

O. JUNGREN.
ELASTIC FLUID TURBINE.
APPLICATION FILED JAN. 9, 1919.

1,352,277.

Patented Sept. 7, 1920.

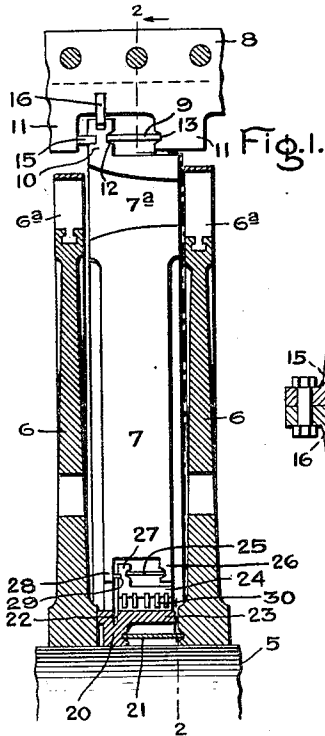


Fig. 1.

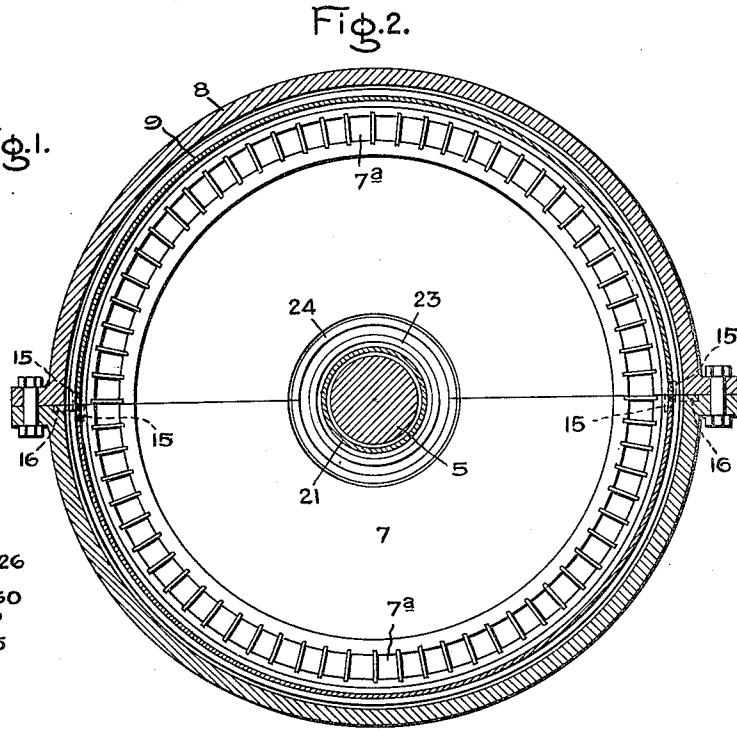


Fig. 2.

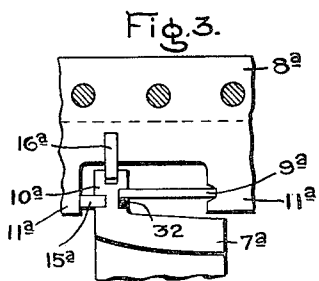


Fig. 3.

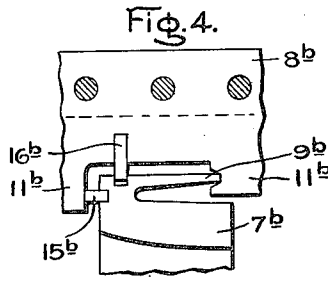


Fig. 4.

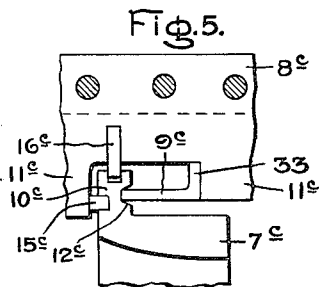


Fig. 5.

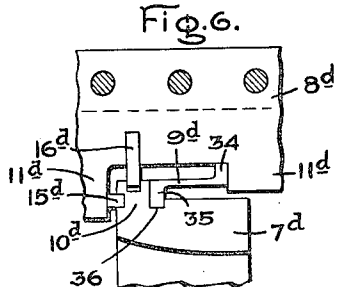


Fig. 6.

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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

1,352,277.

