G. WESTINGHOUSE.
ELASTIC FLUID TURBINE.
APPLICATION FILED FEB. 10, 1908.

935,568. Patented Sept. 28, 1909.

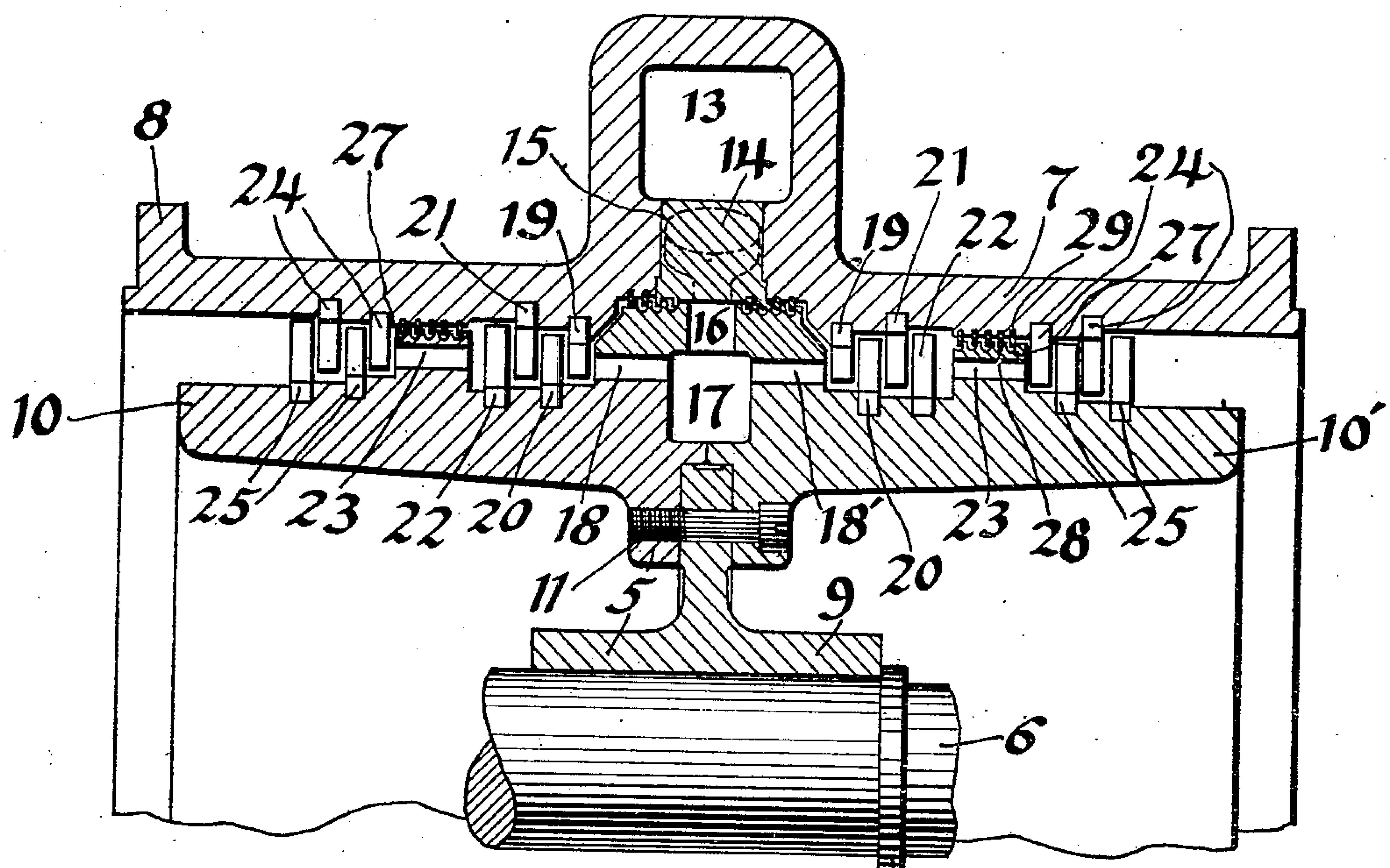

Fig. 1.

