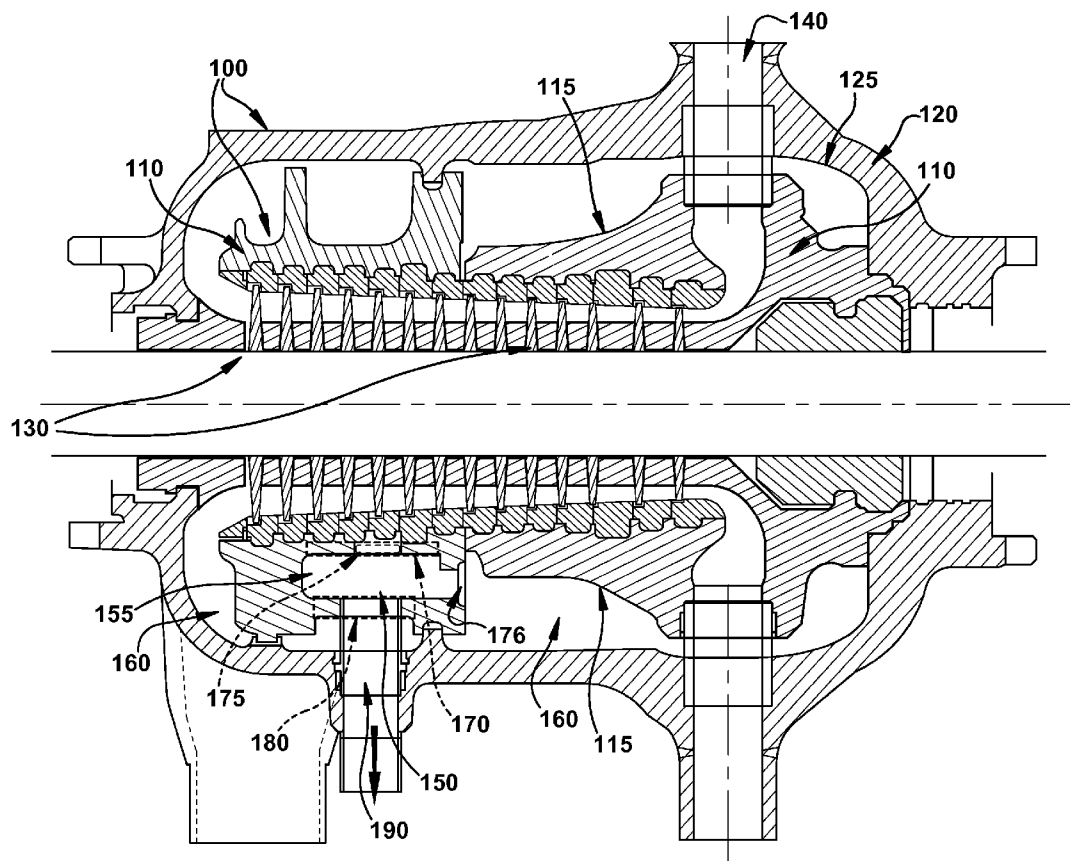




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(19) **United States**(12) **Patent Application Publication**
Kotian et al.(10) **Pub. No.: US 2015/0252681 A1**(43) **Pub. Date: Sep. 10, 2015**(54) **MODULAR TURBOMACHINE INNER AND
OUTER CASINGS WITH MULTI-STAGE
STEAM EXTRACTION SITES**(52) **U.S. Cl.**
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Schenectady, NY (US)(21) Appl. No.: **14/197,720**(22) Filed: **Mar. 5, 2014****Publication Classification**(51) **Int. Cl.**
F01D 9/06 (2006.01)
F01D 25/26 (2006.01)(57) **ABSTRACT**

Various embodiments include methods and apparatuses of forming turbomachine casing intermediate structures. In some embodiments apparatuses include a steam turbomachine casing intermediate structure including an inner shell having an external surface and inner shell cavity, and defining an opening for allowing fluid entry to the cavity and an outer shell having an internal surface, these surfaces defining at least one closed, axial-extending chamber, the inner shell and outer shells each having access regions adjacent the closed chamber, each of the access regions including a plurality of locations, selectable to be machined to create an exhaust slot or an exhaust opening in the inner casing or the outer casing, respectively, and wherein a structural integrity of the casing is uniform regardless of which of the axial locations are selected to be machined, where the exhaust opening is fluidly connected with the at least one closed chamber through the outer shell.



