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(72) Inventors:
• **Gulati, Prarthana**
110034 Delhi (IN)
• **Singh, Paramdeep**
110058 Delhi (IN)

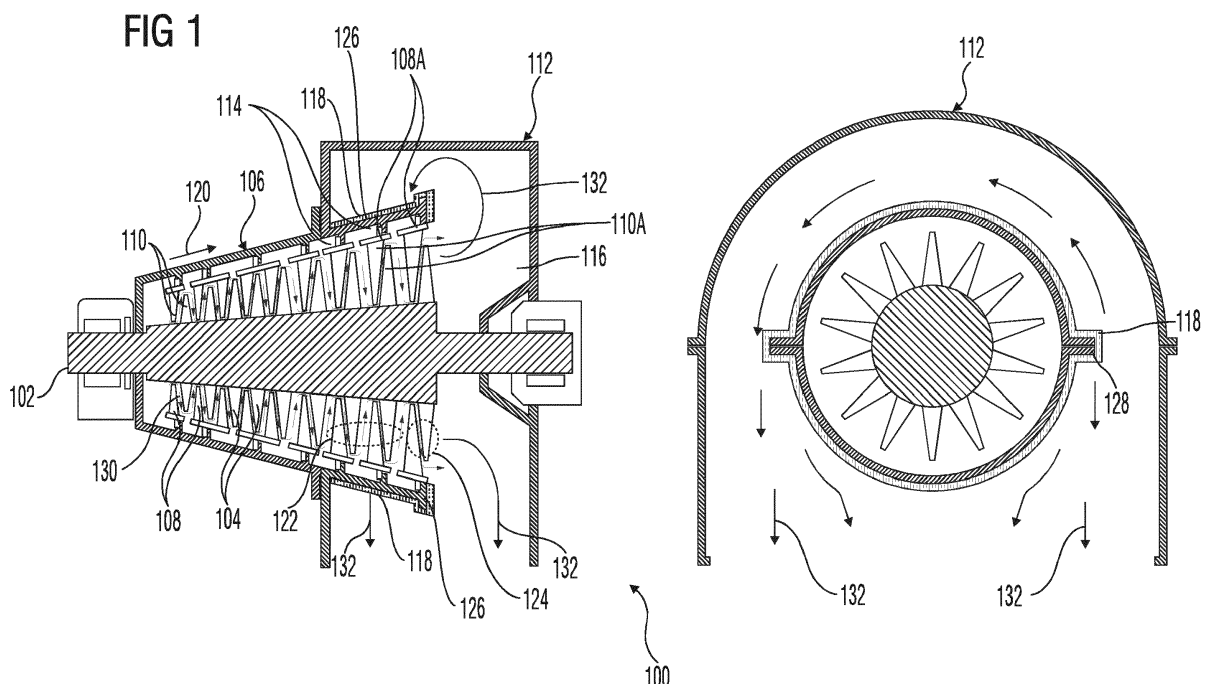
(71) Applicant: **Siemens Aktiengesellschaft**
80333 München (DE)

(74) Representative: **Patentanwaltskanzlei WILHELM & BECK**
Prinzenstraße 13
80639 München (DE)

(54) **Steam turbine with an improved exhaust casing**

(57) The present invention relates to a steam turbine (100) with an improved exhaust casing (112). In one embodiment, the steam turbine (100) comprises a rotor (102) fitted with moving blades (104). The steam turbine (100) comprises an exhaust casing (112) enclosing a portion of the rotor (102) and stationary blades (108A) which form one or more blade stages (110A) with one or more of the moving blades (104) fitted on the portion of the

rotor (102). The exhaust casing (112) comprises a first chamber (114) in communication with hot portion of blade stages (122), and a second chamber (116) connected to cold portion of blade stages (124) that is in direction of steam flow (120) and arranged after the hot portion of blade stages (122). The exhaust casing (112) is provided with an insulation means (118) for thermally insulating the first chamber (114) from the second chamber (116).



