

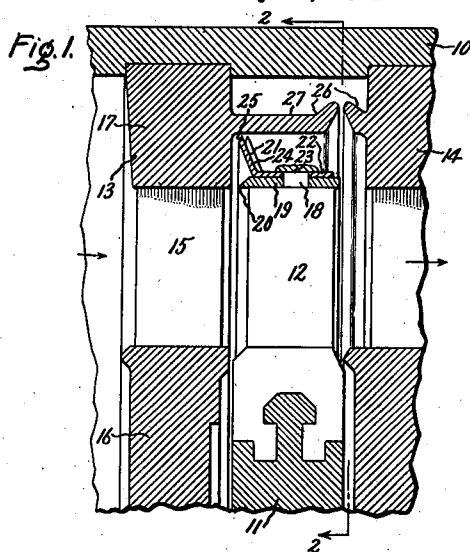
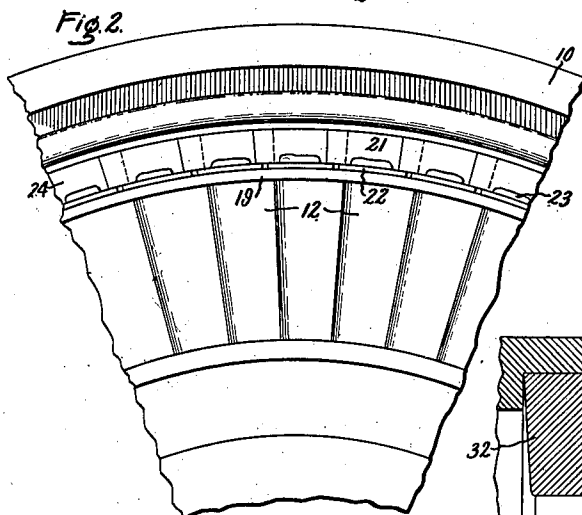
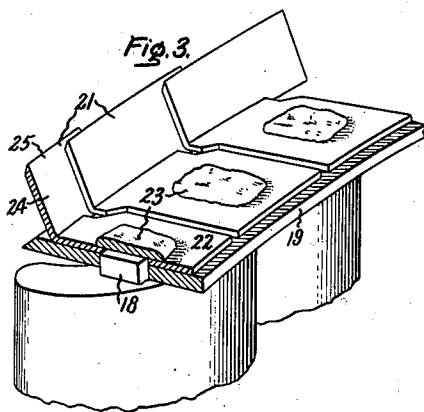
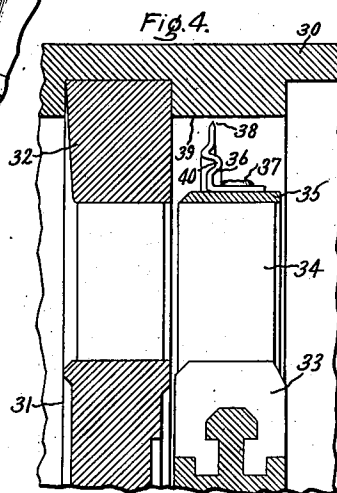
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ELASTIC FLUID TURBINE

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ELASTIC FLUID TURBINE

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5 Claims. (Cl. 253—76)

The present invention relates to elastic fluid turbines comprising a rotor with a plurality of bucket wheels disposed in a casing and a plurality of diaphragms supported on the casing and associated with the bucket wheels to conduct elastic fluid thereto. Each bucket wheel usually has a disk or supporting member and a row of buckets secured thereto and forming bucket passages between them. During operation elastic fluid is directed by the diaphragms into the passages formed between adjacent buckets of the wheels whereby part of its energy is converted into mechanical energy and imparted to the wheel. In order to increase the efficiency of turbines it is the practice to provide each bucket wheel with a shroudband connecting the tips of the buckets and having a sealing edge in cooperative relation with the outer ring of a diaphragm to reduce bucket tip losses, that is, leakage of fluid around the tips of the buckets.

