April 19, 1927. 1,625,541

F. HODGKINSON

ELASTIC FLUID TURBINE

Filed Dec. 21, 1923 2 Sheets-Sheet 1

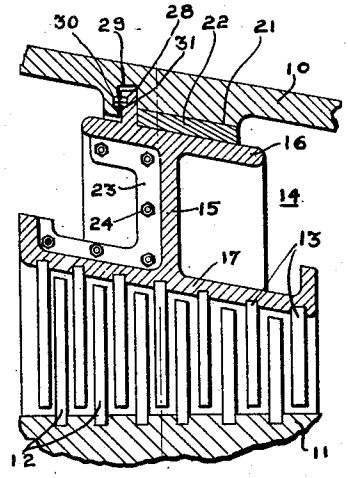

Fig. 1.

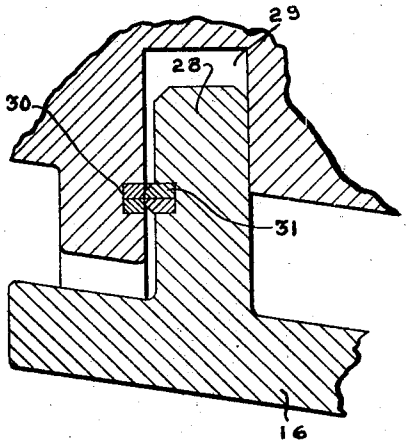

Fig. 5.

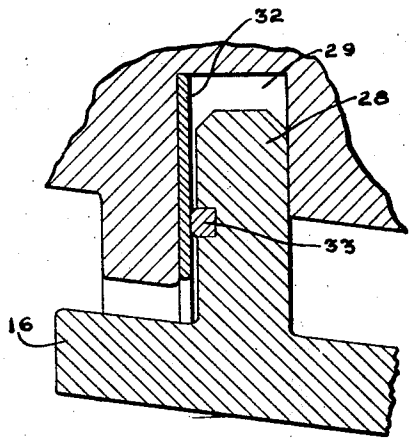

Fig. 6.

Fig. 7.

F. Hodgkinson
INVENTOR

BY D. C. Davis
ATTORNEY

WITNESSES:

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F. HODGKINSON

ELASTIC FLUID TURBINE

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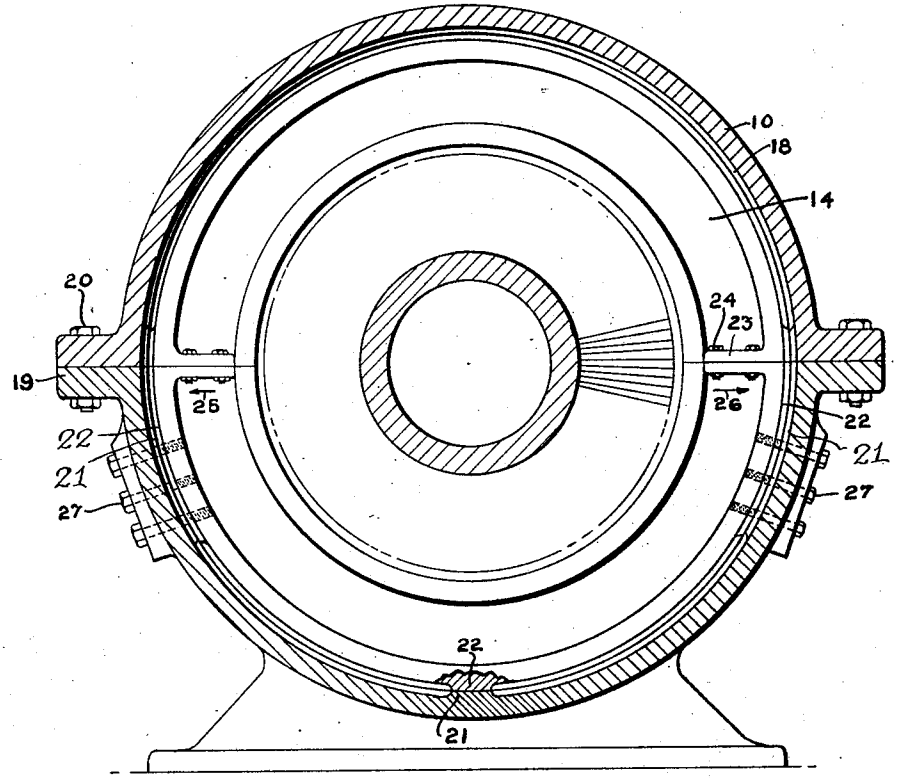

Fig. 2.

