No. 894,927. PATENTED AUG. 4, 1908.

G. WESTINGHOUSE.

FLUID PRESSURE TURBINE.

APPLICATION FILED FEB. 12, 1904.

3 SHEETS—SHEET 1.

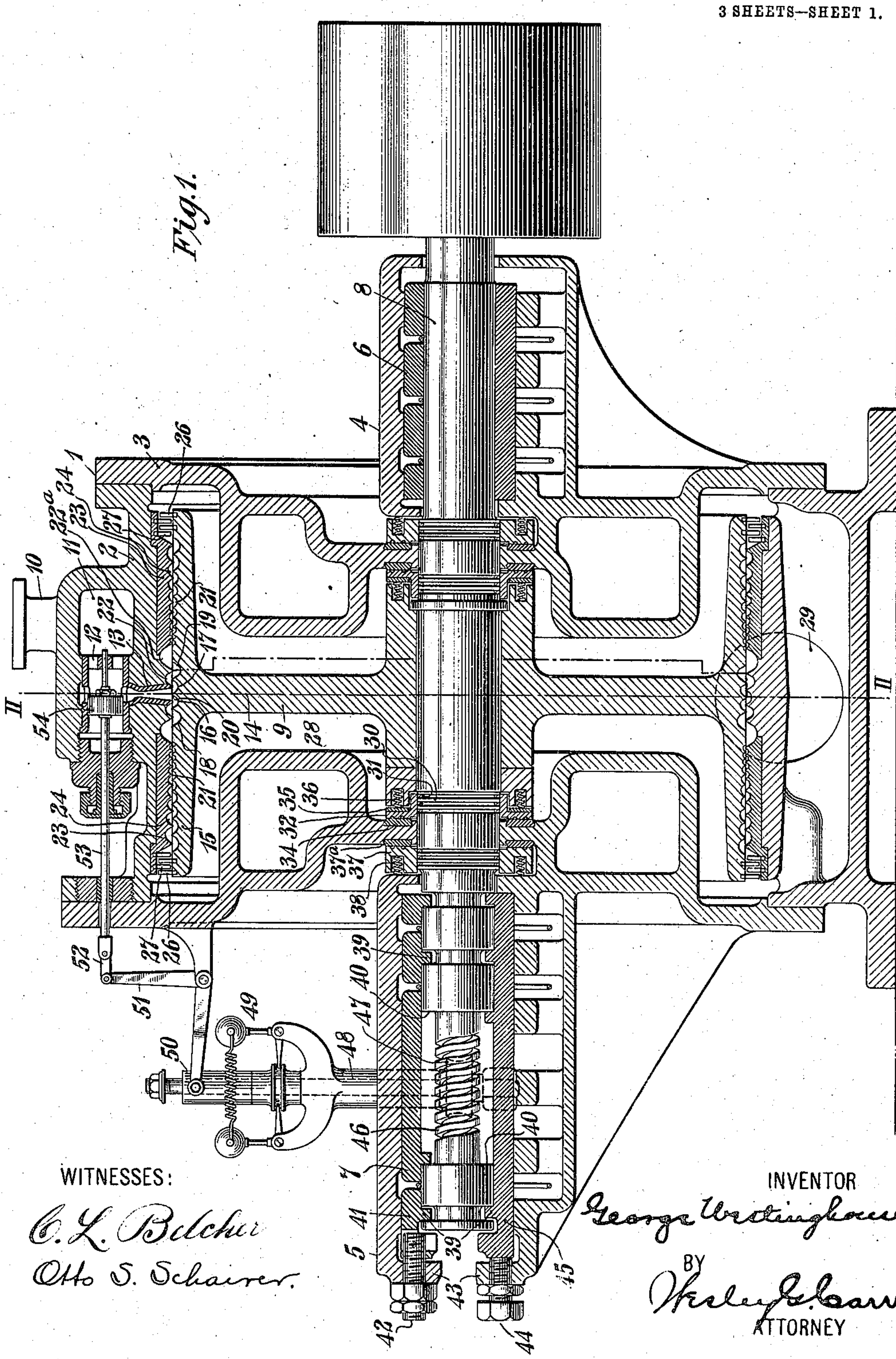

Fig. 1.