Description

[0001] The present invention generally relates to the field of steam turbines, and more particularly relates to an exhaust casing for steam turbines.

[0002] Steam turbines are machines that are used to generate mechanical power from pressure energy of steam. Steam turbine essentially comprises a rotor, an inner casing, and an exhaust casing. The rotor is fitted with moving blades which are arranged in a plurality of rows in an axial direction. Similarly, stationary blades (also known as guide blades) are arranged on the inner casing in a plurality of rows. The inner casing encloses the rotor.

[0003] A pair of moving and stationary blades forms a blade stage. Thus, a steam turbine is comprised of a number of blade stages. The number of blade stages forms a steam flow path in an axial direction.

[0004] The exhaust casing is connected to the inner casing and houses a portion of the rotor towards the exhaust end of the steam turbine. The exhaust casing is provided with one or more stationary blades which form blade stages (sometimes referred to as low pressure stages) with the moving blades fitted on the portion of the rotor. The exhaust casing is divided into a first chamber and a second chamber via a partition wall (e.g., having thickness of 25 to 30 mm). The first chamber is in communication with hot portion of blade stages while the second chamber is in communication with cold portion of blade stages. The cold portion of blade stages is in direction of steam flow and arranged after the hot portion of blade stages. The hot portion of blade stages refers to blade stage(s) which are in communication with high temperature steam flowing in the axial direction towards the exhaust end of the steam turbine. The cold portion of blade stages refers to a final blade stage(s) among the one or more blade stages through which low temperature steam, particularly wet steam, is exhausted into the second chamber.

[0005] During operation of the steam turbine, steam generally flows along the steam flow path in the axial direction from inlet to exhaust. As the steam travels along the steam flow path, the steam does work on the moving blades fitted on the rotor, thereby rotating the rotor of the steam turbine. Due to this, temperature and pressure of the steam gradually reduces as the steam flows towards the exhaust end.

[0006] In the exhaust casing, the steam flows through the hot portion of blade stages. During this phase, the first chamber is in communication with the flowing steam. The steam continues to flow along the steam flow path while doing additional work on the moving blades and finally get exhausted through the cold portion of blade stages into the second chamber for flow to a condenser.

[0007] Normally, temperature of the steam in communication with the first chamber is higher than the temperature of the steam exhausted into the second chamber. Due to difference in temperature, heat transfer takes

place from the first chamber to the second chamber. Consequently, the temperature of the steam which is in communication with the first chamber undergoes heat loss and as a result wetness is introduced in the steam. This may lead to erosion of blades in the blade stages. Further, the wetness in the steam may affect efficiency of the steam turbine. Also, temperature of the steam in communication with the second chamber increases due to heat transfer from the first chamber. Hence, condenser is required to do extra work to condense the exhausted steam. As a result, the efficiency of the condenser is affected.

[0008] Additionally, due to temperature difference across the first chamber and the second chamber, temperature across a horizontal flange connecting two halves of the exhaust casing may vary in the range of 40 to 100 degree centigrade, resulting in opening at joints.

[0009] In light of the foregoing, there is a need for a steam turbine with an improved exhaust casing such that heat transfer across different chambers of the exhaust casing is minimized.

[0010] Therefore, it is the object of the present invention to provide a steam turbine comprising an improved exhaust casing provided with an insulation means for thermally insulating the different chambers.

[0011] The object of the present invention is achieved by a steam turbine employing an improved exhaust casing. The steam turbine comprises an exhaust casing which encloses a plurality of stationary blades and a portion of a rotor fitted with a plurality of moving blades. The moving blades and the stationary blades together form blade stages along a steam flow path. The blade stages are classified as a hot portion of blade stages and a cold portion of blade stages. The hot portion of blade stages comprises one or more blade stages which are in communication with high temperature steam flowing along the steam flow path. The one or more blade stages can be any blade stages other than the final blade stage(s). The cold portion of blade stages comprises at least last blade stage among the blade stages through which low temperature steam is exhausted to flow into condenser(s). The cold portion of blade stages is in direction of steam flow and arranged after the hot portion of blade stages.