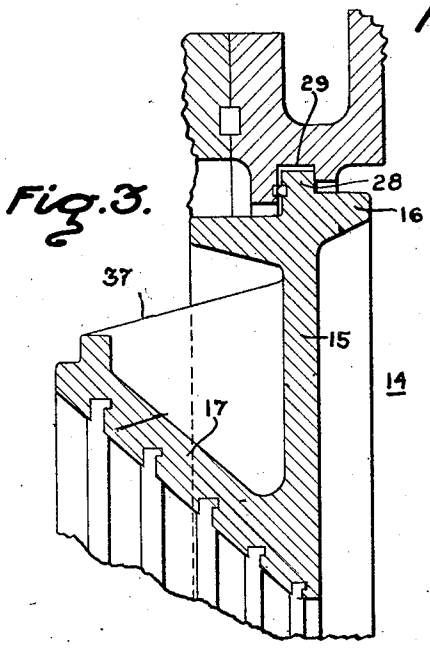

Fig. 3.

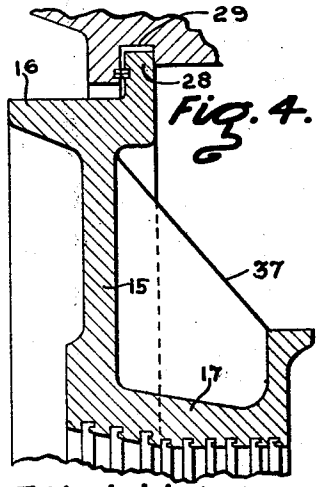

Fig. 4.

F. Hodgkinson
INVENTOR

BY J. C. Davis
ATTORNEY

Patented Apr. 19, 1927. 1,625,541

UNITED STATES PATENT OFFICE.

FRANCIS HODGKINSON, OF SWARTHMORE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ELASTIC-FLUID TURBINE.

Application filed December 21, 1623. Serial No. 682,117.

My invention relates to elastic-fluid turbines, more particularly to the stationary blade or diaphragm-carrying means thereof, and has for an object to provide apparatus of the character designated disposed within the cylinder of the turbine which shall be free to expand within the cylinder while retaining its concentricity with the rotor.

Another object is to provide a stationary blade-carrying ring so arranged within the turbine cylinder that the forces resultant from expansion thereof slightly distort without stretching the cylinder structure and without opening the cylinder joints.

Another object of my invention is to provide a blade-carrying ring of smaller diameter than the cylinder to permit expansion, and to provide packing means to prevent leakage of elastic fluid between the ring and the cylinder.

A further object is to provide apparatus of the character designated circular in form and of such construction that, when subjected to stresses due to local heating, shall retain its original form.

These and other objects are secured by means of my improved apparatus, illustrated in the accompanying drawings, in which Fig. 1 is a partial cross section through a turbine showing my improved blade-carrying ring applied thereto; Fig. 2 is a full cross sectional elevation of a turbine showing my improved blade-carrying ring, together with the means for supporting the ring and transmitting the forces resultant from the expansion thereof; Figs. 3 and 4 are views similar to Fig. 1 showing modified forms of my improved blade ring; Figs. 5 and 6 are detail cross sections showing a part of my improved apparatus with modified forms of packing; and Fig. 7 is a detail view showing a preferred manner of arranging the packing.

Heretofore, in the construction of elastic-fluid turbines, whenever stationary blades or diaphragm-carrying elements have been disposed within the turbine cylinder, difficulties have at times been experienced due to the forces resultant from expansion of the rings when subjected to heat in the operation of the turbine. It has been found that under such conditions, the rings expand at a greater rate than does the cylinder, resulting in stretching the cylinder and opening the cylinder joints, producing leakage.

To overcome this difficulty, it has been proposed to make the ring of smaller diameter than the cylinder so as to provide a certain amount of clearance between the ring and the cylinder. It has been found, however, that the proper amount of clearance between the ring and the cylinder is difficult to determine with any degree of accuracy, and that when the ring expands, disturbances in the relative position of the parts of the turbine have occurred, resulting in serious damage to the turbine. A further difficulty that has been encountered with such construction is that leakage occurs between the blade-carrying ring and the cylinder which, if not causing serious loss of energy, causes serious erosion and damage to the walls of the cylinder and to the ring.

To overcome these difficulties and to provide a better structure for the purposes set forth, I provide a stationary blade or diaphragm-carrying ring smaller in diameter than the bore of the cylinder to allow for expansion, the blade ring being of such construction that, when subjected to the forces of expansion, it will retain its original form. I support this ring in the cylinder in such a manner that when subjected to the forces resultant from expansion the supports serve to transmit these forces to the walls of the cylinder in such a manner that the cylinder structure is slightly distorted without stretching and without opening the cylinder joints. At the same time the ring retains its concentricity with the rotor.

To prevent leakage of elastic fluid between the ring and the cylinder and consequent erosion of the metal, I provide a packing of erosion-resisting material so disposed as to be effective as the ring expands or contracts.

