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TURBINE DIAPHRAGM

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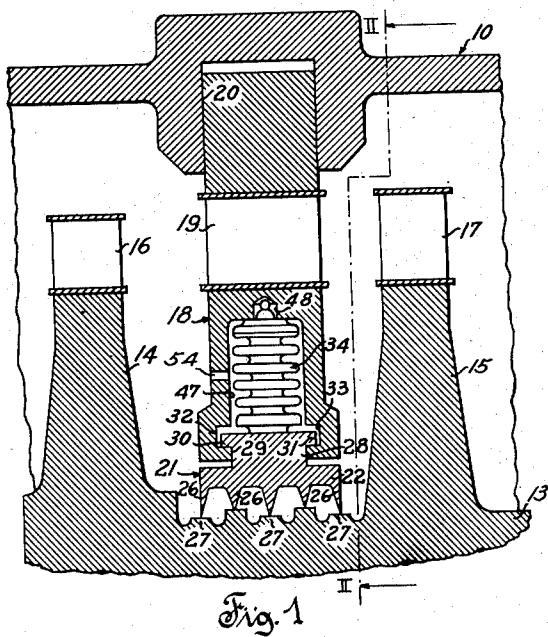
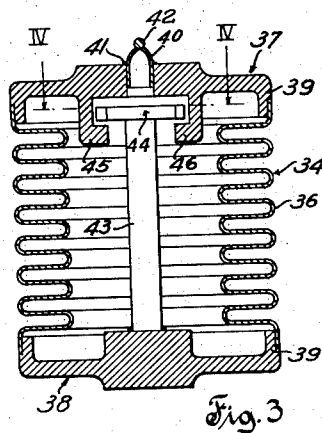
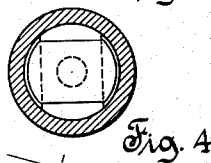
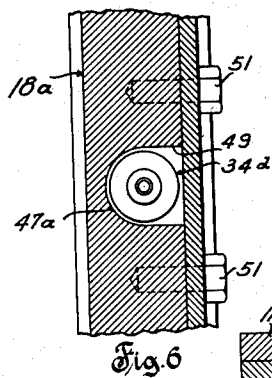
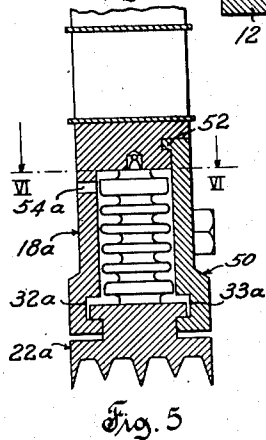
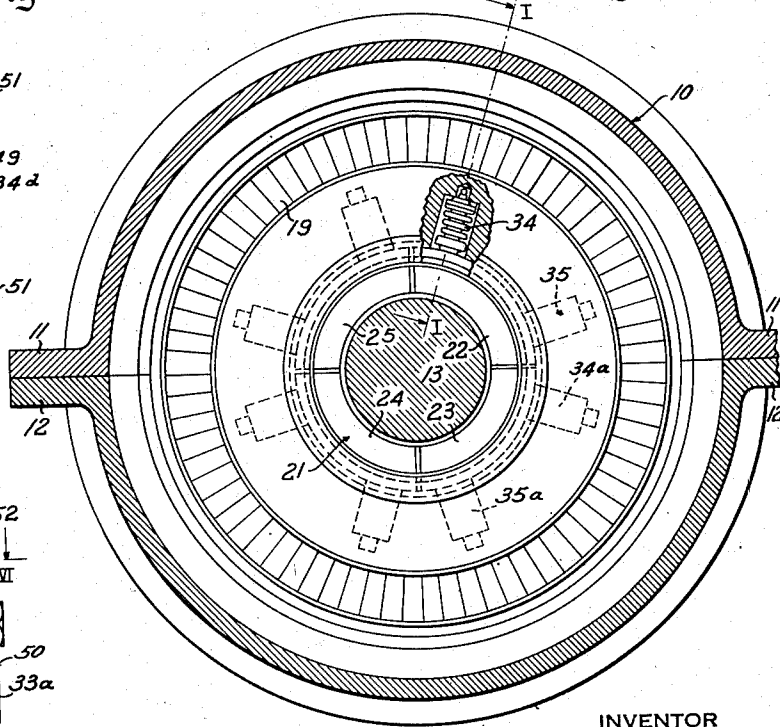


