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(54) STEAM TURBINE WITH STANDARDIZED CASING

DAMPFTURBINE MIT STANDARDISIERTEM GEHÄUSE

TURBINE À VAPEUR AVEC CARTER STANDARDISÉ

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Description

[0001] The present invention relates to a steam turbine adaptable to a differing number of blade/vane stages. . More particularly the present invention relates to a casing of the steam turbine having a customizable exhaust arrangement to accommodate variations in the quantity of stages of the steam turbine.

[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] From document DE 44 25 352 A1 a steam turbine with a casing manufactured in a casting process is known. From document WO 2008/023046 A1 a steam turbine designed to facilitate modification for operation with power plant incorporating carbon capture facilities is known. From document DE 197 08 273 C1 a turbine casing is known. From document US 2015/252681 A1 modular turbine machine inner and outer casings with multi stage steam extraction sites are known.

[0004] 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.

[0005] 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.

[0006] 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 the number of stages to be accommodated in the fluid power equipment.

[0007] According to the present invention, the fluid power equipment is a steam turbine with the features of claim 1. Advantageously, the steam turbine is an industrial steam turbine and specifically a back-pressure turbine employed in facilities such as oil refineries, petrochemical industry, paper-pulp industry, fibre industry, food industry, etc., where large amounts of steam demand is prevalent. The steam turbine includes a plurality of stages and a casing. The stages comprise multiple nozzles and blades. The casing accommodates the stages there-within.

[0008] 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.

[0009] 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 embodi-

ment, 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 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 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.

[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.

List of reference numerals

[0016]

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
403A	face of the leakage prevention unit 403
403B	exhaust pipe of leakage prevention unit 403

Claims

1. A steam turbine (201, 202) adaptable to a differing number of blade/vane stages and having:

- a plurality of stages (201A, 202A) comprising a plurality of blades and a plurality of nozzles;
a casing (203) accommodating the plurality of stages (201A, 202A) there-within and having an open end;
characterized in that:

if a number of the plurality of stages is larger than 3, the open end of the casing is provided with an exhaust pipe (402B, 403B) configured to direct the exhaust mass flow of the steam turbine into a condenser or to a supply for backpressure applications; and
if the number of the plurality of stages is smaller than or equal to 3, the casing is provided with a machined exhaust arrangement (203A') configured as a section of a wall of the casing (203) with removed material not accommodating any of the stages (201A, 202A), and wherein the open end of the casing is provided with a sealing plate (401) configured to direct the exhaust mass flow of the steam turbine through the machined exhaust arrangement (203A') only.

2. Steam turbine according to claim 1, wherein the exhaust arrangement (203A') is configured as a bleed arrangement.

3. Steam turbine according to claim 1, wherein the exhaust arrangement (203A') is configured as an extraction arrangement.

4. Steam turbine (201, 202) according to any one of the claims 1 to 3, wherein a maximum number of stages is 5.

Patentansprüche

1. Dampfturbine (201, 202), die an eine unterschiedliche Anzahl von Schaufel-/Leitschaufel-Stufen anpassbar ist und Folgendes aufweist:

- eine Vielzahl von Stufen (201A, 202A), die eine Vielzahl von Schaufeln und eine Vielzahl von Düsen umfassen;
ein Gehäuse (203), das die Vielzahl von Stufen (201A, 202A) darin aufnimmt und ein offenes Ende aufweist;
dadurch gekennzeichnet, dass:

wenn die Anzahl der Vielzahl von Stufen größer als 3 ist, das offene Ende des Gehäuses mit einem Abgasrohr (402B, 403B) versehen ist, das dazu ausgelegt ist, den Abgasmassenstrom der Dampfturbine in einen Kondensator oder zu einer Versorgung für Gegendruckanwendungen zu leiten; und
wenn die Anzahl der Vielzahl von Stufen kleiner oder gleich 3 ist, das Gehäuse mit einer bearbeiteten Abgasanordnung (203A') versehen ist, die als ein Abschnitt einer Wand des Gehäuses (203) mit entferntem Material ausgelegt ist, der keine der Stufen (201A, 202A) aufnimmt, und wobei das offene Ende des Gehäuses mit einer Dichtungsplatte (401) versehen ist, die dazu ausgelegt ist, den Abgasmassenstrom

der Dampfturbine nur durch die bearbeitete Abgasanordnung (203A') zu leiten.

