US 20150147154A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2015/0147154 A1**

(43) **Pub. Date: May 28, 2015**

BINDINGNAVALE RANGA

(54) **SYSTEM AND METHOD FOR IMPLEMENTING INTRINSIC SAFETY IN ROTATING MACHINE**

(71) Applicant: **KRISHNA KUMAR BINDINGNAVALE RANGA**, BANGALORE (IN)

(72) Inventor: **KRISHNA KUMAR BINDINGNAVALE RANGA**, BANGALORE (IN)

(21) Appl. No.: **14/513,503**

(22) Filed: **Oct. 14, 2014**

(30) **Foreign Application Priority Data**

Nov. 26, 2013 (IN) 3755/CHE/2013

Publication Classification

(51) **Int. Cl.**

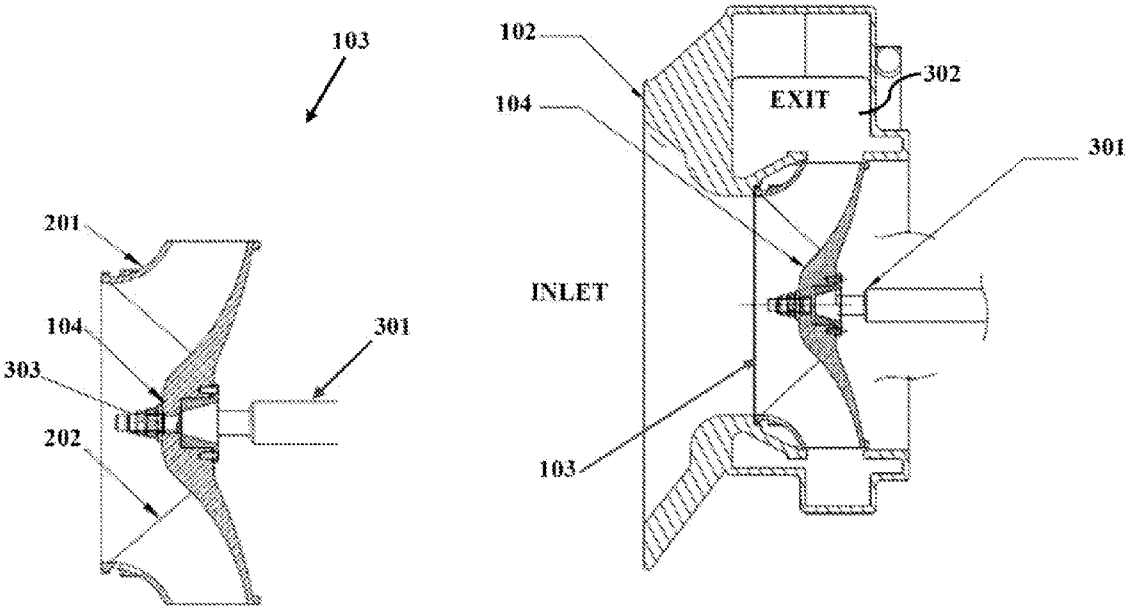
F04D 27/00	(2006.01)
F04D 19/00	(2006.01)
F04D 29/52	(2006.01)

(52) **U.S. Cl.**

CPC ***F04D 27/008*** (2013.01); ***F04D 29/526*** (2013.01); ***F04D 19/002*** (2013.01)

(57) **ABSTRACT**

The embodiments herein disclose a system and method for providing an intrinsic safety to rotating machinery from the failure of internal high speed rotating structures. According to one embodiment herein, a system assembly comprises a unique design of the rotating structure to provide a sufficient safety margin and redundancy in configuration. The system assembly comprises a blower fan assembled inside a blower casing and rotated inside the casing. The fan is manufactured by a single forging process instead of an investment casting. The fan comprises several blades mounted to a hub in a shroud to draw a required quantity of fluid. The fan is mounted to a shaft through the hub. When the blower fan is rotated at a high speed exceeding the design parameters, a 'rub and stop' mechanism is initiated to halt the fan.



