Nov. 21, 1950 J. L. RAY 2,530,908

TURBINE DIAPHRAGM

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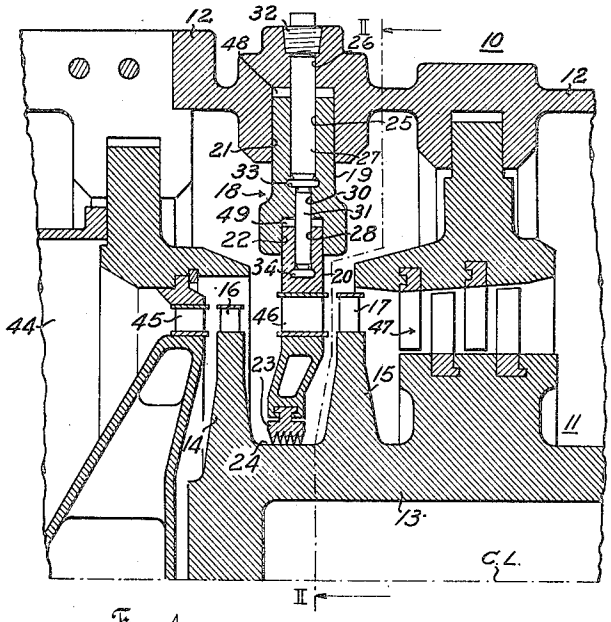


Fig. 1

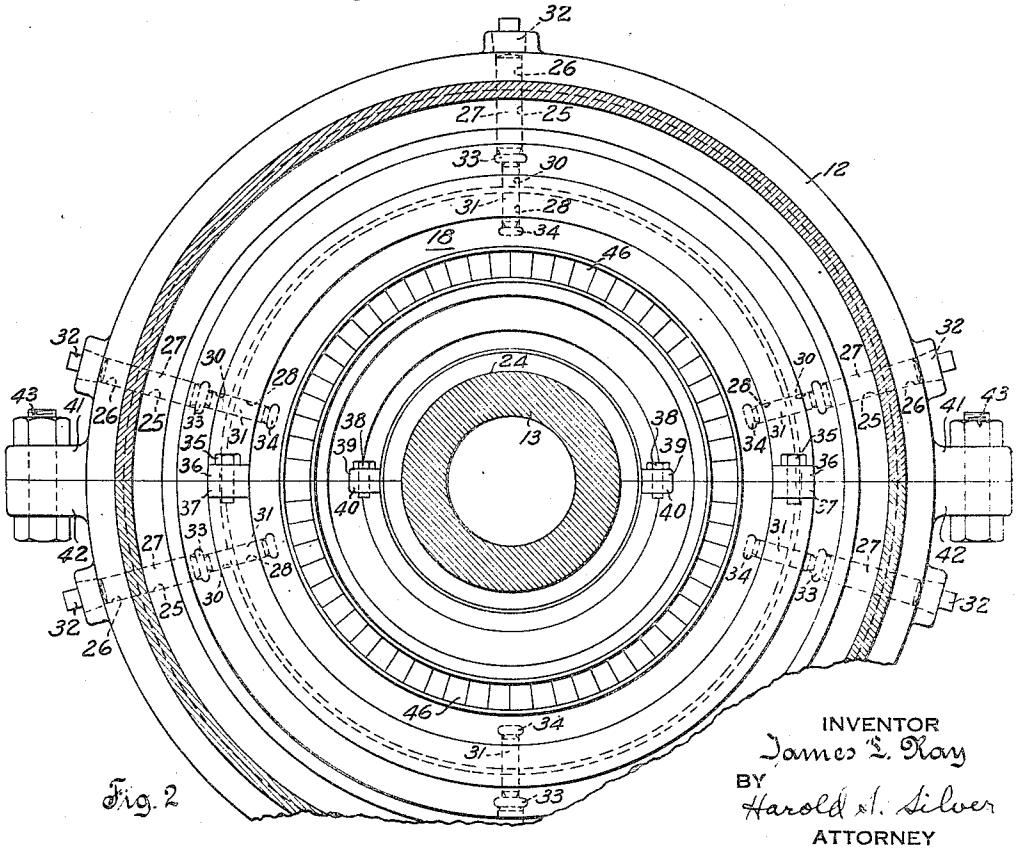


Fig. 2

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## TURBINE DIAPHRAGM

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4 Claims. (Cl. 253—78)

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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. More specifically, the invention relates to diaphragm means which may be embodied in a gas turbine. The principal object of the invention is the provision of new and improved diaphragm means of these types.