2. Dampfturbine nach Anspruch 1, wobei die Abgasanordnung (203A') als Anzapfanordnung ausgelegt ist.

3. Dampfturbine nach Anspruch 1, wobei die Abgasanordnung (203A') als Entnahmeanordnung ausgelegt ist.

4. Dampfturbine (201, 202) nach einem der Ansprüche 1 bis 3, wobei eine maximale Anzahl von Stufen 5 beträgt.

Revendications

1. Turbine à vapeur (201, 202) adaptable à un nombre différent d'étages d'aubes/ailettes et ayant :

   - une pluralité d'étages (201A, 202A) comprenant une pluralité d'aubes et une pluralité de buses ;
   un carter (203) logeant la pluralité d'étages (201A, 202A) à l'intérieur de celui-ci et ayant une extrémité ouverte ;
   caractérisée en ce que :

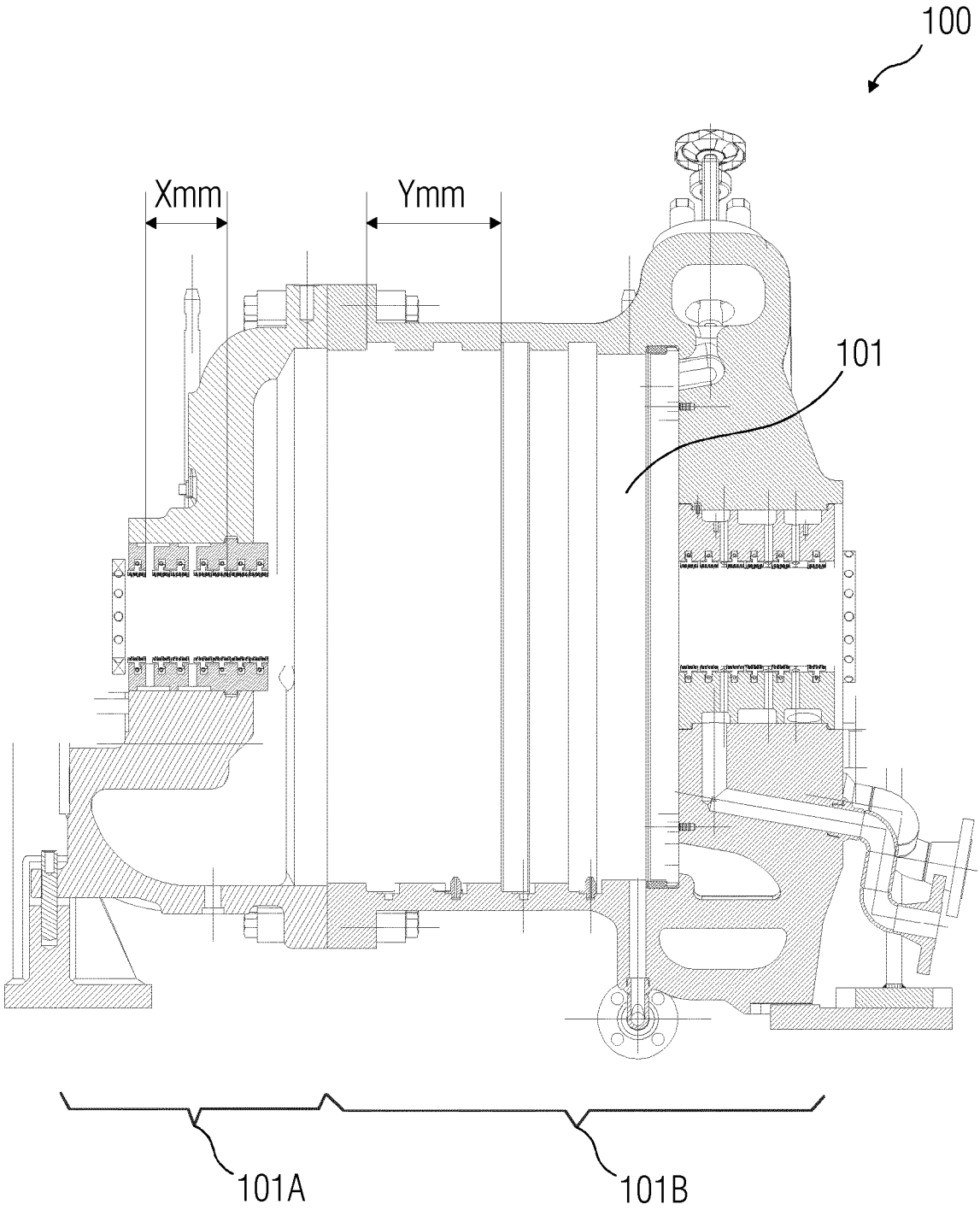
   si un nombre de la pluralité d'étages est supérieur à 3, l'extrémité ouverte du carter est pourvue d'un tuyau d'échappement (402B, 403B) configuré pour diriger le débit massique d'échappement de la turbine à vapeur dans un condenseur ou vers une alimentation pour des applications de contre-pression ; et
   si le nombre de la pluralité d'étages est inférieur ou égal à 3, le carter est pourvu d'un agencement d'échappement usiné (203A') configuré sous forme de section d'une paroi du carter (203) avec matériau enlevé ne logeant aucun des étages (201A, 202A), et dans laquelle l'extrémité ouverte du carter est pourvue d'une plaque d'étanchéité (401) configurée pour diriger le débit massique d'échappement de la turbine à vapeur à travers l'agencement d'échappement usiné (203A') seulement.