Fig. 2

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TURBINE DIAPHRAGM

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This invention relates to means providing a diaphragm in a turbine constructed and arranged for operation by elastic fluid, and especially in a turbine where the operating fluid is utilized at high temperatures. The invention is adapted to be embodied in a gas turbine, and, more specifically, the invention relates to diaphragm means in which is embodied sealing means between the diaphragm means proper and the turbine shaft. The principal object of the invention is to provide new and improved diaphragm means of these types.

The usual steam turbine practice of supporting diaphragm seal ring means by means of springs, the construction and arrangement being such as to permit the seal ring means to deflect when contacted by the shaft, cannot be used in gas turbines because the springs relax at the high temperatures prevailing. It is an object of the invention to provide new and improved diaphragm means comprising seal ring means which will obviate this difficulty.

A more specific object of the invention is the provision of new and improved diaphragm means comprising seal ring means in which the seal ring means is resiliently biased toward the shaft and will resiliently yield and deflect when contacted by the shaft, and wherein the resilience is unaffected by the high temperatures prevailing.

A still more specific object of the invention is the provision of new and improved diaphragm means comprising seal ring means in which the resilience of an elastic fluid or gas is utilized to provide the desired resilient biasing and yielding effect.

Other objects will appear hereinafter as the description of the invention proceeds.

The novel features of the invention and how the objects are attained will appear from this specification and the accompanying drawing showing several embodiments thereof and forming a part of this application, and all these novel features are intended to be pointed out in the claims.

In the drawing, Fig. 1 is an enlarged longitudinal sectional view, on the line I—I of Fig. 2 looking in the direction of the arrows, showing a fragment of a half-section of a gas turbine embodying the invention;

Fig. 2 is a section, on a reduced scale, taken on the line II—II of Fig. 1, looking in the direction of the arrows, partly broken away to show one of the biasing elements;

Fig. 3 is a longitudinal sectional view, on an enlarged scale, of a biasing means element used in the embodiment of Figs. 1 and 2;

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Fig. 4 is a fragmentary sectional view taken on the line IV—IV of Fig. 3, looking in the direction of the arrows;

Fig. 5 is a fragmentary radial sectional view of a detail illustrating another embodiment; and

Fig. 6 is a fragmentary sectional view taken on the line VI—VI of Fig. 5, looking in the direction of the arrows.

The turbine illustrated comprises a stator and a rotor. The stator includes a cylinder or casing 10 surrounding the rotor. As shown in Fig. 2 the casing 10 is made in segmental halves having cooperable pairs of flanges 11, 12 which may be fastened together by bolts (not shown) or in any suitable way. The rotor includes a spindle or shaft 13. The shaft 13 is here shown as carrying wheels 14, 15 each of which is provided at its outer periphery with a set of radially extending circumferentially spaced vanes or blades 16, 17.

Disposed between the wheels 14, 15 and supported across the space between the shaft 13 and the stator casing 10 is diaphragm means. The diaphragm means is here shown as comprising a single ring means 18 which, similarly to the casing 10, may be made in segmental halves fastened together in any suitable way. Interposed in and forming a part of the ring means 18 are a plurality of blades 19 providing nozzles for directing gas against the blades 17 of the wheel 15.

The ring means 18 is here shown as having its outer annular periphery constructed and arranged for lost motion connection with the stator, to permit expansion and contraction of the ring means, the outer periphery, as here shown, being adapted to fit slidably in an annular recess 20 in a wall portion of the stator casing 10. Any suitable centering means (not shown) may be provided for maintaining the ring means 18 coaxial with the casing 10 and hence coaxial with the normal position of the axis of the shaft 13.