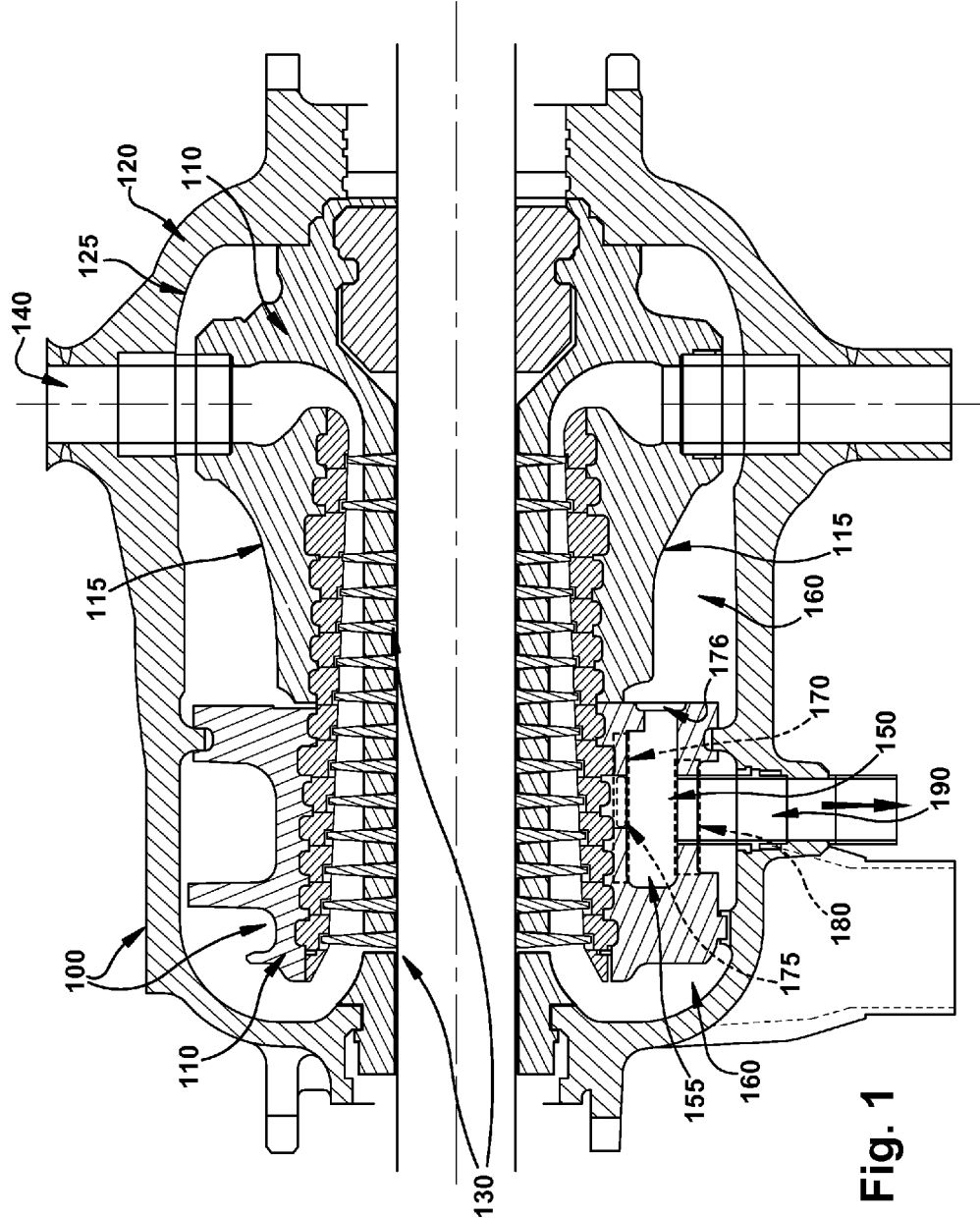


Fig. 1

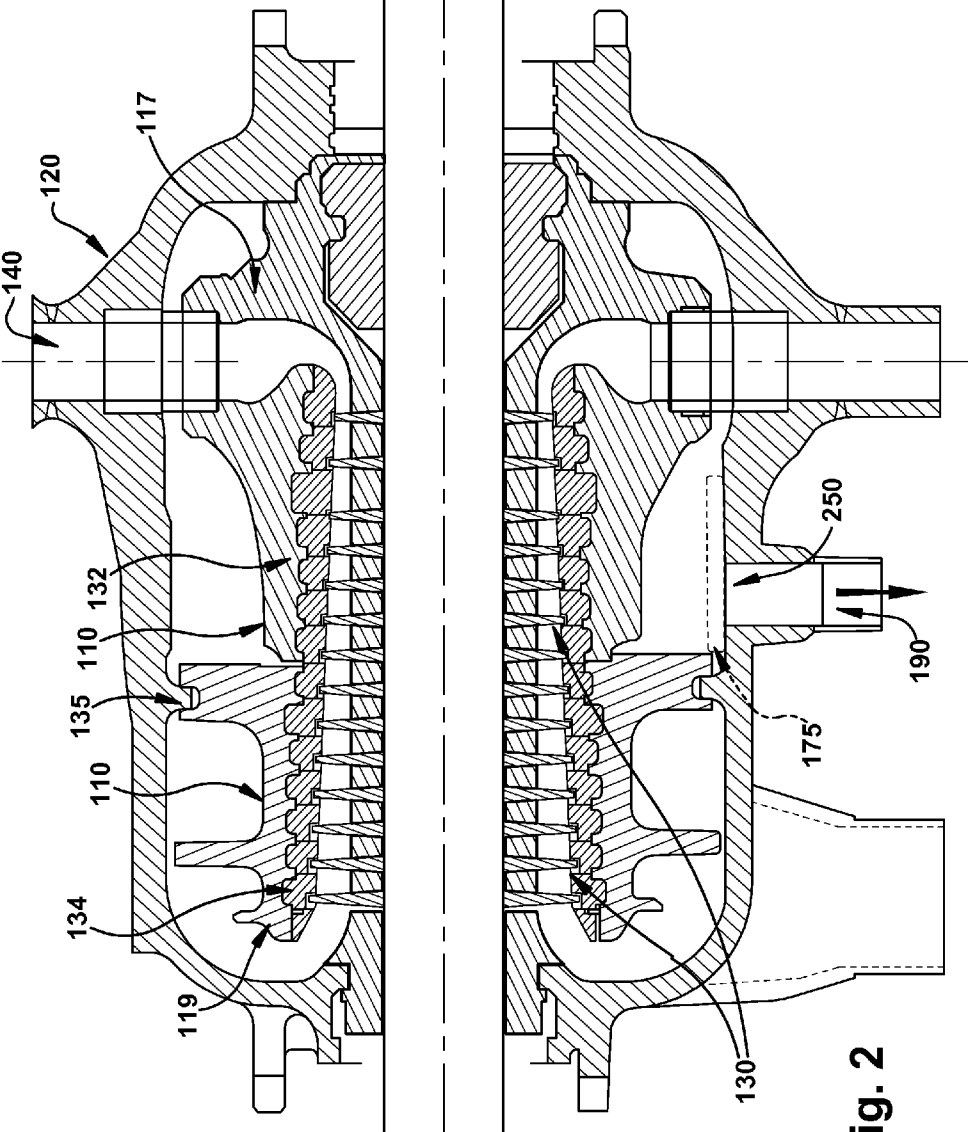


Fig. 2

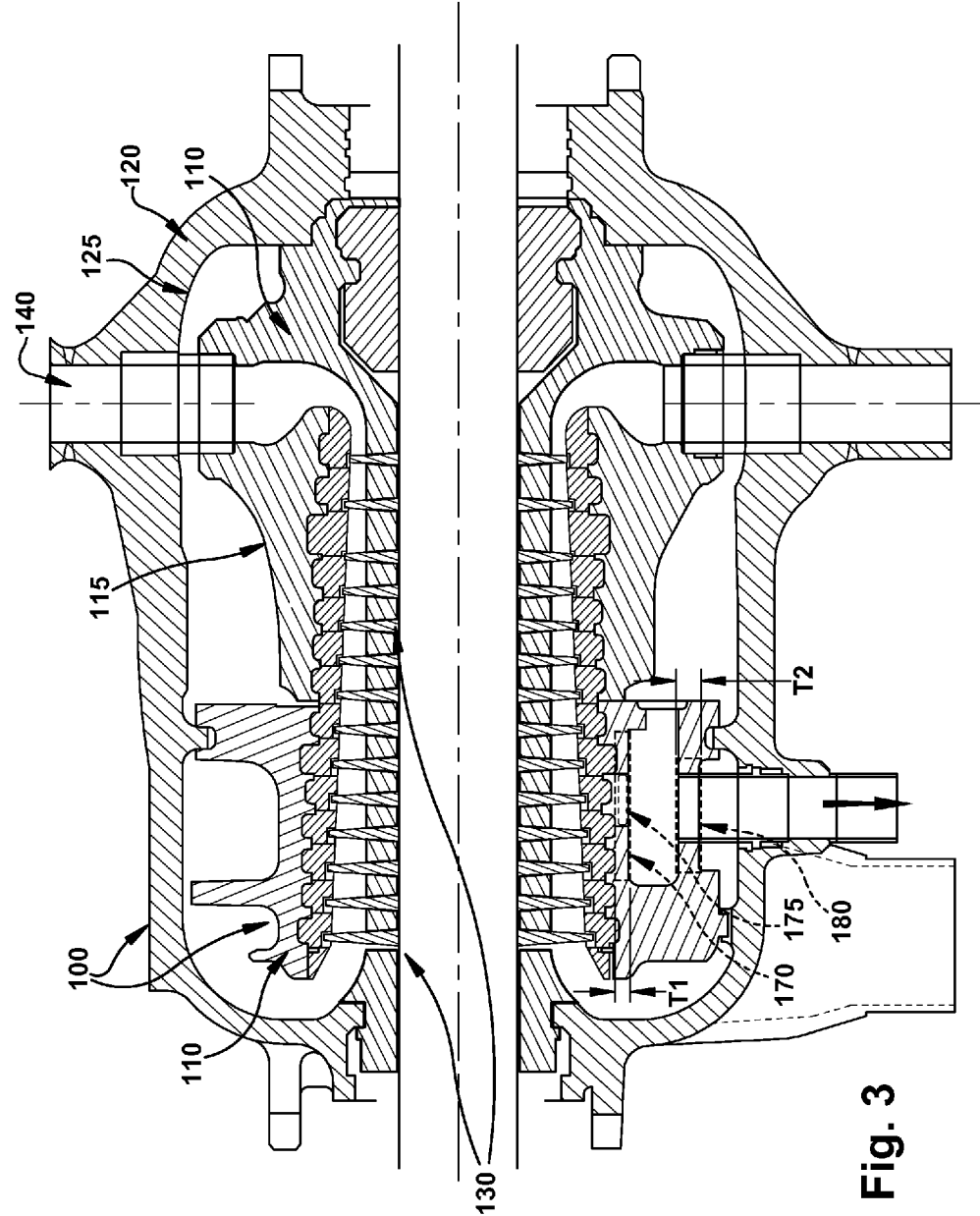


Fig. 3

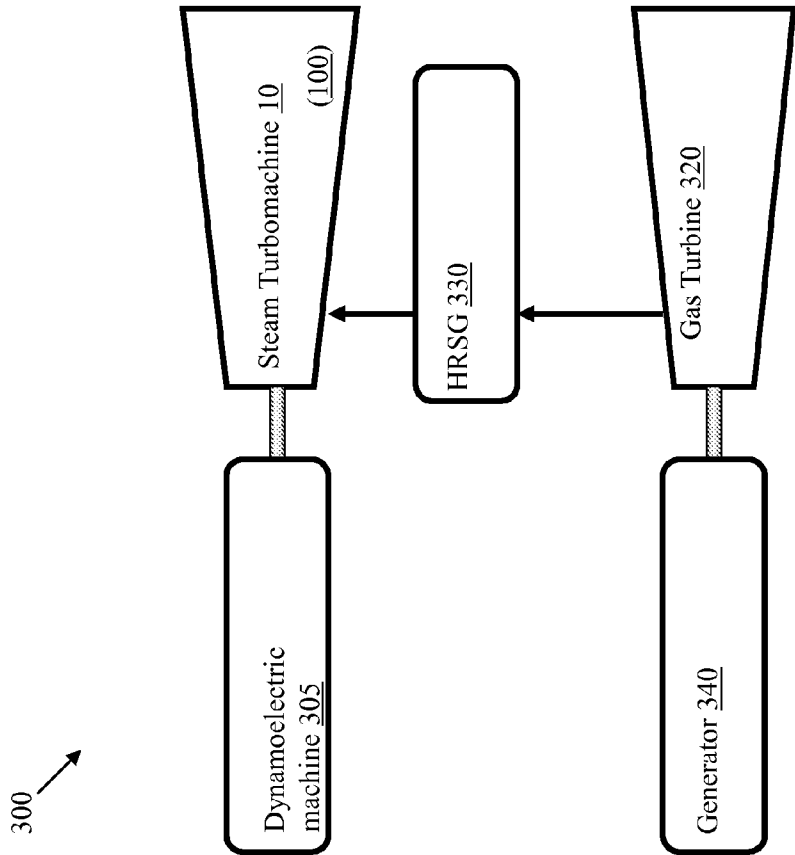


FIG. 4

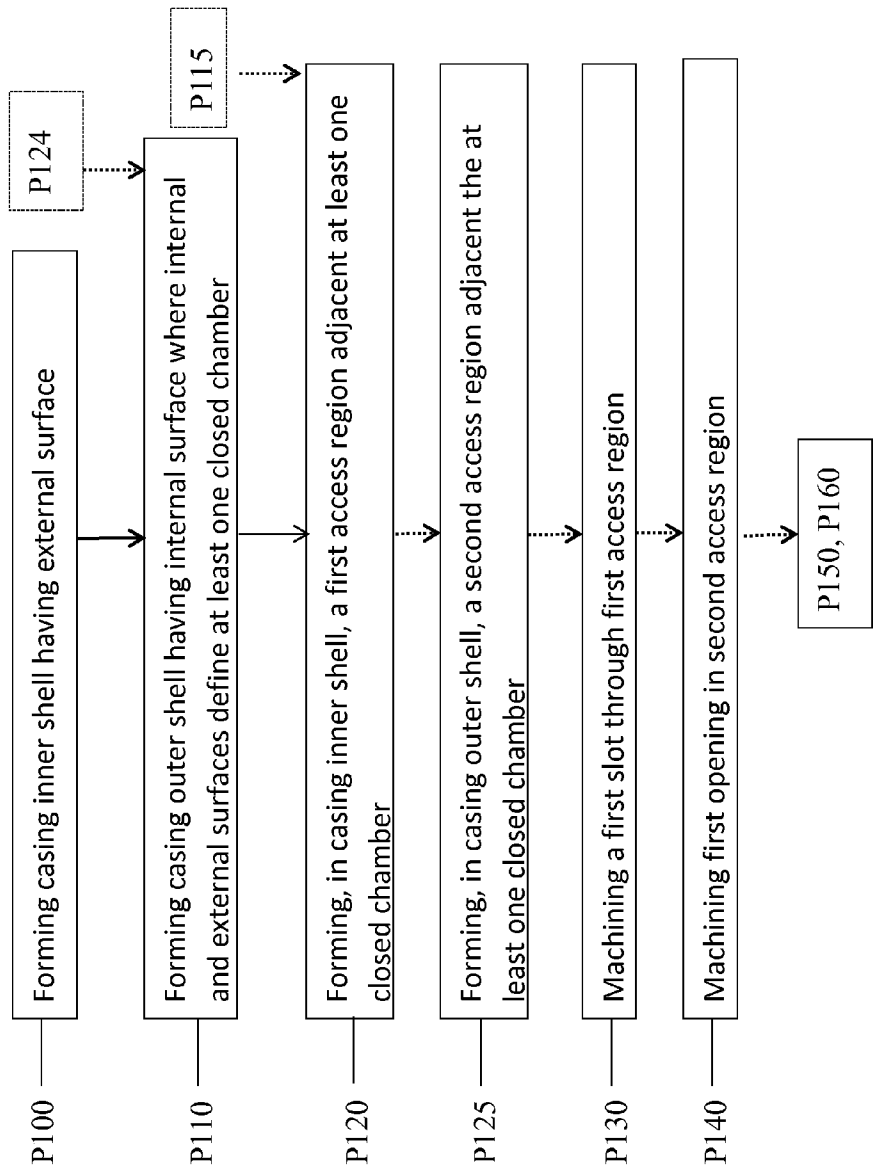


FIG. 5

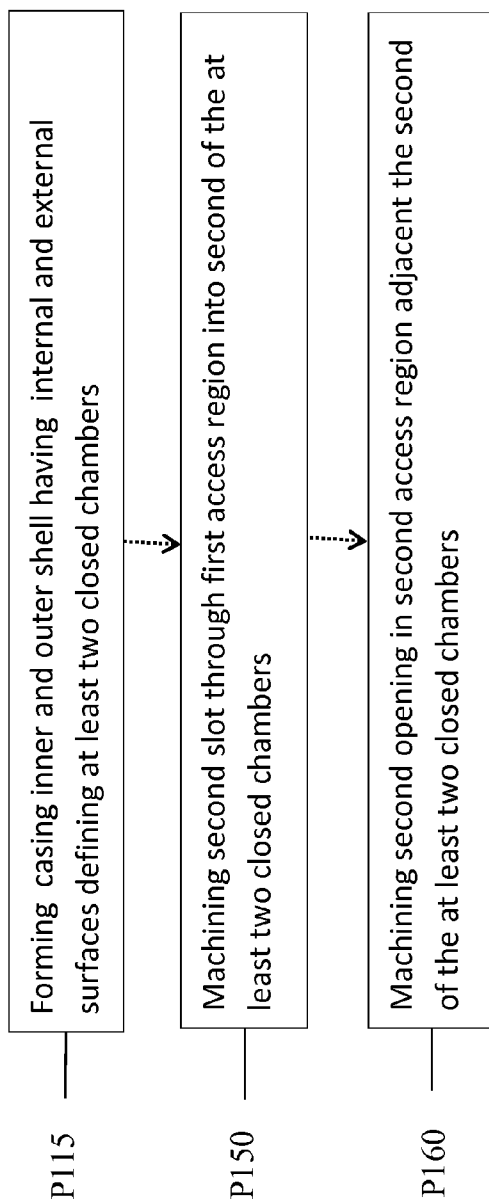


FIG. 6

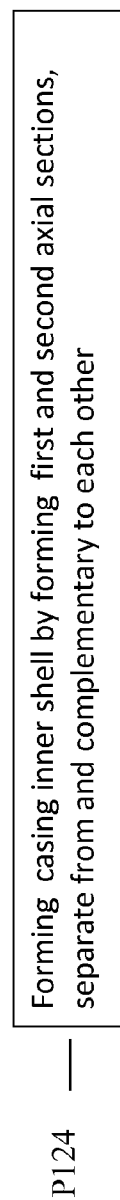


FIG. 7

MODULAR TURBOMACHINE INNER AND OUTER CASINGS WITH MULTI-STAGE STEAM EXTRACTION SITES

FIELD OF THE INVENTION

[0001] The subject matter disclosed herein relates generally to steam turbines. More specifically, the disclosure provided herein relates to inner and outer casings within steam turbines.

BACKGROUND OF THE INVENTION

[0002] There is often a need to extract fluid from a turboelectric machine in order to use the fluid for an industrial process. Turbomachine casings may be tapped in order to extract high pressure fluid circulating within and the high pressure fluid may be used for many different applications which may include powering an adjacent machine or heating water prior to its being used as steam. The location of fluid extraction from the turbomachine casing may be chosen based on characteristics of the high pressure fluid at such a location, i.e., fluid that is extracted through a port in an upstream stage of the turbomachine will have higher pressure than fluid that is extracted from a downstream stage. Also, the site of extraction of the fluid affects the operation of the turbomachine itself.

[0003] Conventionally, fluid extraction location is determined prior to casting of the turbomachine casing, and as discussed above, the location of extraction is chosen based on desired fluid characteristics of the fluid and/or based on the effect that such an extraction will have on the operation of the turbomachine.