2. Turbine à vapeur selon la revendication 1, dans laquelle l'échappement arrangement (203A') est configuré sous forme d'agencement de purge.

3. Turbine à vapeur selon la revendication 1, dans laquelle l'échappement arrangement (203A') est configuré sous forme d'agencement d'extraction.

4. Turbine à vapeur (201, 202) selon l'une quelconque des revendications 1 à 3, dans laquelle un nombre maximum d'étages est de 5.

FIG 1 (STATE OF THE ART)



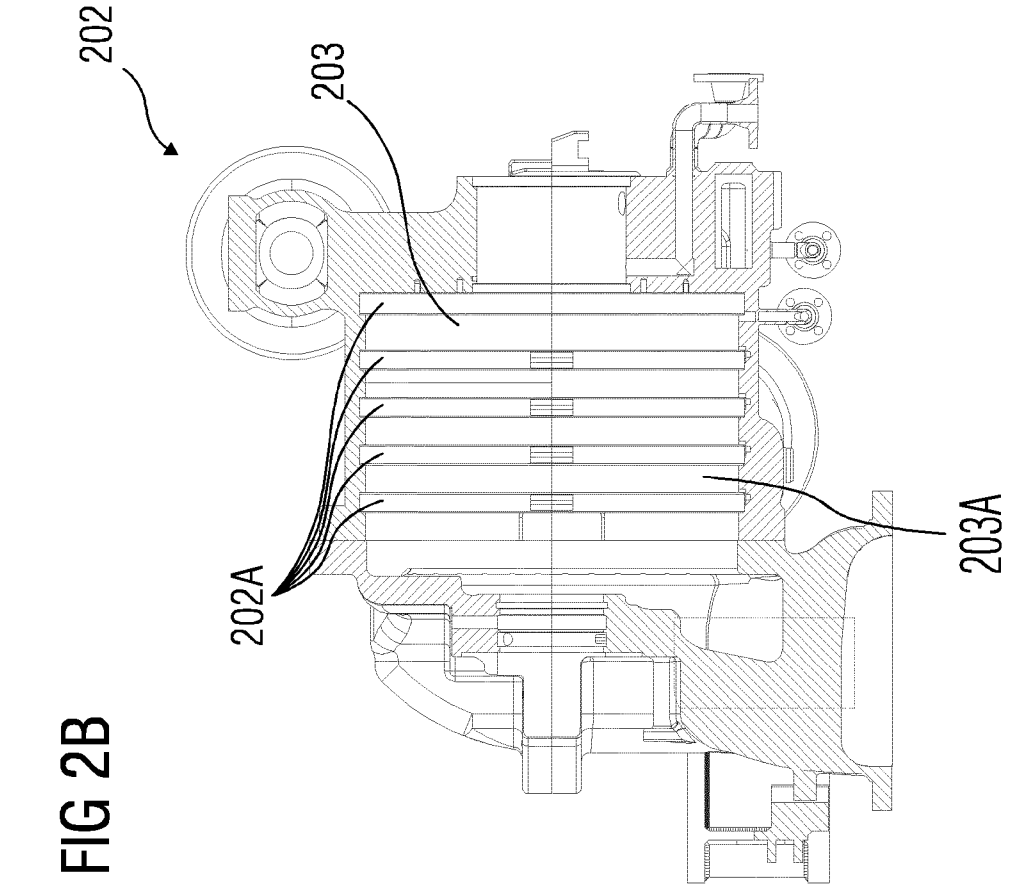