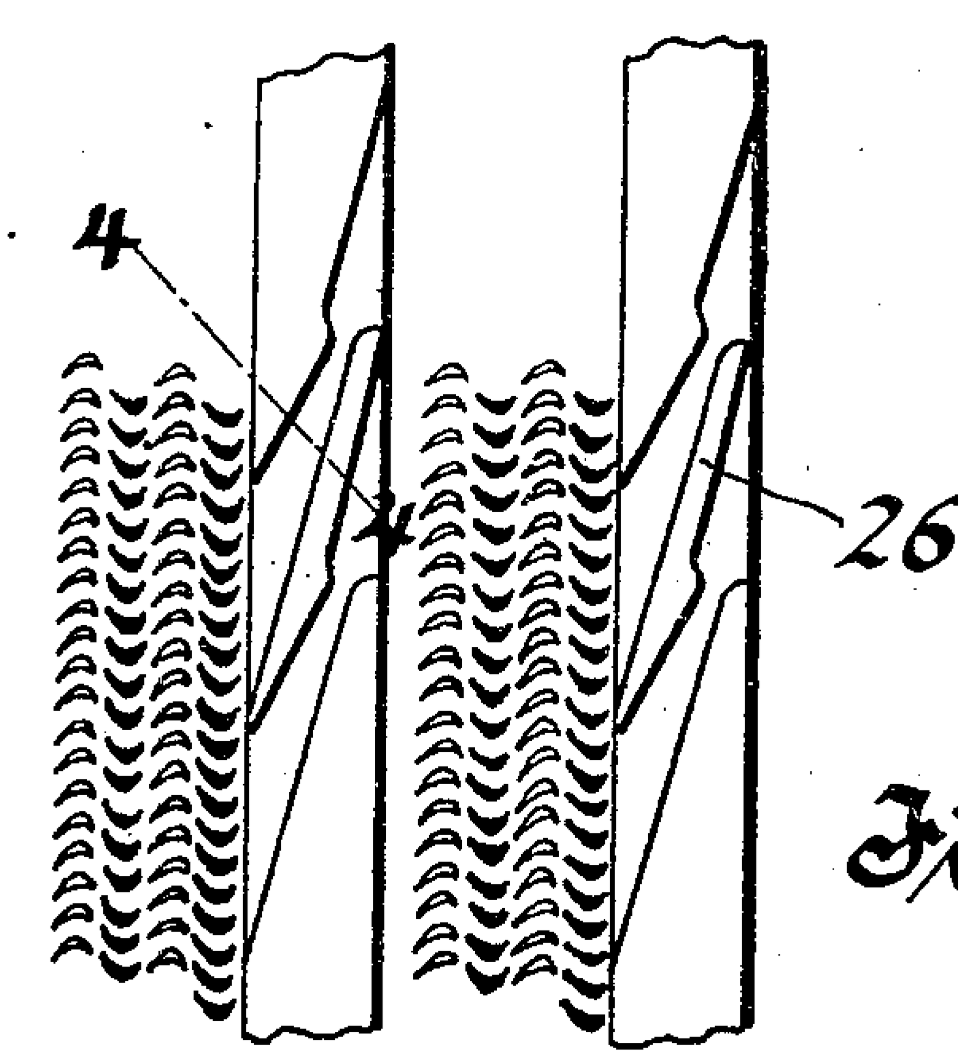

Fig. 2.

Fig. 3.

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UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

ELASTIC-FLUID TURBINE.

935,568. Specification of Letters Patent. Patented Sept. 28, 1909.

Original application filed June 24, 1903, Serial No. 162,910. Divided and this application filed February 10, 1908. Serial No. 415,089.

To all whom it may concern:

Be it known that I, George Westinghouse, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Elastic-Fluid Turbine, of which the following is a specification, this application being a division of an application filed by me on June 24, 1903, Serial No. 162,910.

This invention relates to elastic fluid turbines and has for an object the production of a simple, compact and efficient turbine of relatively great capacity and low speed.

In the turbine herein disclosed as illustrating my invention, motive fluid is introduced through expanding nozzles to a single stage which is located midway between the ends of the turbine and through which the fluid flows in a substantially radial direction. The nozzles are adapted to expand the fluid passing through them and thereby convert a portion of the thermal and pressure energy of the fluid into kinetic energy in the form of fluid velocity, which is preferably wholly absorbed by a moving row of blades which, with the nozzles, constitute the initial stage of the turbine.

The motive fluid discharged from the initial stage is received by an annular rest or pressure chamber formed in the rotor and located midway between the ends of the turbine and from which it is delivered by a series of reaction nozzles carried by the rotor. The reaction nozzles are axially disposed on opposite sides of the rest chamber and are arranged to discharge the fluid rearwardly with reference to the direction of rotation of the rotor. The reactive force of the fluid discharging from the rotating nozzles is utilized in imparting energy to the turbine. Alternate rows of stationary directing vanes and rotating blades, located at each side of the rest chamber, receive the motive fluid discharged from the rotating nozzles and with the nozzles constitute an intermediate stage of the turbine. The motive fluid discharged from each section in the intermediate stage, (which sections are bilaterally symmetrical) is received by sectional nozzles which are adapted to further expand the motive fluid and deliver it to the blades and vanes of a divided low-pressure stage located on each side of the initial stage. The low pressure stage comprises the sectional nozzles and alternate annular rows of directing vanes and moving blades. The motive fluid discharged from the low-pressure stage, and from which all the available pressure and thermal energy has been abstracted, enters exhaust passages formed in the turbine casing and located at each end of the rotor. The exhaust passages are arranged to communicate with a common condenser or with the atmosphere as desired.