Carried by the ring means 18 at its inner periphery is seal ring means 21, here shown (see Fig. 2) as comprising four arcuate segments 22, 23, 24, 25, each of approximately 90°. It will be understood that the number of segments may be a desired suitable number other than four.

Each segment 22—25 is provided with a desired number of axially spaced, arcuate V-shaped projections 26 the points of which are cooperable with annular projections 27 on the shaft 13 to prevent passage of gas, at the shaft, from one side of the diaphragm means 18, 21, to the other as will be understood by those skilled in the art. Each segment 22—25 is here shown as having a portion 28 (see for example segment 22, Fig. 1),

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of reduced axial width which fits slidably in an annular recess 29 in the inner periphery of the ring means 13. Radially inward movement of each segment is here shown as limited by the provision of laterally extending arcuate flanges 30, 31 on the reduced portion 28, the flanges being disposed in annular recesses 32, 33 extending in opposite axial directions into the opposite walls of the recess 29. In the position of the parts shown, when the flanges 30, 31 are in engagement with the radially inner surfaces of the recesses 32, 33, the points of the V-shaped projections 26 are in the desired close juxtaposition with the annular projections 27. Also, in this position of the parts a desired suitable clearance exists between the radially outer surface of the flanges 30, 31 and the radially outer surfaces of the recesses 32, 33. Each segment 22-25 is resiliently, yieldably held in the desired position by biasing means which, in this instance, includes two elements for each segment, cooperable with circumferentially spaced portions of the respective segment. Referring to segment 22 by way of example, this segment is biased by two elements 34, 35, and as seen in Fig. 2, one of the biasing elements 34 is here shown as positioned to act against the segment 22 at or near one end thereof and the other element 35 is positioned to act against the segment 22 at or near the other end thereof. The segment 23 is similarly biased by elements 34a, 35a, the remaining segments being similarly biased by pairs of elements.

Referring now to Fig. 3 which shows one of the biasing elements in detail, the element 34 is in the nature of a capsule and comprises a bellows 36 made of suitable metallic material or other suitable heat resistant material. The bellows 36 is conveniently made of generally cylindrical form and provided with generally disk-form end covers 37, 38. The ends of the bellows 36 are welded or otherwise suitably fastened, gas tight, to the covers 37, 38, the covers being here shown as provided with annular flanges 39 which are recessed to accommodate the ends of the bellows.

The cover 37 is here shown as provided with a gas inlet tube 40 welded at 41, or otherwise suitably fastened, gas tight, in an aperture in the cover. Gas may be introduced into the bellows 36 through the tube 40, the tube being sealed by welding 42, when the gas pressure within the bellows is at a desired selected value. Thus the element 34 is hermetically sealed so that the desired internal gas pressure will be retained permanently.

Desirably, means is provided to prevent excessive expansion of the bellows 36. Such means is here shown as comprising a rod 43 which may be welded to an inside surface of the cover 38, the rod being provided with a head 44 engageable with projections 45, 46 extending radially inward from the end of a flange extending axially from the inside of the cover 37. The head 44 and projections 45, 46 may be so formed that these parts may be readily assembled, the head being here shown as constructed and arranged so that it will pass through a gap between the projections, the parts being then turned 90° to the position shown in Fig. 4, before the bellows 36 is welded to the cover 37 or the cover 38.

Desirably, a suitable clearance exists between the under surface of the head 44 and the adjacent surfaces of the projections 45, 46 when the element 34 has been completed. A suitable clearance also exists between the upper surface of

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the head 44 and the adjacent under side of the cover 37 to permit compression of the element as will appear.

The elements 34, 35, and so on, are freely disposed in recesses extending radially into the ring means 18. One of these recesses, 47, is shown in section in Fig. 1. The construction and arrangement is such that the cover 37 engages the end of the recess 47 and the cover 38 engages the radially outer surface of the seal ring means 22. As here shown a small radially extending recess 48 is provided to accommodate the free end of the tube 40.