FIG 2B

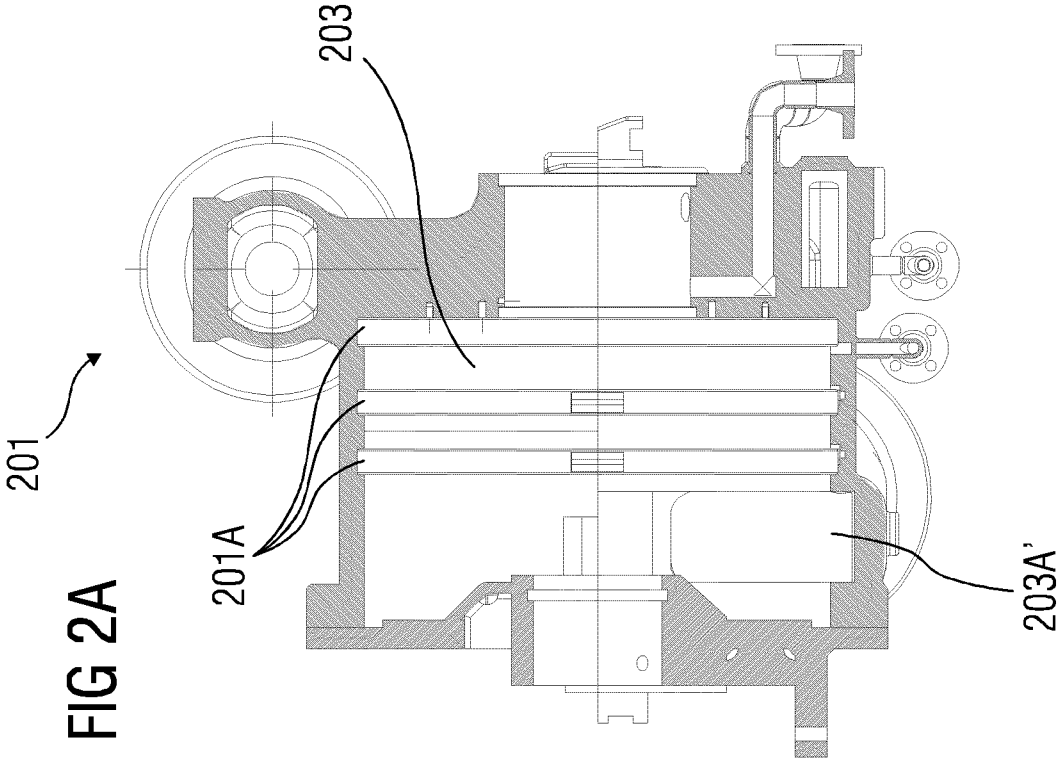


FIG 2A

FIG 3A

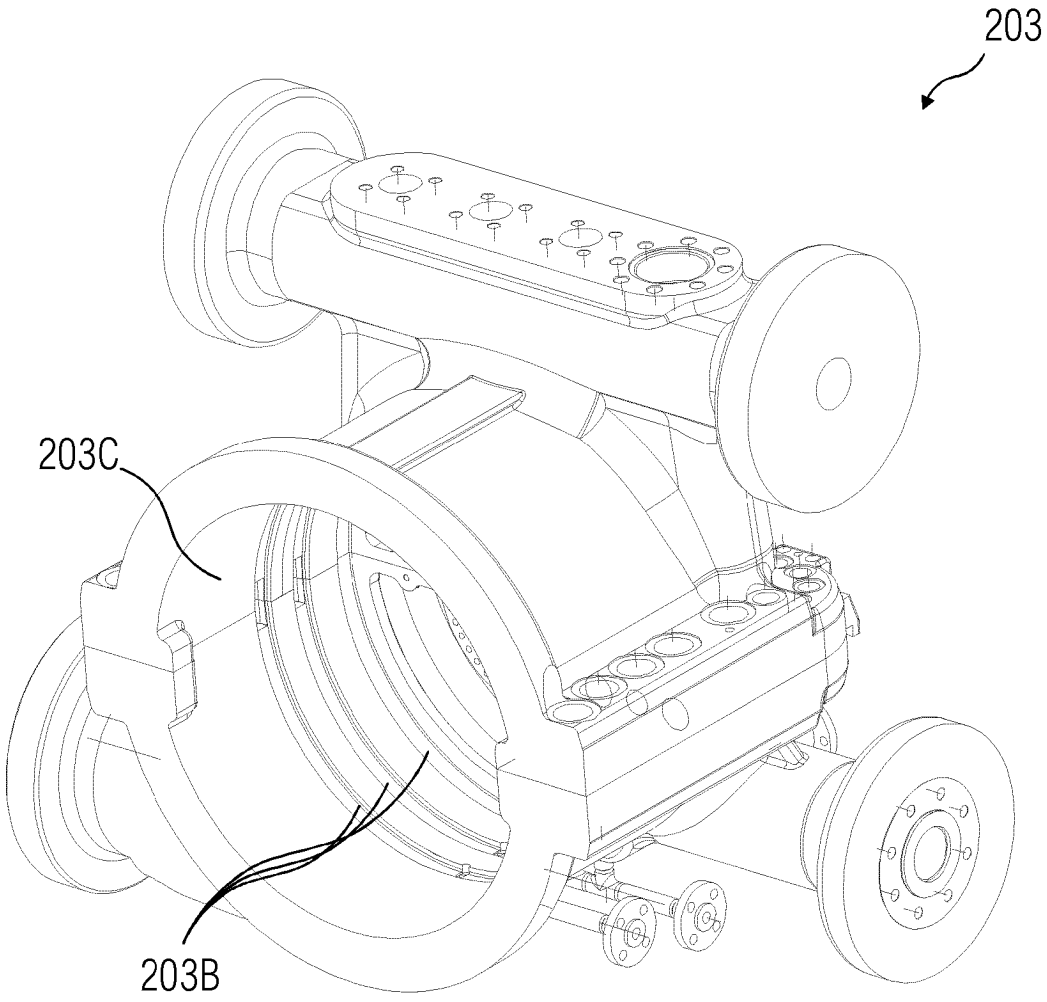


FIG 3B