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3 SHEETS—SHEET 2.

Fig. 2.

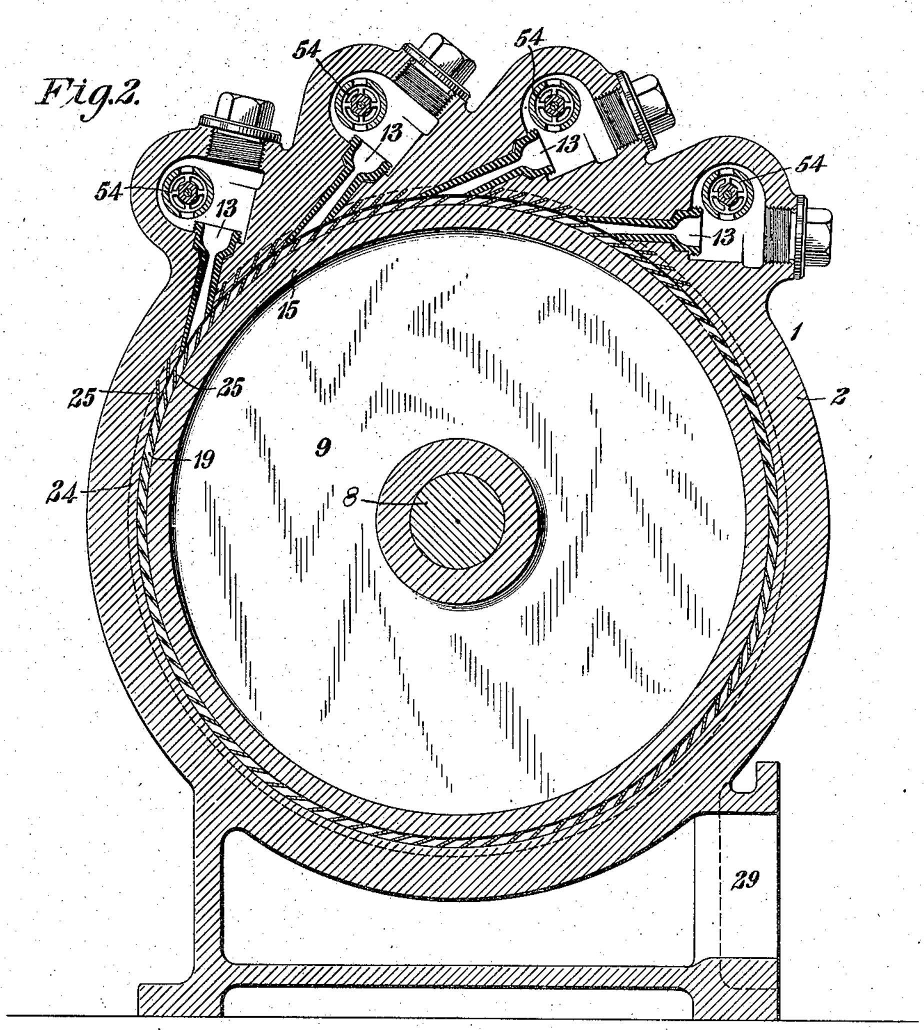
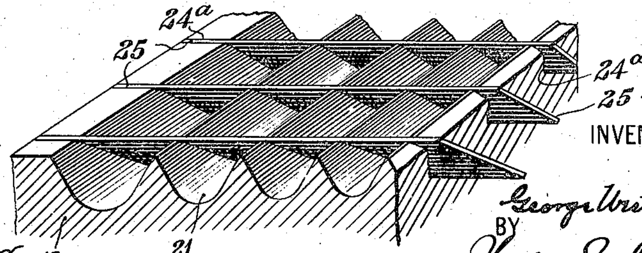


Fig. 3.