BRIEF DESCRIPTION OF THE INVENTION

[0004] Various embodiments include intermediate structure apparatuses designed with a plurality of possible fluid extraction locations and methods of forming same. In some embodiments, a steam turbomachine casing intermediate structure includes an inner shell having an external surface, wherein a material of the inner shell defines an inner shell cavity, and wherein the material of the inner shell defines an opening for allowing fluid from a steam path of the turbomachine to enter the inner shell cavity, and an outer shell having an internal surface, the internal surface of the outer shell and the external surface of the inner shell defining at least one closed chamber extending in an axial direction of the steam turbomachine, the inner shell having a first access region adjacent the at least one closed chamber, the first access region including a plurality of inner shell axial locations, wherein at least one of the plurality of inner shell axial locations is selectable to be machined to create an exhaust slot for allowing fluid to exit the inner shell cavity and enter the at least one closed chamber, and wherein a structural integrity of the casing is uniform regardless of which of the inner shell axial locations is selected to be machined, the outer shell having a second access region adjacent the at least one closed chamber, the second access region including a plurality of outer shell axial locations, wherein at least one of the plurality of outer shell axial location is selectable to be machined to create an exhaust opening fluidly connected with the at least one closed chamber through the outer shell and wherein the structural integrity of the casing is uniform regardless of which of the outer shell axial locations is selected to be machined.

[0005] A first aspect provides a steam turbomachine casing intermediate structure comprising: an inner shell having an external surface, wherein a material of the inner shell defines an inner shell cavity, and wherein the material of the inner shell defines an opening for allowing fluid from a steam path of the turbo machine to enter the inner shell cavity; and an outer shell having an internal surface, the internal surface of the outer shell and the external surface of the inner shell defining at least one closed chamber extending in an axial direction of the steam turbomachine, the inner shell having a first access region adjacent the at least one closed chamber, the first access region including a plurality of inner shell axial locations, wherein at least one of the plurality of inner shell axial locations is selectable to be machined to create an exhaust slot for allowing fluid to exit the inner shell cavity and enter the at least one closed chamber, and wherein a structural integrity of the casing is uniform regardless of which of the inner shell axial locations is selected to be machined, the outer shell having a second access region adjacent the at least one closed chamber, the second access region including a plurality of outer shell axial locations, wherein at least one of the plurality of outer shell axial location is selectable to be machined to create an exhaust opening fluidly connected with the at least one closed chamber through the outer shell and wherein the structural integrity of the casing is uniform regardless of which of the outer shell axial locations is selected to be machined.

