No. 822,257. PATENTED JUNE 5, 1906.

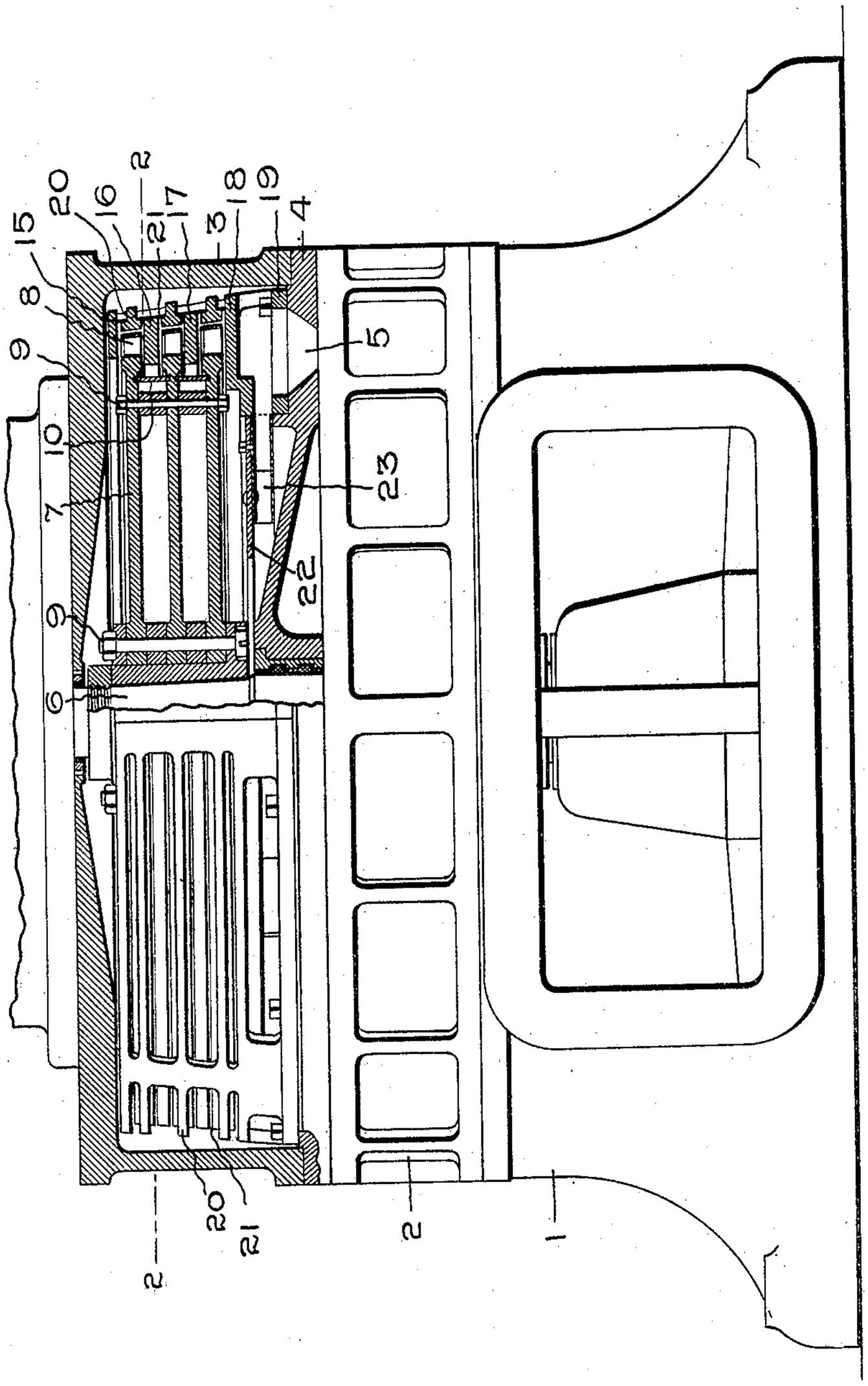
W. L. R. EMMET.

