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- **KUMAR, Gaurav**
110070 New Delhi (IN)
- **PAUL, Sayantan**
110075 New Delhi (IN)
- **SHUKLA, Nidhi**
208017 Kanpur (IN)
- **SINGH, Paramdeep**
110058 Delhi (IN)

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

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

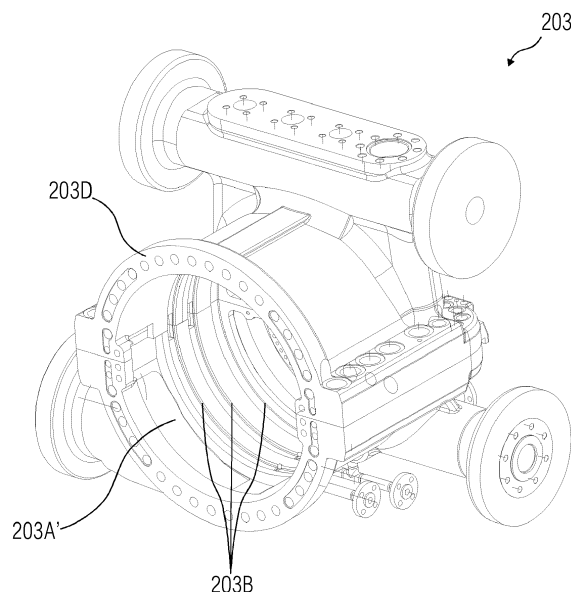
(72) Inventors:
• **KAKAR, Sukesh**
121004 Faridabad (IN)

(54) **STEAM TURBINE WITH STANDARDIZED CASING**

(57) A fluid power equipment (201, 202) having at least one stage (201A, 202A) comprising a plurality of blades and a plurality of nozzles, and a casing (203) accommodating the stages (201A, 202A) there-within is provided. The casing (203) is configured to have a machineable exhaust arrangement (203A) therein, machined based on a number of stages (201A, 202A) to be

accommodated in the casing and to direct a flow of exhaust mass from the casing (203) during operation of the fluid power equipment (201, 202). Thereby, enabling a common casing (203) of a fixed length useable for up to five stages (201A, 202A) of a fluid power equipment (201, 202).

FIG 3B



Description

[0001] The present invention relates to an exhaust arrangement for a fluid power equipment, such as, a steam turbine. More particularly the present invention relates to a casing of the fluid power equipment, having a customizable exhaust arrangement to accommodate variations in the steam path configuration, for example, a quantity of stages of the fluid power equipment.

[0002] FIG 1 illustrates an elevation view of an active part of a fluid power equipment 100, that is, a steam turbine, of the state of the art, as mentioned above. The steam turbine 100 of the state of the art, especially when designed for smaller power ranges, comprises a casing 101 carrying various stages of the turbine there-within in an area 101B of the casing 101, and at a rear end 101A of the fluid power equipment 100, an exhaust casing (not shown) is additionally attached to direct steam flow to a condenser (not shown) for condensing applications or to a customer supply (not shown) for backpressure applications. Conventional turbine casings 101 are designed to be of a standard length to avoid design variations which may lead to design delays and increase in manufacturing and fabrication costs. Fixed length casings 101 may be optimized based on thermodynamic properties to increase power output and improve performance as demanded by the application. Typically, a fixed length of the turbine casing 101 is determined considering maximum number of stages that are demanded on an average. In cases where the number of stage requirements is less, then there is an extra space indicated in FIG 1 by a distance of Y mm which is about 250 mm for smaller power applications, left in the configured fixed length turbine casing 101 leading to an over-designed equipment.

[0003] Moreover, longer the turbine casing 101, farther is the bearing centre, indicated in the FIG 1 by a distance of X mm which is about 300mm for smaller power applications. This in turn, requires larger sized rotors thereby posing challenges for rotor-dynamics due to increased flexibility of the rotor. This may lead to an overall increase in the costs and loss of business against competitors.

[0004] Therefore, it is an object of the present invention to provide a fluid power equipment of the aforementioned kind, which is cost effective and can be easily configured to accommodate various stage requirements.

[0005] The fluid power equipment disclosed in the present invention achieves the aforementioned object, in that the fluid power equipment comprises an exhaust arrangement machineable based on number of stages to be accommodated in the fluid power equipment.

[0006] According to the present invention, a fluid power equipment is provided. As used herein, "fluid power equipment" refers to an electro-mechanical device such as turbomachinery. The fluid power equipment disclosed herein is a steam turbine. Advantageously, the fluid power equipment is an industrial steam turbine and specifically a back-pressure turbine employed in facilities such as oil refineries, petrochemical industry, paper-pulp in-

dustry, fibre industry, food industry, etc., where large amounts of steam demand is prevalent. The fluid power equipment disclosed herein, includes at least one stage and a casing. The stages comprise multiple nozzles and blades. The casing accommodates the stages there-within.

