E. THOMSON.

ELASTIC FLUID TURBINE.

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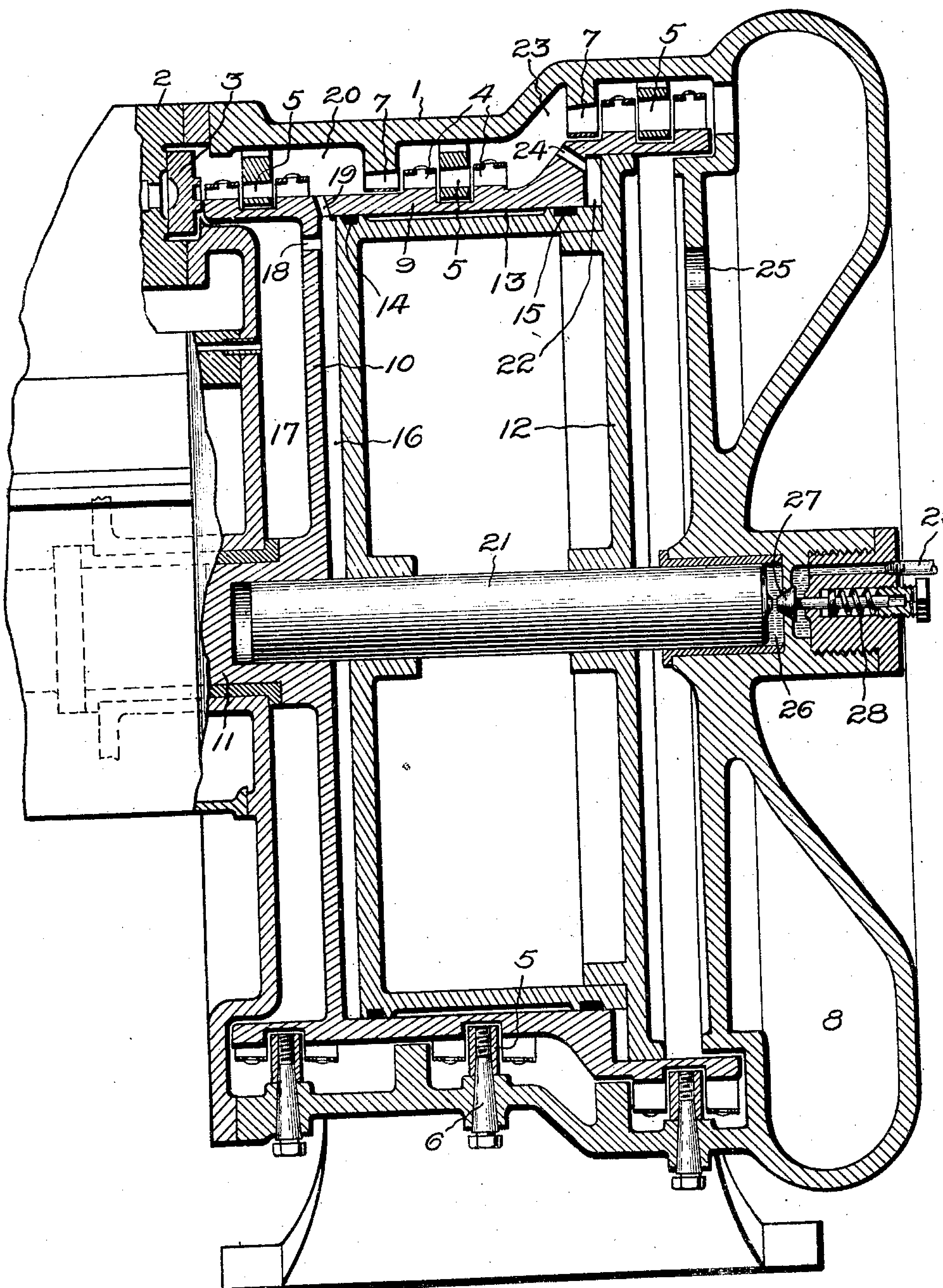
920,790.

Patented May 4, 1909.



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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

No. 920,790. Specification of Letters Patent. Patented May 4, 1909.

Application filed March 3, 1906. Serial No. 303,979.

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

The present invention relates to elastic-fluid turbines, and has for its object to improve their construction, particular reference being made to supporting and balancing the rotating member against end thrust, and to dispensing with the diaphragms now commonly used in certain types of machines to divide them into stages of expansion.

In the accompanying drawing, attached to and made a part of this specification, is shown one of the embodiments of the invention, the illustration being an axial section of a multi-stage turbine of the jet type.