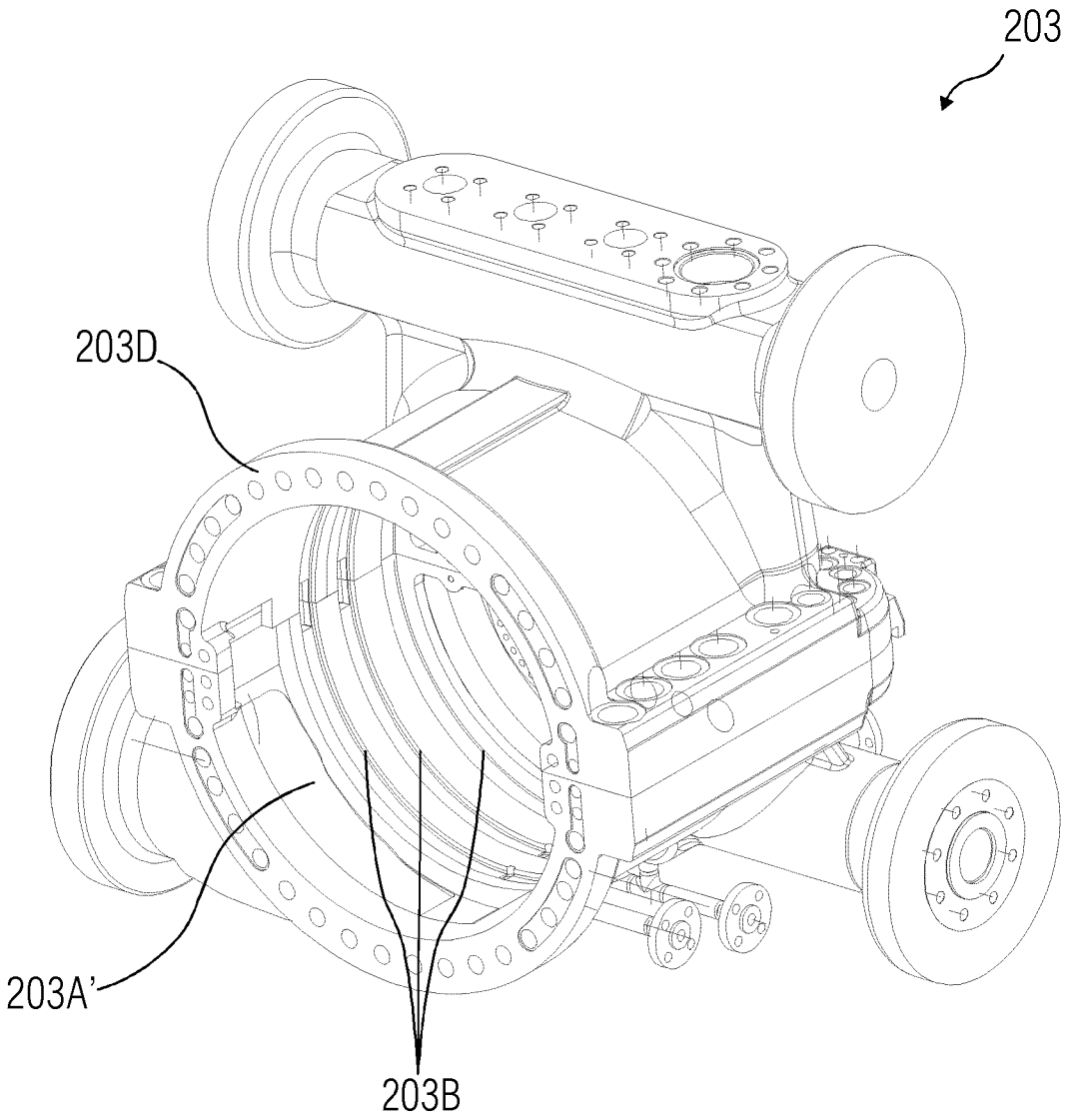


FIG 3C

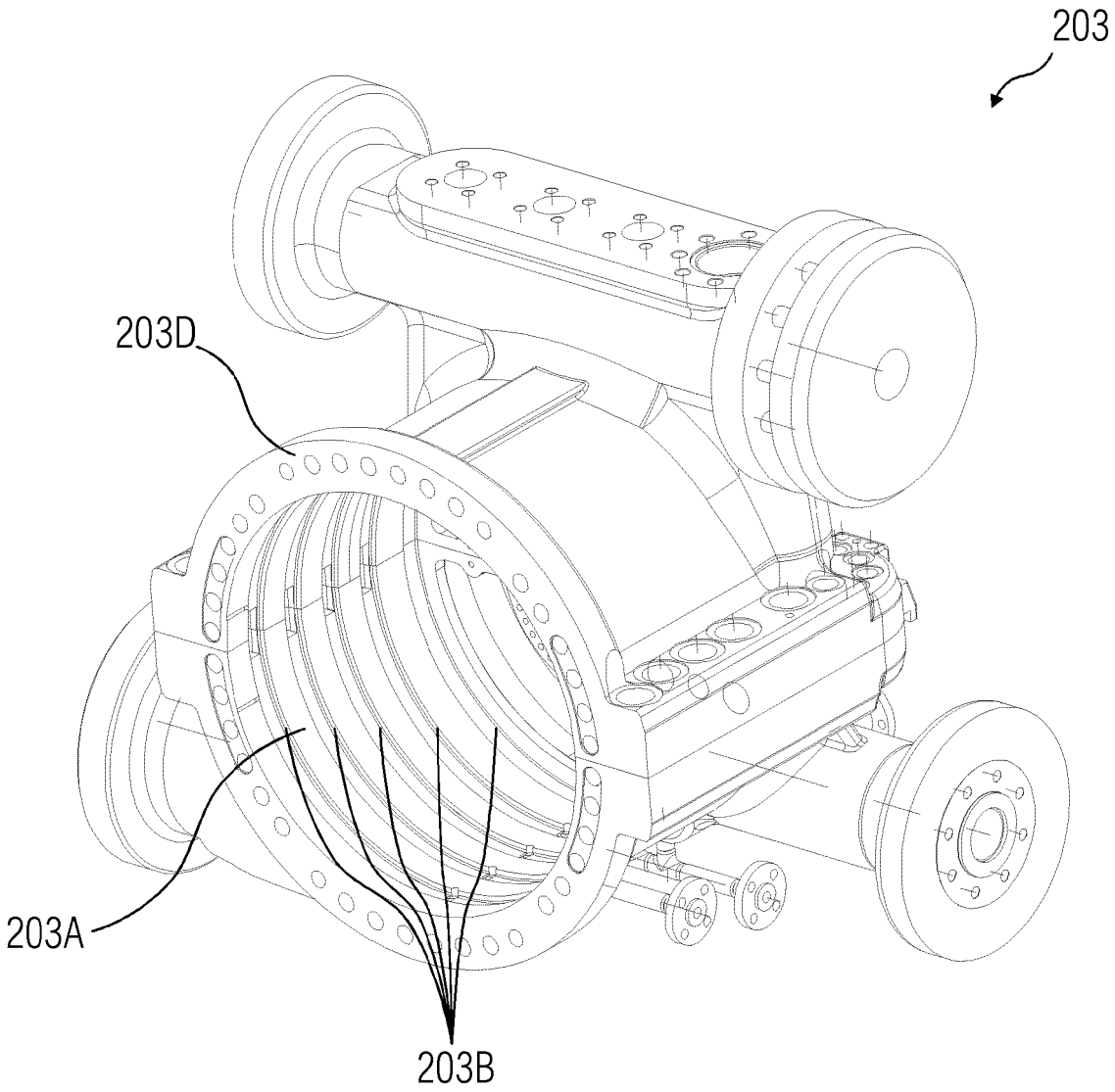


FIG 4A

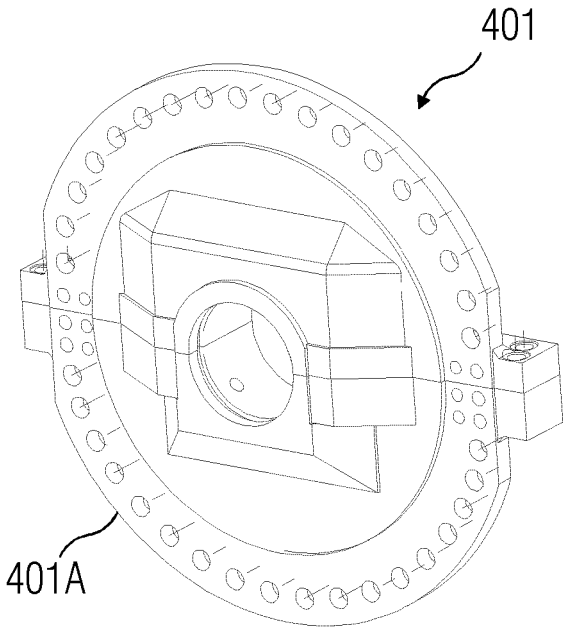


FIG 4B

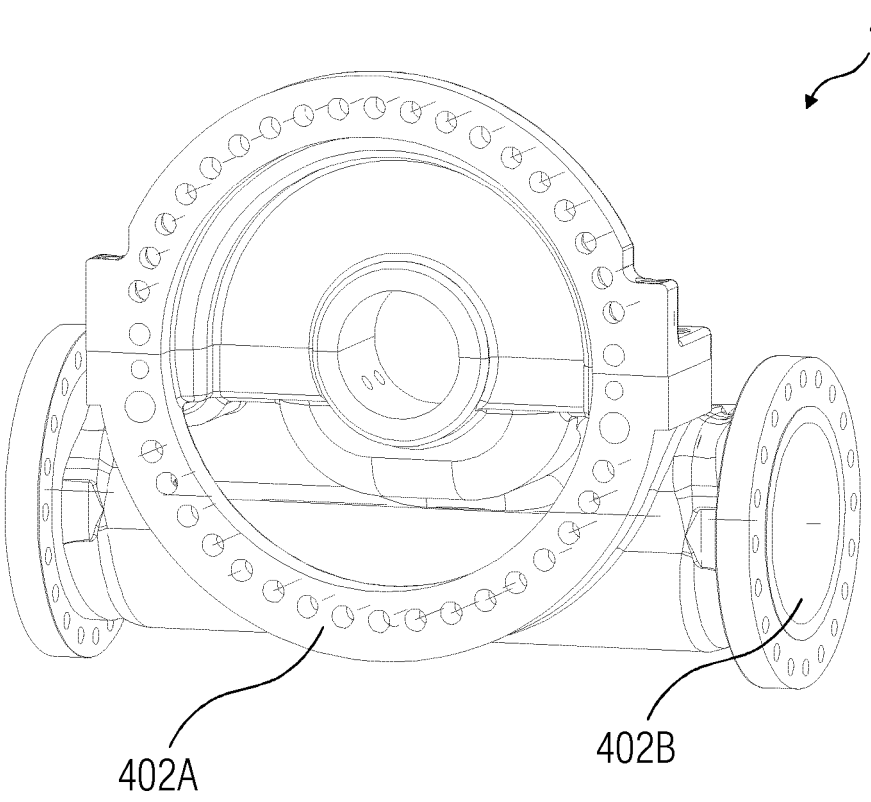