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3 SHEETS—SHEET 3.

Fig. 4.

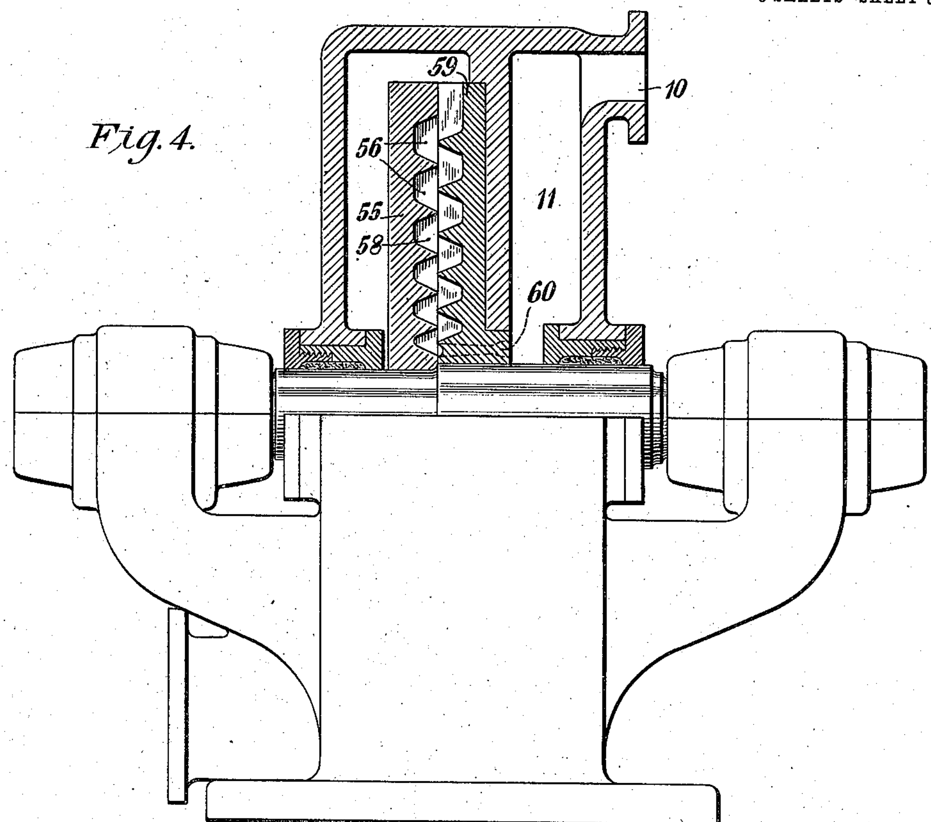
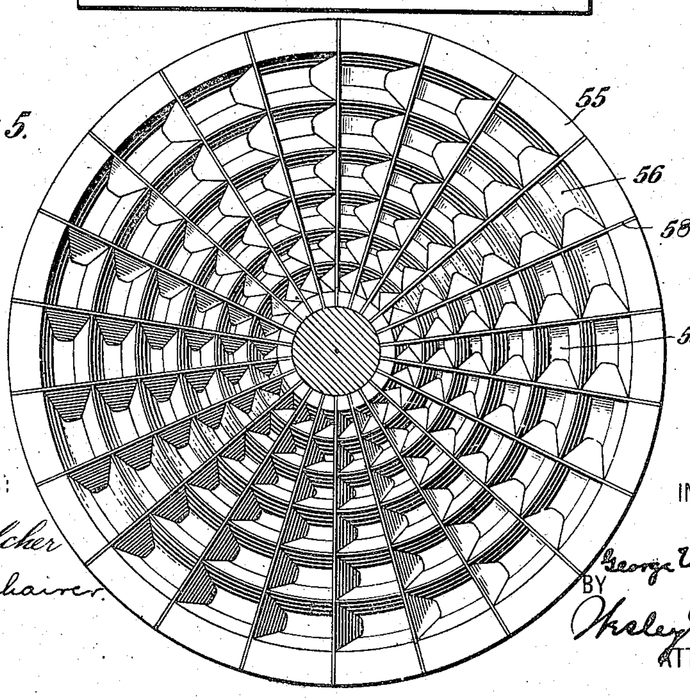


Fig. 5.