1 represents the inclosing casing of the turbine, and 2 a valve chest attached thereto. Steam or other elastic fluid is discharged against the buckets by the nozzle or other device 3. The said device or nozzle may be arranged to discharge fluid against all of the buckets or against only a certain limited number. It may be arranged to expand the motive fluid so as to give a relatively high or relatively low velocity as desired. The wheel buckets 4 are mounted upon a drum or support of novel construction, as will appear later. Between the rows of wheel buckets are rows of intermediate buckets 5, which may extend entirely around the wheel or only partially, depending upon the type of machine, the conditions of service, etc. These buckets are secured to holders, and the latter in turn are secured by bolts 6 to the casing. In addition to the admission nozzle or fluid-discharging device, there are stage nozzles or fluid-discharging devices 7, of which as many may be provided as desired. The number of stages and stage nozzles can be increased or decreased as desired to meet the load conditions. The stage nozzles are or may be formed in an internal shoulder or projection formed on or carried by the inside of the casing. The inner surface of the shoulder coöperates with the periphery of the drum to divide the casing into stages, three being shown as illustrative of the invention. Instead of making the nozzle structure integral with the casing, it may be separate therefrom and bolted or otherwise secured to the casing.

In one end of the casing is a chamber 8 to receive the exhaust, the said chamber being connected by a conduit (not shown because it leads from the other side of the chamber than that illustrated in the sectional drawing) with the atmosphere or with a condenser.

The wheel buckets are mounted on a drum or rim 9 and may be integral therewith or separately formed and attached thereto. The left-hand end of the drum or wheel rim in the present illustration is supported by a disk 10 carried by the main shaft or spindle 11, which disk is shown as being integral with the drum, but it may be separable if desired and rigidly secured thereto. To this disk the main shaft 11 is attached or formed integral therewith. The diameter of the drum is or may be increased in one or more steps to accommodate the increased volume of fluid as the pressure decreases, and also to increase the area of the disk 12 exposed to the low-pressure steam or other fluid. The right-hand end of the drum is supported and centered by the disk 12 mounted on a secondary shaft 21 forming a continuation of the main shaft. It is to be noted however that the disk 12 in no way restrains the expansion and contraction of the drum in its longitudinal dimension. The disk 10 definitely locates the position of the wheel buckets. Located inside of the main drum is a balancing drum which balances the thrust on the bucket drum to a greater or less extent. The disk 12 is shown as being common to the bucket and balancing drums but separate disks or supports may be provided. The cylindrical wall of the balancing drum extends longitudinally of the bucket drum and protects that portion of the drum carrying the second-stage buckets from the effects of the fluid of higher temperature. If, however, it is desired to increase the temperature of the motive fluid in the stages of lower pressure, the chamber 13 may communicate with a stage of higher pressure.

Between the periphery of the balancing drum and the inner surface of the bucket drum are packings 14 and 15. By reason of this arrangement chambers 16 and 17 are provided containing motive fluid at the pressure of the first stage, equalizing passages 18 and 19 being arranged to establish communication between them and the wheel chamber 20. The pressures on opposite sides of the disk 10 will be balanced, or virtually so, and the temperature equalized while the pressure on the adjacent wall of the balancing drum tends to move the latter and the secondary shaft 21 which supports it to the right.

The bucket drum is enlarged between the second and third stages and the chamber 22 thus formed communicates with the wheel chamber 23 by means of the passage 24. The opposite walls of the chamber 22 are exposed to the same pressure and hence the effects thereon are equal and opposite. The entire right-hand side of the disk 12 is exposed to the pressure of steam or other motive fluid in the adjacent chamber, and the pressure in said chamber is maintained the same as that of the exhaust by one or more passages 25.

The balancing drum is fastened to the secondary shaft 21 and the latter is capable of moving slightly to and fro with respect to the outer drum and the main shaft. It rotates however at the same rate of speed as the drum and main shaft. Since the relative amount of longitudinal movement of the inner and outer drums is very small the wear on the packings 14 and 15 is so slight as to be disregarded.

The bucket drum is substantially balanced by reason of the fact that the steam pressures on opposite sides of the disk 10 are the same, and also by reason of the arrangement of the chamber 22. As the pressure changes due to changes in load, the pressures on opposite sides of the disk and in the chamber correspondingly change. There is however a certain small amount of thrust from left to right which must be eliminated to obtain the best results. This is taken care of by suitable collars and bearings on the main shaft.

The thrust on the balancing drum is taken care of by the following means: At the right-hand end of the secondary shaft a small chamber 26 is provided containing water, oil or other lubricating medium. The fluid admitted to the chamber is under a pressure equal to or superior to the resultant end thrust on the balancing drum, and the flow of the liquid is controlled by a valve 27 normally held against its seat by the adjustable spring 28. The end of the shaft is preferably provided with a hardened steel plate and the end of the valve is similarly arranged, the space between the parts being exaggerated for the purpose of illustration. As the shaft moves to and fro—the movement being very slight—the valve is alternately opened to admit fluid and closed to shut it off. Fluid is admitted by the conduit 29, and where water is used it can be permitted to flow through and lubricate the bearing and exhaust with the steam from the wheel buckets. Where oil is used it is best to provide a separate return.