[0012] The exhaust casing comprises a first chamber which is in communication with the hot portion of blade stages and a second chamber which is connected to the cold portion of blade stages. The first chamber and the second chamber are separated by a partition. The exhaust casing is provided with an insulation means for thermally insulating the first chamber from the second chamber. Thus, the insulation means prevents the steam in communication with the first chamber from heat loss and hence no wetness is introduced in the steam.. Consequently, erosion of blades in the blade stages enclosed by the exhaust casing is significantly reduced. As a result, efficiency of the steam turbine is optimized by use of the insulation means. Additionally, efficiency of condenser

handling the exhausted steam is optimized as heat gain by the exhausted steam in the second chamber from the steam in the first chamber is prevented through use of the insulation means. The insulation means is made from material which can prevent heat transfer across the partition separating the first chamber and the second chamber. For example, the insulating means is made from material, such as a coating special acrylic resin blend with ceramic compounds, which can withstand high temperature (in the range of 100 to 200 degree centigrade) and resistant to erosion and moisture.

[0013] In one embodiment, the insulation means is arranged on one side of the partition which separates the first chamber from the second chamber. In another embodiment, the insulation means is arranged on other side of the partition. In yet another embodiment, the insulation means is arranged on both sides of the partition.

[0014] Therein, the insulation means is arranged on outer surface of horizontal flanges of the exhaust casing. Thus, the insulation means ensures that temperature difference across the horizontal flanges is minimal. Advantageously, uneven deformation and expansion of the horizontal flanges is eliminated, thereby ensuring proper contact closure at the horizontal flanges.

[0015] The above-mentioned and other features of the invention will now be addressed with reference to the accompanying drawings of the present invention. The illustrated embodiments are intended to illustrate, but not limit the invention.

[0016] The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1 illustrates a schematic representation of a steam turbine employing an improved exhaust casing according to one embodiment of the present invention.

FIG 2 illustrates a schematic representation of a steam turbine employing an improved exhaust casing according to another embodiment of the present invention.

[0017] Various embodiments are described with reference to the drawings, wherein like reference numerals are used to refer the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for the purpose of explanation, numerous specific details are set forth in order to provide thorough understanding of one or more embodiments. It may be evident that such embodiments may be practiced without these specific details.

[0018] FIG 1 illustrates a schematic representation of a steam turbine 100 employing an improved exhaust casing 112 according to one embodiment of the present invention. The steam turbine 100 comprises a rotor 102, an inner casing 106 and an exhaust casing 112. The inner casing 106 houses the rotor 102. The rotor 102 is

fitted with moving blades 104 arranged in a plurality of rows. Similarly, the inner casing 106 is provided with a stationary blades 108 arranged in a plurality of rows.

[0019] The moving blades 104 and the stationary blades 108 form a steam flow path in an axial direction. Each set of moving and stationary blades form a blade stage. Thus, the moving blades 104 and the stationary blades 108 forms plurality of blade stages 110 along the steam flow path 120.

[0020] The exhaust casing 112 is connected to the inner casing 106 towards the exhaust end of the steam turbine 100. The exhaust casing 112 houses a portion of the rotor 102. The exhaust casing 112 is provided with a set of stationary blades 108A which form one or more blade stages 110A with the set of moving blades 104 fitted on the portion of the rotor 102. Particularly, the one or more blade stages 110A constitute low pressure stages of the steam turbine 100.

[0021] For the ease of understanding, the blades stages 110A is classified as hot portion of blade stages 122 and cold portion of blade stages 124. The hot portion of blade stages 122 refers to blade stage(s) which are in communication with high temperature steam 130 flowing in direction of steam flow 120. The cold portion of blade stages 124 refers to final blade stage(s) among the one or more blade stages 110A through which low temperature steam 132, particularly wet steam, is exhausted. As can be seen, the cold portion of blade stages 124 is located in direction of steam flow 120 and arranged after the hot portion of blade stages 124.