[0007] The casing is configured to have a machineable exhaust arrangement. As used herein, the term "machineable" refers to an arrangement permitting removal of a material, for example, cutting of a metal. Also used herein, "exhaust arrangement" refers to a section of a wall of the casing which when machined from the casing, enables exhaust mass produced during operation of the fluid power equipment to flow there-through. The exhaust arrangement is configured to have a circular cross section. Advantageously, the exhaust arrangement, that is, the physical dimensions, are configured based on one or more fluid dynamics parameters associated with a fluid used in the fluid power equipment. The fluid dynamics parameters comprise, for example, a pressure of the fluid, a velocity of the fluid, and a volumetric flow of the fluid, etc. Upon configuration of the exhaust arrangement, the casing is configured so as to have an area defined by the exhaust arrangement marked on a wall of the casing. This enables the design engineers and other manufacturing personnel to identify the exhaust arrangement. The exhaust arrangement is machined based on a number of stages to be accommodated in the fluid power equipment. When the fluid power equipment is being designed for an application requiring up to three stages, then the exhaust arrangement is machined from the casing. Whereas, when the fluid power equipment is being designed for an application requiring more than three stages, then the exhaust arrangement is not machined. Thus, advantageously, the casing disclosed herein is configured as a common casing that can accommodate up to five stages of the fluid power equipment without requirement of re-designing of the casing. This is achieved due to the aforementioned exhaust arrangement. According to another embodiment of the present invention, the exhaust arrangement is configured as a bleed arrangement or an extraction arrangement within the fluid power equipment.

[0008] The fluid power equipment comprises a leakage prevention unit disposable against one of the faces of the casing. The leakage prevention unit maintains a direction of flow of exhaust mass generated by the fluid power equipment during operation of the fluid power equipment. The leakage prevention unit is configured as a seal, in the shapes comprising, for example, a lid, a plate, a pipe, etc. The leakage prevention unit, according to one embodiment, when disposed against the face of the casing, enables maximal flow of exhaust mass of the fluid power equipment via the machined exhaust arrangement. That is, when the fluid power equipment is having less than or equal to three stages, the leakage prevention unit is designed, for example, as a sealing plate, so as to direct the exhaust mass flow through the

exhaust arrangement. Whereas, when the fluid power equipment is having more than three stages, the leakage prevention unit is designed, for example, as an exhaust pipe, so as to direct the exhaust mass flow through itself into a condenser or to a supply for backpressure applications. The exhaust pipe in such cases is, for example, the exhaust casing used in backpressure type steam turbines or condensing type steam turbines. Thus, one or more physical dimensions of the leakage prevention unit are configured based on a number of stages to be accommodated in the fluid power equipment.

[0009] Also, disclosed herein, is a casing of a fluid power equipment, for example, a turbine casing, configurable to accommodate there-within at least one stage comprising multiple blades and nozzles. The casing comprises an exhaust arrangement. Advantageously, the exhaust arrangement enables the casing to be used for up to five stages with minimal machining and assembling. The exhaust arrangement is machined based on a number of the stages to be accommodated in the casing, for example, for up to three stages. The exhaust arrangement is configured based on one or more fluid dynamics parameters associated with a fluid used in the fluid power equipment, for example, a pressure of the fluid, a velocity of the fluid, and a volumetric flow of the fluid, etc.

[0010] 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.

[0011] The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

- FIG 1 illustrates an elevation view of an active part of a steam turbine, of the state of the art.
- FIGS 2A-2B illustrate elevation views of steam turbines, according to an embodiment of the present invention.
- FIGS 3A-3C illustrate perspective views of turbine casing for the steam turbines shown in FIGS 2A-2B, having a machineable exhaust arrangement, according to an embodiment of the present invention.
- FIGS 4A-4C illustrate a leakage prevention unit disposable against the turbine casing shown in FIGS 3A-3C, according to the present invention.

[0012] Various embodiments are described with reference to 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.

[0013] FIGS 2A-2B illustrate elevation views of steam turbines 201, 202, according to an embodiment of the present invention. FIG 2A illustrates a three-stage steam turbine 201. Each of the stages 201A of the three-stage steam turbine 201 comprise multiple blades and nozzles (not shown) accommodated within a turbine casing 203. FIG 2B illustrates a five-stage steam turbine 202. Each of the stages 201A of the five-stage steam turbine 202 are accommodated within the turbine casing 203. As seen in FIGS 2A and 2B, a common turbine casing 203 can be used to accommodate stages ranging from one to five. This stage accommodation variability using a fixed length turbine casing 203 is possible due to an exhaust arrangement 203A shown in FIG 2A and 2B. The exhaust arrangement 203A comprises a portion of the casing configured such that it can be machined, that is, removed if required. After removal of the portion, the machined exhaust arrangement 203A' shown in FIG 2A enables the turbine casing 203 to be used for a three-stage steam turbine 201. Whereas, if there are more than three stages 201A to be accommodated within the turbine casing 203 then the exhaust arrangement 203A is not machined, that is, not removed from the turbine casing 203. Thus, the same turbine casing 203 can be used for up to five stages of a steam turbine.

[0014] FIGS 3A-3C illustrate perspective views of turbine casing 203 for the steam turbines 201 and 202 having a machineable exhaust arrangement 203A shown in FIGS 2A-2B, according to an embodiment of the present invention. FIG 3A shows the turbine casing 203. Initially, the exhaust arrangement 203A is closed with an inner wall 203C of the turbine casing 203. On the inner wall 203C, multiple grooves 203B are machined, each configured to accommodate a turbine stage 201A therein, shown in FIG 2A. FIG 3B shows the turbine casing 203 with a machined exhaust arrangement 203A' as the turbine casing 203 is for a three-stage arrangement. In this case, a face 203D of the turbine casing 203 is configured so as to be operably coupled with a leakage prevention unit directing the exhaust mass of the steam turbine 201, 202 via the machined exhaust arrangement 203A' only. FIG 3C shows the turbine casing 203 having grooves 203B extended in number to accommodate five stages of the steam turbine 201, 202. In this case, the exhaust arrangement 203A is not machined out from the turbine casing 203 and the face 203D is sealed with help of a standard backpressure or condensing type exhaust casing directing the exhaust mass flow via the exhaust casing.