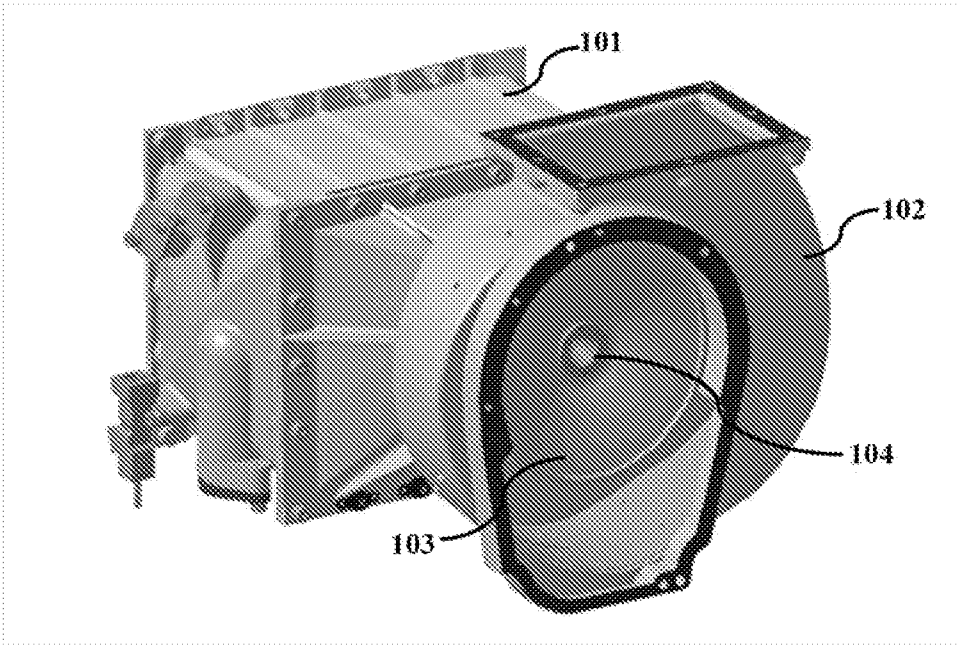


FIG. 1

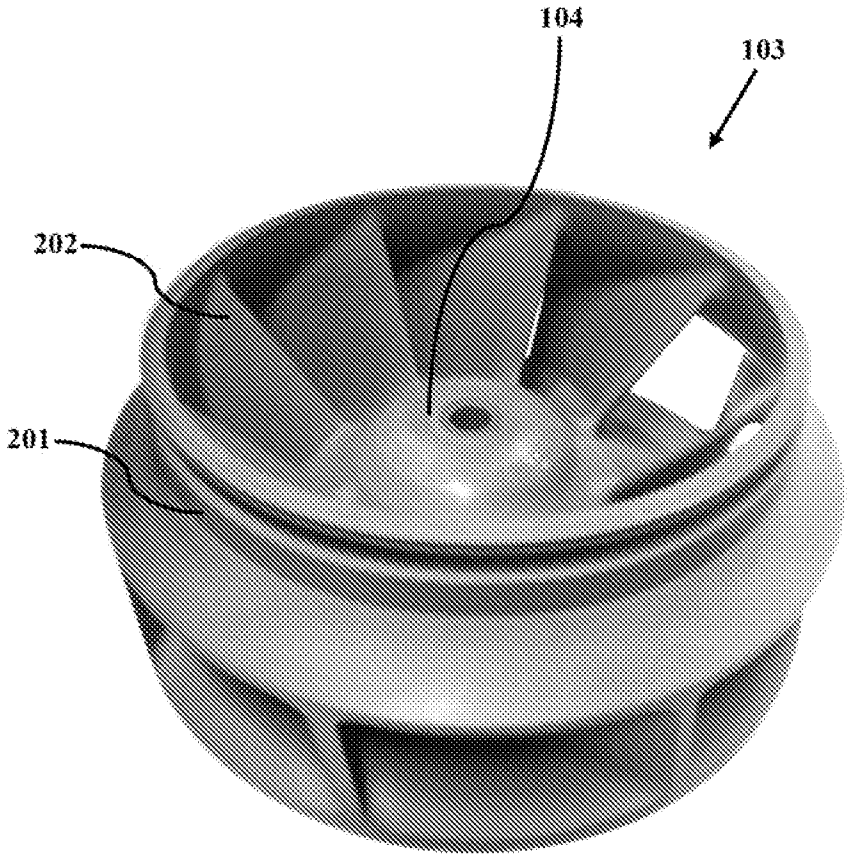


FIG. 2A

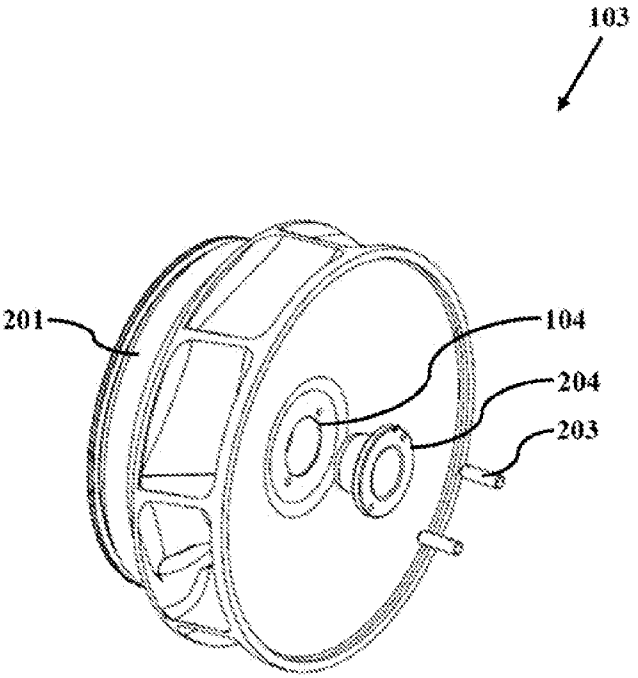


FIG. 2B

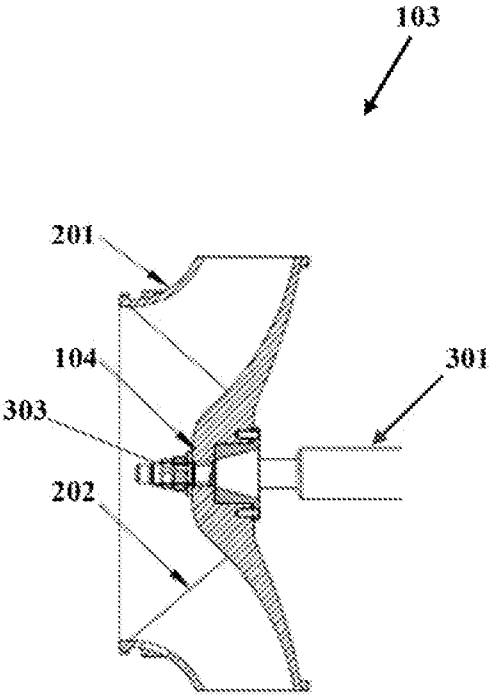


FIG. 3A

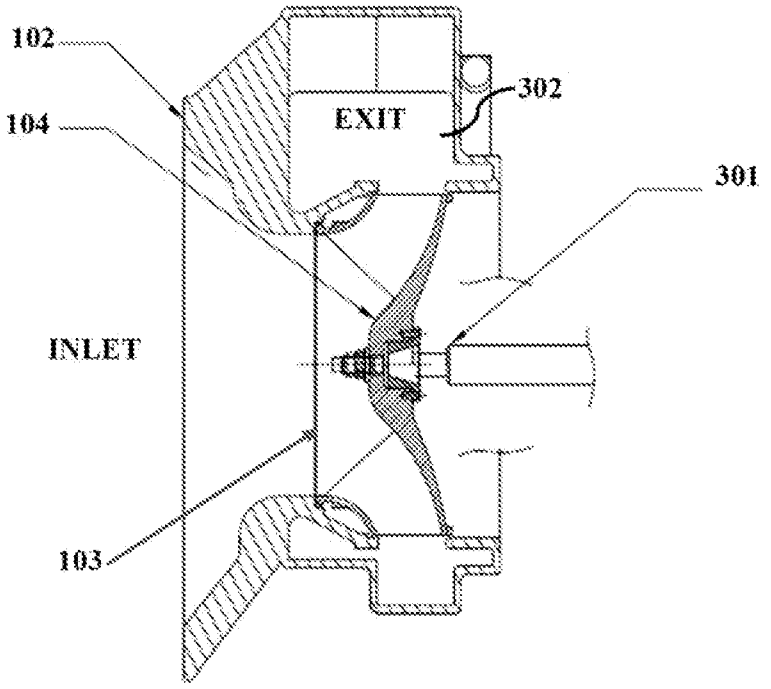


FIG. 3B

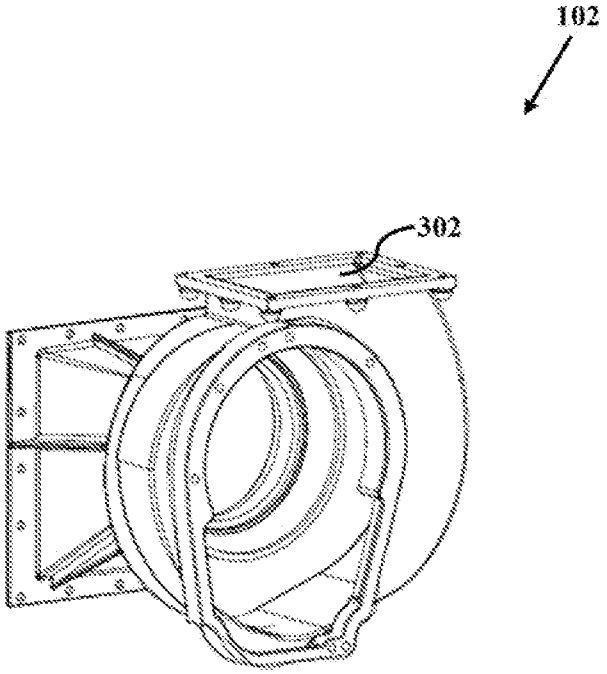


FIG. 4

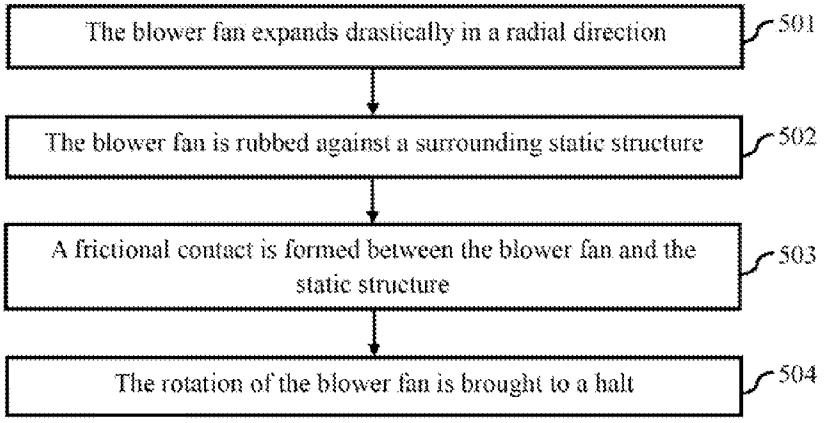

The blower fan expands drastically in a radial direction
501
The blower fan is rubbed against a surrounding static structure
502
A frictional contact is formed between the blower fan and the static structure
503
The rotation of the blower fan is brought to a halt
504

FIG. 5

SYSTEM AND METHOD FOR IMPLEMENTING INTRINSIC SAFETY IN ROTATING MACHINE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the priority of the Indian Provisional Patent Application No. 3755/CHE/2013 filed on Aug. 26, 2013, and postdated to Nov. 26, 2013 with the title "A System and Method of Implementing Intrinsic Safety in Rotating Structures", and the content of which is incorporated in entirety by reference herein.

BACKGROUND

[0002] 1. Technical Field

[0003] The embodiments herein generally relate to rotating machinery and particularly relates to a method for protecting the rotating structures from failures at high speed rotations. The embodiments herein more particularly relates to a system and method for providing an intrinsic safety to the rotating structures of the turbo machines against failure, more specifically disk burst.

[0004] 2. Description of the Related Art