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

FLUID-PRESSURE TURBINE.

No. 894,927. Specification of Letters Patent. Patented Aug. 4, 1908.

Application filed February 12, 1904. Serial No. 193,354.

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 Improvement in Fluid-Pressure Turbines, of which the following is a specification.

My invention relates to fluid-pressure turbines, and it has for its object to provide an engine of this character which shall effectually and economically utilize the energy of expanding fluids and which shall be simple and compact in structure and relatively inexpensive to manufacture as compared with heretofore known types.

My invention is illustrated in the accompanying drawings, in which

Figure 1 is a vertical, longitudinal section of a turbine constructed in accordance therewith. Fig. 2 is a vertical section on line II—II of Fig. 1. Fig. 3 is an enlarged, sectional view of a portion of the rim of the rotatable member. Fig. 4 is a view, partially in side elevation and partially in section, of a turbine embodying a modification of my invention, and Fig. 5 is a view, in end elevation, of the rotatable member thereof.

The engine herein shown and described was primarily designed for operation by means of steam and, for convenience of description, will be referred to as a steam turbine, but it is not limited to such specific use to the exclusion of others which it may be found feasible to employ in practice.

As illustrated in the drawings, the frame 1 of the engine comprises a cylindrical casing 2 and inclosing end brackets 3 provided with suitable bearing housings 4 and 5 for the bearings 6 and 7 of the shaft 8 upon which the rotating member 9 is mounted. An inlet port 10 opens into a chamber 11 from which steam is supplied, through a passage 12, to the discharge nozzles 13 which are circumferentially disposed directly over the center line 14 of the rotatable member 9. These nozzles or expansion passages 13 are made of such size and shape and are set at such angles to the tangents to the circumference of the member 9 as to insure satisfactory expansion of the fluid and suitable impact of the same on the buckets. While I have shown the nozzles grouped at the upper side of the casing, I desire it to be understood that they may be disposed about the periphery of the rotatable member in any other desired manner and that any number of nozzles from one to a full circumferential set may be employed.

The rim 15 of the rotatable member 9 is provided with peripheral grooves 16, 17, 18 and 19, the curvilinear, wedge-shaped portion 20 forming the wall between the grooves 16 and 17 being located on the center line 14 of the wheel, directly beneath the nozzles 13. It is to be noted that the grooves 18 and 19 are of materially larger dimensions than the grooves 16 and 17, in order to compensate for the reduced velocity of the steam after it leaves the nozzles 13. Although I have shown only two sets of such grooves, it is to be understood that any other number may be employed which will satisfactorily utilize the velocity of the steam. On both sides of the central grooves 16, 17, 18 and 19, are series of grooves 21, which also increase in dimensions with the distance from the nozzles 13 in order to allow for the further expansion of the steam after it has acted upon the rotatable member in the grooves 16, 17, 18 and 19.

The inner periphery of the casing 2 is provided, on both sides of the nozzles 13, with peripheral grooves 22 corresponding to those in the rim 15 of the rotatable member, but displaced laterally with reference thereto, passages 22^a permitting of the distribution of the steam about the circumference of the rotatable member. Collars or rings 23, properly secured in the casing 2, are provided with grooves 24 corresponding with and opposite to the series of grooves 21, but, if desired, the said grooves may be provided in the casing itself without departing from the spirit of the invention.

