T. R. SANDERS.

ELASTIC FLUID TURBINE.

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1,038,972.

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Fig. 1.

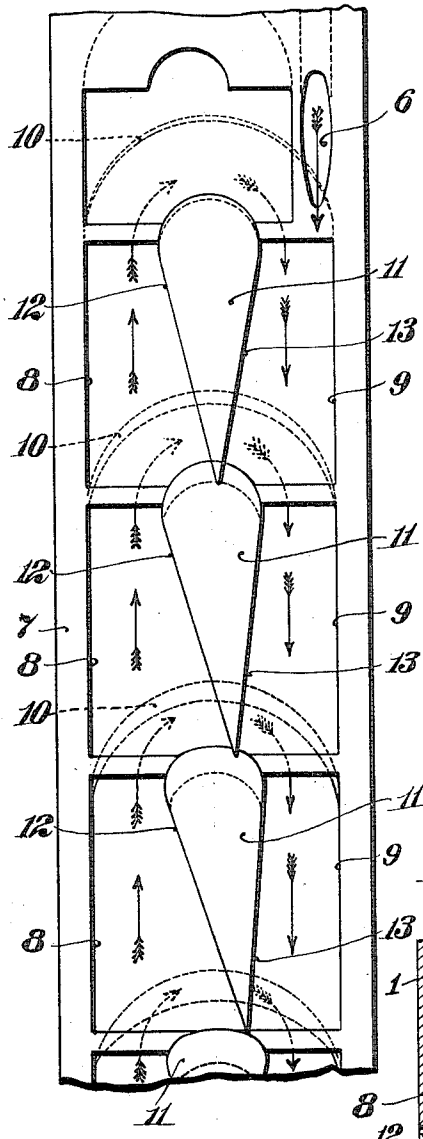


Fig. 2.

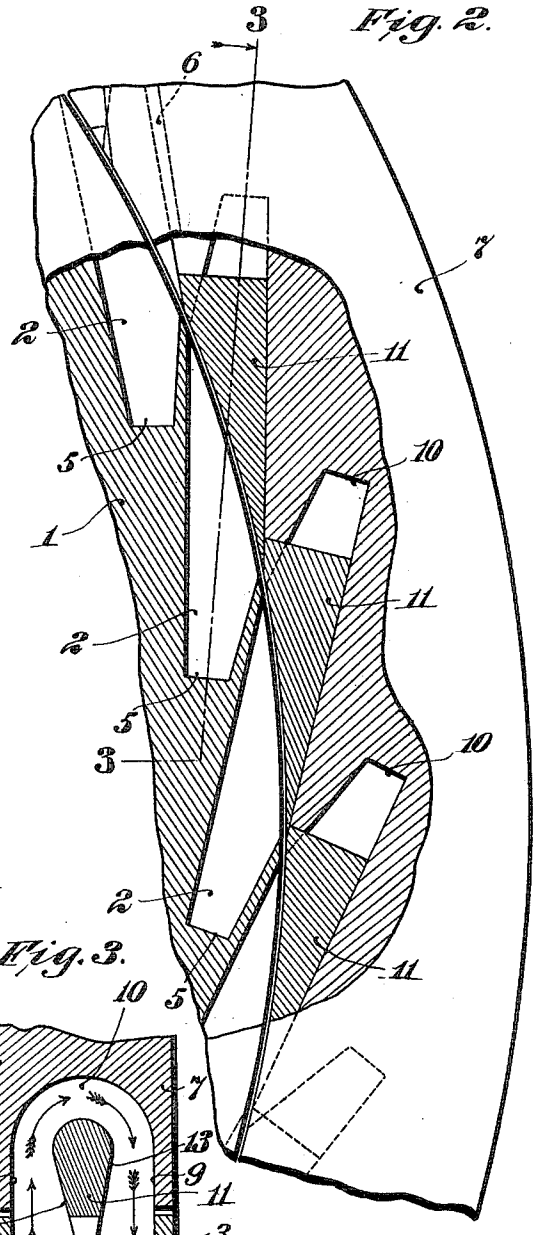
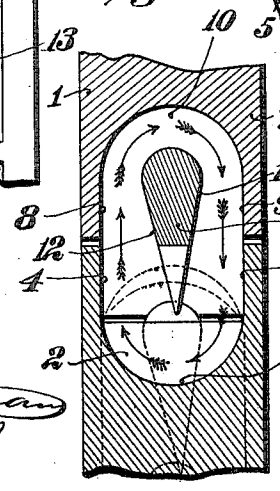


Fig. 3.



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ELASTIC-FLUID TURBINE.