[0015] FIGS 4A-4C illustrate a leakage prevention unit 401, 402, and 403 disposable against the turbine casing 203 shown in FIGS 3A-3C, according to the present invention. FIG 4A shows a leakage prevention unit 401 configured as a circular plate. A face 401A of the plate operably couples with the face 203D of the turbine casing

203 shown in FIG 3B to enable the exhaust mass to flow through the machined exhaust arrangement 203A'. FIGS 4B and 4C show leakage prevention units 402 and 403 respectively configured such that the faces 402A and 403A operably couple with the face 203D shown in FIG 3C. The leakage prevention units 402 and 403 are used for steam turbines having more than three stages, that is, when the exhaust arrangement 203A is not machined from the turbine casing 203. In these cases, the exhaust mass flows through the exhaust pipes 402B and 403B shown respectively in FIGS 4B and 4C.

[0016] The foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention disclosed herein. While the invention has been described with reference to various embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitation. Further, although the invention has been described herein with reference to particular means, materials, and embodiments, the invention is not intended to be limited to the particulars disclosed herein; rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may affect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects.

List of reference numerals

[0017]

100	fluid power equipment of state of the art
101	turbine casing of the state of the art
101A	rear end of the fluid power equipment of the state of the art
101B	area of the casing accommodating stages, of the state of the art
201, 202	fluid power equipment (steam turbines having three and five stages respectively)
201A, 202A	stages of the fluid power equipment/steam turbine
203	casing/turbine casing
203A	machineable exhaust arrangement
203A'	machined exhaust arrangement
203B	groove(s)/diaphragm groove accommodating stages there-within
203C	wall of the casing
203D	face of the casing
401	leakage prevention unit for fluid power equipment having less than or equal to 3 stages
402, 403	leakage prevention units/exhaust casings/exhaust pipes for fluid power equipment having more than 3 stages

401A	face of the leakage prevention unit 401
402A	face of the leakage prevention unit 402
402B	exhaust pipe of leakage prevention unit 402
5 403A	face of the leakage prevention unit 403
403B	exhaust pipe of leakage prevention unit 403

10 **Claims**

1. A fluid power equipment (201, 202) having:

- at least one stage (201A, 202A) comprising a plurality of blades and a plurality of nozzles;
- a casing (203) accommodating the at least one stage (201A, 202A) there-within;

characterized in that:

- the casing (203) is configured to have a machineable exhaust arrangement (203A).

2. The fluid power equipment (201, 202) according to claim 1, wherein the exhaust arrangement (203A) is machined based on a number of stages (201A, 202A) to be accommodated in the fluid power equipment (201, 202).

3. The fluid power equipment (201, 202) according to any one of the claims 1 and 2, wherein the exhaust arrangement (203A) is configured based on one or more fluid dynamics parameters associated with a fluid used in the fluid power equipment (201, 202), wherein the fluid dynamics parameters comprise a pressure of the fluid, a velocity of the fluid, and a volumetric flow of the fluid.

4. The fluid power equipment (201, 202) according to the claim 1, comprising a leakage prevention unit (401) disposable against one of the faces (203D) of the casing (203).

5. The fluid power equipment (201, 202) according to the claim 4, wherein the leakage prevention unit (401) when disposed against the face (203D) of the casing (203), enables maximal flow of exhaust mass of the fluid power equipment (201, 202) via the machined exhaust arrangement (203A').

6. The fluid power equipment (201, 202) according to any one of the claims 4 and 5, wherein one or more physical dimensions of the leakage prevention unit (401, 402, 403) are configured based on a number of stages (201A, 202A) to be accommodated in the fluid power equipment (201, 202).

7. The fluid power equipment (201,202) according to

any one of the previous claims is a steam turbine.

8. A casing (203) of a fluid power equipment (201, 202) configurable to accommodate there-within at least one stage (201A, 202A) comprising a plurality of blades and a plurality of nozzles, the casing (203) **characterized by** a machineable exhaust arrangement (203A). 5
9. The casing (203) according to the claim 8, wherein the exhaust arrangement (203A) is machined based on a number of stages (201A, 202A) to be accommodated in the casing (203). 10
10. The casing (203) according to any one of the claims 8 and 9, wherein the exhaust arrangement (203A) is configured based on one or more fluid dynamics parameters associated with a fluid used in the fluid power equipment (201, 202), wherein the fluid dynamics parameters comprise a pressure of the fluid, a velocity of the fluid, and a volumetric flow of the fluid. 15 20