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To all whom it may concern:

Be it known that I, OSCAR JUNGREN, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

The present invention relates to elastic fluid turbines of the type in which the casing is divided into a number of stages by nozzles containing diaphragms which surround the shaft and are supported in the casing wall, there being a suitable packing between the bore of the diaphragm and the shaft to prevent leakage.

In starting up and during operation a turbine is subjected to considerable variations in temperature, the variations occurring during operation being due to changes in load and variations in the vacuum as is well understood. Also rubbing may sometimes occur between the moving and stationary parts which may be the cause of considerable heat being generated. As a result of the foregoing the turbine parts are subjected to unequal heating which causes unequal expansions, and in the case of the diaphragms and casing, the difference in expansion of a diaphragm and the casing may be considerable so that with the diaphragms connected rigidly to the casing stresses of substantial magnitude may be set up in a diaphragm or on the casing which may result in the one case in buckling of the diaphragm and in the other in cracking of the casing.

In general the packing between the bore of a diaphragm and the shaft is of the labyrinth type and the clearances are close to cut leakage to a minimum. As a result, with structures heretofore in use disturbances in the turbine during operation sometimes cause contact between the packing and the shaft. As soon as such contact takes place heat is generated and as this heating is never uniform it may result in a sprung shaft.

The object of the present invention is to provide an improved turbine structure wherein the nozzle diaphragms are so connected to the casing that they may expand and contract without setting up undue stresses either in themselves or in the casing and wherein the packing between the diaphragm and shaft is so arranged that

direct rubbing with the shaft cannot occur, that the likelihood of any rubbing occurring is remote, and that if rubbing should occur, the heat generated will not be transmitted to the shaft to an appreciable extent.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawing, Figure 1 is a radial sectional view of a part of a turbine embodying my invention, the section being taken on the horizontal diameter where the casing and diaphragms are split so that in the view one is looking down on the lower half of the casing and diaphragms. Fig. 2 is a section taken on line 2—2 of Fig. 1 and Figs. 3, 4, 5 and 6 are views showing modification.

Referring to the drawing, 5 indicates a turbine shaft on which are mounted the rotor elements or wheels 6 having blades or buckets 6^a, and 7 indicates the diaphragms which divide the turbine casing 8 into stages in the well understood manner, there being a difference of steam pressure between the stages or compartments thus formed. In the diaphragm are passages 7^a commonly called nozzles through which the fluid passes from one stage to the wheel buckets in the next lower stage and in so doing has its pressure decreased and its velocity increased.

In Fig. 1 of the drawing only a fragment of the annular casing 8 is shown and only one diaphragm but it will be understood that there may be any suitable number of diaphragms in the complete machine. The casing is split in an axial plane as shown in Fig. 2.

Now, according to my invention, I support or fasten the diaphragms in the turbine casing by means of cylindrical members or rings 9 which while serving to center and to firmly hold the diaphragms in position will permit them to expand and contract independently of the casing by an amount sufficient to avoid undue stresses being set up either in the diaphragm or in the casing. To permit the parts to be readily assembled the ring 9 is preferably made in two parts, the plane of division corresponding to that of the main casing.

The cylindrical members or rings 9 thus form yielding connections between the diaphragms and the turbine casing. The rings 9 may be flat as shown in the drawing or

they may be conical as is obvious. In the present instance each ring 9 is shown as having one edge connected to an annular projection 10 on the diaphragm and the other edge to an annular projection 11 on the casing, the ring being concentric with the diaphragm, and this is the arrangement I prefer because it permits of a ring sufficiently wide being used without increasing the length of the turbine or the distance between diaphragms. In other words, I arrange each diaphragm and its ring in telescopic relation. The connections between ring 9 and projections 10 and 11 are preferably made by providing grooves 12 and 13 in which the edges of the ring are held. This is a very advantageous arrangement in that it is extremely simple and avoids the use of special fastening means. To facilitate assembling the rings 9 may be firmly fixed in grooves 12 but fit loosely into grooves 13 making a tight fit only at the bottoms of such grooves. The sides of grooves 12 and 13 may be made sloping as shown to prevent cramping of the ring. In assembling the turbine, rings 9 first have one edge fixed into grooves 12 thereby fastening the rings to the diaphragms. The other edges of the rings 9 may then be slipped into grooves 13. To accomplish this the space between projections 11 may be made great enough as shown so the diaphragms with the rings attached can be passed between them and then moved axially to bring the edges of the rings into grooves 13, or the upper and lower halves of the diaphragms may be inserted into the respective halves of the casing by a circumferential movement, with the edges of the rings 9 in grooves 13. To hold the diaphragms in position with the edges of the rings firmly against the bottoms of grooves 13 when the supply of steam is cut off, I provide suitable keys 15, which are located between projections 11 and the admission sides of the diaphragms. The keys 15 may be driven into slots in projections 10 and engage the surface of projections 11 so as not to interfere with movements of the diaphragm relatively to the casing. And preferably the keys in the upper and lower halves of the turbine are offset with respect to each other so as not to come one directly under the other. By this arrangement the keys in each half diaphragm are prevented from working loose by the companion half diaphragm. To prevent the diaphragms from turning circumferentially I provide suitable keys as indicated at 16 which engage the casing and the diaphragm, and to prevent such keys from interfering with radial movements of the diaphragms relatively to the casing the key slots in the diaphragms may be made to extend slightly beyond the end of the key. As is obvious any suitable