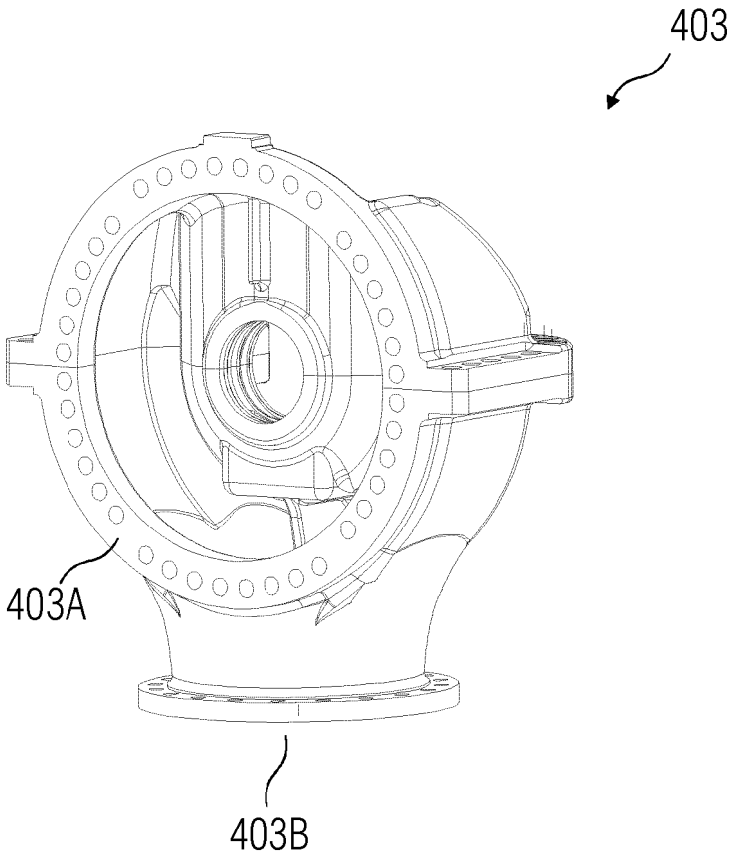


FIG 4C



REFERENCES CITED IN THE DESCRIPTION

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