[0022] The exhaust casing 112 comprises a first chamber 114, and a second chamber 116. The first chamber 114 is in communication with the hot portion of blades stages 122. In an exemplary implementation, the first chamber 114 is a chamber which houses the blade stages 110A. The second chamber 116 is connected to the cold portion of blade stages 124. In an exemplary implementation, the second chamber 116 is a chamber which guides the steam 132 exhausted through the cold portion of blade stages 124 to a condenser.

[0023] The first chamber 114 and the second chamber 116 are separated by a partition 126. An insulation means 118 is arranged on the partition 124. The insulation means 118 thermally insulates the first chamber 114 from the second chamber 116. In one embodiment, the insulation means 118 is arranged on outer surface of the partition 126. In another embodiment, the insulation means 118 is arranged on inner surface of the partition 125. In yet another embodiment, the insulation means 118 is arranged on both surfaces of the partition 126.

[0024] During operation of the steam turbine 100, high temperature and pressure steam 130 flows along the steam flow path 120 through the blades stages 110. Consequently, the high temperature and pressure steam 130 does work on the moving blades 104 fitted on the rotor 102. As a result, the rotor 102 rotates to generate rotational energy. The temperature and pressure of the steam 130 gradually decreases as the steam 130 flows

along the steam flow path towards the final blade stages (i.e., exhaust end).

[0025] Upon entering the exhaust casing 112, the steam 130 flows through the hot portion of blade stages 122. At this point, the first chamber 114 is in communication with the flowing steam 130 which then flows towards the cold portion of blade stages 124 and is finally exhausted into the second chamber 116. The temperature of the steam 130 at the hot portion of blades 122 is higher than temperature of steam 132 exiting the cold portion of blades 124. This is due to the fact that the temperature of the steam 130 gradually decreases as the steam 130 flows from the hot portion of blades 122 towards the cold portion of blades 124. Thus, at any instance during the operation of the steam turbine 100, the inner surface of the partition 126 is in communication with the high temperature steam 130 flowing through the hot portion of blade stages 122 while the outer surface of the partition 126 is in communication with the low temperature steam 132 exhausted through the cold portion of blade stages 124. Hence, there is possibility of heat transfer across the partition 126, i.e., from the first chamber 114 to the second chamber 116. According to the present invention, the insulation means 118 arranged on the partition 126 prevents heat transfer from the first chamber 114 to the second chamber 116. The insulation means 118 prevents heat loss from the steam 130 in the first chamber 114. Thus, no wetness is introduced in the steam 130 in communication with the blade stages 110A. Consequently, erosion of blades in the blade stages 110A is significantly reduced. As a result, efficiency of the steam turbine 100 is optimized. Also, efficiency of condenser handling the steam 132 is optimized as the steam 132 in the second chamber 116 does not undergo heat gain from the steam 130 in the first chamber 114.

[0026] In accordance with the foregoing description, the insulation means 118 is additionally disposed on surface of horizontal flanges 128 connecting upper portion and lower portion of the exhaust casing 118. The insulation means 118 ensures that temperature difference across the horizontal flanges 128 is minimal. Advantageously, uneven deformation and expansion of the horizontal flanges 128 is eliminated, thereby ensuring proper contact closure at the horizontal flanges 128. Thus, no special fastening means, such as bigger bolts and bottle bores, is required to ensure proper contact closure at the horizontal flanges 128.