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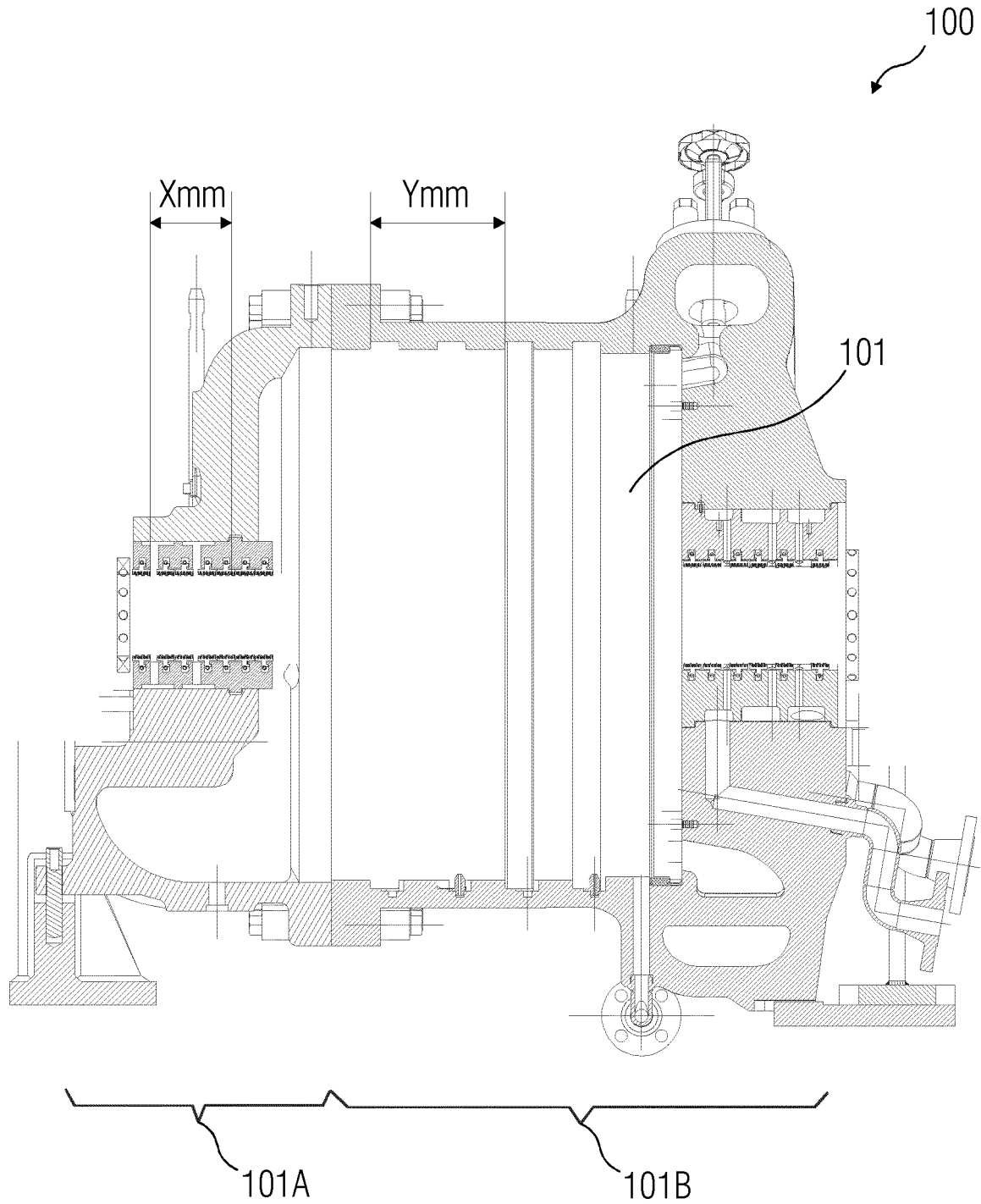
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FIG 1 (STATE OF THE ART)



