No. 811,984. PATENTED FEB. 6, 1906.

J. WILKINSON.

ELASTIC FLUID TURBINE.

APPLICATION FILED MAY 22, 1905.

Fig. 2.

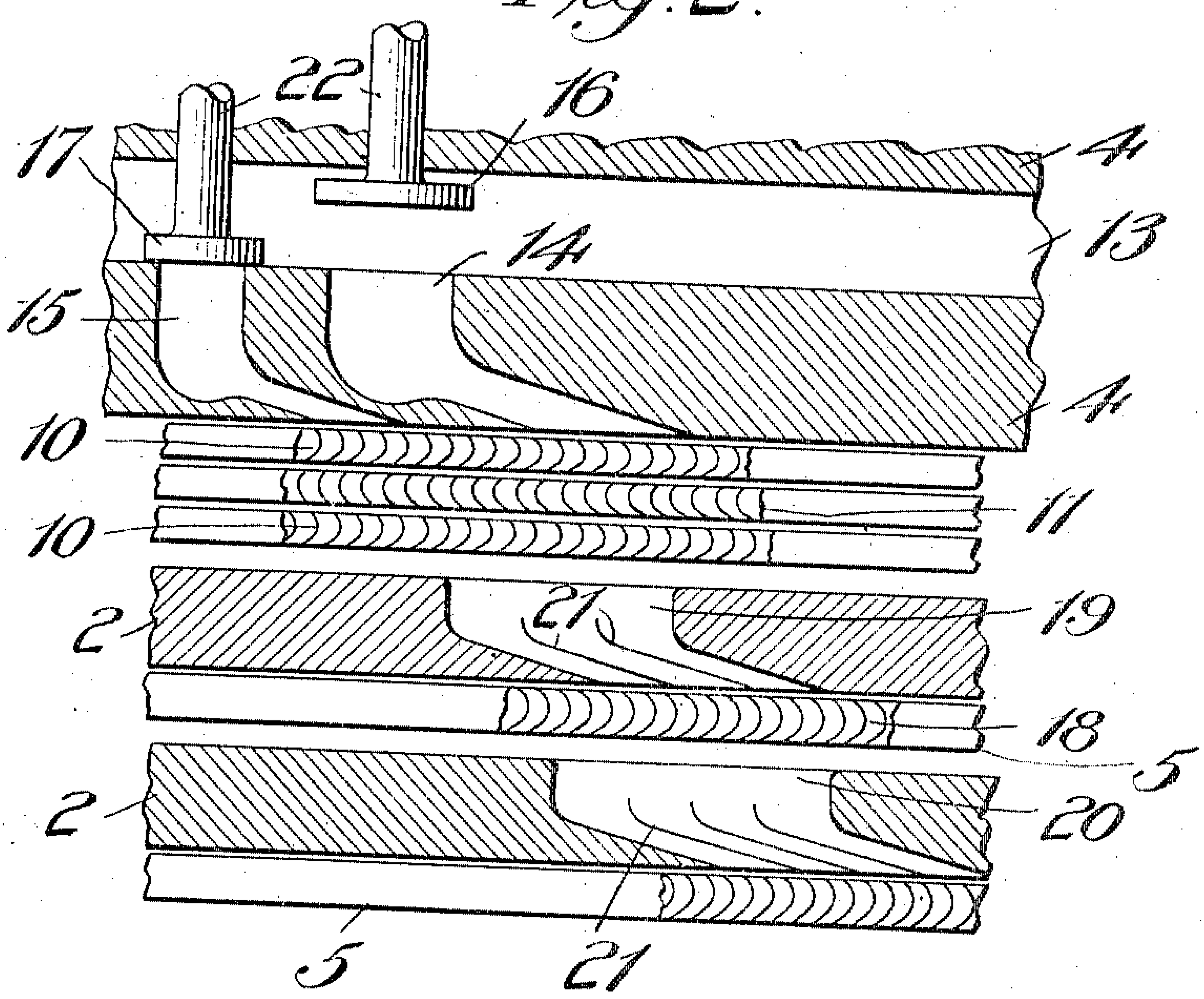
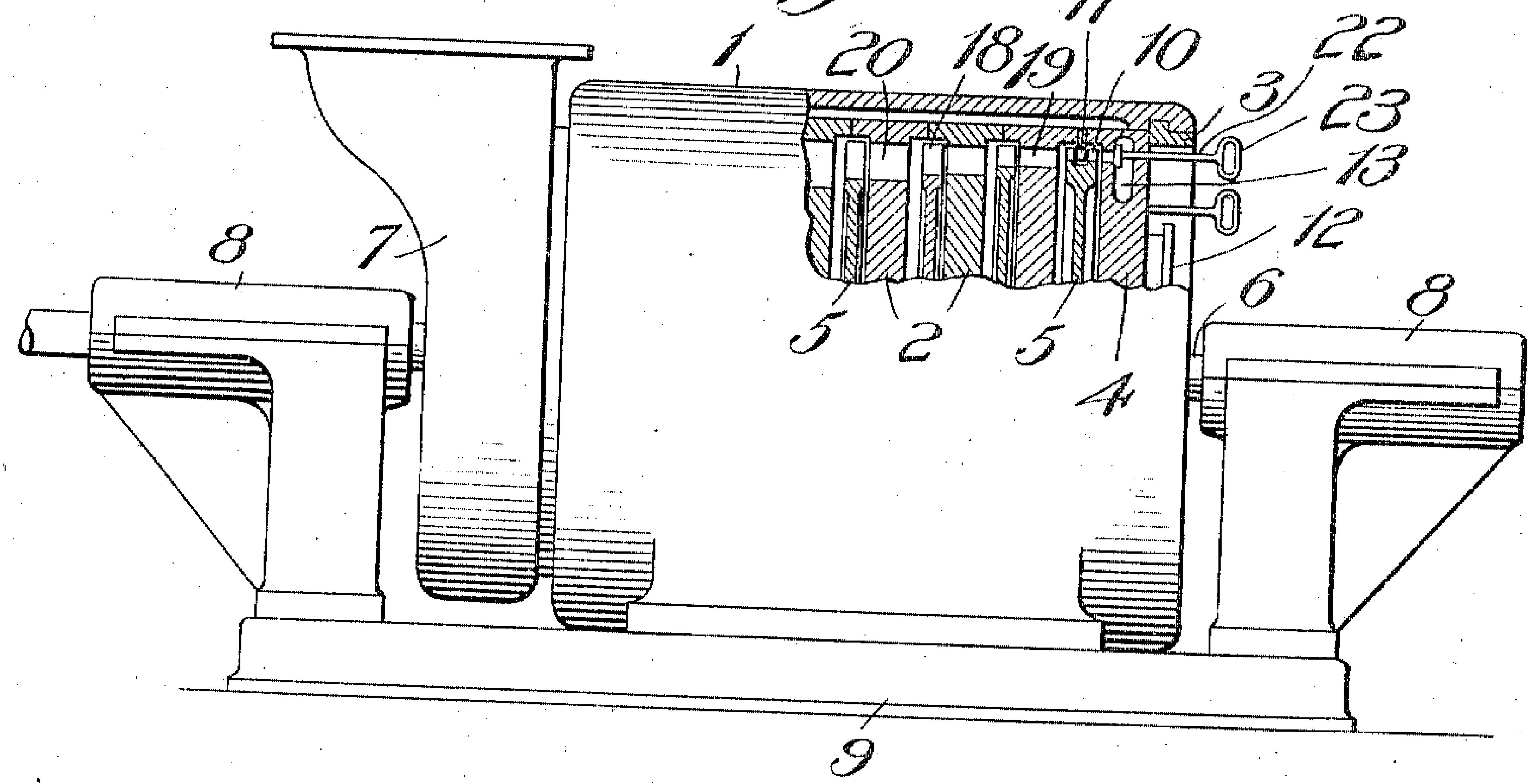