The object of my invention is to provide an improved construction and arrangement of elastic fluid turbines of the kind described above whereby loss due to leakage of elastic fluid around the tips of the buckets is further reduced. This is accomplished in accordance with my invention by the provision of sealing means which in a preferred embodiment comprises a plurality of overlapping flexible sealing strips having portions secured to the outer ends of the buckets or to the shroudband and other portions with a sealing edge in cooperative relation with an adjacent stationary member such as a diaphragm and arranged to be forced outward towards such member by the action of centrifugal force. An arrangement of this kind offers increasing resistance to flow of leakage fluid with increase in speed of the turbine. This is particularly desirable because of the increasing tendency for leakage with increasing speed.

For a better understanding of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing.

In the drawing Fig. 1 illustrates a sectional view, partly broken away, of an elastic fluid turbine embodying my invention; Fig. 2 is a view along lines 2—2 of Fig. 1; Fig. 3 is an enlarged perspective view of a part of Figs. 1 and 2; and Fig. 4 illustrates a modification according to my invention.

The elastic fluid turbine as shown in the drawing has a casing 10. A rotor with a bucket wheel

11 having a row of buckets 12 is disposed in the casing. Diaphragms 13 and 14 are provided on each side of the bucket wheel 11 and supported on the casing 10. Each diaphragm has a row of partitions 15 secured between an inner disk 16 and an outer ring 17 and forming a plurality of nozzles between them. During operation elastic fluid is directed by the nozzles formed between the partitions 15 to the passages defined between the buckets 12 and discharged from the latter to the nozzles of the diaphragm 14.

Each bucket 12 has an outer portion with a tenon 18. A shroudband 19 is secured to the tenons 18 to confine the elastic fluid within the passages formed between the buckets. The shroudband 19, as shown in the present example, may be provided with a sealing edge 20 in proximity to the outer ring 17 of the diaphragm 13 to reduce leakage of fluid discharged from the diaphragm 13 around the outer surface of the shroudband 19 or, from another viewpoint, to reduce the bypassing of fluid between the diaphragms 13 and 14 around the outer portion of the bucket wheel 11.

As a further means to reduce leakage of fluid around the bucket wheel, that is, to reduce tip loss, I provide in accordance with my invention flexible sealing means secured to the outer portion of the bucket wheel in cooperative relation with an adjacent stationary member and offering increased resistance to flow of leakage fluid in response to increasing turbine speed. This sealing means in a preferred embodiment, as shown in the drawing, comprises a plurality of overlapping sealing strips 21 preferably made from a soft metal. Each sealing strip has a portion 22 engaging the outer surface of the shroudband 19 and secured to a tenon 18 by a weld 23. Each sealing strip 21 has another portion 24 which is inclined toward a radial plane of the bucket wheel, that is, towards the plane of rotation of the wheel, and has a sealing edge 25 in proximity to a stationary member.

In the present example the outer rings of the diaphragms have annular projections 26 surrounding the bucket wheel and forming a moisture-collecting groove or grooves 27. The sealing edges 25 of the strips 21 are arranged in cooperative relation with the inner cylindrical sealing surface of the projection 27 on the outer diaphragm ring 17. During operation centrifugal action forces the portions 24 of the sealing strips outward in radial direction whereby the sealing edges 25 are brought closer to the cylindrical sealing surface on the projection 27 and

therefore offer an increased resistance to flow of leakage around the bucket wheel.

The arrangement shown in Fig. 4 comprises a turbine casing 30 and a diaphragm 31 with an outer ring 32 supported on the casing. A bucket wheel 33 is cooperatively associated with the diaphragm 31 and has a plurality of buckets 34 with outer ends connected by a shroudband 35. In order to reduce leakage of fluid around the outer surface of the shroudband 35, that is, around the tips of the buckets, especially at high turbine speed, a sealing strip 36 is provided. This strip has an inner portion securely fastened to the shroudband 35 by a weld 37. An outer portion of the sealing strip has a sealing edge 38 adjacent a sealing surface 39 formed by the casing 30. The sealing strip has a circumferentially corrugated portion 40. This portion permits the strip to be expanded radially at high speed by the action of centrifugal force whereby the clearance formed between the sealing edge 38 and the sealing surface 39 is reduced with increasing speed.

