Nov. 27, 1923. 1,475,214

H. L. WIRT

ELASTIC FLUID TURBINE

Filed July 12, 1922

Fig. 1.

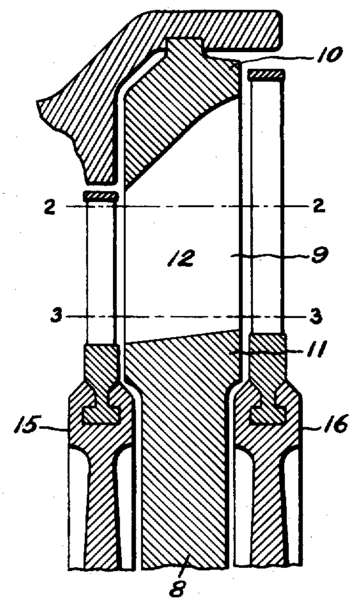


Fig. 2.

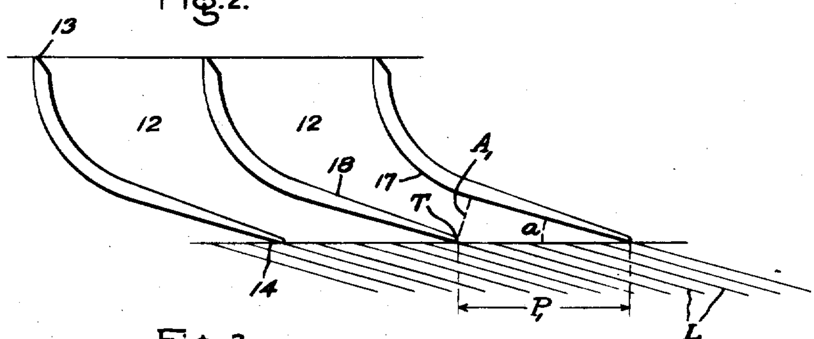
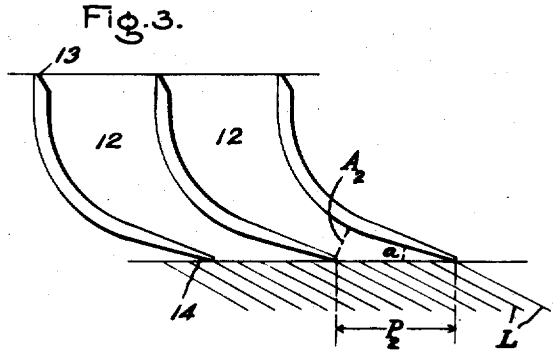


Fig. 3.



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Patented Nov. 27, 1923. 1,475,214

UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

Application filed July 12, 1922. Serial No. 574,477.

To all whom it may concern:

Be it known that I, Harrison Loring Wirt, a citizen of the United States, residing at Schenectady, 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 impulse type and particularly to nozzles for such turbines. As is well understood, the nozzles are stationary, fluid-directing elements which serve to expand the elastic fluid, thereby converting pressure into velocity, and direct it against the adjacent bucket ring of the rotating wheel. In general, the nozzles are formed by mounting or arranging guide blades or partitions between two radially spaced concentric rings, the structure as a whole being termed a nozzle diaphragm. The nozzles may extend entirely around the diaphragm providing for complete peripheral admission or they may extend only part way around.

In axial flow turbines the buckets stand radially which means, of course, that the tips of the buckets travel at higher speed than the roots and in the lower pressure stages of multistage machines where the buckets become quite long this difference in speed is considerable. As is well understood in elastic fluid turbine design, the angle at which the elastic fluid should strike a bucket in order to obtain the highest efficiency depends among other things upon the bucket speed and since in axial flow turbines the bucket speed varies from the root to the tip of the bucket, it follows that the angle of the elastic fluid striking the bucket should vary from root to tip. This result has been obtained in some instances by twisting the discharge ends of the nozzle partitions so as to get a change of the angle of discharge of the elastic fluid issuing from the nozzles but such an arrangement offers such difficulties from a manufacturing standpoint that it is not entirely satisfactory.

The object of my invention is to provide an improved nozzle diaphragm which while being simple in structure and easily manufactured will at the same time give the desired variable angle of discharge.

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, Fig. 1 is a radial sectional view through a nozzle diaphragm and adjacent bucket wheels of an axial flow elastic fluid turbine, the nozzle diaphragm having nozzles embodying my invention, and Figs. 2 and 3 are diagrammatic views on an enlarged scale taken on lines 2—2 and 3—3 respectively of Fig. 1.

Referring to the drawing 8 indicates a nozzle diaphragm having nozzle partitions 9 which, with the outer and inner ring members 10 and 11, define the nozzle passages 12. The entrance edges of the nozzle partitions are designated 13 and the discharge edges 14. The bucket wheels of the stages preceding and following diaphragm 8 are indicated at 15 and 16 and it will be understood that the elastic fluid leaving the buckets of wheel 15 enters nozzle passages 12 and is directed by them to the ring of buckets on wheel 16. What I term the front wall of each nozzle is indicated at 17 and what I term the real wall is indicated at 18.