Fig. 1.



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ELASTIC-FLUID TURBINE.

No. 811,984. Specification of Letters Patent. Patented Feb. 6, 1906.

Application filed May 22, 1905. Serial No. 261,676.

To all whom it may concern:

Be it known that I, JAMES WILKINSON, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to improvements in the construction of multistage elastic-fluid turbines, such as shown and described in Letters Patent No. 766,921, issued to me August 9, 1904, wherein a plurality of overload supply-nozzles are provided for an initial high-pressure stage and utilized to introduce into such stage sufficient motor fluid to compensate overload conditions. The turbine is provided with any desired number of supply and corresponding stage nozzles for delivering motor fluid to drive it under normal loads.

In my present invention I prefer to introduce the overload-supply of fluid into the initial stage or first wheel-compartment, and since the overload capacity of such turbines is usually about fifty per cent. of their estimated full-load capacity the cross-sectional area of the overload-nozzles will be substantially one-half of that of the supply-nozzles. This proportion may be varied in accordance with the requirements for each engine, but is here adopted as merely illustrating general practice. Assuming then that the turbine illustrated has an overload capacity of fifty per cent., I prefer to use as many overload-nozzles as there are supply-nozzles, designing them to have a capacity of about fifty per cent. of the supply-nozzles and arranging each overload-nozzle in juxtaposition to and coöperative relationship with a supply-nozzle. I provide the initial stage to which these nozzles admit fluid-pressure with a discharge nozzle or nozzles, preferably one for each pair of coöperating nozzles.

The introduction of the overload-supply of fluid-pressure to an initial stage requires that the turbine be specially designed to utilize this excess volume of fluid with the highest efficiency. Accordingly I provide the turbine with an initial stage having supply-nozzles designed to convert a relatively larger percentage of pressure into velocity than is converted by the supply-nozzles for succeeding stages and rows of buckets to fractionally abstract the velocity from the expanded streams of motor fluid a sufficient number of times to produce a speed of bucket rotation substantially corresponding with that obtained by the rotating buckets in the succeeding stages which are acted upon by the fluid at a lower velocity. This initial stage, in which the high fluid velocity is fractionally abstracted, I term a "velocity-stage," whereas the succeeding stages are termed "pressure-stages" and are preferably provided with single rows of buckets, so that there will be no fractional abstraction in them of the fluid velocities developed by the successive expansions of the fluid in supply-nozzles for the pressure-stages. If the initial velocity-stage be provided with normal-load supply-nozzles designed to expand the fluid-pressure to such a volume that the capacity of the nozzles required to discharge it efficiently into a succeeding pressure-stage will substantially correspond with the combined capacity of both normal and overload supply-nozzles, the efficiency of the turbine under normal-load conditions will be substantially unaffected by the provision of the overload-nozzles, whereas when the latter are brought into service this efficiency will not be materially reduced, for the pressure will be raised in the first stage to a point where it becomes substantially equal to the initial high-pressure supply and the discharge-nozzles from the velocity-stage will act as supply-nozzles for the succeeding pressure-stages, of which there may be a large number, or for the succeeding working passage of the turbine, which may be of any desired character. A turbine having any desired number of pressure-stages may thus be provided with an initial velocity-stage at its supply end, the normal-load supply-nozzles for the latter stage having a cross-sectional area approximately two-thirds of that of the stage-nozzles discharging therefrom. It will be evident that only a small number of rows of buckets are necessary for the velocity-stage in any case, even where the turbine has a large number of pressure-stage compartments succeeding the velocity-stage. The nozzles which connect the several stage-compartments subsequent to the first two being properly proportioned in accordance with the increase in volume of the fluid as it is fractionally expanded in flowing through them will act at substantially the same efficiency whether the initial pressure be that of the motor fluid as supplied to the first stage or as expanded therein and discharged therefrom under normal conditions.

I desire to protect, broadly, a turbine having the initial or supply end of its working passage formed as a velocity-stage—*i. e.*, one provided with a bucket element adapted to operate efficiently under fluid moving at greater velocity than in other parts of the working passage, said velocity-stage having discharge-openings so proportioned to the fluid-admission openings that under an overload condition the motor fluid is caused to bank up in said stage until it practically flows therefrom into the succeeding portion of the working passage at substantially the same pressure as that of the fluid-pressure supply to the turbine.

My invention further consists in the details of construction and arrangement of parts, in describing which reference will be made to the accompanying drawings, forming a part of this application, in which—

Figure 1 is a side elevation of the turbine provided with my improvements and broken away to illustrate a portion of the working passage across stages for the fluid-pressure. Fig. 2 is a partial sectional view taken on a circular axial plane through the turbine, which will illustrate the construction and arrangement of parts constituting the working passage.

Similar reference-numerals refer to the same parts throughout the drawings.

The turbine as illustrated comprises an outer casing 1, surrounding the several diaphragms 2, which divide the interior of the turbine into wheel compartments or stages, their outer flanged peripheries abutting and forming the inner casing of the turbine. A locking-ring 3 is detachably connected to the outer casing 1 and serves as an abutment which engages the supply-head 4 and holds the sectional inner casing together. Within each stage is disposed a bucket-wheel 5, keyed to the turbine-shaft 6, which projects through the supply-head 4 and the exhaust-head 7 and is supported in suitable bearings 8, mounted upon the bed-plate 9, which supports the turbine. The bucket-wheel 5 in the first or velocity stage is provided with two rows of buckets 10, between which is disposed a row of stationary intermediates 11, suitably secured to the inner casing. These intermediates are curved in the opposite direction to that of the buckets 10.