It will be understood that the elements 34, 35 may be placed in the respective recesses 47 and the flanges 30, 31 of the segment 22, for example, inserted into the annular recesses 32, 33 by circumferential movement. If desired, recesses 47a, corresponding to recesses 47, may be made axially accessible by forming them with an aperture 49 extending axially into a face of ring means 18a as shown in Fig. 6, the ring means 18a corresponding to ring means 18. A seal ring segment 22a and a biasing element 34d may then be assembled sidewise with the ring means 18a, and held in position by a plate 50 fastenable by screws 51 to the ring means 18a, the plate 50 having an annular recess 33a corresponding to the annular recess 33 of Fig. 1, and being here shown as having an annular axially extending flange 52 cooperating with an annular recess in the ring means 18a.

It will be evident that the elements 34, 35 and so on will resiliently bias the seal ring means 21 toward the shaft 13 and one or more of the elements will resiliently yield to permit radial local movement or deflection of the seal ring means in accordance with the particular radial direction and amount of movement of the shaft 13. The clearance between the head 44 and the adjacent inner surface of the cover 37, and the clearance between the radially outer surfaces of the flanges 30, 31 and the radially outer surfaces of the recesses 32, 33, are made sufficient to allow for the maximum anticipated movement of the seal ring means 21 by reason of radial movement of the shaft 13. It will also be evident that the biasing force provided by the biasing elements 34, 35 and so on will not be lessened under high temperature conditions.

Desirably, but not essentially, a small hole 54 (Fig. 1) is provided, this hole placing the recess 47 in communication with the upstream side of the diaphragm means. This is to assure that the external fluid pressure on the bellows 36 is the same as that at the upstream side of the diaphragm means. It will be understood that a similar hole 54 may be provided for each recess 47. The hole 54a, Fig. 5, corresponds to the hole 54.

From the foregoing it will be apparent to those skilled in the art that the illustrated embodiments of the invention provide new and improved turbine diaphragms and accordingly accomplish the objects of the invention. On the other hand, it will also be obvious to those skilled in the art that the illustrated embodiments of the invention may be variously changed and modified, or features thereof singly or collectively, embodied in other combinations than those illustrated without departing from the spirit of the invention, or sacrificing all of the advantages thereof, and that, accordingly, the disclosed embodiments are illustrative only, and the invention is not limited thereto.

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It is claimed and desired to secure by Letters Patent:

1. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, comprising: at least two concentric parts; lost motion connection means between said parts permitting relative radial movement therebetween; one of said parts having at least one recess the opening of which faces toward the other of said parts; and resilient means for biasing said parts radially away from each other, said biasing means including at least one hermetically sealed receptacle containing elastic fluid, said receptacle being disposed in said recess and removable therefrom merely by relative movement of said receptacle and recess, said receptacle when in said recess yieldingly permitting relative radial movement of at least a portion of said parts.

2. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, comprising: primary diaphragm means cooperable with and movable radially in sealing relation with respect to said annular wall, said diaphragm means having a plurality of circumferentially spaced recesses; sealing means including a plurality of segments forming a ring about and cooperable with said shaft and cooperable with and movable radially with respect to said primary diaphragm means; the openings of said recesses facing toward said sealing means and resilient means for biasing said sealing means toward said shaft, said biasing means including a plurality of hermetically sealed bellows of heat resistant material containing an inert gas, said plurality of bellows being disposed in said recesses respectively and removable therefrom merely by relative movement of said bellows and the respective recesses, said bellows when in said recesses yieldingly permitting radial movement of said segments respectively.

3. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, comprising: at least two concentric parts; lost motion connection means between said parts permitting relative radial movement therebetween; one of said parts having at least one recess the opening of which faces toward the other of said parts; resilient means for biasing said parts radially away from each other, said biasing means including at least one hermetically sealed receptacle containing elastic fluid, said receptacle being disposed in said recess and removable from said recess merely by relative movement of said receptacle and recess, said receptacle when in said recess yieldingly permitting relative radial movement of at least a portion of said parts; and means whereby the fluid pressure in said recess is equalized with the fluid pressure within said annular wall at a selected side of said diaphragm means.

4. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including relatively radially movable parts, and means for yieldingly biasing said parts radially away from each other comprising hermetically sealed receptacle means

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containing elastic fluid, reacting oppositely radially toward said parts.

5. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including primary diaphragm means cooperable with and movable radially in sealing relation with respect to said annular wall, sealing means cooperable with said shaft and cooperable with and movable radially with respect to said primary diaphragm means, and means for yieldingly biasing said sealing means toward said shaft comprising hermetically sealed receptacle means containing elastic fluid, reacting oppositely radially toward said primary diaphragm means and said sealing means.

6. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including relatively radially movable parts, and means for yieldingly biasing said parts radially away from each other comprising a plurality of circumferentially spaced hermetically sealed receptacles containing elastic fluid, individually reacting radially oppositely toward said parts.

7. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including relatively radially movable parts, and means for yieldingly biasing said parts radially away from each other comprising a hermetically sealed bellows containing an inert gas, reacting radially oppositely toward said parts.

8. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including primary diaphragm means cooperable with and movable radially in sealing relation with respect to said annular wall, sealing means cooperable with said shaft and cooperable with and movable radially with respect to said primary diaphragm means, and means for yieldingly biasing said sealing means toward said shaft comprising a hermetically sealed bellows of heat resistant material containing an inert gas, reacting oppositely radially toward said primary diaphragm means and said sealing means.

9. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including at least two concentric parts, lost motion connection means between said parts permitting relative radial movement therebetween; one of said parts having at least one recess facing an adjacent one of said parts, and means for yieldingly biasing said parts radially away from each other comprising at least one hermetically sealed receptacle containing elastic fluid disposed in said recess and reacting oppositely radially toward said adjacent parts.

10. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including primary diaphragm means cooperable with and movable radially in

sealing relation with respect to said annular wall, sealing means including a plurality of segments forming a ring about and cooperable with said shaft and cooperable with and movable radially with respect to said primary diaphragm means, and means for yieldingly biasing said sealing means toward said shaft comprising a plurality of hermetically sealed receptacles containing elastic fluid, reacting oppositely radially toward said primary diaphragm means and said sealing means.

11. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including primary diaphragm means cooperable with and movable radially in sealing relation with respect to said annular wall, sealing means including a plurality of segments forming a ring about and cooperable with said shaft and cooperable with and movable radially with respect to said primary diaphragm means, and means for yieldingly biasing said sealing means toward said shaft comprising a plurality of hermetically sealed bellows of heat resistant material containing an inert gas, individually reacting radially oppositely toward said primary diaphragm means and said sealing means.

12. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including primary diaphragm means cooperable with and movable radially in sealing relation with respect to said annular wall, said diaphragm means having a plurality of circumferentially spaced radially directed recesses, sealing means including a plurality of segments forming a ring about and cooperable with said shaft and cooperable with and movable radially with respect to said primary diaphragm means, and means for yieldingly biasing said sealing means toward said shaft comprising a plurality of hermetically sealed bellows of heat resistant material containing an inert gas, disposed in said recesses respectively and individually reacting radially oppositely toward said primary diaphragm means and said sealing means.

13. Means providing a diaphragm for the space

between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including relatively radially movable parts, means for yieldingly biasing said parts radially away from each other comprising hermetically sealed receptacle means containing elastic fluid, reacting radially oppositely toward said parts, and means whereby the external fluid pressure on said receptacle means is equalized with the fluid pressure within said annular wall at a selected side of said diaphragm means.

14. Means providing a diaphragm for the space between the rotor shaft and an annular wall surrounding said rotor shaft of a turbine constructed and arranged for operation by elastic fluid, said diaphragm means including at least two concentric parts, lost motion connection means between said parts permitting relative radial movement therebetween, one of said parts having at least one radially facing recess; means for yieldingly biasing said parts radially away from each other comprising at least one hermetically sealed receptacle containing elastic fluid disposed in said recess and reacting radially oppositely toward said parts, and means whereby the fluid pressure in said recess is equalized with the fluid pressure within said annular wall at a selected side of said diaphragm means.

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