Where the operating fluid is utilized at high temperatures, and especially such temperatures as obtain in gas turbines, difficulties are encountered by reason of the relatively large expansion of the diaphragm means when subjected to such high temperatures, and it is an object of the invention to provide new and improved diaphragm means which will obviate these difficulties.

Another object of the invention is the provision of diaphragm means in which is embodied new and improved means for centering the diaphragm means while at the same time permitting expansion and contraction thereof, and, more specifically, permitting large expansion and contraction which occurs by reason of a large range of temperatures.

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 one embodiment 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 a fragmentary, longitudinal half-sectional view of a gas turbine embodying the invention; and

Fig. 2 is a cross-sectional view, partly fragmentary, taken on the line II—II looking in the direction of the arrows.

The turbine illustrated comprises a stator 10 and a rotor 11. The stator includes a cylinder or casing 12 surrounding the rotor. The rotor 11 includes a spindle or shaft 13, the center line of which is indicated by the line C. L.

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 12 is diaphragm means 18. The diaphragm means 18 comprises a

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plurality of concentric ring means, here shown as two principal ring means 19, 20. The outermost ring means 19 has its outer annular periphery constructed and arranged for lost motion connection with the stator, the outer periphery as here shown, being adapted to fit slidably in an annular recess 21 in a wall portion of the stator casing 12. The smaller ring means 20 has its outer annular periphery constructed and arranged for lost motion connection with the outermost ring means, the outer periphery of the smaller ring means 20, as here shown, being adapted to fit slidably in an annular recess 22 in the inner periphery of the outermost ring means 19. The inner periphery of the innermost ring means (in this instance the smaller ring means 20, next adjacent the outermost ring means 19) carries in any suitable way, shaft seal ring means 23 of any desired and suitable type, cooperating with the surface portion 24 of the shaft 13 to prevent leakage of gas, at the shaft, from the left side to the right side of the diaphragm means 18.

Centering means is provided for maintaining the plurality of ring means comprised in the diaphragm means 18 coaxial with the shaft 13. The centering means may include a plurality of radial keys, abutments, pins, or other suitable means. In this instance a plurality of radial pins is shown, as will more fully appear.

Considering first the centering means associated with the outermost ring means 19. The outermost ring means 19 has a set of a plurality of circumferentially spaced radial holes 25 extending thereinto from the outer periphery of the ring means, the number of holes being here shown as six in number; and the turbine casing 12 has a set of a plurality of radial holes 26 extending through the casing wall, the holes 26 being of the same size and number as the holes 25. When the parts are assembled, the holes 26 of the set in the turbine casing 12 are in radial alinement with the holes 25 of the set in the outermost ring means 19, and the pairs of alined holes of the sets has slidably disposed therein, pins 27.

The smaller ring means 20 has a set of a plurality of circumferentially spaced radial holes 28 etxending thereinto from its outer periphery, the number of holes 28 being here shown as six in number; and the outermost ring means 19 has a set of a plurality of radial holes 30 extending thereinto from the inner periphery, the holes 30 being of the same size and number as the holes 28. The holes 30 of the set in the

inner periphery of the outermost ring means 19 are in radial alinement with the holes 28 of the set in the outer periphery of the smaller ring means 20, and when the parts are assembled, the pairs of alined holes of the sets have slidably disposed therein, pins 31.

As here shown, the holes 30 of the set in the inner periphery of the outermost ring means 19 are in radial alinement with the holes 25 of the set of holes in the outer periphery of the outermost ring means 19. Furthermore, in the embodiment shown the pins 31 and the holes with which they cooperate, are of smaller diameter than the pins 27 and the holes with which they cooperate.