The invention is especially important in connection with reaction turbine blading. The reaction which exists in a given stage increases with increasing speed. This increasing reaction causes an increasing pressure drop across the buckets and therefore an increased tendency of the elastic fluid to bypass the bucket wheel because the pressure drop across the bucket also exists between the inlet and outlet edges of the shroudband, that is, across the tips of the buckets. The centrifugal sealing device as described above has the advantage of sealing the space between the tips of the buckets and the adjacent stationary elements at high speeds. The sealing device forms a small clearance at high speed and a larger clearance at low speeds. This large clearance at low speed is desirable especially in the case of turbines which are frequently shut down because with a large clearance any deflection due to non-uniform cooling or heating of the rotor will not permit of rubbing between the rotor and the stationary elements during the starting operation.

Having described the method of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. Elastic fluid turbine comprising a casing member, a diaphragm member disposed within and supported on the casing member and forming an inner cylindrical sealing surface, a rotor having a bucket wheel with a row of buckets cooperatively associated with the diaphragm member, and sealing means to reduce leakage of fluid around the tips of the buckets, said sealing means comprising a plurality of sealing strips each having a portion secured to an outer portion of the bucket wheel and a flexible portion inclined to the radial plane of the bucket and with an outer sealing edge in proximity to said sealing surface.

2. Elastic fluid turbine comprising a casing member, a rotor with a bucket wheel having a plurality of buckets disposed within the casing member, diaphragm members on opposite sides of the bucket wheel and supported on the casing member, and sealing means to reduce leakage

between the diaphragm members around the outer tips of the buckets comprising a plurality of overlapping sealing strips secured to outer portions of the bucket wheel, one of the diaphragm members having a lateral projection concentrically surrounding the strips, each strip having a flexible portion with a sealing edge in cooperative relation with the projection and arranged to be forced outward towards the projection by the action of centrifugal force to increase the resistance to leakage flow with increasing speed of the bucket wheel.

3. Elastic fluid turbine comprising a casing, a rotor with a row of buckets disposed within the casing, a diaphragm on each side of the buckets and having a cylindrical projection surrounding the buckets and forming a moisture-collecting groove, and sealing means to reduce leakage of elastic fluid around the tips of the buckets comprising a shroudband secured to the tips of the buckets and having a sealing edge in proximity to a diaphragm and a plurality of circumferentially spaced overlapping sealing strips located concentrically within the projection, each strip having a portion secured to the shroudband and another flexible portion inclined towards the plane of rotation of the buckets and with a sealing edge in cooperative relation with the inner cylindrical surface of the projection, said other portion being arranged to be forced outward towards the cylindrical surface by the action of centrifugal force to offer an increasing resistance to leakage flow with increasing speed.

4. Elastic fluid turbine comprising a casing member, a diaphragm member supported on the casing member, the diaphragm member having a lateral annular projection forming a cylindrical sealing surface, a bucket wheel having a row of buckets disposed within the casing member and cooperatively associated with the diaphragm member, and means to reduce leakage around the tips of the buckets comprising a sealing strip secured to the outer portion of the bucket wheel and having a portion with a sealing edge in proximity to and surrounded by said sealing surface, said portion being circumferentially corrugated to cause the sealing edge to be forced closer to the sealing surface at high turbine speed.

5. Elastic fluid turbine comprising a casing, a diaphragm having an outer ring with a cylindrical projection supported on the casing, a bucket wheel with a row of buckets disposed within the casing and arranged to receive elastic fluid from the diaphragm, and means to reduce leakage of fluid around the tips of the buckets comprising a shroudband attached to the tips of the buckets and having a sealing edge in close proximity to said ring and a plurality of sealing strips, each strip having a portion engaging the shroudband and secured to an outer portion of a bucket and another flexible portion concentrically surrounded by said projection and inclined towards the plane of rotation with a sealing edge in proximity to the inner surface of the cylindrical projection, said other portion being flexible and adapted to be forced outward with increasing speed towards said cylindrical sealing surface in order to increase the restriction to leakage flow around the tips of the buckets with increasing speed of the turbine.

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