[0005] Rotating structures are subject to the centrifugal forces which cause stresses. These stresses tend to exist in the radial and tangential directions of the rotating structures. In case the speed of the rotating component exceeds a certain critical value termed as the burst speed, the rotating structure fails catastrophically due to the stresses. For instance, in aircraft systems, it is essential that all systems be designed to contain all the fragments generated by such an event, internally. This leads to heavy and bulky structures for containment of the fragments.

[0006] In the case of the rotors in the steam turbine, the rotor is designed such that the operating speed is well below the burst speed. This results in the rotor being thick and bulky. In case of a disk burst or blade failure, the fragments cause a cascading failure of a multistage rotor.

[0007] Hence, there is a need for an improved system and a method for protecting the rotating machinery from catastrophic failure intrinsically.

OBJECTIVES OF THE EMBODIMENTS

[0008] The primary object of the embodiments herein relate to a system and method for providing an intrinsic safety to the rotating machines against the failure of high speed rotating structures.

[0009] Another object of the embodiments herein is to provide a method and system for preventing failure of rotating structures.

[0010] These and other objects and advantages of the embodiments herein will become readily apparent from the following detailed description taken in conjunction with the accompanying drawings.

SUMMARY

[0011] The various embodiments of the embodiments herein provide a system and method for providing an intrinsic safety to a rotating machinery from the failure of internal high speed rotating structures. The intrinsic safety system for a rotating machine comprises a blower fan which is a rotating structure and a blower casing for holding the blower fan. The blower fan is rotated under the influence of pressure from an incoming fluid. The blower fan further comprises a plurality of blades configured to assist the blower fan in drawing a required quantity of the in fluid, a hub configured to mount the blower fan on a shaft and a shroud configured to enclose the blades of the blower fan.

[0012] According to one embodiment herein, the plurality of blades imposes a centrifugal load on the hub and the shroud when rotated at high speeds.

[0013] According to one embodiment herein, the blower fan is mounted on a shaft through the hub, and wherein the blower fan and the shaft are assembled by means of a plurality of pins, a bushing and a lock nut.

[0014] According to one embodiment herein, the bushing and the plurality of pins are configured to position the shaft properly with respect the blower fan, and wherein a lock nut is adopted to tighten the blower fan to the shaft.

[0015] According to one embodiment herein, the blower fan further comprises a loading section and a loaded section, wherein the loaded section is the hub and the shroud and wherein the loading section comprises the plurality of blades.

[0016] According to one embodiment herein, the loading section of the blower fan is supported by at least two loaded sections, wherein the blower fan is designed to pro vide a dual redundant retention structure.