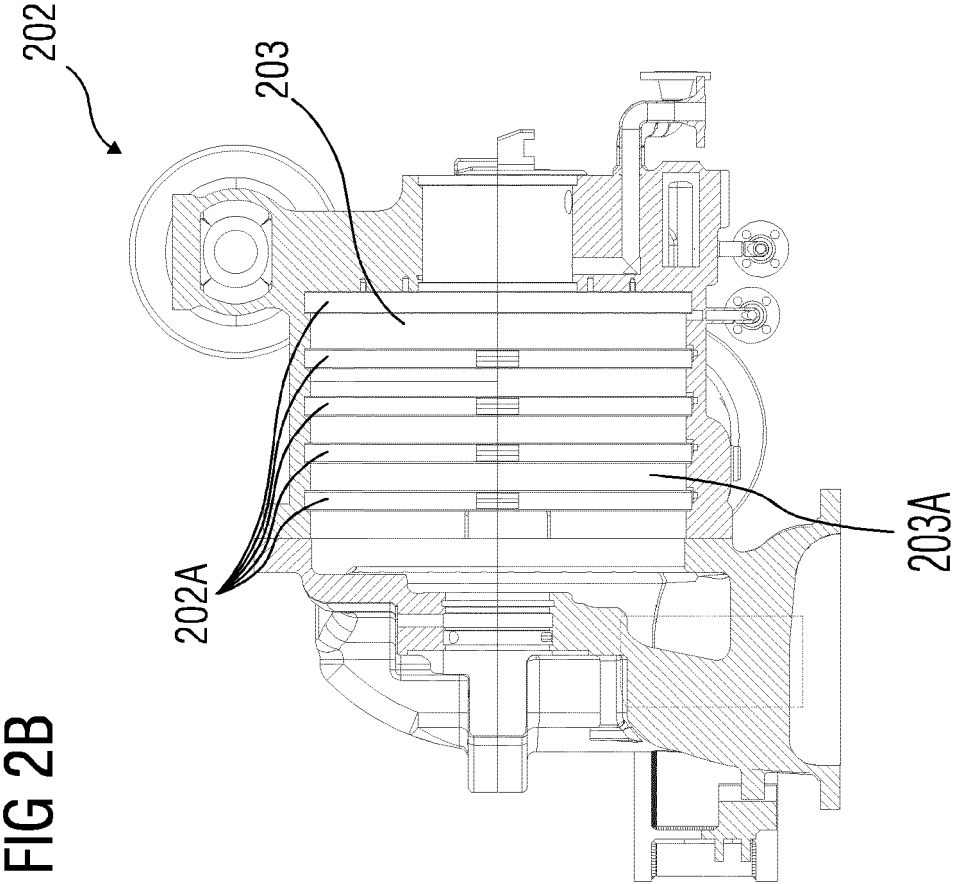
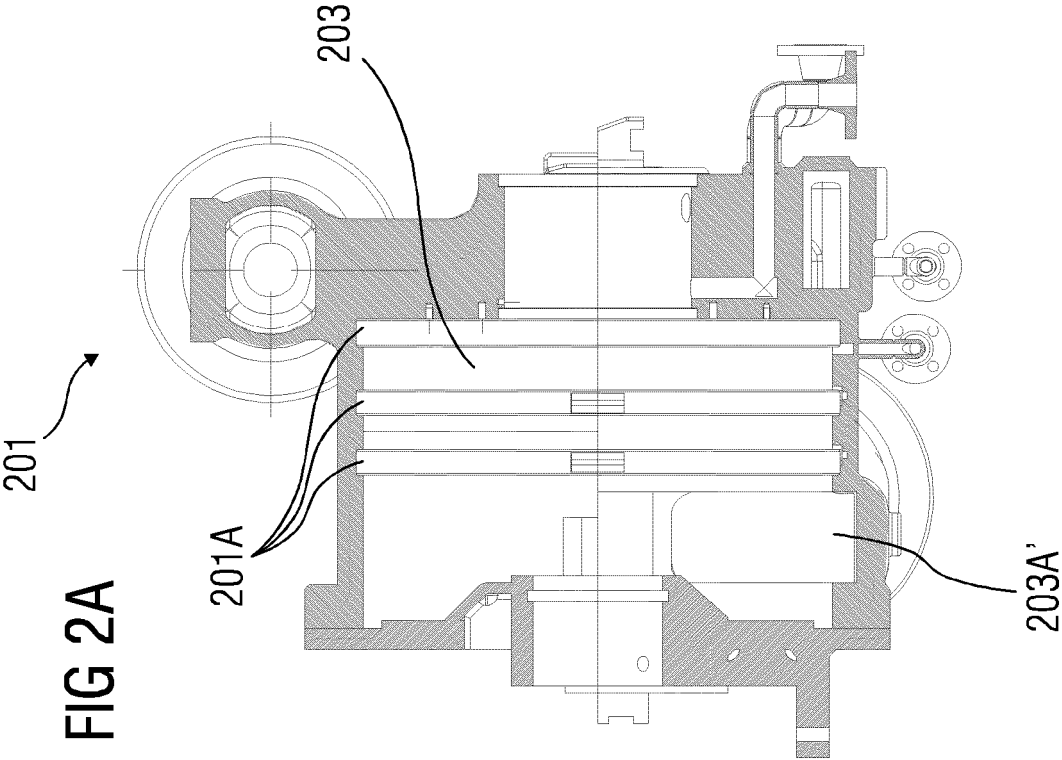