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To all whom it may concern:

Be it known that I, THOMAS R. SANDERS, a citizen of the United States, residing at Hyde Park, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Turbines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to elastic fluid turbines, and more particularly to that class of turbines in which the rotor buckets or vanes are of the parallel return type, and in which the fluid is returned to the same series of rotor buckets by parallel return guides or buckets in the stator. It has been customary in elastic turbines of this type to deliver the steam or other elastic fluid to the rotor buckets through an expanding nozzle, so proportioned that all the pressure in the steam is converted into velocity which is fractionally extracted by the repeated return of the steam to the rotor buckets. In certain constructions of this type of turbines the stator buckets have been arranged with their open ends opposed to the open ends of the rotor buckets, and so arranged that the motive fluid is given a whirling motion in a helical path as it is directed through the rotor and stator buckets.

It is the primary object of the present invention to improve the construction of this class of parallel return bucket turbines.

In carrying out my invention I deliver the steam or other elastic fluid to the rotor bucket through an expanding nozzle which converts a part only of the pressure into velocity, and I so construct the return buckets of the stator that the pressure of the fluid jet is converted into velocity in successive stages as the fluid passes through the stator buckets. This enables the rotor to run efficiently at a comparatively low speed, and also provides a simple and efficient construction for extracting a maximum amount of energy from the motive fluid during its passage through the rotor and stator buckets. I prefer to so construct the expanding nozzle that all the pressure will be converted into velocity by the nozzle, except such as may be required to thereafter develop sufficient velocity to compensate for the frictional loss in the rotor and stator buckets. This is not essential, however, and in case less pressure is converted into velocity by the nozzle, the remaining pressure may be converted into velocity during its passage through the stator buckets, the delivery ends of the stator buckets being expanded to convert the pressure remaining in the motive fluid into velocity above that which is required to compensate for the decrease in velocity produced by the friction of the fluid upon the rotor and stator buckets. The rotor buckets are preferably constructed with the usual parallel receiving and delivery surfaces, and the stator buckets are arranged opposite the rotor buckets, and are provided with outer receiving and delivering surfaces lying in the same planes with the delivery and receiving surfaces respectively of the rotor buckets. In order that the steam or other motive fluid may be confined during its passage through the stator buckets, and may be guided and acted upon thereby to maintain the fluid jet in most efficient condition, or to convert the pressure of the fluid into velocity, the stator buckets are provided with inner guiding surfaces which converge toward the outer guiding surfaces at the entrance side of the bucket, and are either parallel to or diverge from the outer surfaces of the buckets at the delivery side of the buckets.

The various features of the invention will be readily understood from the accompanying drawings and the following detailed description of the construction referred to therein.

In the drawings Figure 1 is a view showing an elevation of a part of the interior of the stator ring of a turbine embodying the invention in its preferred form; Fig. 2 is a sectional elevation showing a part of the stator ring and a part of the periphery of the rotor; and Fig. 3 is a sectional view on line 3—3, Fig. 2

In the construction illustrated in the drawings the rotor 1 is provided on its periphery with a series of parallel return buckets 2. These buckets are of common and well known form, and are provided with parallel entrance and delivery surfaces 3 and 4 which lie in planes at right angles to the axis of the rotor. The rotor buckets are provided with semi-circular bottoms 5 connecting the surfaces 3 and 4, and acting to turn the fluid jet discharged into the

buckets through an angle of 180° so that it enters and leaves the buckets in parallel planes. The steam or other elastic motive fluid is delivered into the rotor buckets through a nozzle 6 which is of the usual expanding type to convert the pressure of the fluid into velocity. The jet or ribbon of steam directed by the expanding nozzle 6 into the entrance side of the rotor buckets is discharged from the delivery side of the buckets into a series of return buckets or passages formed in the stator ring 7. The stator buckets are arranged opposite the rotor buckets, and are provided with the parallel entrance and delivery surfaces 8 and 9 which register with or are in the same planes with the delivery and entrance surfaces 4 and 3 respectively of the rotor buckets. The stator buckets are provided with semi-circular bottoms 10 connecting the receiving and delivery surfaces 8 and 9, so that the jet of motive fluid received from a stator bucket is turned and directed back into the receiving side of a succeeding rotor bucket. The fluid jet or ribbon is then given a whirling motion and directed in a helical path through the stator and rotor buckets, as is usual in this class of parallel return bucket turbines. In the construction shown the fluid jet is confined and controlled during its passage along the outer guiding surfaces of the stator buckets by inner guiding surfaces which are preferably formed by inserting blocks 11 in the buckets. The blocks are preferably so shaped that the surfaces 12 at the entrance side of the buckets form inner guiding surfaces which converge toward the outer guiding surfaces 8, while the surfaces 13 of the blocks at the delivery side of the buckets diverge from the outer surfaces 9 in the direction of the flow of the fluid jet. It is also preferred to so arrange the blocks 11 that the entrance area at the ends of the successive stator buckets increases in the direction of the travel of the rotor, as indicated in Fig. 1. The cross sectional area of the passage between the inner end of the block and the bottom of the bucket also increases in the successive stator buckets, for a purpose which will be presently explained.