The anular recess 21 in the turbine casing 12 is sufficiently deep to leave annular clearance space 48 with respect to the outer periphery of the outermost ring means 19 such that the outermost ring means may freely expand, and the annular recess 22 in the inner periphery of the outermost ring means 19 is sufficiently deep to leave annular clearance space 49 such that the smaller ring means 20 may freely expand, when the parts are subjected to the respective maximum temperatures.

Radially outward movement of the pins 27 may be limited by any suitable means, in this instance by plugs 32 screwed into enlarged outer ends of the holes 26. The pins 27 and the pins 31 are of such length that a desired suitable amount of radial clearance will be left when the ring means 19 and the ring means 20 have expanded to the maximum amount.

Desirably, an annular recess 33 is formed at the junction between the holes 25 and the holes 30; and an annular recess 34 is formed at the bottoms of the holes 28. The recesses 33 and 34 provide "run-outs" for the boring and reaming tools, making it unnecessary to bore and ream clear to the bottom of the respective holes.

As here shown, the outermost ring means 19 is made in two semi-circular segments fastened together by machine screws 35 cooperating with flanges 36, 37 extending laterally from the respective segments. In like manner the smaller ring means 20 may be made in two semi-circular segments fastened together by machine screws 38 cooperating with flanges 39, 40 extending laterally from the respective segments. The turbine casing 12 may be made in halves having flanges 41, 42 held together by bolts and nuts 43.

Gas is adapted to enter an inlet chamber 44 from which it passes through suitable nozzles 45 against the blades 16 of the wheel 14. Gas discharged from the blades 16 passes through nozzles 46 which may be provided, as here shown, by a plurality of blades interposed in and forming a part of the inner ring means 20. From the nozzles 46 gas is discharged against the blades 17 of the wheel 15, and from thence it may be discharged, as here shown, to one or more other stages 47 of the turbine.

As the outermost ring means 19 is heated, it is free to expand radially, and when it cools off it is free to contract radially, moving relatively to the turbine casing in the annular recess 21, but at all times the axis of the ring means 19 is maintained coaxial with the shaft 13 by the pins 27. Likewise, the smaller ring means 20 is free to expand radially when heated and free to contract radially when cooled, moving relatively to the outermost ring means 19, and relatively to the turbine casing 12, in the annular recess 22, but at all times the axis of the smaller ring means 20 is



maintained coaxial with the outermost ring means 19, and hence also coaxial with the shaft 13, by the pins 31.

The parts may be assembled as follows. Assuming that the upper half of the turbine casing 12 has not yet been applied, and that the seal ring means 23, which, if desired, may be in segments, has been assembled with the respective halves of the smaller ring means 20, the halves of the smaller ring means 20 are placed about the shaft and the halves fastened together with the screws 38. Then the halves of the outermost ring means 19 are positioned around the smaller ring means 20, the halves of the ring means 19 are fastened together by the screws 35, and the pins 31 are inserted, through the holes 25, into the holes 30, 28, the holes 30 and holes 28 having been brought into alinement. Then the upper half of the turbine casing 12 is positioned on the lower half thereof, and the pins 27 are inserted, through the holes 26, into the holes 25, the holes 25 having been positioned in alinement with the holes 26. The pins 27, as hereinbefore mentioned, are prevented from moving radially outwardly by applying the plugs 32.

While the holes 25 and 30 could be made of the same diameter and a single pin could be substituted for the two pins 27 and 31, the embodiment illustrated is preferred because the use of two pins 27 and 31 of different diameters facilitates manufacturing operations. For example, the holes 30 and 28, can be line reamed with a small reamer during assembly of ring means 19 and ring means 20, without affecting hole 25. Subsequently, hole 25 and hole 26 may be line reamed together when assembling ring means 19 and cylinder 12. It would be possible but more complicated to temporarily aline cylinder 12, ring means 19, and ring means 20 and line ream clear through all three of these parts for the same size of pin. While the same final result would be achieved, the use of two pins of different diameters is preferred for the reasons hereinbefore stated.

From the foregoing it will be apparent to those skilled in the art that the illustrated embodiment of the invention provides a new and improved turbine diaphragm and accordingly accomplishes the objects of the invention. On the other hand, it will also be obvious to those skilled in the art that the illustrated embodiment 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 embodiment is illustrative only, and the invention is not limited thereto.