In order to form buckets and guide vanes, longitudinal slots 24^a intersecting the grooves are provided respectively in the rim 15 of the rotatable member, in the casing 2 and in the collars 23, and partition strips or blades 25 are inserted and secured therein by calking or in any other suitable manner. I have found it convenient, however, to provide only the portions of the periphery of the casing 2 which are nearest the nozzles 13 with such partitions, but it is to be understood that the whole or any fraction of the periphery may, if desired, be so provided. The angles which the partitions 25 make with the tangents to the periphery of the rotatable member 9 and the form and dimensions of the grooves in the rim 15, the casing 2 and the collars 23 may be readily determined by those skilled in the art and are such that the velocity of the steam may be most effectually and economically utilized.

In order to further utilize the energy of the steam after it has left the buckets, I have provided circumferential sets of blades 26 at the ends of the rim 15 of the rotatable member and corresponding sets of guide vanes 27 at the ends of the collars 23, the blades and vanes being constructed and arranged in accordance with the usual practice in connection with turbines of the well known Parsons type, it being understood, however, that this is not an essential feature of my invention.

In operation, the steam is partially expanded in the nozzles 13 and is discharged, at high velocity, into the buckets in the peripheral grooves 16 and 17, by which its direction is reversed, and it is then discharged into the grooves 22 in the casing 2 and, subsequently, into the distributing passages 22ª, the velocity thereof attained in the nozzles being given up to the rotatable member. From the distributing passages 22ª, the steam passes through a series of pressure drops in the grooves 21 and 24, the velocity thereof being abstracted at each step, and after operating upon the blades 26 and the vanes 27, it is discharged into the exhaust chamber 28 and from thence into the exhaust port 29.

In order to prevent leakage of the steam and, at the same time, to permit of free rotation of the shaft, I provide the shaft 8 with sets of flanges or collars 30, in the grooves between which any suitable packing material 31 may be employed. Packing rings 32, having L-shaped cross-sections, surround the said collars and packing material, their annular surfaces bearing respectively upon stationary Babbitt wearing rings 34 and rotatable wearing rings 35. pressure being exerted upon the rings 35 by means of springs 36, substantially as shown. Similarly, packing rings 37 bear upon Babbitt wearing rings 37ª in the outside of the end brackets 3, pressure being exerted by springs 38 to insure good contact between said parts.

In order to provide for longitudinal adjustment of the rotatable member 9, the bearing 7 is constructed in two parts, each having flanges 39 which intermesh with flanges 40 on the shaft 8. Secured to one end of the upper half 41 of the bearing 7, is a bolt 42 which threads in the end 43 of the bearing housing 5, while a bolt 44, also threading in the end 43 of the bearing housing 5, bears on the end of the lower half 45 of the bearing. By means of the bolt 42, the shaft 8 may be moved longitudinally in one direction, and in the other direction by means of the bolt 44.

One end of the shaft is provided with a worm 46, which meshes with a gear 47 at one end of a spindle 48 carrying, at its upper end, a ball governor 49, though it is obvious that the governor may be of any other desired type or may be operated in any other suitable manner. If the speed of the turbine increases above the normal, the collar 50 is raised, thereby operating a bell crank lever 51 one end of which is connected, by means of links 52 or in any other suitable manner, to the free ends of piston rods 53, and pistons 54 close one or more of the expansion passages or nozzles 13. By means of this arrangement, the speed of the turbine is governed and maintained practically constant.

While I have shown the nozzles as individually provided with pistons for governing the supply of steam thereto, it is to be understood that, if desired, the structure may be so modified as to permit a single piston or valve to effect the same result.

In Fig. 4, I have shown, as a modification of my invention, a turbine comprising a rotatable disk 55 having concentric, annular grooves 56 in one face and radial partition strips 58 set at the proper angles, and an adjacent casing 59 similarly provided with concentric, annular grooves and radial partition strips. Steam is introduced through the nozzles 60 near the center of the disk, and during its passage from the center to the circumference, imparts kinetic energy thereto. Both sides of the disk may be provided with concentric, annular grooves and a plurality of disks may be mounted upon the same shaft, if desired.

Certain of the features of the construction of the turbine may be altered and other arrangements of parts may be employed, if desired or convenient, and the details of construction of the engine as a whole may be otherwise varied from what is shown within the range of the knowledge of those skilled in the art without departing from the scope of my invention.