The turbine rotor is composed of a plurality of parts clamped together and mounted on the turbine shaft in such a manner that one end of the mounting member is fixed with reference to the shaft while the other is capable of longitudinal motion along the shaft to accommodate expansion.

In the drawings accompanying this application: Figure 1 is a partial longitudinal section of a turbine embodying my invention; Fig. 2 is a plan development of a portion of two groups of expansion passages or nozzles and adjacent blades and vanes, the vanes being in section and the shrouds for the expansion passages or nozzles removed; and Fig. 3 is a section along the line 4—4 of Fig. 2.

Referring to the drawings: The turbine comprises a rotor 5, which is mounted on a shaft 6, and an inclosing casing 7. The casing consists of a substantially cylindrical portion and end portions (not shown), which are adapted to be secured to the annular flanges 8 at each end of the cylindrical portion.

The rotor element comprises a hub portion 9 mounted on the shaft and two similar ring portions 10 and 10′ secured on opposite sides of the hub portion by screws 11. The hub portion is keyed or otherwise secured to the shaft 6 in such a way that it is capable of independent expansion longitudinally of the shaft. A collar 12 formed on the shaft and against which the hub portion abuts, limits the relative motion between the hub portion and the shaft in one direction. Under such conditions the hub portion 9 is capable of free longitudinal expansion in one direction and consequently the tendency to distortion caused by restricting the expansion of either the hub or shaft is overcome. The shaft 6 extends through the casing co-axially with the cylindrical portion and is provided with suitable packing glands (not shown), which are located between the end portions of the casing and the shaft, and suitable bearings (not shown), which are located outside of the casing.

The casing is provided with an annular chamber 13 formed integrally with the cylindrical portion and which communicates with a source of fluid supply. A nozzle block 14, which is provided with divergent nozzles 15, is located between the chamber 13 and the working passages of the turbine. The nozzles 15 are arranged to partially expand the motive fluid supplied to the turbine and to discharge it in substantially radial streams against a single row of rotating blades 16 which are mounted on the rotor and which are preferably adapted to wholly absorb the velocity energy resulting from the partial expansion of the motive fluid.

The fluid discharged from the blades 16 enters an annular chamber 17, which is formed in the rotor element midway between the ends of the turbine. The fluid entering the chamber 17 is devoid of inherent velocity and must be further expanded before giving up further energy to the turbine. Oppositely disposed reaction nozzles 18 and 18′ are formed in the rotor element and communicate with the chamber 17. These nozzles 18 and 18′ are axially disposed with reference to the rotor and rearwardly inclined relative to the direction of its rotation. The motive fluid passing through the nozzles is partially expanded and delivered to the blades and vanes of the divided sections of an intermediate stage of the turbine. Since the working passages communicating with the nozzles 18 and 18′ are alike, only one will be described.

A row of directing vanes 19 receives the motive fluid discharged from the nozzles 18, and redirecting it, delivers it to an annular row of blades 20 mounted on the rotor. The blades 20 are adapted to abstract a portion of the velocity energy of the fluid stream and deliver the motive fluid to an annular row of directing vanes 21, which redirect and deliver it to blades 22. The blades 22 are mounted on the rotor and are preferably so constructed that they abstract all the remaining velocity energy of the motive fluid. The nozzles 18 and 18′ with their respective sets of directing vanes and moving blades comprise the intermediate stage of the turbine. The fluid delivered by the blades 22 is further expanded in sectional reaction nozzles 23 and delivered to alternate rows of stationary directing vanes 24 and moving blades 25, mounted on the casing and rotor respectively. Each row of vanes 24 is adapted to redirect the flow of motive fluid and deliver it in the most efficient manner to the adjacent row of blades, and the rows of blades 25 are adapted to fractionally abstract the kinetic energy of the motive fluid. The motive fluid discharged from the last row of blades 25, and from which all the available energy has been abstracted, is conducted to a condenser or the atmosphere through exhaust passages, which are located at each end of the turbine. The nozzles 23 with their respective sets of vanes and blades comprise the low pressure stage of the turbine.

Each of the nozzles 23 preferably comprises a row of radial vanes 26 formed integrally with the rotor and of proper contour and inclination to provide for the expansion of the fluid passing therethrough. The outer or free ends of the vanes 26 are provided with a shroud 27, which is provided on its peripheral face with a series of grooves 28 with which annular strips 29, mounted on the casing, interleave to form a fluid packing. The interleaving labyrinth packing presents a tortuous passage to the motive fluid and thereby prevents leakage through the clearance space between the rotor and the casing.