[0006] A second aspect provides a steam turbomachine casing intermediate structure comprising: at least one shell casing defining at least one cavity and having a plurality of pre-formed extraction opening sites selectable for use, wherein a structural integrity of the at least one shell casing is uniform regardless of which of the plurality of pre-formed extraction opening sites is selected for use.

[0007] A third aspect provides a method of fabricating a turbomachine casing structure, the method comprising: forming a casing inner shell having an external surface, wherein a material of the casing inner shell defines an inner shell cavity and a fluid opening for allowing fluid from a turbomachine steam path to enter the inner shell cavity; and forming a casing outer shell having an internal surface such that the internal surface of the outer shell and the external surface of the inner shell define at least one closed chamber extending in an axial direction of the steam turbomachine; forming, in the casing inner shell, a first access region adjacent the at least one closed chamber, the first access region including a plurality of inner shell axial locations, wherein at least one of the plurality of inner shell axial locations is selectable to be machined to create an exhaust slot for allowing fluid to exit the inner shell cavity and enter the at least one closed chamber, and wherein a structural integrity of the casing is uniform regardless of which of the inner shell axial locations is selected to be machined; and forming, in the casing outer shell, a second access region adjacent the at least one closed chamber, the second access region including a plurality of outer shell axial locations, wherein at least one of the plurality of outer shell axial location is selectable to be machined to create an exhaust opening fluidly connected with the at least one closed chamber through the outer shell and wherein the structural integrity of the casing is uniform regardless of which of the outer shell axial locations is selected to be machined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] These and other features of this invention will be more readily understood from the following detailed description of the various aspects of the invention taken in conjunction with the accompanying drawings that depict various embodiments of the invention, in which:

[0009] FIG. 1 illustrates a cross sectional view of an apparatus according to embodiments of the invention.

[0010] FIG. 2 illustrates a cross-sectional view of an apparatus according to embodiments of the invention.

[0011] FIG. 3 illustrates a cross-sectional view of an apparatus according to embodiments of the invention.

[0012] FIG. 4 shows an illustrative environment according to embodiments of the invention.

[0013] FIG. 5 shows illustrative processes that may be performed in methods according to embodiments of the invention.

[0014] FIG. 6 shows illustrative processes that may be performed in methods according to embodiments of the invention.

[0015] FIG. 7 shows an illustrative process that may be performed in methods according to embodiments of the invention.

[0016] It is noted that the drawings of the invention are not necessarily to scale. The drawings are intended to depict only typical aspects of the invention, and therefore should not be considered as limiting the scope of the invention. It is understood that elements similarly numbered between the figures may be substantially similar as described with reference to one another. Further, in embodiments shown and described with reference to FIGS. 1-7, like numbering may represent like elements. Redundant explanation of these elements has been omitted for clarity. Finally, it is understood that the components of FIGS. 1-7 and their accompanying descriptions may be applied to any embodiment described herein.

DETAILED DESCRIPTION OF THE INVENTION

[0017] The subject matter disclosed herein relates generally to steam turbines. More specifically, the disclosure provided herein relates to inner and outer casings within steam turbines.

[0018] As indicated herein, illustrative embodiments of turbomachine casing intermediate structures and methods of their manufacture are disclosed. Embodiments described herein include turbomachine intermediate structures having many different possible fluid extraction locations which may be selected to be machined after desired characteristics of extractable fluid are known. Intermediate structures may be produced in order to be adapted at a later date. That is a casing intermediate structure may be produced with a plurality of locations for potential steam extraction, however none of such steam extraction locations are machined to define fluid extraction ports or openings in an intermediate structure. Intermediate structures are useful because a single, modular design may be modified in many different ways, after design characteristics are known. That is, such characteristics may not be known at the time of creation of the casing, therefore a the creating of a casing intermediate structure having a plurality of possible fluid extraction locations allows a single intermediate casing to be used in a plethora of potential applications. As differentiated from conventional turbomachine casings which have pre-formed or pre-machined fluid extraction sites, embodiments described herein include intermedi-

ate structures and methods of forming same which allow for very many possible fluid extraction sites and combinations of sites.

[0019] Turning to FIG. 1, a cross sectional view of an apparatus according to embodiments of the invention is shown. FIG. 1 illustrates casing intermediate structure 100 having inner shell 110. Inner shell 110 is designed to encase a plurality of stages 130 of steam turbomachine 10 and to enclose part of a steam path from steam inlet 140 to a steam extraction location such as slot 150 or 250, the latter described below with respect to FIG. 2. Inner shell 110 has an external surface 115. The material of inner shell 110 defines an inner shell cavity 155 and an opening such as exhaust slot 150. Exhaust slot 150 is machined into one of a plurality of inner shell axial locations 175. Exhaust slot 150, in axial location 175 allows fluid to exit steam path 130 and enter inner shell cavity 155.

[0020] Inner shell cavity 155 may be cast at the time of creation of inner shell 110, in some embodiments. It is understood that, according to embodiments, the inner shell cavity 155 is entirely contained within the inner shell 110. Intermediate structure 100 also includes outer shell 120. Outer shell 120 is illustrated surrounding inner shell 110 and having an internal surface 125. Internal surface 125 of outer shell 120 and external surface 115 of inner shell 110 define at least one closed chamber 160 extending in an axial direction A of the steam turbomachine 10. Inner shell 110 has a first access region 170 adjacent the at least one closed chamber 160. First access region 170 includes a plurality of inner shell axial locations 175, (inner shell axial locations 175 shown in FIG. 3). According to embodiments, at least one axial location 175 of the plurality of inner shell axial locations 175 is selectable to be machined to create exhaust slot 150. Inner shell axial locations 175 are sections of inner shell 120 which may be machined for extraction of fluid from an adjacent closed chamber 160. According to embodiments of the invention, inner shell axial locations 175 may, as a whole, define an elongated shape, extending in an axial direction A of turbomachine 10. Inner shell axial locations 175 may be located in inner shell 110, contiguous to one another; that is, there may be no distinct separation between two adjacent inner shell axial locations 175. Inner shell axial locations 175 define potentially machinable areas of inner shell 120 for creation of fluid extraction. The creation of exhaust slot 150 by machining a selected inner shell axial location 175 is performed while maintaining a structural integrity of casing intermediate structure 100, and the structural integrity remains uniform regardless of which of the inner shell axial locations 175 is selected to be machined. It should be understood that the terms "slot" and "opening" are used to differentiate between the ports through the inner and outer casings, 110 and 120, respectively; no other differences between "slot" and "opening" need be inferred.

[0021] The creation of inner shell 110 with the plurality of machinable axial locations 175 allows for a designer to select fluid extraction locations when desired characteristics of extracted fluid are known. As described above, an inner shell axial location 175 adjacent an upstream stage of a turbomachine 10 may be machined in order to extract high pressure fluid, if a designer determines that high pressure fluid is desired for a particular industrial purpose. Likewise, fluid may be extracted from inner shell axial locations adjacent other stages of turbomachine 10 according to the needs of the designer and the pressure or other characteristics of the fluid

within such stages, such characteristics may include, but are not limited to moisture content or temperature.