Fluid-pressure enters the turbine through an inlet-passage 12, which communicates with a supply-passage 13, formed in the head 4. From this supply-passage a number of nozzles 14 lead obliquely through the head and discharge fluid-pressure against the buckets 10. The turbine may be provided with any desired number of these nozzles sufficient to take care of all normal-load conditions to which it may be subjected—in other words, to deliver sufficient fluid-pressure to the turbine to operate it up to what is termed "full load" or approximately that. To take care of overload conditions to which the turbine may be subjected, I provide a number of auxiliary overload-nozzles 15, which lead in the same oblique direction through the supply-head, each auxiliary nozzle being preferably disposed in close relationship with one of the nozzles 13. I provide separate valves 16 and 17 to control the admission of fluid-pressure to the nozzles 14 and 15, respectively. It will be noted that the overload-nozzles 15 are of considerably smaller capacity than the supply-nozzles 14, as they will not be called upon in the construction illustrated to supply fluid-pressure to take care of more than a fifty-per-cent. overload. Since I desire to provide an overload-nozzle for coöperation with each supply-nozzle, it will be evident that the former will deliver sufficient fluid-pressure for overload conditions if they are substantially half the capacity of the nozzles 14. The stage into which the supply-nozzles discharge is the velocity-stage, and it will be noted that the bucket-wheel in each of the succeeding stages is provided with but a single row of buckets 18. The fluid-pressure supplied to the velocity-stage is partially converted into velocity in the supply-nozzles, and this velocity is fractionally abstracted by the rows of buckets 10, after which the fluid-pressure is discharged through a nozzle or nozzles 19 against the buckets 18 in the next stage, each discharge-nozzle being disposed so as to receive the streams of motor fluid delivered to the velocity-stage by its corresponding coöperating nozzles 14 15 and to further expand the same. The steam flows through each of the succeeding diaphragms through stage-nozzle passages 20 of increasing proportions to accommodate the expanded condition of the fluid, any desired number of succeeding pressure-stages being used. The nozzles 18 and 19 are preferably subdivided by division-plates 21, starting at a point near the inlet end and continuing to the discharge end of the nozzle.

The supply-nozzles 19 for the first pressure-stage are so proportioned that the cross-sectional area of each corresponds substantially with the combined cross-sectional area of the pair of nozzles 14 and 15, which coöperate therewith, it being understood that it is preferable, but not essential, to have the successive rows of nozzles 19 and 20 across stages maintain the separate identity of the streams of motor fluid as initially supplied to the velocity-stage. The working passage for the motor fluid discharged from said velocity-stage may be of any desired character within the scope of my invention, it only being necessary to so design the buckets and the stationary guides or nozzles as to produce a speed of bucket rotation substantially equal to that obtained by the buckets in the velocity-stage.

Under normal conditions the stream of motor fluid flowing through a nozzle 14 will be expanded thereby and also by its action upon the buckets 10 in its passage through the velocity-stage, so that the discharge-nozzle 19 for that stage will be properly proportioned to receive the fluid in its expanded condition and discharge it at high efficiency into the first pressure-stage. The supply-nozzles 14 for the velocity-stage being proportioned relatively to the first nozzles 19 in the line of the fluid's flow, it will be evident that the turbine under these conditions will be operating at highest efficiency. If overload conditions occur, one of the overload-nozzles 15 will be opened. This presents a condition in which the cross-sectional area of the pair of open coöperating nozzles will substantially equal the cross-sectional area of the corresponding discharge-nozzle. It will therefore be evident that the velocity-stage will tend to become a high-pressure supply-chamber for nozzles 19, and they will discharge more motor fluid into the succeeding pressure-stages than before. The velocity-stage being a small fraction of the turbine, the fact that the fluid does little or no service therein during the overload conditions is more than compensated for by the increased power derived from the large number of rows of buckets for the succeeding working passage, due to the greater volume of motor fluid flowing therethrough. The greater the number of overload-valves open in the first stage the greater will be the pressure therein, and it will be evident that when they are approximately all open they will have the effect of raising the pressure in the velocity-stage to a point where it substantially equals that of the initial supply, in which case the steam will flow through the velocity-stage as through a steam-supply passage and exert its driving effect in the succeeding working passage. Thus the variation in the power derived from the fractional abstractions of velocity in the velocity-stage under overload conditions will not materially effect the general efficiency of the turbine.