[0027] The insulation means 118 is made from material which can prevent heat transfer across the partition 126 especially when temperature difference across the partition 126 is in the range of 100 to 200 degree centigrade. Also, the insulation means 118 is selected such that it is resistant to moisture and non-deteriorating. For example, the insulation means 118 may be a coating of special acrylic resin blend with ceramic compounds. The coating of 5mm to 10mm can be sprayed on the partition 126 to reduce heat losses from the first chamber 114 to the second chamber 116 by almost 80% to 90%. It can be noted

that, type and amount of the insulation means 118 may depend on the material used for making the exhaust casing 112.

[0028] FIG 2 illustrates a schematic representation of a steam turbine 200 employing an improved exhaust casing 202 according to another embodiment of the present invention. The steam turbine 200 of FIG 2 is similar to the steam turbine 100 of FIG 1 except the construction of the steam turbine 200 at the exhaust end. At the exhaust end of the steam turbine 200, the exhaust casing 202 houses the inner casing 106 carrying the stationary blades 108. The inner casing 106 is provided with an opening 204 at the hot portion of blade stages 122 so that the first chamber 114 is in communication with the hot portion of blade stages 122.

[0029] According to the present invention, the exhaust casing 112 comprises the insulation means 118 which thermally insulates the first chamber 114 from the second chamber 116. In an exemplary implementation, the insulation means 118 is arranged on at least one side of a partition which separates the first chamber 114 and the second chamber 118.

[0030] During operation of the steam turbine 200, certain amount of steam 130 flowing through the hot portion of blade stages 122 enters the first chamber 114 via the opening 204 in the inner casing 106. It is understood that, certain amount of steam 130 is extracted in the first chamber 114 for use in various industrial processes. The remaining steam 132 continues to flow along the steam flow path 120 towards the cold portion of blade stages 124 and is finally exhausted through the cold portion of blade stages 124 into the second chamber 116 for flow to condenser(s). The steam 132 exhausted into the second chamber 116 is having temperature lower than the steam 130 accumulated in the first chamber 114. Due to this, there is a possibility of heat transfer across the partition 126 which separates the first chamber 114 and the second chamber 116. However, the insulation means 118, arranged on the surface of the partition 126, prevents heat losses from the high temperature steam 130 in the first chamber 114 to the low temperature steam 132 in the second chamber 116. Advantageously, the high temperature steam 132 extracted in the first chamber 114 can be efficiently used for industrial purposes.

[0031] One skilled in the art would understand that the exhaust casing 112 may comprise more than one first chamber 114, wherein the steam 130 collected in such chambers is used for different industrial processes. At least one chamber may be located before low pressure blade stage of the steam turbine 200 and at least one chamber may be located after the low pressure blade stage of the steam turbine 200.

[0032] While the present invention has been described in detail with reference to certain embodiments, it should be appreciated that the present invention is not limited to those embodiments. In view of the present disclosure, many modifications and variations would be present themselves, to those skilled in the art without departing

from the scope of the various embodiments of the present invention, as described herein. The scope of the present invention is, therefore, indicated by the following claims rather than by the foregoing description. All changes, modifications, and variations coming within the meaning and range of equivalency of the claims are to be considered within their scope. 5

Claims 10

1. A steam turbine (100) comprising:

an exhaust casing (102) enclosing multiple blade stages (110A) arranged in an axial direction, wherein the exhaust casing (112) comprises a first chamber (114) which is in communication with a hot portion of blade stages (122), and a second chamber (116) which is connected to a cold portion of blade stages (124), wherein the cold portion of blade stages (124) is located in the direction of steam flow (120) and arranged after the hot portion of blade stages (122), **characterized by** an insulation means (118) for thermally insulating the first chamber (114) from the second chamber (116). 15 20 25

2. The steam turbine (100) according to claim 1, wherein the insulation means (118) is arranged on one side of a partition (126) which separates the first chamber (114) from the second chamber (116). 30

3. The steam turbine (100) according to claim 1, wherein the insulation means (118) is arranged on other side of a partition (126) which separates the first chamber (114) from the second chamber (116). 35

4. The steam turbine (100) according to claim 1, wherein the insulation means (118) is arranged on both sides of a partition (126) which separates the first chamber (114) from the second chamber (116). 40