[0022] According to embodiments, outer shell **120** includes a second access region **180** adjacent at least one closed chamber **160**, and second access region **180** includes a plurality of outer shell axial locations **185** (shown in FIG. 3). Outer shell axial locations **185** are locations which may be machined to create a fluid extraction port, e.g. an opening **190**, from closed chamber **160**. According to embodiments, at least one of the plurality of outer shell axial locations **185** is selectable to be machined to create an exhaust opening **190** fluidly connected with the at least one closed chamber **160** through outer shell **120**. The creation of the exhaust opening **190** by machining is performed while maintaining the structural integrity of the casing **100** and the structural integrity remains uniform regardless of which of the outer shell axial locations **185** is selected to be machined.

[0023] Inner shell **110** and outer shell **120** may be formed by casting using at least one of steel, nickel, chromium or alloys thereof, e.g., ferritic steel, ferritic-martensitic steel, austenitic stainless steel, 2.25 Cr-1 Mo steel, 1-2 CrMo steel, etc. Other materials may be used as known by those skilled in the art. The casting of the shells may be performed using molds. The inner and outer shells **110**, **120**, respectively, may be created at the same time, using the same mold, or they may be created separately, using different sets of molds. The at least one closed chamber **160** may be created as follows. First, internal surface **125** of outer shell **120** and external surface **115** of inner shell **110** may be defined by at least one mold. Then molten metal may be poured into a mold, or molds, as appropriate. A core may be inserted into the mold(s) in order to create the surfaces defining at least one chamber **160**. Such a core may comprise sand which is inserted into the mold space prior to the pouring of the molten metal. When the metal solidifies, the core is removed, creating the at least one chamber **160**. At this stage, it should be understood that the chamber may need to be cleaned of any debris, e.g., remaining sand. The casting process described enables accessibility for cleaning of the chamber **160** after solidification of metal casting and core removal.

[0024] Turning to FIG. 2, a cross-sectional view of an apparatus according to embodiments is shown. FIG. 2 illustrates an embodiment having inner shell **110** including first and second axial sections, **117** and **119**, respectively. Furthermore, FIG. 2 illustrates options for embodiments according to aspects. In some embodiments, steam extraction exhaust slot **250** may be in a position different from steam extraction exhaust slot **150**, as illustrated in FIG. 2.

[0025] According to embodiments, inner shell **110** may include separate first and second axial sections **117** and **119**, the axial sections **117** and **119** are shaped complementary to one another, with a 360 degree fit **135**, acting as a dividing wall or support between axial sections **117**, **119**. In embodiments that include first and second axial sections **117** and **119** of inner shell **110**, at least one first stage **132** may be supported on first axial section **117**, and at least one second stage **134** may be supported on second axial section **119** as illustrated in FIG. 2. It should be understood that the first and second stages, **132** and **134** are stationary stages of turbomachine **10**. Such stationary stages may include, but are not limited to nozzle stages.

[0026] Exhaust slots **150** and **250**, shown in FIGS. 1 and 2, respectively, allow extraction of a high pressure fluid from inner shell **110** at a steam extraction location, such as slot **150**

or **250**, proximate a selected stage **130**, (selected stage not specifically shown) of steam turbomachine **10**, the steam extraction location, such as slot **150** or **250**, being related to a fluid characteristic of the fluid within steam turbomachine **10** in operation. Such fluid characteristics are described above with respect to FIG. 1 and will not be repeated for the sake of brevity. According to embodiments, fluid, such as steam may be released via slots **150** adjacent various stages **130**. In embodiments where fluid, such as steam is extracted from a location **150/250** upstream of second axial section **117**, the outer shell may be machined to allow for extraction of fluid upstream of the 360 degree fit **135** and second axial section **119** may not be machined (opened) to allow for fluid extraction therefrom. In embodiments where machined extraction locations are desired adjacent second axial section **119**, the outer casing **120** may be machined to allow for fluid extraction downstream of 360 degree fit **135** and in such embodiments, second axial section **119** lies adjacent a closed chamber **160** designed specific to that particular stage.

[0027] According to embodiments, inner shell cavity **155** may be sealed by a closure, such as plate **176**. Such closure may be accomplished using now-known or later-developed fabrication techniques, including, e.g., welding, or casting of plate **176**. Exhaust slot **150** in axial location **175** may be machined by access through steam path **130** directly, in embodiments using multiple inner shells **110**. According to other embodiments, opening **175** may be created by machining plate **176** to allow fluid flow from closed chamber **160**. Such procedures may for example be performed in embodiments having single or multiple inner shell casing sections. According to embodiments having a single inner casing **110** or embodiments having first and second axial sections **117**, **119**, respectively, of inner casing **110**, the fluid characteristic may be a characteristic of steam. Such a characteristic may include, but are not limited to: pressure, moisture content (wetness), temperature, flow rate. In either case, steam may be released via steam extraction location, such as slot **150** or **250** proximate a selected stage **130** of the turbomachine **10**. As discussed above, this steam (or fluid) may be used for an industrial process or it may be sent to a boiler feed water heater to alter (e.g., to increase) cycle efficiency.

[0028] According to embodiments, one of a plurality of axial locations **175** may be selected to be machined in order to allow for extraction of fluid, from exhaust opening **190** proximate a relatively upstream stage of the steam turbine, in order to allow extraction of a relatively high pressure fluid from the at least one closed chamber **160** proximate a selected stage of the turbomachine **10**. Alternatively exhaust slot **150** may be selected in order to extract fluid from an exhaust opening **190** proximate a relatively downstream stage of the previously mentioned upstream stage in order to extract a lower pressure fluid. The location of fluid extraction may determine the fluid characteristics of the extracted fluid.

[0029] FIG. 3 illustrates a cross-sectional view of an apparatus according to embodiments. FIG. 3 illustrates an embodiment where first and second access regions **170** and **180**, respectively, each have a uniform thickness **T1**, **T2** respectively, different from a thickness of the inner shell **110** adjacent first access region **170** and different from a thickness of the outer shell **120** adjacent second access region **180**. According to some embodiments, first access region **170** has a thickness **T1** that is less than half a thickness of a remainder of inner shell **110**. And likewise, according to embodiments,

second access region **180** has a thickness **T2** that is less than half a thickness of a remainder of the outer shell **120**.

[0030] FIG. 3 further illustrates an embodiment where internal surface **125** of outer shell **120** and external surface **115** of inner shell **110** define at least two closed chambers **160** extending in an axial direction **A** of the steam turbomachine **10**. While only two chambers **160** are illustrated in FIG. 3, any number of closed chambers **160** may be created. It should be noted that the intermediate structures described herein, are designed to allow for fluid extraction at any of a number of locations **175**, but actual extraction at a plurality of locations within the same turbomachine is not necessary according to all embodiments of the invention.