The partitions 25 referred to obviously must be placed close enough together and at such an angle as to insure the proper action and reaction of the steam as it passes from groove to groove. They are preferably in a line parallel with the axis, but it would not be a departure from my invention to arrange them in a slightly spiral direction.

The arrangement of the form of blade described has the effect of entraining any steam that tends to leak longitudinally in such a manner as to cause such leakage to act effectively along with the steam which entrains it.

When the engine is intended for use for marine purposes, a separate short drum containing the impulse part referred to under numerals 13, 16, 17, 18, 19 and 20 may be put in a cylindrical extension, but so arranged that when steam is admitted to this portion instead of to the central jets, the shaft of the engine will revolve in the opposite direction.

I claim as my invention:

1. In an elastic fluid turbine, a stationary member provided with a plurality of separately-controlled inlet ports, a rotatable member adjacent thereto, each of said members being provided with annular sets of grooves and intersecting partitions coöperating therewith to form buckets, the dimension of the grooves increasing with the distance from the inlet nozzles.

2. In an elastic fluid turbine, a stationary member provided with a plurality of governor-controlled inlet ports, a rotatable member adjacent thereto, each of said members being provided with annular sets of grooves and intersecting partitions coöperating therewith to form buckets, the dimensions of said grooves increasing with the distance from said nozzles.

3. In an elastic fluid turbine, a stationary member provided with a motive fluid inlet, a rotatable member adjacent thereto, each of said members being provided with sets of annular grooves and intersecting partitions coöperating therewith to form buckets, the dimensions of said grooves increasing with the distance from the inlet openings, and the set or sets nearest said openings comprising a number of grooves of larger dimensions than the succeeding sets.

4. In an elastic fluid turbine, a rotatable member having annular sets of buckets, formed by annular grooves and intersecting strips, adapted to abstract the energy from the motive fluid supplied to said turbine by impact, and blades located adjacent thereto adapted to fractionally expand the fluid discharge from said buckets and abstract the available energy by impact and reaction.

5. In an elastic fluid turbine, a plurality of separately-controlled fluid nozzles adapted to partially convert the pressure energy of the motive fluid into velocity energy, a plurality of annular grooves formed in the rotor of said turbine and adapted to abstract the available energy by impact, and means for fractionally expanding the motive fluid discharged from said grooves and abstracting the available energy by impact and reaction.

6. In an elastic fluid turbine, a plurality of separately-controlled fluid nozzles, a plurality of annular sets of buckets formed by annular grooves and intersecting strips adapted to receive motive fluid from said nozzles and a series of alternate rows of moving blades and stationary vanes adapted to receive the fluid discharged from said buckets.

7. In a fluid pressure turbine, a stator provided with a plurality of inwardly-discharging fluid nozzles, a plurality of rows of peripheral grooves on each side of said discharging nozzles and rows of stationary vanes adjacent to each set of grooves, a turbine rotor provided with annular grooves alternating in position with the grooves in the stator and annular rows of blades alternating with the stator vanes.

8. A fluid pressure turbine comprising a stationary member having a plurality of divergent nozzles and a rotatable member adjacent thereto, each of said members being provided with a plurality of annular grooves adjacent to said nozzles which increase in dimensions with the distance from the nozzles, and intersecting partitions, set at an angle with corresponding radial blades, coöperating therewith to form annular sets of buckets, and a series of grooves adjacent to said plurality of grooves which also increase in dimension with the distance from said nozzles.

9. In an elastic fluid turbine, a plurality of fluid nozzles adapted to partially convert the pressure energy of the motive fluid into kinetic energy in the form of velocity, a plurality of annular sets of peripheral buckets adapted to partially abstract the energy by impact, and alternate rows of moving blades and stationary vanes adapted to fractionally expand the motive fluid discharged from said buckets and to abstract the available energy by impact and reaction.