From the construction described it will be apparent that it is unnecessary to have any very accurate adjustment of the balancing drum, thereby greatly simplifying the construction of the turbine. The location of the bucket drum being fixed on the main shaft as to longitudinal movement, it follows that the balancing drum can move back and forth slightly without danger to the parts. Of course under this condition differences in pressures on opposite ends of the balancing drum would be brought about which would limit its movements. It will also be seen that in addition to balancing the thrust on the bucket drum the balancing drum really supports one end of it and centers the same, and this without constraining the bucket drum in any way. By supporting the buckets on a drum and locating the nozzles or fluid-discharging devices in rings which closely encircle the drum and coöperate therewith to form separate compartments or stages, I am enabled to dispense with the diaphragms now commonly used in machines of the jet type. Owing to the fact that the temperatures on opposite sides of the disk 10 are the same, all warping is prevented. There is a difference in temperature between opposite ends of the balancing drum, but this does no damage because it does not affect the alinement or adjustment of the buckets.

The invention is also applicable to turbines of the reaction type where all of the buckets in each stage are active.

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 can be carried out in other ways.

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

1. In an elastic-fluid turbine, the combination of buckets which are relatively rotatable, an inclosing casing, and a means for balancing the thrust on one set of buckets comprising a member which is movable axially of the casing and also assists in supporting one set of buckets.

2. In an elastic-fluid turbine, the combination of buckets which are relatively rotatable, an inclosing casing for the buckets, and a means within the casing and acting on the rotating member for balancing the thrust

thereon which is responsive to changes in fluid pressure within the casing and is movable independently of the buckets.

3. In an elastic-fluid turbine, the combination of a casing, buckets carried thereby, a bucket-carrying drum, and means for balancing the thrust on the bucket drum, which is movable axially and independently of the bucket drum.

4. In an elastic fluid-turbine, the combination of a casing, relatively rotatable buckets inclosed thereby, a shaft carrying one set of buckets, and a drum for balancing the end thrust on one set of buckets, which is movable longitudinally with respect to said shaft.

5. In an elastic-fluid turbine, the combination of a casing, buckets carried thereby, fluid-discharging devices, a drum carrying the revolving buckets, a balancing drum located inside of the bucket drum, which is movable axially with respect thereto, and a means for taking up the thrust on the balancing drum.

6. In an elastic-fluid turbine, the combination of a casing, fluid-discharging devices carried thereby, a bucket-carrying drum which is rotated by the fluid from said devices, a main shaft, a means for supporting the drum from the main shaft, a balancing drum, a secondary shaft supporting the balancing drum, which is movable longitudinally with respect to the main shaft in response to pressure changes, and a means for receiving the thrust of the secondary shaft.

7. In an elastic-fluid turbine, the combination of a casing, a bucket-carrying drum inclosed thereby, a shaft supporting the drum, means for preventing endwise movement thereof, a balancing drum which supports and centers the bucket drum without constraining its movements due to expansion and contraction, the said balancing drum being free to move slightly in an axial direction, and a means arranged to receive the thrust of the balancing drum.

8. In an elastic-fluid turbine, the combination of a casing, a bucket-carrying drum, a wall carried by the casing and supporting fluid-discharging devices, the said wall cooperating with the surface of the drum to form stages, a balancing drum extending inside of the bucket drum, and a means for taking up the thrust on the balancing drum.

9. In an elastic-fluid turbine, the combination of a casing, a bucket-carrying drum, a wall carried by the casing and supporting fluid-discharging devices, the said wall cooperating with the surface of the drum to form stages, a balancing drum located inside of the bucket drum and movable longitudinally thereof to a limited extent, and a fluid-pressure means for taking up the thrust on the balancing drum.

10. In an elastic-fluid turbine, the combination of a bucket carrying drum, a disk for supporting the drum, the opposite sides of which are balanced as to temperature, and a balancing drum which assists in supporting the bucket drum, the opposite ends of which are subjected to different temperatures.

11. In an elastic fluid turbine, the combination of a casing, fluid discharging devices carried thereby, a bucket carrying support within the casing which is rotated by the fluid from said devices, a main shaft on which the support is mounted, a balancing drum, a secondary shaft supporting the balancing drum which is movable longitudinally with respect to the main shaft, and means for receiving the thrust of the secondary shaft comprising a source of fluid under pressure, and a valve which is moved from its seat by the movement of the shaft to permit the fluid pressure to oppose the thrust.

12. In combination in an elastic fluid turbine, a rotor element comprising a wheel mounted on the spindle of the turbine, a disk mounted adjacent the wheel which is movable axially of said wheel and tends to balance the pressures thereon, a packing between the periphery of the disk and the rim of the wheel, and a means for taking up the thrust on the disk.

In witness whereof, I have hereunto set my hand this twenty eighth day of February, 1906.

ELIHU THOMSON.

Witnesses:
JOHN A. MCMANUS, Jr.
HENRY O. WESTENDARP.