FIG 3A

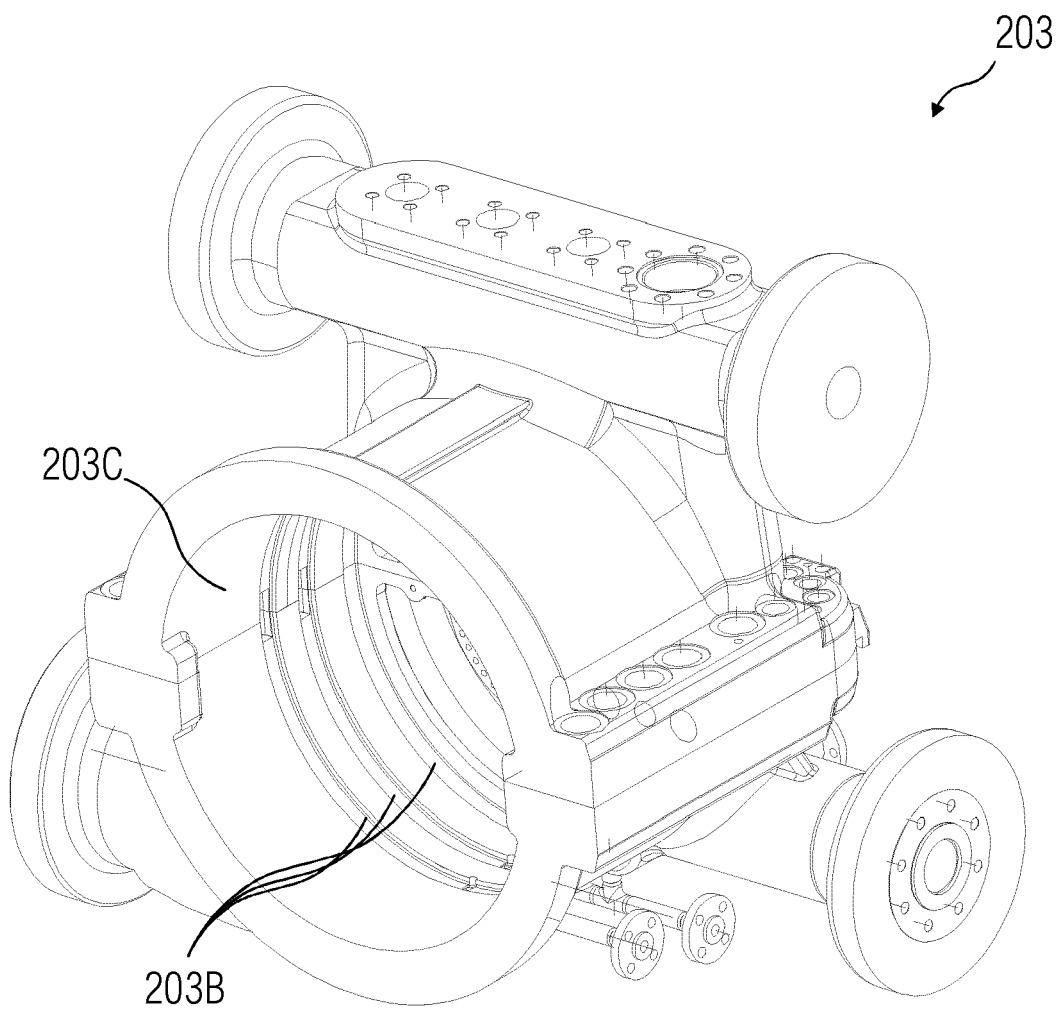


FIG 3B

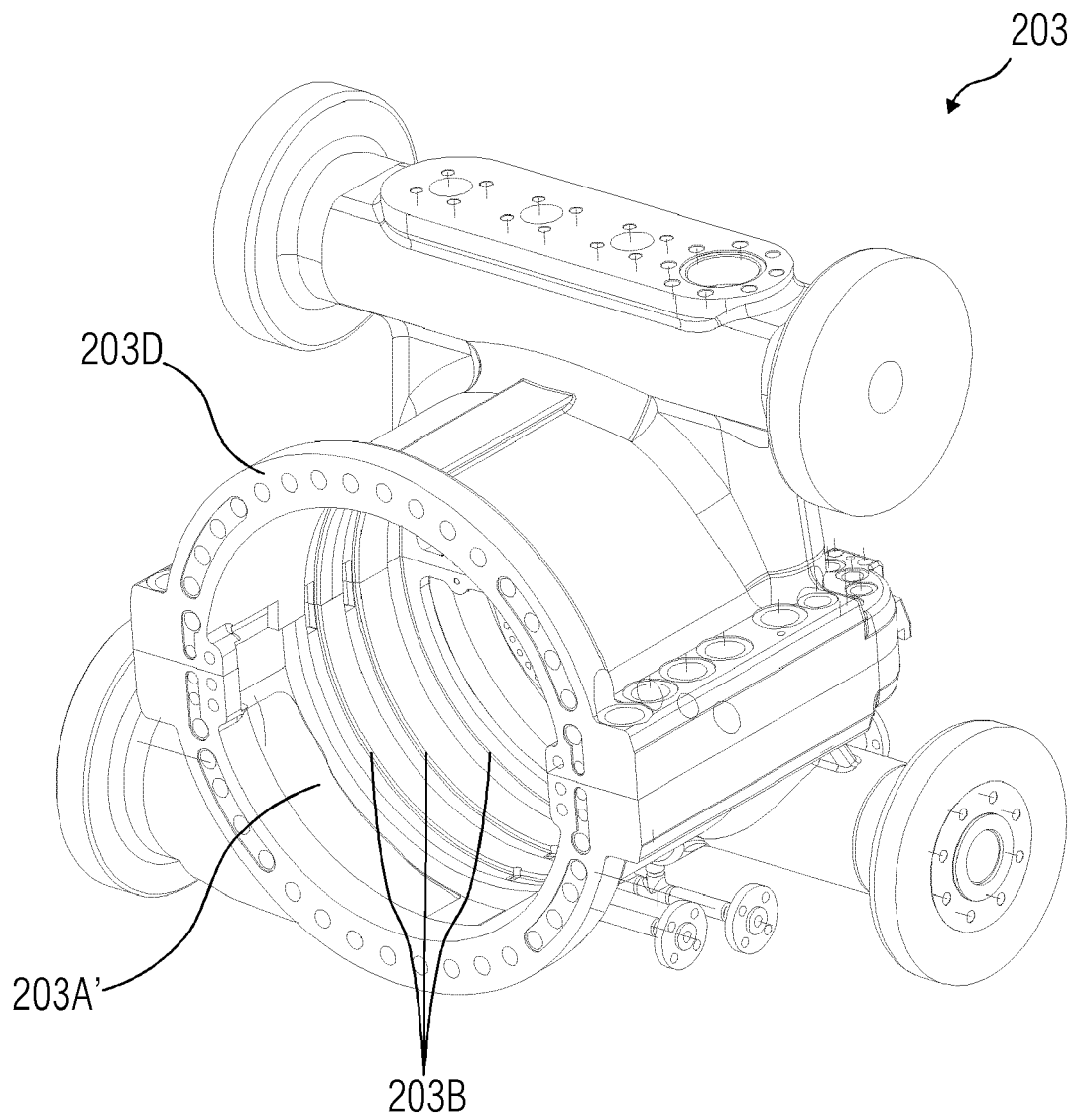


FIG 3C

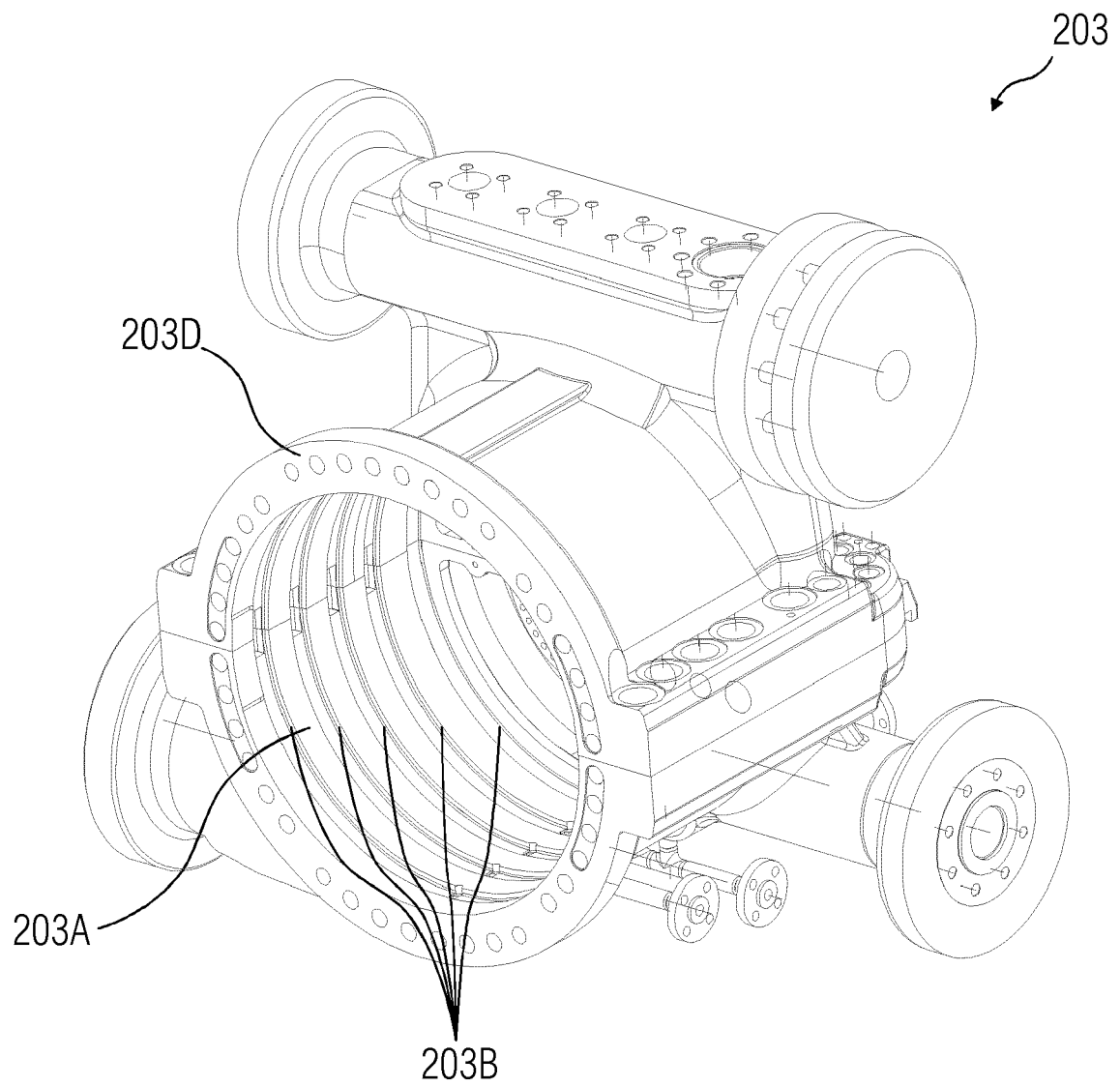


FIG 4A

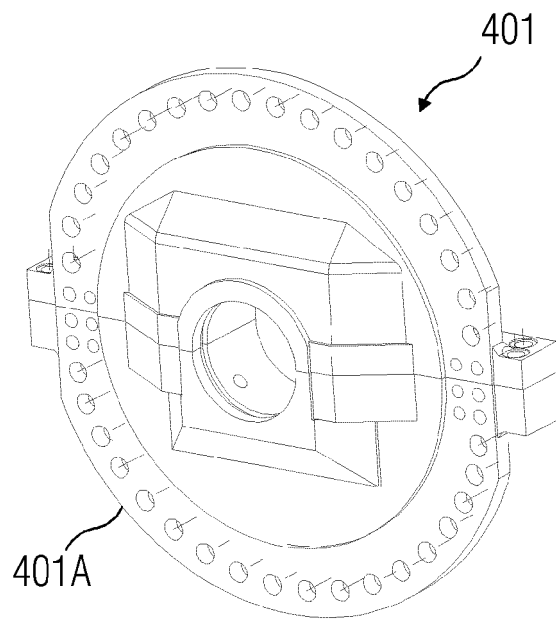


FIG 4B

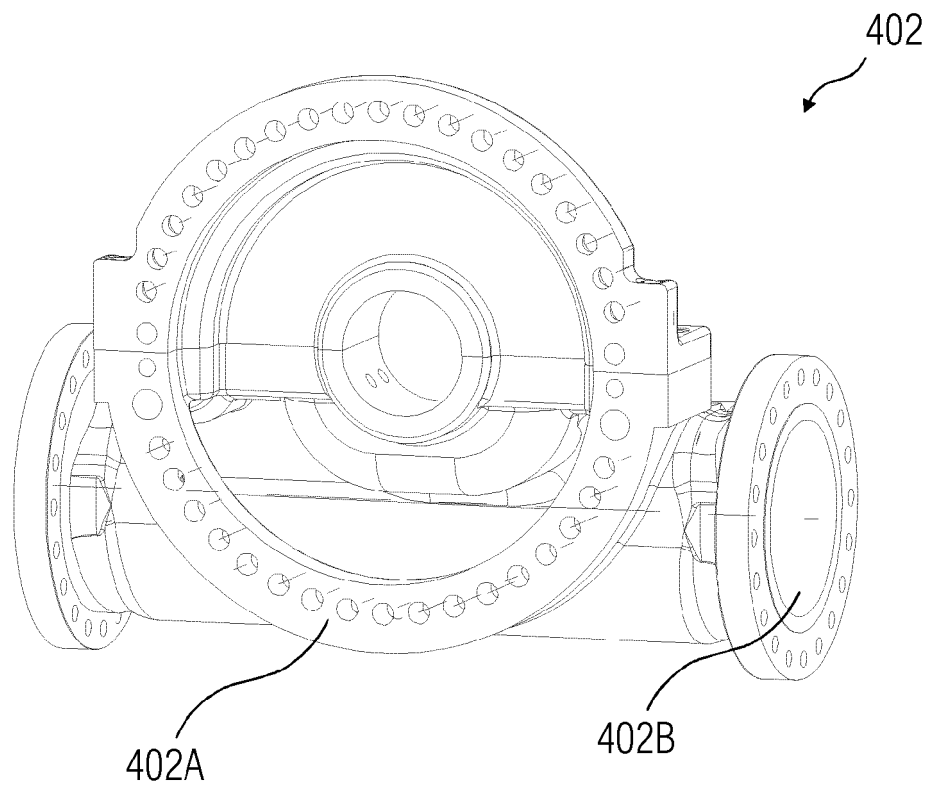
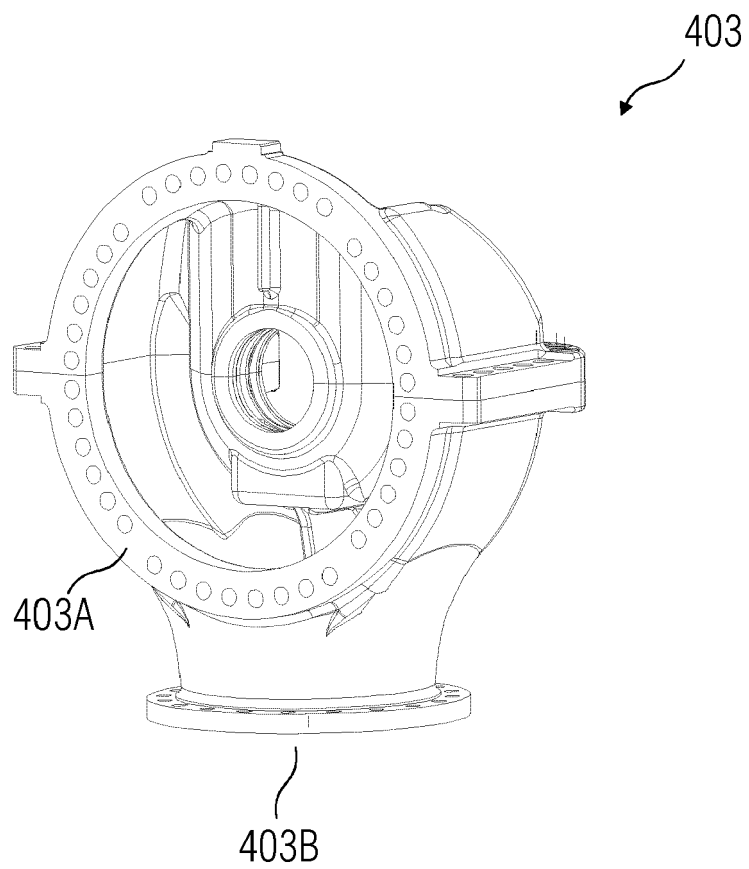


FIG 4C





EUROPEAN SEARCH REPORT

Application Number
EP 19 17 1955

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X	DE 44 25 352 A1 (ABB PATENT GMBH [DE]) 25 January 1996 (1996-01-25) * column 1, lines 27-46; figures 1-12 * * column 3, line 62 - column 4, line 36 * -----	1-10	INV. F01D25/26
X	WO 2008/023046 A1 (ALSTOM TECHNOLOGY LTD [CH]; LORD MARTIN ROBERT [GB] ET AL.) 28 February 2008 (2008-02-28) * page 6, line 18 - page 8, line 25; figures 1,2 * -----	1-10	
X	DE 197 08 273 C1 (SIEMENS AG [DE]) 30 April 1998 (1998-04-30) * column 1, line 43 - column 2, line 6; figures 1,2,3a,3b * -----	1-10	
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
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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			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 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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