ELASTIC FLUID TURBINE.

APPLICATION FILED APR. 7, 1904. RENEWED SEPT. 28, 1905.

3 SHEETS—SHEET 1.

Fig. 1.



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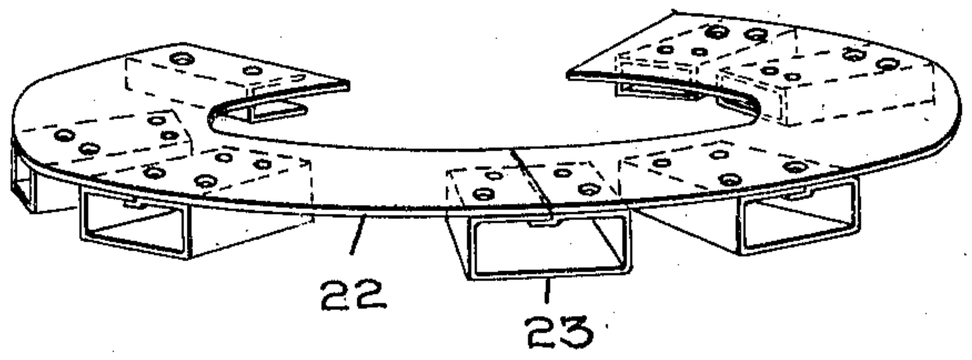
3 SHEETS—SHEET 2.

Fig. 2.

Fig. 3.



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3 SHEETS—SHEET 3.

Fig. 4.