The nozzles 18 and 18′ are preferably similar to the nozzles 23 with the exception that the shrouding portion is heavier owing to the construction of the casing at that point. An interleaving seal, similar to the seal between the shrouds 27 and the casing, is located between the shrouding of the nozzles 18 and 18′ and the casing, thereby preventing leakage of fluid around the nozzles 18 and 18′. The nozzles 18, 18′ and 23 are so arranged that the reactive force of the motive fluid passing through them delivers energy to the turbine. The axial or longitudinal components of the reactive forces induce axial or longitudinal thrusts on the rotor element, but the divided portions of each of the intermediate and the low pressure stages are so arranged that the forces counterbalance each other and the rotor element is in longitudinal equilibrium.

It will be apparent to those skilled in the art that one or more single-flow stages may be operated in connection with the divided low-pressure stages, that the capacity of the turbine may be increased by increasing the number of nozzles 15, 18, 18′ and 23, and that various modifications and arrangements of parts may be made without departing from the spirit and scope of this invention.

What I claim is:

1. In a steam turbine, a casing having a steam chamber and one or more nozzles, in combination with a rotary member having an annular steam chamber, a set of blades between said chamber and said nozzle or nozzles, and a number of nozzles that receive steam from said annular chamber and expand it to increase its impact velocity, said nozzles being so arranged that their orifices practically touch each other and form a continuous opening, and a group of sets of

blades and vanes against which the steam is projected from said opening.

2. In a fluid-pressure turbine, the combination with a drum having a plurality of sectional nozzles and a plurality of annular sets of blades alternating with the nozzles, of a casing having means for supplying fluid to the initial fluid-using portions of the drum and a plurality of annular sets of guide vanes that alternate with the annular sets of blades on the drum.

3. In a fluid-pressure turbine, the combination with a drum having an annular receiving chamber, a plurality of sectional nozzles and a plurality of annular sets of blades, of a casing having means for supplying actuating fluid to the receiving chamber of the drum and a plurality of annular sets of guide vanes that alternate with the annular sets of blades on the drum.

4. In a fluid-pressure turbine, the combination with a drum having a plurality of annular chambers, a plurality of sectional nozzles severally receiving fluid from said chambers and a plurality of annular sets of blades alternating with said nozzles, of a casing having means for supplying fluid to the first annular chamber and a plurality of sets of vanes that alternate with the drum-blades.

5. In a fluid-pressure turbine, the combination with a drum having a plurality of annular chambers, a plurality of sectional nozzles severally disposed to receive the fluid from said chambers and a plurality of sets of blades severally disposed to be acted upon by the fluid from said nozzles, of a casing having means for supplying fluid to the first of said annular chambers and guide vanes that alternate with the drum blades.

6. In a fluid-pressure turbine, the combination with a drum having a plurality of sectional nozzles, a plurality of annular sets of blades intermediate said sectional nozzles and annular chambers which severally supply the propelling fluid to the sectional nozzles, of a casing having means for supplying fluid to the initial fluid-using portions of the drum and a plurality of annular sets of guide vanes that alternate with the annular sets of blades on the drum.

7. In a multi-stage fluid turbine, nozzles in direct communication with adjacent stages and a labyrinth packing between said adjacent stages and adjacent said nozzles for causing the fluid to pass through the nozzles.

8. In a multi-stage fluid turbine, nozzles between adjacent stages through which fluid exhausts from one stage into the other and a labyrinth packing between adjacent stages and located between the periphery of the rotor and the interior circumference of the stator whereby steam from one stage will be directed through nozzles into another stage.

9. In an elastic fluid turbine, a rotor provided with a plurality of rows of sectional nozzles.

10. In an elastic fluid turbine, a rotor element provided with a plurality of rows of sectional nozzles with fluid delivery passages therethrough which successively increase from the inlet to the exhaust of said turbine.

11. In a rotary engine of the character described, a moving part having in one side vanes or buckets and in the opposite side reaction nozzles and an intervening steam passage communicating with the channels between the vanes or buckets and with said nozzles.

12. In a rotary engine of the character described, moving parts each provided with vanes or buckets, a series of reaction nozzles and a chamber between said vanes or buckets and nozzles, a stationary impact nozzle arranged to discharge steam against said vanes or buckets and stationary abutments against which the reaction nozzles discharge.

In testimony whereof, I have hereunto subscribed my name this fifth day of February, 1908.

GEO. WESTINGHOUSE.

Witnesses:
GEO. J. TAYLOR,
JNO. S. GREEN.