[0017] According to one embodiment herein, the hub and the shroud act as the retention structures in the presence of a crack in the blower fan, and wherein the retention structures provide a sufficient strength to bear the imposed loads to drastically reduce the chances of failure.

[0018] According to one embodiment herein, the plurality of blades is designed to drive a lame volume of fluid through the blower fan, and wherein the fluid enters the blower fan through the plurality of blades and exits through an exit duct.

[0019] According to one embodiment herein, the blower casing is configured to guide the fluid flow to a peripheral device attached to the rotating machine, through the exit duct.

[0020] According to one embodiment herein, the system adopts a rub and stop mechanism configured to halt the rotating blower fan, and wherein the rub and stops mechanism is initiated when the blower fan is rotated at a high speed exceeding a plurality of design parameters.

[0021] According to one embodiment herein, the rub and stop mechanism causes a rubbing of the blower fan against a surrounding static structure, and wherein the static structure surrounding the blower fan is the blower casing.

[0022] According to one embodiment herein, the blower fan is brought to halt due to a friction caused b rubbing of the blower fan with the surrounding static structure.

[0023] The various embodiments herein provide a method for providing an intrinsic safety to a rotating machine. The method comprising steps of expanding the blower tan drastically in a radial direction, when a blower fan is rotated at a high speed exceeding a plurality of design parameters. Due to the radial expansion of the blower fan, a surrounding static structure is rubbed against the blower fan. The rotation of the blower fan is stopped due to a frictional contacts between the blower fan and the surrounding static structure.

[0024] According to one embodiment herein, the radial expansion is sufficient to cause a rubbing against the surrounding static structures to bring the blower fan to a halt.

[0025] According to one embodiment herein, the frictional contact gradually reduces the speeds of the rotating blower fan and brings the rotating fan to a halt thereby providing an intrinsic safety to the rotating machine.

[0026] The embodiments herein provide a system and method for providing an intrinsic safety to a rotating machinery from the failure of internal high speed rotating structures. According to one embodiment, a system for an intrinsic safety to the rotating machinery comprises a unique design for the rotating structure to provide a sufficient safety margin and redundancy in configuration. The system comprises a blower fan assembled inside a blower casing. The blower fan is the rotating structure which rotates inside the blower casing and is manufactured by machining from a single forging instead of an investment casting. The blower fan comprises a plurality of blades, a hub and a shroud. The plurality of blades assists in drawing a required quantity of the fluid such as air. The blower fan is mounted to a shaft through the hub. The shroud encloses the blades of the blower fan. When the blower fan is rotated at a high speed exceeding the design parameters, a 'rub and stop' mechanism is initiated to halt the rotation of the blower fan.

[0027] According to one embodiment herein, the rotating structure such as a blower fan comprises a loading section and a loaded section. The loaded section is the hub and the shroud, while the loading section comprises the plurality of blades. The blower fan is designed such that the loading section of is supported by two loaded sections and hence provides a dual redundant retention mechanism/structure. This design to facilitates an intrinsic safety for the rotating machines.

[0028] According to one embodiment herein, a 'rub and stop' mechanism halts the blower fan rotating at undesirable high speeds. The 'rub and stop' mechanism causes rubbing of blower fan against a surrounding static structures such as blower casing. When the blower fan is rotated at a high speed exceeding the design parameters, the blower fan yields drastically in a radial direction. The radial expansion is sufficient to cause a rubbing against the surrounding static structures to bring the blower fan to a halt. This mechanism is termed rub and stop.

[0029] According to one embodiment herein, the rub and stop mechanism is devised based on frictional contact between a high speed rotating part and an enclosure of the rotating part. The frictional contact gradually reduces the speed of the rotating part and brings the rotating part to a halt thereby providing an intrinsic safety to the rotating machine.

[0030] According to one embodiment herein, a method of designing rotating machinery against failure is provided. The method facilities a greater safety for the turbine disks against failure. Further, the design of the disk described prevents any chance of disk burst by means of the construction. The method is applicable to all rotating machinery.

[0031] These and other aspects of the embodiments herein will be better appreciated and understood when considered in conjunction with the following description and the accompanying drawings. It should be understood, however, that the following descriptions, while indicating the preferred embodiments and numerous specific details thereof, are given by way of an illustration and not of a limitation. Many changes and modifications may be made within the scope of the embodiments herein without departing from the spirit thereof, and the embodiments herein include all such modifications.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The other objects, features and advantages will occur to those skilled in the art from the following description of the preferred embodiment and the accompanying drawings in which:

[0033] FIG. **1** illustrates a rear perspective view of an oil cooling system assembly, according to one embodiment herein.

[0034] FIG. **2**A illustrates a perspective view of the blower fan, according to one embodiment herein.