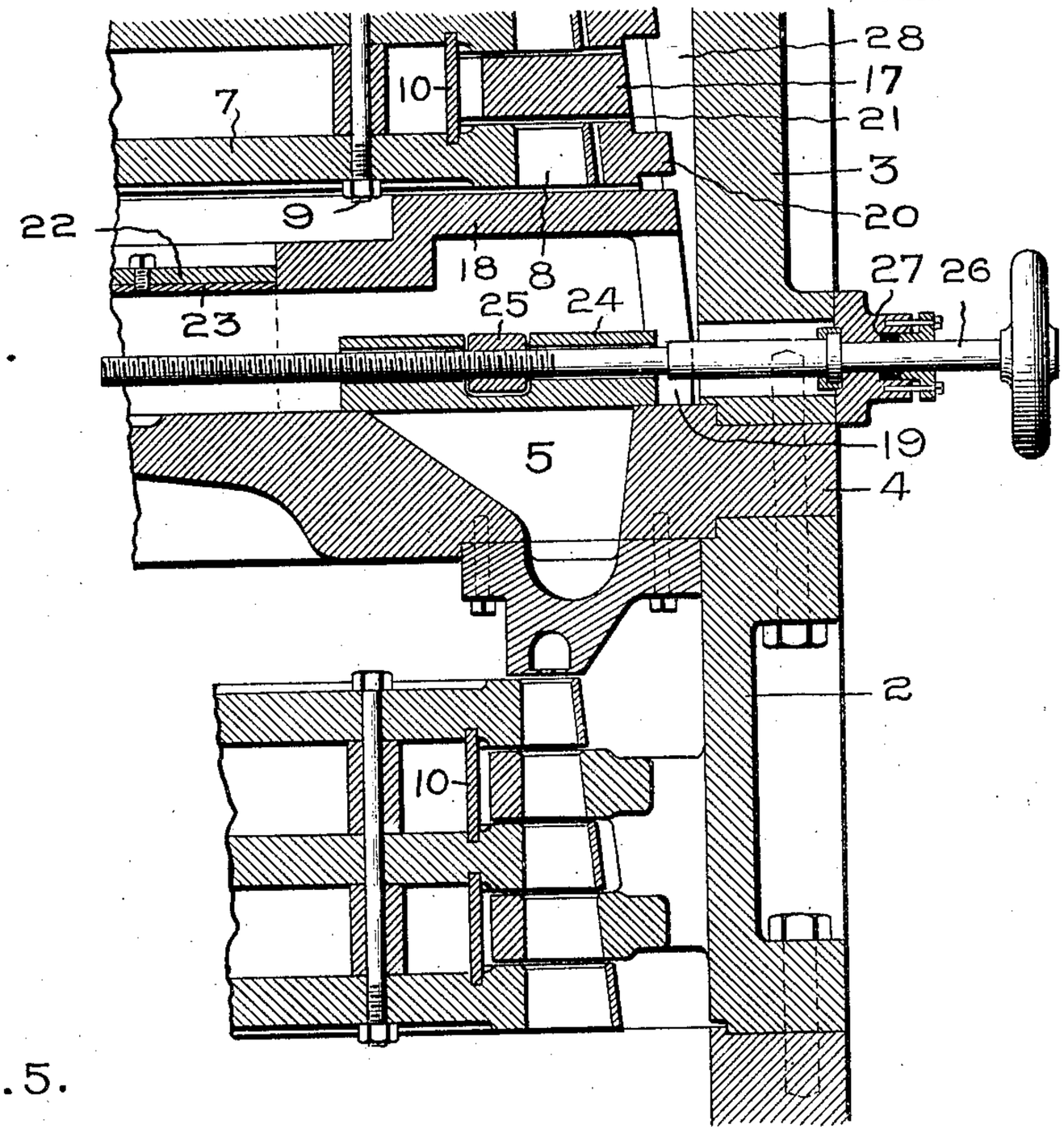


Fig. 5.

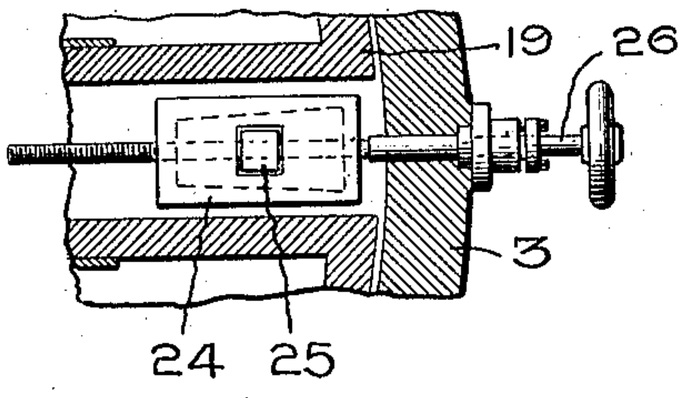
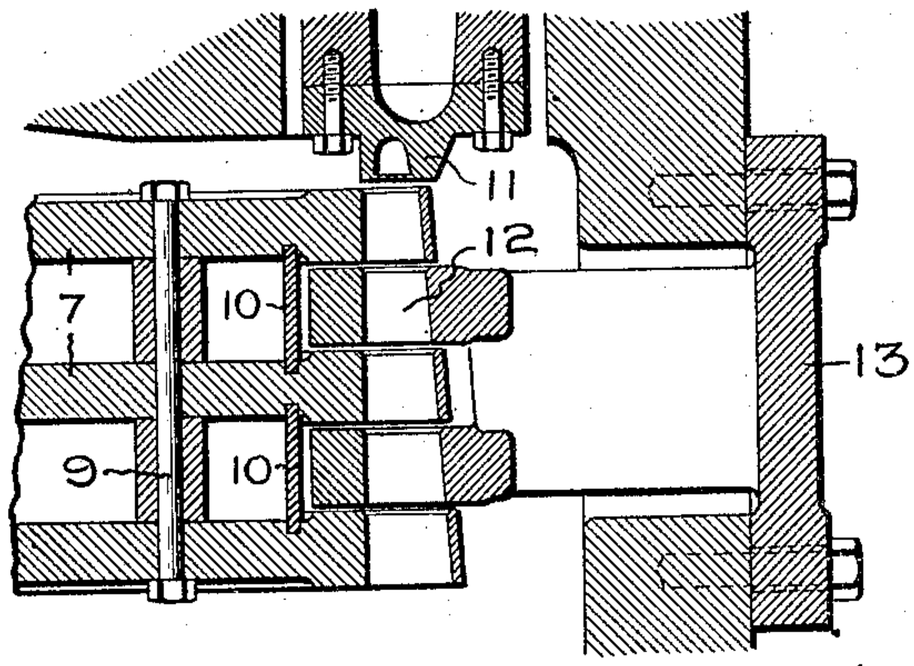