The nozzle-valves may be operated by hand, having stems 22, which project through the head, and have handles 23, as shown, or any desired governor-controlled mechanism such as shown in my aforesaid Letters Patent may be used to operate them.

The supply-nozzles for the several stages may be of any desired shape or proportion as the design of the turbine may require to best carry out the operation hereinbefore described, and a similar operation may be obtained where the velocity-stage has only a single row of buckets, provided its supply-nozzles are designed to expand the fluid-pressure sufficiently.

Having thus described an illustrative embodiment of my invention, but without limiting myself thereto, what I claim as new, and desire to protect by Letters Patent, is—

1. In an elastic-fluid turbine, a working passage for the motor fluid therein comprising successive rows of rotating buckets, means to deliver the motor fluid at greater velocity to the first row or rows of buckets than to the succeeding rows, and means to discharge fluid from said buckets subjected to the higher velocities, said means consisting of openings of substantially the same cross-sectional area as the initial fluid-supply openings, for the purposes described.

2. In a turbine, rows of nozzles coöperating with rows of revolving buckets, bucket-wheels supporting said buckets and disposed in separate wheel-compartments in combination with fluid streams for moving said buckets, means to cause the streams to act with greater velocity on the first row or rows of buckets than on the succeeding rows, and independent valves for cutting said streams into and out of service, said nozzles being so proportioned for the first stages that when said valves are open, the row or rows of buckets in the first wheel-compartment are substantially cut out of service.

3. In a turbine, the provision of a velocity-stage compartment, motor-fluid supply and discharge openings therefor of substantially the same cross-sectional area, rotatable buckets therein, means to control the supply of motor-fluid to said compartment, and a working passage comprising stationary guide devices for the fluid and interposed rows of rotating buckets into which passage the motor fluid flows from said velocity-stage compartment and in which the velocity developed in its passage through the turbine is abstracted.

4. In a turbine, a compartment and means therein for fractionally abstracting velocity from fluid-pressure and converting it into rotary motion, fluid supply and discharge ports for said compartment of substantially the same cross-sectional area, valve means to vary the supply of fluid to said compartment, and one or more compartments having means therein to further abstract velocity from the fluid-pressure discharged from said first-mentioned compartment.

5. In a multistage turbine, supply-nozzles and coöperating buckets for each stage adapted to drive the turbine under normal-load conditions, the supply nozzle or nozzles for the initial stage being adapted to convert a greater per cent. of the fluid-pressure into velocity than the succeeding nozzles and one or more overload-nozzles adapted to discharge fluid-pressure, to compensate overload conditions, into said initial stage, the cross-

sectional area for the discharge opening or openings for said stage corresponding substantially with the combined cross-sectional area of the nozzles supplying fluid-pressure thereto.

6. In a turbine having a plurality of separate compartments to which the fluid-pressure is delivered in succession, nozzle-passages connecting said compartments and rotatable buckets within said stages which coöperate with said nozzle-passages and convert fluid velocity into mechanical power, in combination with a plurality of nozzles for admitting an overload supply of pressure to the turbine, said overload-nozzles being equal in number with the supply-passages for the compartments into which they discharge, but of less capacity.

7. In a multistage turbine in which the fluid-pressure is fractionally expanded, the combination with a supply-nozzle for an initial stage, of an overload supply-nozzle arranged in juxtaposition to said supply-nozzle, and a discharge-opening from said initial stage formed by a nozzle-passage leading to a succeeding stage, said nozzle-passage being disposed in line with the fluid streams flowing through said supply and overload nozzles and being of a capacity calculated to cause the motor fluid to flow through the said initial stage without material driving effect upon the buckets therein when the overload-nozzle is in service.

8. In a multistage turbine having a plurality of supply-nozzles for an initial stage designed to admit sufficient fluid to drive the turbine up to its full load capacity, the combination with a plurality of overload supply-nozzles designed to admit an additional supply of motor fluid to said initial stage, said overload-nozzles being of smaller capacity than the supply-nozzles and arranged each in close relationship with a supply-nozzle, and stage-nozzle passages leading from said initial compartment and communicating with a succeeding stage.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JAMES WILKINSON.

Witnesses:

S. G. JAMESON,

J. J. DEVENISH.