[0035] FIG. **2**B illustrates a rear isometric view of the blower fan, according to one embodiment herein.

[0036] FIG. **3**A illustrates a cross sectional view of a blower fan, according to one embodiment herein.

[0037] FIG. **3**B illustrates a cross sectional view of the blower fan mounted to a shaft and assembled in a blower casing, according to one embodiment herein.

[0038] FIG. **4** illustrates a blower casing for enclosing the blower fan, according to one embodiment herein.

[0039] FIG. **5** illustrates a flowchart indicating a method for providing an intrinsic safety to rotating machinery, according to one embodiment herein.

[0040] Although the specific features of the embodiments herein are shown in some drawings and not in others. This is done for convenience only as each feature may be combined with any or all of the other features in accordance with the embodiments herein.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0041] In the following detailed description, a reference is made to the accompanying drawings that form a part hereof, and in which the specific embodiments that may be practiced is shown by way of illustration. These embodiments are described in sufficient detail to enable those skilled in the art to practice the embodiments and it is to be understood that the logical, mechanical and other changes may be made without departing from the scope of the embodiments. The following detailed description is therefore not to be taken in a limiting sense.

[0042] The various embodiments herein provide a system and method for providing an intrinsic safety to a rotating machinery from the failure of internal high speed rotating structures. The intrinsic safety system for a rotating machine comprises a blower fan which is a rotating structure and a blower casing for holding the blower fan. The blower fan is rotated under the influence of pressure from an incoming fluid. The blower fan further comprises a plurality of blades configured to assist the blower fan in drawing a required quantity of the fluid, a hub configured to mount the blower fan on a shaft and a shroud configured to enclose the blades of the blower fan.

[0043] According to one embodiment herein, the plurality of blades imposes a centrifugal load on the hub and the shroud when rotated at high speeds.

[0044] According to one embodiment herein, the blower fan is mounted on a shaft through the hub, and wherein the blower fan and the shaft are assembled by means of a plurality of pins, a bushing and a lock nut.

[0045] According to one embodiment herein, the bushing and the plurality of pins are configured to position the shaft properly with respect the blower fan, and wherein a lock nut is adopted to tighten the blower fan to the shaft.

[0046] According to one embodiment herein, the blower fan further comprises a loading section and a loaded section, wherein the loaded section is the hub and the shroud and wherein the loading section comprises the plurality of blades.

[0047] According to one embodiment herein, the loading section of the blower fan is supported by at least two loaded sections, wherein the blower fan is designed to provide a dual redundant retention structure.

[0048] According to one embodiment herein, the hub and the shroud act as the retention structures in the presence of a crack in the blower fan, and wherein the retention structures provide a sufficient strength to bear the imposed loads to drastically reduce the chances of failure.

[0049] According to one embodiment herein, the plurality of blades is designed to drive a large volume of fluid through the blower fan, and wherein the fluid enters the blower fan through the plurality of blades and exits through an exit duct.

[0050] According to one embodiment herein, the blower casing is configured to guide the fluid flow to a peripheral device attached to the rotating machine, through the exit duct.

[0051] According to one embodiment herein, the system adopts a rub and stop mechanism configured to halt the rotating blower fan, and wherein the rub and stops mechanism is initiated when the blower fan is rotated at a high speed exceeding a plurality of design parameters.

[0052] According to one embodiment herein, the rub and stop mechanism causes a rubbing of the blower fan against a surrounding static structure, and wherein the static structure surrounding the blower fan is the blower casing.

[0053] According to one embodiment herein, the blower fan is brought to halt due to a friction caused by rubbing of the blower fan with the surrounding static structure.

[0054] The various embodiments herein provide a method for providing an intrinsic safety to a rotating machine. The method comprising steps of expanding the blower fan drastically in a radial direction, when a blower fan is rotated at a high speed exceeding a plurality of design parameters. Due to the radial expansion of the blower fan, a surrounding static structure is rubbed against the blower fan. The rotation of the blower fan is stopped due to a frictional contact between the blower fan and the surrounding static structure.

[0055] According to one embodiment herein, the radial expansion is sufficient to cause a rubbing against the surrounding static structures to bring the blower fan to a halt.

[0056] According to one embodiment herein, the frictional contact gradually reduces the speed of the rotating blower fan and brings the rotating an to a halt thereby providing an intrinsic safety to the rotating machine.

[0057] The embodiments herein provide a system and method for providing an intrinsic safety to rotating machinery from the failure of internal high speed rotating structures. According to one embodiment herein, a system for an intrinsic safety to the rotating machinery comprises a unique design for the rotating structure to provide a sufficient safety margin and redundancy in configuration. The system comprises a blower fan assembled inside a blower casing. The blower fan is the rotating structure which rotates inside the blower casing and is manufactured from a single forging. The blower fan comprises a plurality of blades, a hub and a shroud. The plurality of blades assists in drawing a required quantity of the fluid, such as water, oil, air and the like. The blower fan is mounted to a shaft through the hub. The shroud encloses the blades of the blower fan. When the blower fan is rotated at a high speed exceeding the design parameters, a rub and stops mechanism is initiated to halt the rotation of the blower fan.