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

No. 822,257. Specification of Letters Patent. Patented June 5, 1906.

Application filed April 7, 1904. Renewed September 28, 1905. Serial No. 280,461.

To all whom it may concern:

Be it known that I, WILLIAM L. R. EMMET, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Means for Decreasing the Rotation Losses in Elastic-Fluid Turbines, of which the following is a specification.

By test it has been demonstrated that there is a certain loss in elastic-fluid turbines due to the fan or blower like action of the buckets and also to the friction between the wheel and the surrounding body of motive fluid. These are commonly referred to as "rotation losses" and decrease the efficiency of the turbine to a greater or less extent, because energy is consumed which does not result in useful work. The losses vary in different types of machine and also in machines of the same type having different angular velocities. The character of the wheel construction also has a bearing. All things being equal, the greater the density of the surrounding medium the greater will be the loss. From this it follows that the rotation losses due to a wheel subjected to motive fluid at atmospheric pressure or above is greater than with a wheel directly acted upon by a condenser.

The present invention has for its object to increase the efficiency of a turbine by decreasing the rotation losses.

In carrying out my invention the turbine is provided with as many stages and as many rows of wheel-buckets as are necessary, and the latter may be of any desired shape or form and arranged in any suitable manner. Motive fluid is supplied to the buckets by means of a nozzle or nozzles or other discharging devices of any suitable construction. Where two or more rows of wheel-buckets are provided in each stage, intermediate buckets are arranged between adjacent rows and receive the motive fluid from one row of buckets and direct it against the next at the proper angle. These intermediates are usually, although not necessarily, arranged to extend only partly around the wheel or wheels of the high-pressure stage or stages. In the low-pressure stage or stages they may extend entirely around the wheel, if desired.

Situated in close proximity to the buckets and arranged to inclose all but the active portion of the wheel or buckets receiving steam or other motive fluid is a hood, inclosure, or mask, which can be constructed in a variety of ways. This hood may be a part of the main structure or it may be made separate. I have chosen to illustrate as one embodiment a construction wherein walls having smooth surfaces are provided on opposite sides of the idle wheel-buckets, or those out of range of the column of steam discharged by the nozzle or nozzles. These walls conform in a general way to the contour of the wheel and are located in close proximity. Situated outside of the ends of the wheel-buckets is a cylindrical wall, which may extend entirely around the wheel or only a limited portion thereof. Where the outer ends of the buckets are closed in by a cover, a small space should be left between it and the wall to prevent the liquid given up by the motive fluid from collecting therein and acting as a water-brake. On the other hand, the wall must be near enough to assist in reducing rotation losses. In order to provide an escape for the liquid particles given up by the steam or other motive fluid which may be discharged through the clearances, radial or otherwise, between relatively movable buckets, passages are provided, and these passages can conveniently be formed in the end wall or between the side walls on opposite sides of the wheel and the end or surrounding wall. The parts of the hood exposed to the wheel should be given a smooth finish in so far as it is practicable. Care should also be exercised in making the wheel-body and attached parts smooth as far as possible.