[0031] According to embodiments of the invention, a steam turbomachine intermediate structure may have at least one shell casing having a plurality of pre-formed extraction opening sites selectable for use, wherein a structural integrity of the at least one shell casing is uniform, regardless of which of the plurality of pre-formed extraction opening sites is selected for use. The at least one shell casing according to this embodiment is analogous to the inner and outer shell casings, **110** and **120**, described herein above with respect to FIGS. 1-3. Also, the pre-formed extraction opening sites according to such embodiments are analogous to inner shell axial locations **175** and outer shell axial locations **185** described herein above with respect to FIGS. 1 and 3, respectively. According to such an embodiment, an extraction opening may be selected to be used based on the location of the opening. That is, an opening may be selected because it is adjacent a relatively upstream stage in the steam turbo machine and because a designer desires to access high pressure steam for use in an industrial process. Likewise, an extraction opening may be selected due to its proximity to a relatively downstream stage because a designer chooses to access steam from the turbomachine having a different fluid characteristic than steam from an upstream stage. For non-limiting example a designer may need relatively high moisture content (wet) steam or relatively low temperature steam for an industrial purpose and therefore the designer may use an extraction opening appropriate for this desired industrial purpose.

[0032] According to embodiments of the invention the at least one casing may be an inner casing having first and second axial sections **117** and **119**, as described above with respect to FIG. 2. And according to embodiments of the invention, the pre-formed extraction opening site may be selected for use based on one or more fluid characteristics of a fluid within the steam turbomachine during operation, adjacent the selected opening site. Such fluid characteristics are described herein and will not be repeated here, for the sake of brevity.

[0033] FIG. 4 illustrates an environment according to embodiments of the invention. System **300** includes a dynamoelectric machine **305** and a steam turbomachine **10** coupled with the dynamoelectric machine **305**. Steam turbomachine **10** as illustrated, includes steam turbomachine casing intermediate structure **100** as described above with respect to FIGS. 1-3, and such description will not be repeated for the sake of brevity. Some embodiments of the invention include a gas turbine **320** fluidly connected with generator **340**, as illustrated in FIG. 4. Embodiments may further include heat recovery steam generator (HRSG) **330** fluidly coupled with the gas turbomachine **320** and the steam turbomachine **10**, as illustrated in FIG. 4. Embodiments of the invention may also include generator **340** operationally con-

nected with gas turbine **320** or alternatively with steam turbomachine **10** (such connection is not shown in FIG. 4).

[0034] FIG. 5 illustrates processes in a method of fabricating a turbomachine casing structure according to embodiments of the invention. Process **P100** is illustrated in FIG. 5 and includes, forming a casing inner shell having an external surface, wherein a material of the casing inner shell defines an inner shell cavity and a fluid opening for allowing fluid from a turbomachine steam path to enter the inner shell cavity. Process **P110** may be performed concurrently with, or after process **P100** and includes forming a casing outer shell having an internal surface such that the internal surface of the outer shell and the external surface of the inner shell define at least one closed chamber extending in an axial direction of the steam turbomachine. It should be understood that the timing of performance of processes **P100** and **P110** may not affect the method as a whole. Processes **P100** and **P110** may include casting as describe above which will not be repeated for the sake of brevity. Optional Process **P115**, shown in FIG. 6, includes forming a casing inner shell and the forming of the casing outer shell such that the outer surface of the casing inner shell and the inner surface of the casing outer shell define at least two closed chambers extending in an axial direction of the steam turbomachine. According to embodiments, optional process **P115** may be performed in lieu of processes **P100** and **P110**, or process **P115** may be performed as an embellishment to processes **P100** and **P110**.

[0035] Referring back to FIG. 5, process **P120** includes forming, in the casing inner shell, a first access region adjacent the at least one closed chamber, the first access region including a plurality of inner shell axial locations. The first access region may be formed of casing material of a different thickness than adjacent casing material. As a non-limiting example, the first access region may be cast of steel having a thickness half of the thickness of the steel that makes up the inner casing adjacent to the first access region. According to embodiments, each of the plurality axial locations within the inner shell is selectable to be machined to create an exhaust slot for allowing fluid to exit the inner shell cavity and enter the at least one closed chamber. As discussed above, an exhaust slot may be located to allow high pressure fluid, such as steam, to flow from the inner shell and into one or more of the closed chambers. Any machining performed to create an exhaust slot maintains the structural integrity of the casing uniformly, regardless of which of the inner shell axial locations may be selected to be machined. According to aspects, the forming of the first access region may include forming the first access region to have a uniform thickness, different from a thickness of the inner shell adjacent the first access region. Also according to aspects the forming of the first access region may include forming the first access region to have a thickness less than half a thickness of the remainder of the inner shell.

[0036] According to embodiments, the inner shell casing may be formed using optional process **P124**, which is illustrated in FIG. 7. Optional process **P124** includes forming the casing inner shell by forming a first axial section and forming a second axial section, the second axial section being separate from and complementary to the first axial section.

[0037] Referring back to FIG. 5, process **P125** includes forming, in the casing outer shell, a second access region adjacent the at least one closed chamber, the second access region including a plurality of outer shell axial locations, wherein at least one of the plurality of outer shell axial loca-

tion is selectable to be machined to create an exhaust opening fluidly connected with the at least one closed chamber through the outer shell and wherein the structural integrity of the casing is uniform regardless of which of the outer shell axial locations is selected to be machined. According to aspects, the forming of the second access region may include forming the second access region to have a uniform thickness, different from a thickness of the outer shell adjacent the second access region. Also according to embodiments, the forming of the second access region may include forming the second access region to have a thickness less than half a thickness of a remainder of the outer shell.

[0038] FIG. 5 shows optional processes P130 and P140. Optional process P130 includes machining a first slot through the first access region, wherein a location of the first slot is based upon a performance characteristic of the turbomachine. Optional process P140 includes machining a first opening in the second access region, the first opening extending through the outer shell. Such locations and associated performance characteristics were discussed above with respect to FIG. 1 and will not be repeated for the sake of brevity.

[0039] Optional processes P150 and P160 are illustrated in FIG. 6; optional processes P150 and P160 may be performed after optional process P115. Optional process P150 includes machining a second slot through the first access region into a second of the at least two closed chambers while maintaining the structural integrity of the casing, a location of the second slot being based upon a performance characteristic of the turbomachine. Optional process P150 may be performed, for example in cases where a designer may desire two outputs from a steam turbine and where the designer desires fluid having different characteristics to perform different functions. For example a designer may desire fluid of relatively high pressure for some industrial process and therefore the designer may locate a first slot adjacent an upstream stage of a steam turbomachine. The designer may also desire lower pressure fluid to operate a different industrial application, and the designer may locate a second slot adjacent a stage downstream of the first slot to attain such relatively lower pressure fluid. While two slots located adjacent different stages are discussed, embodiments of the invention may include any number of slots, located adjacent the same or different stages of a steam turbomachine without deviating from the spirit of the invention.