In order to secure the best and most efficient results, the nozzle 6 should be so proportioned that a part only of the pressure in the motive fluid will be transformed into velocity by the nozzle. The initial velocity of the fluid jet will therefore be reduced, with a resulting reduction in the velocity of the rotor requisite for the most efficient action of the fluid jet upon the rotor buckets. Since the pressure of the fluid is not all converted into velocity by the nozzle, there will be a tendency for the jet to divide and expand somewhat as it whirls about the bottom of the rotor bucket. When the steam jet is delivered from the rotor bucket into the stator bucket, the divided portions of the jet will be collected between the inner surface 12 and the outer surface 8 of the bucket, and the jet will be reduced by the converging surfaces to its normal volume or condition, and will be directed into the inner end of the passage between the surfaces 9 and 13. If the surface 13 is arranged parallel to the surface 9, the compacted jet will be redelivered into one of the succeeding rotor buckets, to be discharged from this bucket into the succeeding stator bucket without increase in its velocity. If the surface 13 is arranged so that it diverges from the surface 9 in the manner shown, then the jet is expanded, and a part of the pressure remaining in the fluid is transformed into velocity, so that the jet is delivered from the stator bucket at a velocity equal to or greater than the velocity at which it entered the stator bucket. All of the stator buckets may be thus constructed to collect the divided or scattered jet, and to transform a part of the pressure in the jet into velocity, or a part only of the stator buckets may be constructed to transform pressure into velocity, as may be found desirable. It is preferred to so proportion the parts that the velocity of the jet decreases through successive stages, and the entrance area of each stator bucket, as well as the cross sectional area of the passage at the bottom of the bucket, is greater than that of the preceding bucket, in order to compensate for the increase in the volume of the jet and the decrease in its velocity.

By this construction of the stator parallel return buckets, a simple and efficient construction is provided for transforming the pressure of the motive fluid into velocity by successive stages, and for extracting the velocity fractionally, so that the turbine may operate efficiently while the rotor is driven at a comparatively low speed.

While it is preferred to employ the specific construction and arrangement of the rotor and stator buckets shown and described, it will be understood that this construction and arrangement is not essential, and that the buckets may be otherwise arranged upon the rotor and stator so as to direct the fluid jet in a helical path as it travels through the rotor and stator buckets.

Having explained the nature and object of the invention, and specifically described one form of turbine in which it may be embodied, what I claim is:—

1. An elastic fluid turbine, having, in combination, a rotor provided with parallel return buckets, a nozzle partially converting the pressure of the elastic fluid into velocity arranged to direct the fluid into the rotor buckets, a stator provided with parallel return buckets opposed to the rotor buckets and

provided with inner and outer walls for controlling the jet which diverge at the delivery side in the direction of the flow of the fluid jet, substantially as described.

2. An elastic fluid turbine, having, in combination, a rotor provided with parallel return buckets, a nozzle arranged to direct the elastic fluid into the rotor buckets converting pressure into velocity, a stator provided with parallel return buckets opposed to the rotor buckets and provided with inner and outer walls for controlling the jet which converge at the entrance side of the buckets in the direction of the flow of the fluid jet, substantially as described.

3. An elastic fluid turbine, having, in combination, a rotor provided with parallel return buckets, a nozzle partially converting the pressure of the elastic fluid into velocity arranged to direct the fluid into the rotor buckets, a stator provided with parallel return buckets opposed to the rotor buckets and provided with inner and outer walls which converge at the entrance sides and diverge at the delivery side in the direction of the flow of the fluid jet, substantially as described.

4. An elastic fluid turbine, having, in combination, a rotor provided with parallel return buckets, a nozzle arranged to direct the fluid into the rotor buckets converting pressure into velocity, a stator provided with a series of parallel return buckets opposed to the rotor buckets, and provided with inner and outer walls for controlling the jet which converge at the entrance side in the direction of the flow of the fluid jet, the entrance areas at the ends of successive buckets increasing in the direction of rotation of the rotor, substantially as described.

5. An elastic fluid turbine, having, in combination, a rotor provided with parallel return buckets, a nozzle partially converting the pressure of the elastic fluid into velocity arranged to direct the fluid into the rotor buckets, a stator provided with a series of parallel return buckets opposed to the rotor buckets and provided with inner and outer walls which converge at the entrance side and diverge at the delivery side in the direction of the flow of the fluid jet, the entrance areas at the ends of succeeding buckets and the cross sectional areas of the passages at the bottoms of the buckets increasing in the direction of the rotation of the rotor, substantially as described.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."