Where a number of wheels or a number of rows of wheel-buckets are provided in a single stage, it is advantageous to inclose each wheel or row in the manner specified. In event of a number of wheels or rows of buckets being used it simplifies the construction if the walls adjacent to each row of wheel-buckets are joined together and a base provided for the whole, which may rest on the diaphragm between stages or other support. I may, however, make the hood, covering, or mask out of a number of pieces or out of a

single piece. Where two or more rows of wheel-buckets are employed and either mounted on the same or different wheels, the same structure may be used for closing in the inactive discharge side of one row and the inactive inlet side of the adjacent row. The hood may be divided into any number of parts to suit the requirements, and this whether one or more wheels are provided in each stage. In one construction illustrated the hood is divided into two parts, and the first-stage casing is removable like the cover of a box.

Where separate wheel-disks are provided and strung on the same shaft, it is desirable to place a ring between each pair in such manner that access of motive fluid to the central portion of the wheels is prevented. On the exhaust side of the last wheel a space more or less great is formed, in which exhaust steam or other fluid from the wheel is collected. In order to reduce the friction or rotation losses at this point, the last side wall or extension thereof is made deeper in the radial dimension and is extended well under the wheel toward the shaft.

The motive fluid passes to the second or adjacent stage of lower pressure through suitable passages in the diaphragm connecting with nozzles or other discharging devices. Since the same construction as the first is or may be followed in a subsequent stage, further description is unnecessary. In order to more effectively direct the exhaust motive fluid from one wheel compartment or stage to the next, radially-extending passages may be provided which discharge into or adjacent to the passages leading to the subsequent nozzles or other discharging devices.

The hood, inclosure, or mask is made somewhat smaller than the casing, so that a chamber is provided which surrounds the wheel and discharging devices to a greater or less extent and is filled with motive fluid exhausting from the wheel. The size of the chamber can be varied to suit the requirements; but it should be large enough to accommodate a considerable volume of motive fluid. The fluid in said chamber is quiet, or relatively so, so that in the case of steam acting as the motive fluid the water contained therein, which is released by expansion, instead of being retained in a finely-divided state is permitted to separate, so that it can be collected and removed through suitably-formed passages. To state the matter in a different way, the idle turbine-buckets are inclosed by a hood or mask, which is located within the main casing, and between the hood and the casing is a chamber wherein the rotating effect of the wheel is felt but little or not at all. Owing to the fact that the exhaust fluid in the chamber is out of the whirling effect of the wheel, the necessary time element is provided to permit the minute particles of water to be discharged. Obviously the more moisture that is removed the less reëvaporation takes place, and the efficiency of the turbine is correspondingly increased.

It is preferable to completely inclose or mask the idle wheel-buckets of each row, as specified; but certain advantages will follow where the inclosure is not so complete, and I aim to embrace this in the claims.

The parts of the hood cannot be maintained in frictional contact with the revolving wheel-buckets on account of the high speed of the latter, and hence the invention must not be confused with rotary-engine constructions wherein the rotary piston engages the walls and receives steam from a port and after being advanced a certain angular distance discharges the steam into a second port. Obviously the space necessary in my improved construction would be fatal to the operation of a rotary engine.

It will be seen that the turbine is of the multistage type and, further, that each stage contains a compound wheel. The wheel may be compounded as many times as is necessary to properly abstract the energy from the fluid stream discharged from the nozzle or nozzles. Where more than a single nozzle is employed composed of one or a group of passages, the hood for reducing rotation losses covers a correspondingly smaller number of buckets, because the proportion of active to idle buckets has been changed.

In order to prevent objectionable eddying of the exhaust steam or other motive fluid in the plane of the wheel, a means is provided which may extend parallel or substantially parallel to the last wheel, and on the opposite side from the wheel the said means may be provided with means for conveying the steam away from the wheel-flange as it flows to the adjacent nozzles. Between the stages I may employ one or more valves for regulating the passage of fluid from one to the other, the said valves being operated by hand or automatically.