number and arrangement of keys to accomplish the purposes desired may be used.

The direction of flow of elastic fluid is from left to right in Fig. 1 and with the arrangement shown, rings 9 serve as compression rings to take the end thrust of the diaphragms occasioned by the difference in pressure which exists on opposite sides thereof. As a result the pressures on the diaphragms are such as to always force the edges of rings 9 into the grooves in which they are held. The rings 9 center the diaphragms and hold them in spaced relation to the turbine casing. They also serve to prevent leakage of elastic fluid around the peripheries of the diaphragms from one stage to the next. This latter has an important consideration for with the peripheries of the diaphragms spaced from the casing wall it is very desirable that all leakage around such peripheries be prevented.

As shown in Fig. 2, the casing and diaphragms are split horizontally on the axis of the shaft, this being customary to facilitate assembling, and the rings 9 are accordingly split in a similar manner. However, such rings may be made solid or have their adjacent ends suitably fastened together if found desirable.

Referring now to the arrangement of the packing between the bore of the diaphragm and the shaft, 20 is a sleeve which fits loosely around the shaft 5 and is centered by a cylindrical member or ring 21 one end of which is fastened to sleeve 20 and the other to the hub of a wheel 6, which in effect is the same as though it is fastened to the shaft because it rotates therewith. The arrangement of the connections may be similar to that described above in connection with ring 9. Ring 21 holds sleeve 20 firmly against the adjacent wheel 6 and to give the sleeve some axial flexibility so adjacent wheels may expand axially along the shaft a cylindrical groove 22 is cut out therein. The bottom of the groove should be below the inner wall of the sleeve 23 so as to permit the parts to freely expand without causing undue stresses. Projecting axially from sleeve 20 is a tubular member or flange which forms a cylindrical packing member 23 and surrounding this is a cylindrical packing member 24 which is supported and centered by a cylindrical member or ring 25 similar to ring 21. Ring 25 has one end fixed to a projection 26 on diaphragm 7 and the other end fixed to a flange 27 on packing member 24. Ring 25 and flange 27 are located in an annular recess formed between projection 26 and a second projection 28 on the diaphragm, and between projection 28 and flange 27 are suitable keys 29 arranged similar to keys 15 referred to above and performing the same function. Between packing members 23 and 24 are arranged teeth 30 to form a labyrinth or cellu-

lar packing. In the present instance teeth 30 are shown as being carried by member 24 but any suitable arrangement may be used.

As stated above the turbine casing is split horizontally and also the diaphragm and rings 9 and in order to facilitate assembling and disassembling I also preferably split the rings 25 and packing members 24 horizontally as this permits the respective halves of the casing and diaphragm to be assembled complete independently of each other. The sleeves 20 and rings 21, however, are made solid and are assembled by slipping them over the shaft.

The packing members 23 and 24 are of substantially the same mass and with the foregoing arrangement it will be clear that they will expand and contract together and with substantially the same rapidity so there is little likelihood that rubbing will occur. Should rubbing occur however, the heat generated will not be transmitted to the shaft to any great extent because sleeve 20 fits the shaft loosely and has a comparatively short length as regards the space between wheels. Sleeve 20 and ring 21 also serve as a barrier to protect the shaft from sudden changes in temperature which during operation occur in the various stages of the machine and as a result the temperature of the shaft will remain more uniform and will not be subjected to sudden wide fluctuations in temperature.