Referring now to the drawings for a better understanding of my invention, I show in Fig. 1 a partial cross section of a turbine having a cylinder 10, a rotor 11 having moving blades 12—12 and stationary blades 13. The stationary blades 13 are carried by my improved blade-carrying ring 14. The blade-carrying ring 14 consists of

a web 15 uniting two heavy flange portions 16 and 17 so as to form a substantially circular I-beam construction, the web of the beam being disposed substantially normal to the longitudinal axis of the turbine. With this construction, when the ring expands due to the heat in the turbine, it resists to a maximum degree any tendency to expand out of round. For ease of assembly the ring 14 is made in halves and the web 15 is provided with flanges 23 for securing the halves together in any suitable manner as by bolts 24—24.

The ring 14 is of smaller diameter than the bore of the cylinder 10 (Fig. 2), so that there is a clearance space 18 between the ring and the cylinder to permit expansion. In Fig. 2, I show the cylinder 10 of conventional form with longitudinal joints 19 having securing means 20 for the joints. The cylinder 10 is preferably provided with strengthening bores or inward annular projections 21, which may be continuous or interrupted around the cylinder, located at points where my improved blade-carrying rings are applied. For supporting the ring 14 and for directing the forces resultant from expansion thereof, I provide at the sides and bottom pads or projections 22 which bear against the bore 21. These pads are so disposed that the forces resultant from expansion of the ring force the wall of the cylinder outward in the direction of the longitudinal joints of the turbine as indicated by the arrows 25 and 26. Inasmuch as the longitudinal joints 19 are secured by the means 20 beyond the outer periphery of the cylinder, the forces of expansion being transmitted in the manner aforesaid in cooperation with the securing means 20, slightly distort, without stretching the cylinder structure and without opening the cylinder joints 19, tending in fact, to close them more tightly together. To counteract the torsional strain on the blade ring 14 in the operation of the turbine, I provide means 27—27 for securing the blade ring 14 and the pads 22 to the cylinder 10. The pads 22 may be integral with the ring or separate as desired.

This construction maintains the blade ring concentric with the rotor in the following manner: The center line of the ring is obviously maintained laterally due to the symmetry of the parts on opposite sides thereof. The center line is substantially maintained vertically by the securing means 27, located just below the horizontal plane of the center line. When the ring expands, the side pads 22 move radially outwardly, forcing the cylinder outwardly at the contacting points of the bore 21. As the ring is held against vertical movement by the securing means 27, the bottom pad 22 must move downwardly, forcing the adjacent part of the bore 21 downwardly. The portions of the cylinder between bottom pad 22 and the side pads 22 will be slightly flattened to allow this outward movement, as will also the upper half of the casing. The center of the blade ring, it will be apparent, will remain substantially stationary and concentric with the rotor.

In Figs. 3 and 4, I show modified forms of my improved blade ring in which the blade-carrying portion 17, the outer supporting portion 16 and the connecting web 15, instead of forming substantially a circular I-beam construction, have the lower portions 17 extending from one side only of the web 15. In constructions such as are shown in these views, I employ a suitable number of stiffening ribs 37 to prevent distortion of the ring when subjected to the forces resultant from expansion.

The flange 16 of the blade ring 14 is provided with a shoulder 28 which fits into a complementary groove 29 in the cylinder. The diameter of the groove 29 is greater than the diameter of the blade ring at the shoulder 28 so as to permit expansion of the ring within the groove. Packing means 30 are inserted in any suitable manner in one side of the groove 29, which packing means cooperate with packing means 31 carried by the shoulder, and thus prevent leakage between the ring and the cylinder. The packing means employed are of Monel metal, nickel or some other material suitable for resisting erosion. In Fig. 6, I show a modified form of packing in which a wide strip 32 is inserted in any suitable manner along the side of the groove 29 and a cooperating strip 33 is carried by the shoulder 28. In Fig. 7, I show a preferred manner of arranging the packing in order to overcome difficulties that I have encountered due to relative expansion of the parts. In this view, I show an arrangement of packing means which may be employed in either the cylinder groove, the shoulder of the blade-carrying ring, or both, which consists of packing inserted in short sections 35 and 36 arranged in double rows with offset joints. As shown in Figs. 5 and 6, I prefer to arrange the strips 30 flush with the side of the groove 29 and to arrange the packing 31 projecting from the shoulder 28, the packing 31 having beveled edges. By this arrangement I provide a packing that is easily renewed.

It will be apparent that apparatus made in accordance with my invention and applied to a turbine is of such construction as to retain its circular form when subjected to heat and consequent expansion in the operation of the turbine. The pads 22 are so arranged that the ring is free to expand on one side of the center line of the cylinder and the major part of the forces resultant

from the expansion of the ring are directed as herebefore described toward the longitudinal joints of the cylinder. As the rings expand the forces of expansion transmitted to the cylinder through the pads 22 deform the cylinder and the rings remain concentric with the rotor. In this manner, it will be seen that I have overcome the aforementioned difficulties resulting from expansion of the blade-carrying ring in constructions heretofore proposed.