In the accompanying drawings, which illustrate embodiments of my invention, Figure 1 is a partial vertical section of a vertical-shaft turbine. Fig. 2 is a horizontal sectional view of the same. Fig. 3 is a perspective view illustrating a part of the hood, together with the conduits or passage-ways for conveying motive fluid from the center of the wheel-chamber to the nozzle of the adjacent stage of lower pressure. Fig. 4 is a partial sectional view of a jet-turbine, showing a means for reducing rotation losses and a valve for varying the transfer of fluid from one wheel-compartment to another. Fig. 5 is a plan view of the valve and its actuator, on a small scale; and Fig. 6 is an enlarged sectional view of a turbine having three rows of wheel-buckets per stage and adjustable intermediates.

1 represents the chambered base of the machine, which may be connected to a condenser or atmosphere, as desired. In the present instance it is connected to a condenser by the conduit situated in the front of Fig. 1. Mounted on top of the base is a wheel casing or shell 2, which incloses the second-stage wheel. Situated on top of this casing is a second casing or shell 3, which incloses the first-stage wheel. Between the casings is a diaphragm or separator 4, provided with the necessary passages 5 for conveying steam or other motive fluid to the second-stage nozzles. 6 represents the shaft, and mounted thereon are wheels 7, each provided with a peripheral row of buckets 8. The wheels are secured together by bolts 9, and the space between the wheels is cut off from the steam-space by the rings 10, which are let into grooves formed in the side faces of the wheel. Supported by the casings and in line with the wheel-buckets are one or more nozzles 11 of suitable construction. These nozzles may be of the expanding or non-expanding type, as is desired, and are preferably composed of a plurality of closely-associated passages or sections so arranged that the fluid discharged therefrom issues as a solid column. Each section may be controlled by a separate valve under the control of a speed-responsive device or two or more sections may have a common valve. Situated in line with the nozzle and covering a somewhat greater arc than the nozzle itself are intermediate buckets 12, which are supported by a frame 13, that is bolted to the outside of the casing and may or may not be adjustable. Detachable observation-plates 14 are provided, so that the clearances between the relatively moving parts can be measured or observed. The intermediate buckets are adjustable toward and away from the wheel-buckets in an axial plane. Situated above the idle buckets of the first wheel is a smooth side wall or plate 15, which runs in close proximity to the wheel and buckets, but is out of contact therewith. Between the first and second wheels is a side wall or plate 16, which covers the under side of the idle buckets in the first wheel and may, and preferably does, cover the upper side of the idle buckets in the second wheel. Situated below the idle buckets of the second wheel is a smooth side wall or plate 17, which is similar to the wall or plate 16. Situated below the last wheel and covering its idle buckets is the wall or plate 18. This wall or plate, together with those previously mentioned, is supported by a base 19, that rests on the diaphragm 4 between stages.

Surrounding the covers of the various wheel-buckets and located inside of the casing are cylindrical walls 20, which may extend entirely around the wheel or only around the idle buckets, as desired. These walls are situated between adjacent plates, and between the side and end walls are one or more radially-extending passages 21, through which the water released by expansion of the steam is discharged. The side and end walls are preferably formed in a single casting, the said casting being divided into two or more parts, as is desired. I have used the term "side walls" to designate those walls occupying positions at the receiving and exhaust sides of the wheel-buckets, and while they are shown as flat they may be curved, if desired, to make them conform more closely to the shape of the wheel. The term "end walls" is used to designate those walls which surround the outer ends of the buckets, or the cover where such a construction is employed.

Attached to the lower plate 18 and situated between it and the shaft is a segmental plate or wall 22. As the wheel rotates within a chamber containing a more or less dense fluid medium, there is a tendency for eddy-currents to be created in a radial direction from the center of the wheel outward, and this wall or plate decreases these eddy-currents to a very great degree, if, in fact, it does not entirely prevent them. Attached to the under side of the plate 22 are conduits or passage-ways 23, which convey motive fluid from the central portion of the wheel-chamber to the outer portion thereof, where it is discharged into the passages 5, of which there are several, leading to the nozzles of the second stage.