5. The steam turbine (100) according to any of the preceding claims 1 to 4, wherein the insulation means (118) is arranged on outer surface of a horizontal flange (128) of the exhaust casing (112). 45

6. The steam turbine (100) according to any of the preceding claims 1 to 5, wherein the insulation means (118) is moisture resistant. 50

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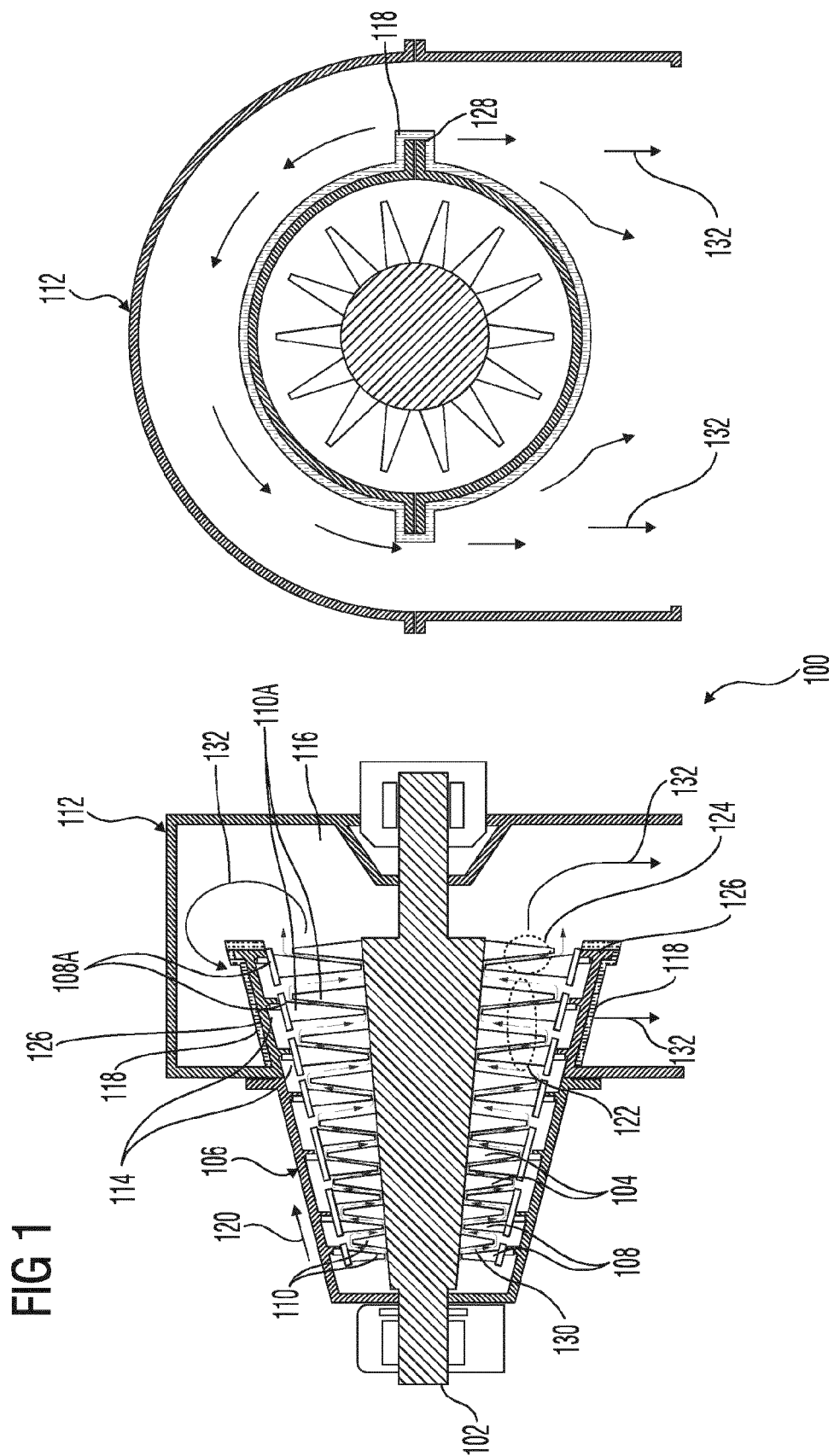