[0058] According to one embodiment herein, the rotating structure such as a blower fan comprises a loading section and a loaded section. The loaded section is the hub and the shroud, while the loading section comprises the plurality of blades. The blower fan is designed such that the loading section is supported by two loaded sections and hence provides a dual redundant retention mechanism/structure. This design facilitates an intrinsic safety for the rotating machines.

[0059] According to one embodiment herein, a rub and stop mechanism halts the blower fan rotating at undesirable high speeds. The rub and stop mechanism causes rubbing of the blower fan against a surrounding static structures such as blower casing. When the blower fan is rotated at a high speed exceeding the design parameters, the blower fan yields drastically in a radial direction. The radial expansion is sufficient to cause a rubbing against the surrounding static structures to bring the blower fan to a halt. This mechanism is termed rub and stop.

[0060] According to one embodiment herein, the rub and stop mechanism is devised based on a frictional contact between a high speed rotating part and an enclosure of the rotating part. The frictional contact gradually reduces the speed of the rotating part and brings the rotating part to a halt thereby providing an intrinsic safety to the rotating machine.

[0061] According to one embodiment herein, a method of designing rotating machinery against failure is provided. The method facilities a greater safety for the turbine disks against failure. Further, the design of the disk prevents any chance of disk burst by virtue of the construction. The method is applicable to all rotating machineries. Still further, the method is applicable in turbo machinery industry, power industry, etc.

[0062] FIG. **1** illustrates a rear isometric, view of an oil cooling system assembly, according to one embodiment herein. The system assembly comprises a blower casing **102**, a blower fan **103** and a heat exchanger **101**. The FIG. **1** shows a rear view of the blower fan **103**. The blower fan **103** is the rotating structure and is enclosed within the blower casing **102**. The blower fan **103** is mounted on a shaft (not shown) through a hub **104**. The blower fan **103** is used to channelize the fluid through the heat exchanger duct **101** in the oil cooling system. When the blower fan **103** is rotated at speeds greater than a normal value, the blower fan **103** expands/yields drastically. The blower fan **103** yields, and starts rubbing against the inner surface of the blower casing **102**, which causes the blower fan **103** to come to a standstill and thus prevents a disc burst.

[0063] FIGS. **2**A and **2**B illustrate the top and rear isometric views of the blower fan, according to one embodiment herein. The blower fan **103** comprises a complex three dimensional (3D) profile and is machined from a single forging instead of an investment casting or similar method. A suitable material with desirable properties of elongation and strength is chosen for the forging. The blower fan **103** comprises as plurality of blades **202**. The plurality of blades **202**, when rotated at high speeds, imposes a centrifugal load on the hub **104** and on a shroud **201**. The shroud **201** is the peripheral structure surrounding the plurality of blades **202**. The blower fan **103** is categorized to a loaded section and a loading section. The loaded section comprises the hub **104** and the shroud **201**, while the loading section comprises the plurality of blades **202**. The hub **104** is the central portion of the blower fan **103**, whilst the shroud **201** is the peripheral portion of the blower fan **103**. The blower fan **103** is mounted to a shaft through the hub **104** and is assembled by means of pins **203**, a bushing **284** and a lock nut **303**. The hub **104** and the shroud **201** act as the retention structures in the presence of a crack in the blower fan **103**. The presence of two retention structures like the hub

104 and the shroud **201** provides a sufficient strength to bear the imposed loads to drastically reduce the chances of failure. This method of dual redundant design virtually eliminates all the possibilities for a catastrophic failure.

[0064] FIG. **3**A illustrates a cross sectional view of a blower fan, according to one embodiment herein. The blower fan **103** is mounted to a shaft **301** at the hub **104**. The plurality of blades **202** is designed as to to drive a large volume of fluid efficiently. The shaft **301** is attached to the blower fan **103** by means of a bushing **204** and pins **203** (as shown in FIG. **2***b*). The bushing and pins serve to position the shaft properly with respect the blower fan **103**. The lock nut **303** is used, (as shown in FIG. **3**) to tighten the blower fan to the shaft.

[0065] FIG. **3**B illustrates a cross sectional view of the blower fan mounted to a shaft and assembled in a blower casing, according to one embodiment herein. The blower fan **103** when made from a forging has greater capacity to expand plastically and hence has well over speed capacity. The blower fan **103** is assembled inside a blower casing **102**. The fluid enters through the plurality of blades and exits through the exit duct **302**. The blower fan **103** is mounted to the shaft **301** and rotates when the shaft **301** is rotated. The shaft **301** is coupled with he blower fan **103** through the hub **104**.