10. A fluid-pressure turbine comprising a stationary member provided with one or more nozzle openings, a plurality of annular grooves located on both sides of the nozzle openings and increasing in dimensions with the distance therefrom and a series of grooves on both sides of the said plurality of grooves which also increase in dimensions with the distance from the nozzles, and an adjacent rotatable member having peripheral grooves corresponding to those in the casing but alternating in position therewith, both of said members being provided with partitions intersecting the grooves therein which coöperate therewith to form annular sets of buckets.

11. A fluid-pressure turbine comprising a stationary member having one or more nozzle openings therein and a rotatable member adjacent thereto, each of said members being provided with sets of annular grooves and intersecting partitions coöperating therewith to form buckets, the dimensions of the grooves increasing with the distance from the nozzle openings and the set or sets nearest the said openings being of larger dimensions than the succeeding set or sets.

12. A fluid-pressure turbine comprising a stationary member having one or more nozzle openings therein and a rotatable member adjacent thereto, each of said members being provided with sets of annular grooves and intersecting partitions coöperating therewith to form buckets, the dimensions of the grooves increasing with the distance from the nozzle openings and the set or sets nearest the said openings comprising a

smaller number of grooves of larger dimensions than the succeeding set or sets.

13. In an elastic fluid turbine, a rotatable member having a plurality of annular sets of peripheral buckets adapted to abstract the energy from the motive fluid by impact, and alternate annular rows of stationary vanes and moving blades arranged to fractionally expand the motive fluid discharged from said buckets and abstract the available energy by impact and reaction.

14. In an elastic fluid turbine, a rotatable member provided with a plurality of annular sets of peripheral buckets, in combination with alternate annular rows of radially extending stationary vanes and rotating blades adapted to receive the motive fluid delivered by said buckets.

15. In an elastic fluid turbine, a rotatable member provided with a plurality of peripheral buckets, in combination with alternate annular rows of radially extending stationary vanes and rotating blades.

16. In an elastic fluid turbine, a rotating member provided with a plurality of annular sets of peripheral buckets, in combina tion with annular rows of stationary vanes and moving blades.

17. In an elastic fluid turbine, a fluid nozzle adapted to partially convert the pressure energy of the motive fluid into kinetic energy, a plurality of annular sets of peripheral buckets adapted to abstract the available energy from the motive fluid by impact, and alternate annular rows of stationary vanes and moving blades arranged to fractionally expand the motive fluid discharged from said buckets and abstract the available energy by impact and reaction.

18. In an elastic fluid turbine, a fluid inlet nozzle adapted to partially convert the pressure energy of the motive fluid into kinetic energy in the form of fluid velocity, in combination with a rotatable member provided with a plurality of annular sets of peripheral buckets and alternate annular rows of stationary vanes and moving blades.

19. In an elastic fluid turbine, means for partially converting the pressure and thermal energy of the motive fluid into kinetic energy in the form of velocity, a plurality of peripheral buckets adapted to abstract the available energy of the motive fluid, and alternate annular rows of stationary vanes and moving blades arranged to abstract the available energy of the motive fluid discharged from said buckets.

20. In combination in an elastic fluid turbine, annular rows of peripheral buckets and alternate rows of stationary vanes and moving blades.

21. In combination in an elastic fluid turbine, annular rows of coöperating moving and stationary peripheral buckets, and alternate rows of stationary vanes and moving blades.

22. In an elastic fluid turbine, in combination with means for partially converting the pressure and thermal energy of the motive fluid into kinetic energy in the form of velocity, a double-flow stage comprising peripheral buckets adapted to abstract the available energy of the motive fluid and to deliver the motive fluid in two separate streams toward each end of the turbine, and alternate annular rows of stationary vanes and moving blades located on each side of said buckets and adapted to abstract the available energy of the motive fluid discharged from said buckets.

In testimony whereof, I have hereunto subscribed my name this 25th day of January, 1904.

GEO. WESTINGHOUSE.

Witnesses:

WM. H. CAPEL,

H. C. TENER.