I have found by tests and experiments that with nozzles which are wholly converging the angle of discharge of the elastic fluid from the nozzles varies with the ratio between the pitch P of the nozzle partitions and the width A of the throat. By pitch of the nozzle partitions I mean the distance between similar points on the partitions measured in a plane parallel to the diaphragm, such distances being designated P_1 and P_2 in Figs. 2 and 3. By width of throat I mean the distance between adjacent nozzle partitions in the plane of least cross section. As will be clear, with wholly converging nozzles the throat occurs at the exit end of the nozzles as indicated at A_1 and A_2 in Figs. 2 and 3. With decrease in the value of $\frac{P}{A}$ the angle of discharge increases, and according to my invention, therefore, I so construct the nozzles that there is a gradual decrease in the value $\frac{P}{A}$ from the radially outer end to the radially inner end of the nozzles, while at the same time the angle which the discharge ends of the front walls of the partitions make with the plane of the diaphragm, which angle is indicated at *a* in Figs. 2 and 3, is the same throughout the radial length of the nozzles. With nozzles constructed in this way I obtain a gradual change in the angle of discharge of elastic fluid from the nozzles and am thus enabled to provide nozzles which discharge elastic fluid with such variations in the angle of discharge as to compensate for the difference in speed between the roots and tips of the buckets.

Viewed from another aspect, whenever the pitch B of the nozzle partitions multiplied by the sine of the angle a which the front walls of the nozzle partitions make with the plane of the discharge ends of the nozzles is equal to or less than the width A of the throat plus the thickness T of the end of the nozzle partitions, the nozzles are wholly converging providing there is no parallel portion, while if it is greater the nozzle will have a diverging discharge end portion. When the condition exists that sine $a x P = A + T$, and there is no parallel portion there is obtained a nozzle having what I term a "zero throat length" this being the point at which the nozzle passes from a converging nozzle to a nozzle having a parallel section or "positive throat length." If sine $a x P$ is less than $A + T$ then I have what I term a "negative throat length." The extent of either a negative throat or a positive throat may be expressed in terms of linear measurement, the measurements being made from what would be the point of zero throat parallel to the undersides of the nozzle partitions. I may have, for example, a nozzle having a quarter inch or a half inch negative throat, or a quarter inch or half inch positive throat, as the case may be, meaning thereby that the nozzle actually terminates a quarter inch or a half inch before it would reach a condition of zero throat or that it terminates a quarter inch or a half inch beyond zero throat.

Expressing my invention in terms of throat length as explained in the preceding paragraph, I provide a nozzle diaphragm having nozzles which have a greater negative throat length at their radially inner ends than they have at their radially outer ends. For example, such a nozzle may have zero throat length at its radially outer end and one-half inch negative throat length at its radially inner end, or other suitable values. The thing which I have discovered is that the angle of discharge increases with increase in the amount of negative throat so that by providing nozzle partitions which give the desired variations in the negative throat length I obtain the desired variations in the angle of discharge to take care of the differences in bucket speed due to the lengths of the buckets. In Figs. 2 and 3 of the drawing, I have shown sections taken on lines 2—2 and 3—3, Fig. 1. The nozzles at the section 3—3 have a greater negative throat length than at the sections 2—2 and as will be noted by the lines L which indicate the angles of discharge, the angle of discharge at the section 3—3 is greater than that at the section 2—2.

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

1. A nozzle diaphragm having nozzle partitions so spaced and formed that the ratio of the pitch to the width of throat is less at the radially inner ends of the nozzle than at their radially outer ends, while at the same time the angle which the discharge ends of the front walls of the partitions make with the plane of the diaphragm is the same throughout the radial length of the nozzles.

2. A nozzle diaphragm having nozzle partitions so spaced and formed that the ratio of the pitch to the width of throat decreases from the radially outer ends of the nozzles to their radially inner ends, while at the same time the angle which the discharge ends of the front walls of the partitions make with the plane of the diaphragm is the same throughout the radial length of the nozzles.

3. A nozzle diaphragm comprising walls forming nozzle passages characterized by the fact that the nozzles have a greater negative throat length at their radially inner ends than they have at their radially outer ends.

4. A nozzle diaphragm having wholly converging nozzles, the walls forming the nozzles being so spaced and formed that the ratio of the pitch between nozzle walls to the width of throat decreases from the radially outer ends of the nozzles to their radially inner ends, while at the same time the angle which the discharge ends of the front walls of the partitions make with the plane of the diaphragm is the same throughout the radial length of the nozzles.

In witness whereof, I have hereunto set my hand this 11th day of July, 1922.

HARRISON LORING WIRT.