Owing to the shape of cylindrical members or rings 9, 21 and 25 they are very strong and even when made as thin as practical from a manufacturing standpoint, they are still able to take care of many times the load to which they are subjected. As a result even though a very considerable amount of corrosion should take place in them, they will still be amply strong to perform their duties.

Cylindrical members or rings 9, 21 and 25 form in substance yielding supporting connections between the parts which they connect and in Figs. 3, 4, 5 and 6 are shown a number of modified forms which such rings may take. For purposes of illustration such modifications are shown in these four figures as connecting a diaphragm to the casing but it will be understood they are applicable to other places. In Figs. 3, 4, 5 and 6 corresponding parts are indicated by the same numerals as are used in connection with Figs. 1 and 2 except that exponents *a*, *b*, *c* and *d* respectively are added.

In Fig. 3 cylindrical member or ring 9^a is shown as being fastened to projection 10^a by a calking strip 32. Otherwise the arrangement is the same as that of Figs. 1 and 2. In Fig. 4 the arrangement is the same as that already described except that the ring 9^b is formed integral with one of the two members which it connects, in the present instance with the diaphragm. In Fig. 5 ring 9^c is shown as being provided with a

flange 33 which makes it L-shaped in cross section. Flange 33 rests on projection 11^c while the other end of ring 9^c rests in a groove 12^c. In Fig. 6 ring 9^d has flanges 34 and 35 at its opposite ends making it Z-shaped in cross section. Flange 34 rests on projection 11^d and flange 35 rests on projection 10^d and has its edge entering in a groove 36 cut in the periphery of diaphragm 7^d.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an elastic fluid turbine, the combination of a casing, a nozzle diaphragm which divides the casing into stages, said diaphragm being mounted in spaced relation to the inner wall of said casing, and a ring which connects the diaphragm to the casing and forms a yielding connection for holding the diaphragm in spaced relation thereto whereby it may expand and contract relatively to and independently of the casing.

2. In an elastic fluid turbine, the combination of a casing, a nozzle diaphragm which divides the casing into stages, said diaphragm being mounted in spaced relation to the inner wall of the said casing, and a ring which surrounds the diaphragm and connects it to the casing, said ring forming a yielding connection for holding the diaphragm in spaced relation whereby the diaphragm and casing may expand and contract relatively to each other.

3. In an elastic fluid turbine, a casing, diaphragms which divide the casing into stages, and rings which connect the diaphragms to the casing, and serve to support them therein and permit the diaphragms and the casing to expand and contract relatively to each other, said rings being so arranged that the pressures on the diaphragms put them under compression, and said rings also serving to prevent leakage between the peripheries of the diaphragms and the casing.

4. In an elastic fluid turbine, a casing, a diaphragm which divides the casing into stages and is mounted in spaced relation to the inner wall of the casing, and a cylindrical ring having one edge connected to the diaphragm and the other to the casing, said ring forming a yielding supporting connection between the diaphragm and the casing which positions the diaphragm but per-

mits the diaphragm and casing to expand and contract relatively to each other.

5. In an elastic fluid turbine, a casing, a diaphragm which divides the casing into stages and is mounted in spaced relation to the inner wall of the casing, and a cylindrical ring which surrounds the diaphragm and has one edge connected to the diaphragm and the other to the casing, said ring forming a yielding supporting connection between the diaphragm and the casing which positions the diaphragm but permits the diaphragm and casing to expand and contract relatively to each other.

6. In an elastic fluid turbine, a casing, diaphragms which divide the casing into stages, and cylindrical rings which surround the diaphragms and yieldingly support them in the casing, said rings serving to support the diaphragms in spaced relation to the casing and forming connections between the diaphragms and the casing which prevent leakage of elastic fluid and permit the diaphragms and casing to expand relatively to each other.

7. In an elastic fluid turbine, a casing, a diaphragm in the casing, the peripheral edge of said diaphragm being spaced from the inner wall of the casing, and a ring which yieldingly connects the diaphragm to the casing and supports it in spaced relation thereto whereby said diaphragm and casing may expand and contract relatively to each other.

8. In an elastic fluid turbine, the combination of an annular casing having an internal supporting member, a nozzle containing diaphragm which divides the interior of the casing into wheel compartments in which a difference of pressure exists, there being a radial clearance between the periphery of the diaphragm and the inner wall of the casing, and an annular member which is relatively thin in cross-section, is seated in the diaphragm at one extremity, and in said member at the other extremity and is held under compression by the action of the fluid in the casing, whereby the diaphragm and casing may expand and contract with temperature changes at different rates without setting up stresses in the diaphragm or casing.