While I have illustrated one ring in a cylinder it is to be understood that one or more such rings may be employed, according to the design of the turbine, and that I have only shown one for the purpose of illustration. It will also be apparent that while I have illustrated a blade-carrying ring in connection with a reaction type turbine, the character of blading carried by the ring is immaterial and that my improved blade ring would be equally applicable to a turbine of the multi-cellular type for supporting the diaphragm structures of such turbines.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a turbine having a cylinder and a rotor, a stationary blade-carrying ring supported by the cylinder and concentric with the rotor and means cooperating between the ring and the cylinder whereby the ring may expand within the cylinder and remain substantially concentric with the rotor while maintaining a predetermined spacing with respect to the cylinder at at least three points.

2. In a turbine, the combination of a cylindrical casing, a stationary blade-carrying ring disposed within the casing and spaced therefrom to allow for expansion, and supporting means between the cylinder and the ring, said supporting means maintaining the ring in predetermined spaced relation with respect to the casing at a plurality of points to allow free expansion of the ring within the cylinder and to cause deformation of the cylinder in response to the expansion of the ring.

3. In a turbine, the combination of a cylindrical casing formed in parts with longitudinal joints, means for securing the parts together, a blade-carrying ring disposed within the casing in spaced relation thereto to permit expansion, and means for transmitting the forces resultant from expansion of the ring, so as to distort, without stretching, the cylinder structure.

4. In a turbine, the combination of a cylinder, blade-carrying rings disposed within the cylinder smaller in diameter than the cylinder, means disposed between the rings and the cylinder for supporting the rings and transmitting to the cylinder the forces resultant from the expansion of the rings, and distorting the cylinder upon expansion of the rings, and packing means arranged between the rings and the cylinder for preventing leakage of elastic fluid therebetween.

5. In a turbine, the combination of a cylinder, a blade-carrying ring disposed within said cylinder of smaller diameter than the cylinder to permit expansion, means disposed between the ring and the cylinder for supporting the ring and transmitting to the cylinder the forces resultant from expansion of the ring, and distorting the cylinder upon expansion of the rings, the major part of said means being disposed on one side of an axial plane of the cylinder, and packing means arranged to prevent leakage of elastic fluid between the cylinder and the ring.

6. In a turbine, the combination of a cylinder having longitudinal joints, means for securing the joints, a blade-carrying ring disposed within said cylinder of smaller diameter than the cylinder, means disposed between the ring and the cylinder for supporting the ring and transmitting to the cylinder the forces resultant from the expansion of the ring, whereby as the ring expands the force exerted thereby is transmitted to the casing in the direction of the longitudinal joints forcing the longitudinal joints outwardly.

7. In a turbine, the combination of a cylinder having longitudinal flange joints, means, for securing the joints, a blade-carrying ring disposed within said cylinder of smaller diameter than the cylinder, a plurality of pads disposed between the ring and the cylinder for supporting the ring and transmitting to the cylinder the forces resultant from the expansion of the ring, means for securing the rings and the pads to the cylinder and for counteracting the torsional stress on the ring, the pads being so disposed that the forces resultant from expansion of the ring are mainly directed toward the longitudinal joints distorting, without stretching, the cylinder structure and permitting the longitudinal joints to remain tight.

8. In a turbine, a casing, a blade-carrying ring of a substantially circular I-beam construction, and means for supporting the ring in the casing so that the ring upon expansion will distort the casing.

9. In a turbine, a casing, a blade-carrying ring of a substantially circular I-beam construction, the web of said I-beam being

substantially normal to the longitudinal axis of the turbine, and means for supporting the ring in the casing so that the ring upon expansion will distort the casing.

10. In a turbine, the combination of a cylinder having an annular groove, a blade-carrying ring, a shoulder formed upon said ring, fitting into the groove, packing means at one side of the groove and cooperating packing means carried by the shoulder, said packing means being formed in segments and disposed in double rows with offset joints.

11. In a turbine, a casing, a stationary blade-carrying structure comprising an inner blade-carrying ring, an outer supporting ring, and a stiffening web between the inner and outer rings, and means for supporting the ring in the casing so that the ring upon expansion will distort the casing.

12. In a turbine having a cylinder and a rotor, a stationary blade-carrying ring supported by the cylinder and concentric with the rotor and means cooperating between the ring and the cylinder whereby the ring may expand within the cylinder and remain substantially concentric with the rotor while maintaining a predetermined spacing with respect to the cylinder at at least two points.

In testimony whereof, I have hereunto subscribed my name this tenth day of December, 1923.

FRANCIS HODGKINSON.