When it is desired to regulate the passage of fluid from one wheel-compartment to another, one or more valves 24 may be provided, which are operated by means external to the wheel-casing. Each valve is provided with a flat under surface which engages the upper side of the diaphragm or wall containing the passage 5, leading to the nozzles of the adjacent stage. The upper surface of the valve is cored out to receive a nut 25, through which the actuator 26 extends. The actuator is guided by the valve itself and extends through a packing 27, supported by the casing, and is moved manually or otherwise. Rotating the actuator causes the valve to move in or out, depending upon the direction of rotation. The valve or valves may be located between sections of the base 19, or it or they may be located in openings formed therein. The valve may be operated by hand or by motors under the control of the same governor which regulates the action of the first-stage valves.

The water that is collected in the chamber 28, which is located between the hood and the casing, can be drawn off in any suitable manner—as, for example, by the valved pipe 29, Fig. 2.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but

I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. An elastic-fluid turbine comprising intermediate buckets, two or more rows of wheel-buckets, and a device for discharging motive fluid against them, in combination with means presenting a smooth surface and acting on the idle buckets to reduce the rotation losses.

2. An elastic-fluid turbine comprising a bucket-wheel, and a sectionalized nozzle or device for discharging motive fluid against it, in combination with a hood which is located in proximity to the idle wheel-buckets for reducing rotation losses.

3. An elastic-fluid turbine comprising a compound bucket-wheel, and a device for discharging motive fluid against it, in combination with a hood for reducing rotation losses, which comprises a wall that is situated adjacent to the idle buckets.

4. An elastic-fluid turbine comprising a casing, a bucket-wheel, and a device for discharging motive fluid against the wheel, in combination with a hood having a smooth wall in close proximity to the buckets, and a passage for discharging the liquid given up by the motive fluid.

5. An elastic-fluid turbine comprising a casing, a bucket-wheel, and a device for discharging motive fluid against it, in combination with a hood comprising walls situated on opposite sides of the idle buckets, and passages for discharging the liquid given up by the motive fluid.

6. An elastic-fluid turbine comprising a bucket-wheel and a sectionalized nozzle or device for discharging motive fluid against it, in combination with a hood comprising walls situated on opposite sides of the idle buckets, and a wall surrounding said buckets.

7. An elastic-fluid turbine comprising a bucket-wheel and a device for discharging motive fluid against it, in combination with a hood comprising side walls situated on opposite sides of the idle buckets, an end wall surrounding said buckets, and a discharge-passage for the liquid given up by the motive fluid.

8. An elastic-fluid turbine comprising two or more rows of wheel-buckets and a device having a group of closely-associated passages for discharging motive fluid against them, in combination with a means acting on the idle buckets of each of the wheels to reduce rotation losses, and a support which is common to the said means.

9. An elastic-fluid turbine comprising two or more rows of wheel-buckets and a device for discharging motive fluid against them in an axial direction, in combination with a hood comprising walls which cover the idle end buckets, other walls which cover those between the ends, and a support which is common to all of the walls.

10. An elastic-fluid turbine comprising two or more rows of wheel-buckets and a device for discharging motive fluid against them in combination with a hood made up of segmental side walls and segmental end walls which cover the idle buckets, and a support common to the walls, which is also segmental.

11. An elastic-fluid turbine comprising separate wheel compartments or shells, buckets carried on the wheel-peripheries, nozzles for discharging the motive fluid in an axial direction, a plurality of discharging devices for directing fluid into the adjacent stage of lower pressure, and a conduit or passage for conveying motive fluid from the central part of a wheel-chamber to the said discharging devices.

12. An elastic-fluid turbine comprising a bucket-wheel and a device for discharging fluid against it, in combination with a means acting as a cover or hood for the idle buckets, and an outwardly-extending conduit or passage-way discharging motive fluid.

13. An elastic-fluid turbine comprising a bucket-wheel and a device for discharging motive fluid against it, in combination with a hood for the idle buckets, a plurality of outwardly-extending conduits or passage-ways, and a support which is common to the conduits or passage-ways.