9. In an elastic fluid turbine, the combination of an annular casing having an internal supporting member, a nozzle containing diaphragm which divides the interior of the casing into wheel compartments in which a difference of pressure exists, there being a radial clearance between the periphery of the diaphragm and the inner wall of the casing, and an annular member which is relatively thin in cross-section and is arranged in telescopic relation with respect to the diaphragm, said member re-

ceiving the load on the diaphragm at one end and transmitting it to said internal support at the other, said member also serving to permit the diaphragm and casing to expand and contract relatively to each other without setting up excessive stresses.

10. In an elastic fluid turbine the combination of an annular casing, a nozzle containing diaphragm located within the casing which is smaller in diameter than the interior of the casing, and a cylindrical member which is connected at one extremity to the casing member permitting the casing and diaphragm to expand and contract unequally and preventing the effects of said expansions and contractions from being transmitted from one to the other, said members also cooperating with the diaphragm to divide the casing into compartments in which a difference of fluid pressure exists.

11. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, and a packing member surrounding the shaft and yieldingly connected to the diaphragm.

12. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, and a packing member which surrounds the shaft and is yieldingly connected thereto.

13. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, and packing members which surround the shaft and are yieldingly connected to the diaphragm and the shaft.

14. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, and packing members which surround the shaft and are yieldingly connected to the diaphragm and the shaft, said packing members having substantially the same mass.

15. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, a packing member which surrounds the shaft within the bore of the diaphragm and is yieldingly connected to the shaft, a second packing member which surrounds the first named packing member, and a ring yieldingly connecting it to the diaphragm.

16. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, concentric packing members which surround the shaft within the bore of the diaphragm, and cylindrical members which connect said

packing members to the diaphragm and shaft.

17. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a yielding connection between the diaphragm and casing, concentric packing members which surround the shaft within the bore of the diaphragm, and cylindrical members which yieldingly connect the packing members to the diaphragm and shaft, said packing members being of substantially the same mass.

18. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, and a diaphragm packing comprising a packing member yieldingly connected to the diaphragm.

19. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, and a diaphragm packing comprising a packing member yieldingly connected to the shaft.

20. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, and a diaphragm packing comprising two packing members, one of which is yieldingly connected to the shaft and the other yieldingly connected to the diaphragm.

21. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, and a diaphragm packing comprising a packing member and a ring which yieldingly connects it to the diaphragm.

22. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, and a diaphragm packing comprising a packing member and a ring which yieldingly connects it to the shaft.

23. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a diaphragm packing comprising two packing members, and cylindrical members which yieldingly connect one of said packing members to the shaft and the other to the diaphragm.

24. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a cylindrical member which yieldingly connects the diaphragm to the casing, concentric packing members located in the bore of the diaphragm, and cylindrical members which yieldingly connect

said packing members to the diaphragm and shaft.

25. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, a diaphragm packing comprising two packing members and cylindrical members which yieldingly connect one of said members to the shaft and the other to the diaphragm, said packing members being of substantially the same mass.

26. In an elastic fluid turbine, a casing, a shaft, a diaphragm having a bore through which the shaft passes, wheels on the shaft on each side of the diaphragm, a cylindrical packing member which is located between the wheels and loosely surrounds the shaft, a ring which supports the member and permits it to freely expand and contract, said member and ring serving to protect the shaft from sudden changes of temperature, a second cylindrical packing member surrounding the first, a ring which supports the second member on the diaphragm and permits it to freely expand and contract, and cellular packing means located between the members and carried by one of them.

27. In an elastic fluid turbine, a casing having an annular projection, a diaphragm having an annular projection, and means for yieldingly connecting the diaphragm and casing comprising a cylindrical member which surrounds the diaphragm and has its two ends engaging said projections.

28. In an elastic fluid turbine, a casing having an annular projection, a diaphragm having an annular projection, and means for yieldingly connecting the diaphragm and casing comprising a cylindrical member which surrounds the diaphragm, said cylindrical member being fixed to one of said projections and detachably engaging the other.

29. In an elastic fluid turbine, a casing having an annular projection, a diaphragm having an annular projection, and means for yieldingly connecting the diaphragm and casing comprising a cylindrical member which surrounds the diaphragm said cylindrical member being formed integral with one of said projections and detachably engaging the other.

In witness whereof, I have hereunto set my hand this 8th day of January, 1919.

OSCAR JUNGREN.