[0040] Optional process P160 includes machining a second opening in the second access region adjacent the second of the at least two closed chambers while maintaining the structural integrity of the casing, the second opening extending through the outer shell. According to embodiments, a second opening may allow a designer to access fluid from a second location to be used for a second industrial purpose. It should be noted that the slots and openings described herein are not necessarily intended to remain open or to constantly allow release of fluid. Such openings and slots may be capped, and/or valves may be used to allow for release of fluid only when desired. Optional processes P150 and P160 may be performed subsequent to process P115, in which a plurality of closed chambers is defined.

[0041] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosure. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/

or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0042] As used herein, the terms “axial” and/or “axially” refer to the relative position/direction of objects along axis A, which is substantially parallel with the long axis of a conduit at a pipe crossing. As further used herein, the terms “radial” and/or “radially” refer to the relative position/direction of objects along radius (r), which is substantially perpendicular with axis A and intersects axis A at only one location. Additionally, the terms “circumferential” and/or “circumferentially” refer to the relative position/direction of objects along a circumference which surrounds axis A but does not intersect the axis A at any location.

[0043] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A steam turbomachine casing intermediate structure comprising:

an inner shell having an external surface, wherein a material of the inner shell defines an inner shell cavity, and wherein the material of the inner shell defines an opening for allowing fluid from a steam path of the turbomachine to enter the inner shell cavity; and

an outer shell having an internal surface, the internal surface of the outer shell and the external surface of the inner shell defining at least one closed chamber extending in an axial direction of the steam turbomachine,

the inner shell having a first access region adjacent the at least one closed chamber, the first access region including a plurality of inner shell axial locations, wherein at least one of the plurality of inner shell axial locations is selectable to be machined to create an exhaust slot for allowing fluid to exit the inner shell cavity and enter the at least one closed chamber, and wherein a structural integrity of the casing is uniform regardless of which of the inner shell axial locations is selected to be machined,

the outer shell having a second access region adjacent the at least one closed chamber, the second access region including a plurality of outer shell axial locations, wherein at least one of the plurality of outer shell axial location is selectable to be machined to create an exhaust opening fluidly connected with the at least one closed chamber through the outer shell and wherein the structural integrity of the casing is uniform regardless of which of the outer shell axial locations is selected to be machined.

2. The steam turbomachine casing of claim 1, wherein the inner shell includes a first axial section and a second axial section separate from and complementary to the first axial section.

3. The steam turbomachine casing of claim 1, wherein the exhaust slot allows extraction of a high pressure fluid from the inner shell at a location proximate a selected stage of the turbomachine, the location being related to a fluid characteristic.

4. The steam turbomachine casing of claim 1, wherein the exhaust opening allows extraction of a high pressure fluid from the at least one closed chamber proximate a selected stage of the turbomachine.

5. The steam turbomachine casing of claim 1, wherein the first and second access regions each have a uniform thickness, different from a thickness of the inner shell adjacent the first access region and different from a thickness of the outer shell adjacent the second access region.

6. The steam turbomachine casing of claim 5, wherein the first access region has a thickness that is less than half a thickness of a remainder of the inner shell.

7. The steam turbomachine casing of claim 5, wherein the second access region has a thickness that is less than half a thickness of a remainder of the outer shell.

8. The steam turbomachine of claim 1, wherein the internal surface of the outer shell and the external surface of the inner shell define at least two closed chambers extending in an axial direction of the steam turbomachine.

9. A steam turbomachine casing intermediate structure comprising:

at least one shell casing defining at least one cavity and having a plurality of pre-formed extraction opening sites selectable for use, wherein a structural integrity of the at least one shell casing is uniform regardless of which of the plurality of pre-formed extraction opening sites is selected for use.

10. The steam turbomachine casing intermediate structure of claim 9, wherein the at least one shell casing includes an inner shell casing and an outer shell casing, wherein the at least one cavity is defined by a material of the inner shell.

11. The steam turbomachine casing intermediate structure of claim 10, wherein the inner shell casing includes a first axial section and a second axial section.

12. The steam turbomachine casing intermediate structure of claim 9, wherein the pre-formed extraction opening site is selected for use based on a fluid characteristic of a fluid within the steam turbomachine during operation adjacent the selected opening site.

13. A method of fabricating a steam turbomachine casing structure for a steam turbomachine, the method comprising:

forming a casing inner shell having an external surface, wherein a material of the casing inner shell defines an inner shell cavity and a fluid opening for allowing fluid from a turbomachine steam path to enter the inner shell cavity; and

forming a casing outer shell having an internal surface such that the internal surface of the outer shell and the external surface of the inner shell define at least one closed chamber extending in an axial direction of the steam turbomachine;

forming, in the casing inner shell, a first access region adjacent the at least one closed chamber, the first access region including a plurality of inner shell axial locations, wherein at least one of the plurality of inner shell axial

locations is selectable to be machined to create an exhaust slot for allowing fluid to exit the inner shell cavity and enter the at least one closed chamber, and wherein a structural integrity of the casing is uniform regardless of which of the inner shell axial locations is selected to be machined; and

forming, in the casing outer shell, a second access region adjacent the at least one closed chamber, the second access region including a plurality of outer shell axial locations, wherein at least one of the plurality of outer shell axial location is selectable to be machined to create an exhaust opening fluidly connected with the at least one closed chamber through the outer shell and wherein the structural integrity of the casing is uniform regardless of which of the outer shell axial locations is selected to be machined.

14. The method of claim 13, wherein the forming of the casing inner shell includes:

forming a first axial section; and

forming a second axial section, the second axial section being separate from and complementary to the first axial section.

15. The method of claim 13, further comprising:

machining a first slot through the first access region, wherein a location of the first slot is based upon a performance characteristics of the turbomachine; and

machining a first opening in the second access region, the first opening extending through the outer shell.

16. The method of claim 13, wherein the forming of the casing inner shell and the forming of the casing outer shell are performed such that the outer surface of the casing inner shell and the inner surface of the casing outer shell define at least two closed chambers extending in an axial direction of the steam turbomachine.

17. The method of claim 16, further comprising:

machining a second slot through the first access region into a second of the at least two closed chambers while maintaining the structural integrity of the casing, a location of the second slot being based upon a performance characteristics of the turbomachine; and

machining a second opening in the second access region adjacent the second of the at least two closed chambers while maintaining the structural integrity of the casing, the second opening extending through the outer shell.

18. The method of claim 13, wherein the forming of the first access region includes forming the first access region to have a uniform thickness, different from a thickness of the inner shell adjacent the first access region.

19. The method of claim 13, wherein the forming of the second access region includes forming the second access region to have a uniform thickness, different from a thickness of the outer shell adjacent the second access region.

20. The method of claim 13, wherein the forming of the first access region includes forming the first access region to have a thickness less than half a thickness of the remainder of the inner shell; and

wherein the forming of the second access region includes forming the second access region to have a thickness less than half a thickness of a remainder of the outer shell.

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