14. An elastic-fluid turbine comprising a bucket-wheel and devices for discharging motive fluid against it, in combination with a means for preventing eddying of the motive fluid in the plane of the wheel.

15. An elastic-fluid turbine comprising separate stages, fluid-discharging devices for each stage, and a wall or plate located in one stage for preventing eddying of the motive fluid in the plane of the wheel as it passes from one stage to another.

16. An elastic-fluid turbine comprising a bucket-wheel, a device for discharging motive fluid against it, and a casing, in combination with a means for reducing eddying of the motive fluid within the casing, and conduits or passage-ways for conveying motive fluid from the center of the compartment to the periphery.

17. An elastic-fluid turbine, comprising two or more rows of wheel-buckets, a compartment which is common to the said rows, and a nozzle for discharging motive fluid against the wheel, in combination with a means located in close proximity to the idle wheel-buckets for reducing the rotation losses.

18. An elastic-fluid turbine comprising rows of wheel-buckets, a compartment therefor, and a nozzle for discharging motive fluid against the buckets, in combination with a

wall which is located between the idle buckets of adjacent rows in each compartment and acts on both of them to reduce the rotation losses.

19. An elastic-fluid turbine comprising a plurality of wheels strung on the same shaft, a casing for the wheels, a nozzle for discharging motive fluid against the wheel-buckets, in combination with a means for decreasing the rotation losses, which is carried by the wheel at a point near the periphery for cutting off the space between them, and a means which closely surrounds the idle wheel-buckets for further decreasing the rotation losses.

20. In an elastic-fluid turbine, the combination of a casing, a wall for dividing the casing into compartments, a valve which rests on the wall and controls the passage from one side of the wall to the other, a screw-threaded actuator, and a nut on the actuator, which engages the valve.

21. In an elastic-fluid turbine, the combination of a casing, a wall for dividing the casing into compartments, a valve which rests on the wall and controls the passage of fluid from one compartment to another, an actuator for the valve, which extends through the valve and is guided thereby, and a means engaging the actuator and valve for moving the latter.

22. In an elastic-fluid turbine, the combination of a casing, a bucket-wheel, a hood or inclosure for idle buckets for reducing rotation losses, and a chamber between the hood or inclosure and the casing, in which the exhaust motive fluid is given an opportunity to discharge the moisture due to expansion.

23. In an elastic-fluid turbine, the combination of a casing, relatively movable buckets and a discharging device, a means acting to reduce the rotation losses of idle buckets, a chamber receiving exhaust fluid from the buckets, and discharging devices in which the moisture due to expansion is separated from the fluid.

24. In an elastic-fluid turbine, the combination of a casing, relatively movable buckets and a discharging device, a hood for reducing the rotation losses of idle buckets comprising walls situated in close proximity thereto, and a chamber surrounding the buckets and hood which receives exhaust fluid and affords an opportunity for the moisture and vapor to separate.

25. An elastic-fluid turbine comprising two or more rows of wheel-buckets in the same compartment, a device for discharging motive fluid against one row of buckets, and a device for discharging motive fluid against a second row of buckets, in combination with walls presenting smooth surfaces to the buckets for decreasing the rotation losses.

26. An elastic-fluid turbine, comprising two or more rows of wheel-buckets, intermediate buckets between the rows which extend partially around the wheel, and a means between the rows of buckets extending around the remaining portion of the wheel which presents smooth and unbroken walls to the movable buckets for preventing rotation losses.

27. An elastic-fluid turbine, comprising two or more rows of movable buckets, a device which discharges motive fluid against a limited number of the buckets, a wall or inclosure adjacent the ends of the buckets, and means projecting from the said wall into the space between the rows of buckets, the portion of the means in the path of the motive fluid having passages which receive the motive fluid from the preceding row and after changing its direction discharge it against the succeeding row of buckets, the remaining portion of said means serving to prevent rotation losses.

In witness whereof I have hereunto set my hand this 5th day of April, 1904.

WILLIAM L. R. EMMET.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.