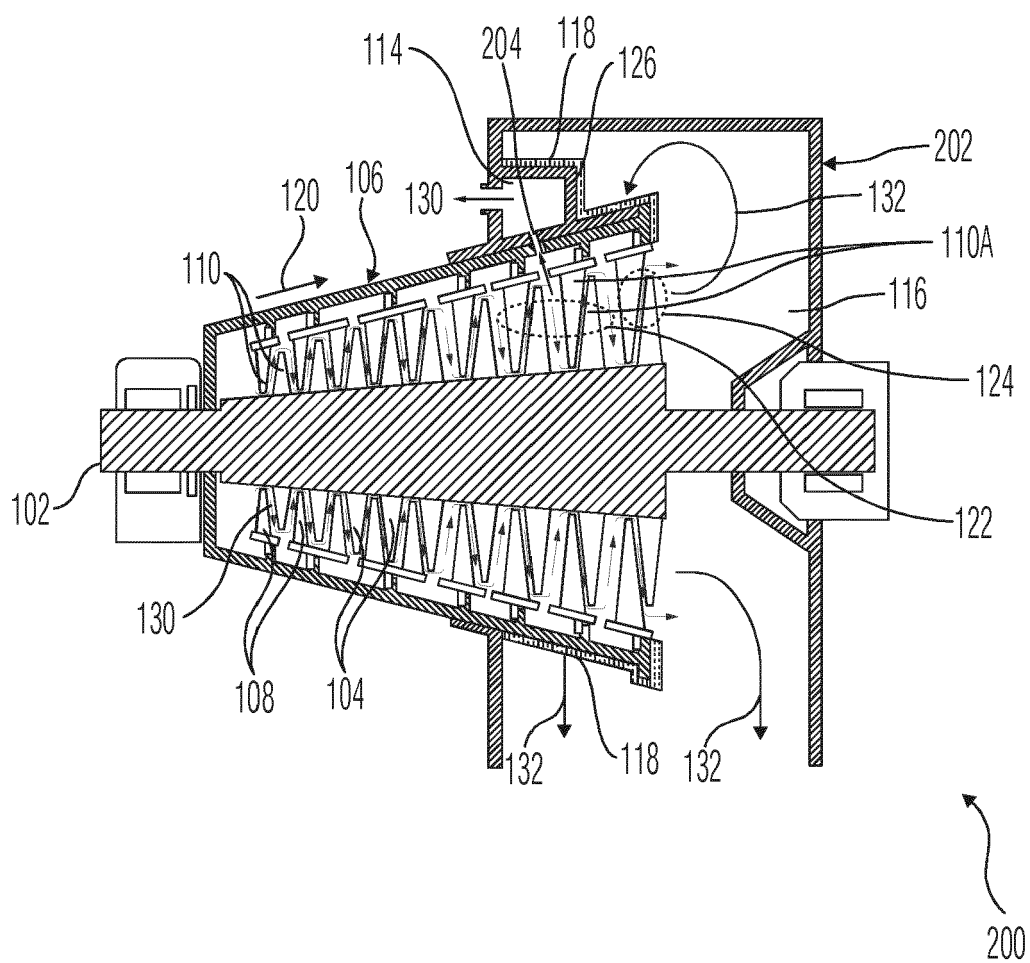


FIG 2





EUROPEAN SEARCH REPORT

Application Number
EP 14 17 2597

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Place of search Munich		Date of completion of the search 17 October 2014	Examiner Balice, Marco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 14 17 2597

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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