It is claimed and desired to secure by Letters Patent:

1. A turbine constructed and arranged for operation by elastic fluid, comprising: a rotor shaft; an annular wall surrounding said shaft and leaving a space between said wall and said shaft; diaphragm means including a plurality of concentric ring means across said space, the outermost of said ring means having a lost motion connection with said annular wall, and having a lost motion connection with adjacent smaller ring means; first centering means for maintaining said outermost ring means coaxial with said shaft while permitting free expansion and contraction of said outermost ring means in all radial directions, said first centering means including a first plurality of sets of circumferen-

tially spaced holes in said outermost ring means and said wall respectively, holes of said respective sets being in radial alinement and a plurality of first members cooperating with alined sets of said first plurality of sets; and second centering means for maintaining said smaller ring means coaxial with said shaft while permitting free expansion and contraction of said smaller ring means in all radial directions, said second centering means including a second plurality of sets of circumferentially spaced holes in said outermost ring means and said smaller ring means respectively, holes of said respective sets being in radial alinement and in radial alinement with alined holes of said first plurality of sets, and a plurality of second members, separate from said first members, cooperating with alined sets of said second plurality of sets.

2. A turbine constructed and arranged for operation by elastic fluid, comprising: a rotor shaft; an annular wall surrounding said shaft and leaving a space between said wall and said shaft; diaphragm means including a plurality of concentric ring means across said space, the outermost of said ring means having a lost motion connection with said annular wall, and having a lost motion connection with the adjacent smaller ring means; first centering means for maintaining said outermost ring means coaxial with said shaft while permitting free expansion and contraction of said outermost ring means in all radial directions, said first centering means including a first plurality of sets of circumferentially spaced holes in said outermost ring means and said wall respectively, the holes of each set being in radial alinement; second centering means for maintaining said smaller ring means coaxial with said shaft while permitting free expansion and contraction of said smaller ring means in all radial directions, said second centering means including a second plurality of sets of circumferentially spaced holes in said outermost ring means and said smaller ring means respectively, the holes of each set being in radial alinement; said first plurality of sets comprising sets which are radially alined with sets of said second plurality of sets; and said first and second centering means including members cooperating with alined sets of said first and second plurality of sets.

3. A turbine constructed and arranged for operation by elastic fluid, comprising: a rotor shaft; an annular wall surrounding said shaft and leaving a space between said wall and said shaft; diaphragm means including a plurality of concentric ring means across said space, the outermost of said ring means having a lost motion connection with said annular wall, and having a lost motion connection with adjacent smaller ring means; first centering means for



maintaining said outermost ring means coaxial with said shaft while permitting free expansion and contraction of said outermost ring means in all radial directions, said first centering means including a first plurality of sets of circumferentially spaced holes in said outermost ring means and said wall respectively, the holes of each set being in radial alinement and a plurality of first members cooperating with alined sets of said first plurality of sets; and second centering means for maintaining said smaller ring means coaxial with said shaft while permitting free expansion and contraction of said smaller ring means in all radial directions, said second centering means including a second plurality of sets of circumferentially spaced holes in said outermost ring means and said smaller ring means respectively, the holes of each set being in radial alinement with and of smaller diameter than the holes of said first plurality of sets, and a plurality of second members, separate from said first members, cooperating with alined sets of said second plurality of sets.

4. A turbine constructed and arranged for operation by elastic fluid, comprising: a rotor shaft; an annular wall surrounding said shaft and leaving a space between said wall and said shaft; diaphragm means supported across said space, said diaphragm means including a plurality of concentric ring means, the outermost of said ring means having a lost motion connection in all radial directions with said annular wall, and having a lost motion connection in all radial directions with the adjacent smaller ring means; and centering means for maintaining said plurality of ring means coaxial with said shaft while permitting free expansion and contraction of said plurality of ring means radially in all directions relatively to each other and relatively to said annular wall, said centering means including a plurality of circumferentially spaced members cooperative with a plurality of sets of circumferentially spaced holes in said plurality of ring means and said wall respectively, the holes of each set being in radial alinement with the holes of the other sets.

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