[0066] FIG. **4** illustrates a blower casing for enclosing the blower fan, according to one embodiment herein. The blower casing **102** is used to guide the fluid flow to the heat exchanger through the exit duct **302**. The fluid is then used to cool the oil in the oil cooling system.

[0067] FIG. **5** illustrates a flowchart indicating a method for providing an intrinsic safety to rotating machinery, according to one embodiment herein. The method comprises steps of expanding the blower fan drastically in a radial direction, when a blower fan is rotated at a high speed (**501**). The run and stop mechanism causes the blower fan to yield drastically in a radial direction, when the fan exceeds a plurality of design parameters. The radial expansion of the blower fan causes a rubbing of the blower fan against a surrounding static structure (**502**). The static surface surrounding the blower fan is the blower casting which makes a frictional contact with the blower fan, due to the radial expansion (**503**). The frictional contact enables the rotation of the blower fan to be brought a halt, thus preventing a disk burst (**504**).

[0068] The embodiments herein provide a system and method designed for rotating machinery for safeguarding against failure. The system facilities a greater safety for the turbine disks against failure. Further, the design of the disk prevents any chance of disk burst by virtue of the construction. The system and method is applicable to all rotating machineries. Still further, the system and method is applicable in turbo machinery industry, power industry, etc.

[0069] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments.

[0070] It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modifications.

[0071] Although the embodiments herein are described with various specific embodiments, it will be obvious for a person skilled in the art to practice the embodiments herein with modifications.

[0072] It is also to be understood that the following claims are intended to cover all of the generic and specific features of the embodiments described herein and all the statements of the scope of the embodiments which as a matter of language might be said to fall there between.

What is claimed is:

1. An intrinsic safety system for a rotating machine comprising:

a rotating structure and wherein the rotating structure a is a blower fan, and wherein the blower fan is rotated under the influence of pressure from an incoming fluid, an wherein the blower fan comprises a plurality of blades configured to assist the blower fan in drawing a required quantity of the fluid, a hub configured to mount the blower fan on a shaft and a shroud configured to enclose the blades of the blower fan;

a blower casing configured for holding the blower fan;

a rub and stop mechanism configured to halt the rotating blower fan, wherein the rub and stops mechanism is initiated when the blower fan is rotated at a high speed exceeding a plurality of design parameters, and wherein the rub and stop mechanism causes a rubbing of the blower fan against a surrounding static structure, and wherein the static structure surrounding the blower fan is the blower casing.

2. The system according to claim **1**, wherein the plurality of blades imposes a centrifugal load on the hub and the shroud when rotated at high speeds.

3. The system according to claim **1**, wherein the blower fan is mounted on the shaft through the hub, and wherein the blower fan and the shaft are assembled with a help of a plurality of pins, a bushing and a lock nut.

4. The system according to claim **1**, wherein the bushing and the plurality of pins are configured to position the shaft properly with respect the blower fan, and wherein the lock nut is adopted to tighten the blower fan to the shaft.

5. The system according to claim **1**, wherein the blower fan further comprises a loading section and a loaded section, wherein the loaded section is the hub and the shroud and wherein the loading section comprises the plurality of blades.

6. The system according to claim **1**, wherein the loading section of the blower fan is supported by at least two loaded sections, wherein the blower fan is designed to provide a dual redundant retention structure.

7. The system according to claim **1**, wherein the hub and the shroud act as the retention structures when a crack is present in the blower fan, and wherein the retention structures provide a desired strength to bear the imposed loads to reduce a failure.

8. The system according to claim **1**, wherein the plurality of blades is designed to drive a large volume of fluid through the blower fan, and wherein the fluid enters the blower fan through the plurality of blades and exits through an exit duct.

9. The system according to claim **1**, wherein the blower casing is configured to guide the fluid flow to a peripheral device attached to the rotating machine, through the exit duct.

10. The system according to claim **1**, wherein the blower fan is brought to halt due to a friction caused by rubbing of the blower fan with the surrounding static structure.

11. A method for providing an intrinsic safety to a rotating machine, comprising steps of:

expanding a blower fan in a radial direction, when a blower fan is rotated at a high speed exceeding a plurality of design parameters;

rubbing the blower fan against a surrounding static structure, due to the radial expansion of the blower fan; and

stopping a rotation of the blower fan due to a frictional contact between the blower fan and the surrounding static structure.

12. The method according to claim **11**, wherein the blower fan is radially expanded to cause a rubbing against the surrounding static structures to bring the blower fan to a halt.

13. The method according to claim **11**, wherein the frictional contact reduces a speed of the rotating blower fan and brings the rotating fan to a halt thereby providing an intrinsic safety to the rotating machine.

* * * * *