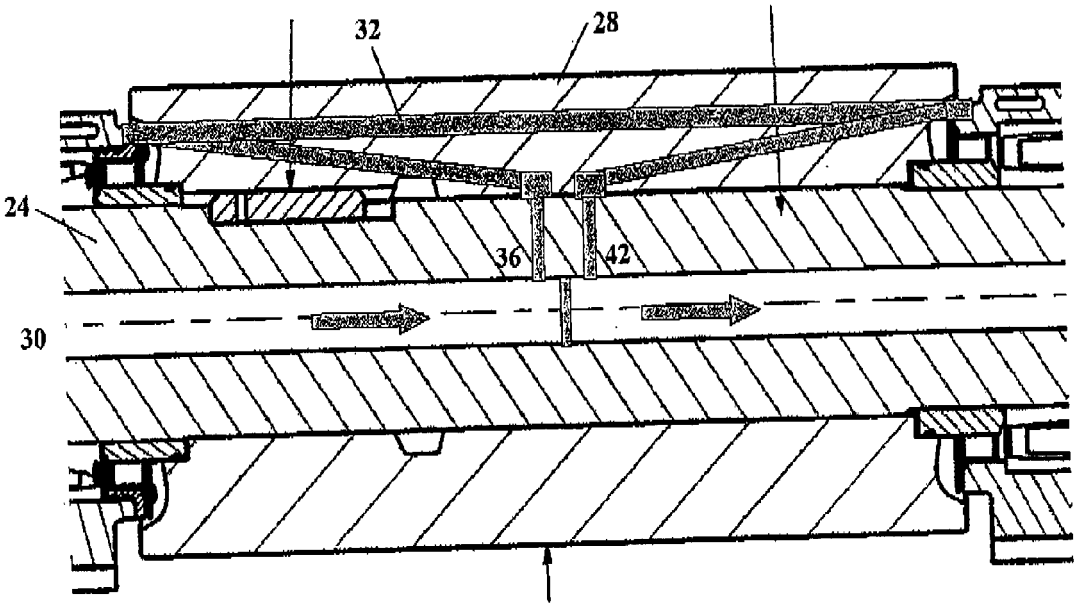

Fig. 7

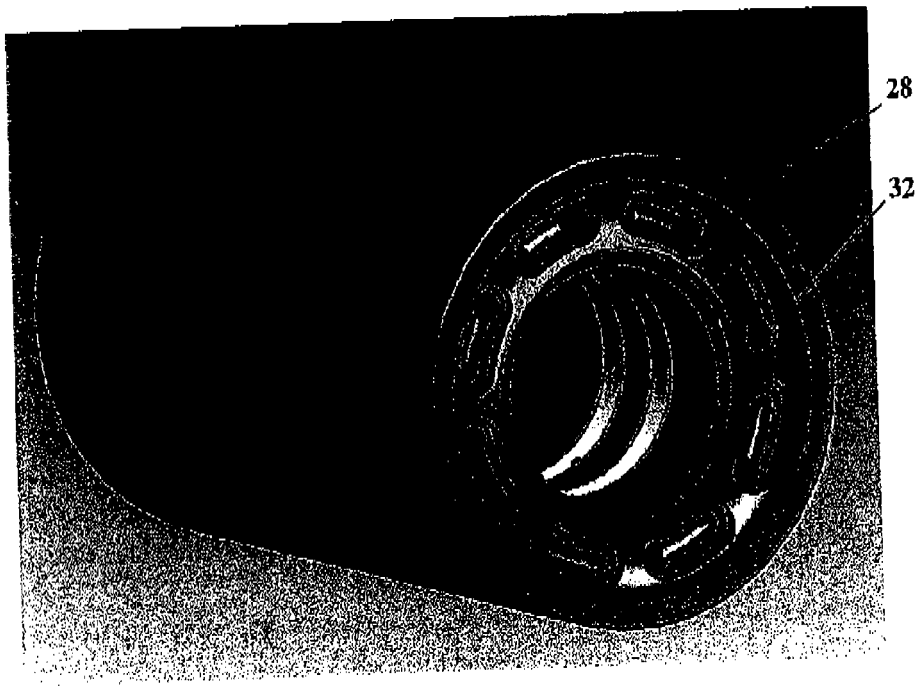

Fig. 8

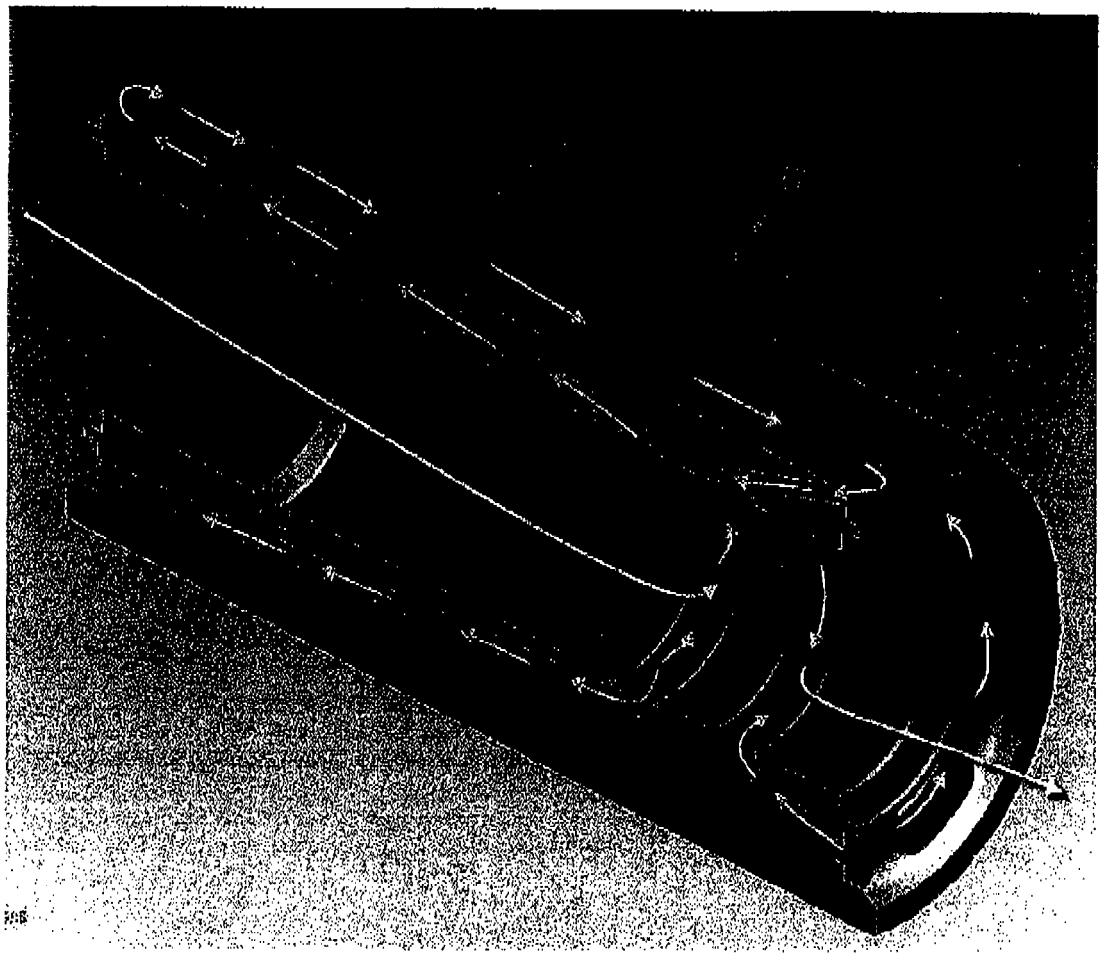

Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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