E. THOMSON.

ELASTIC FLUID TURBINE.

APPLICATION FILED DEC. 14, 1904.

920,789. Patented May 4, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

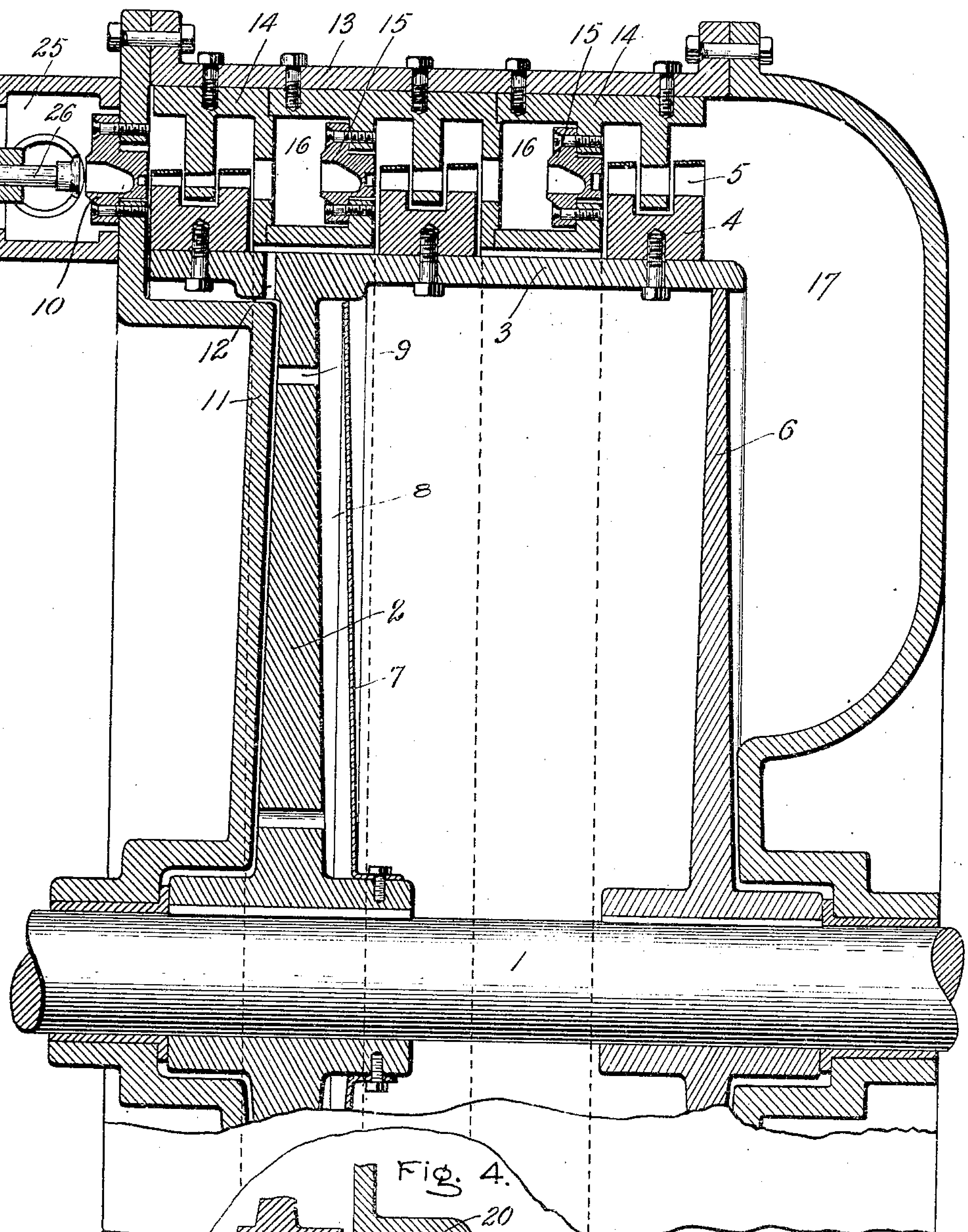
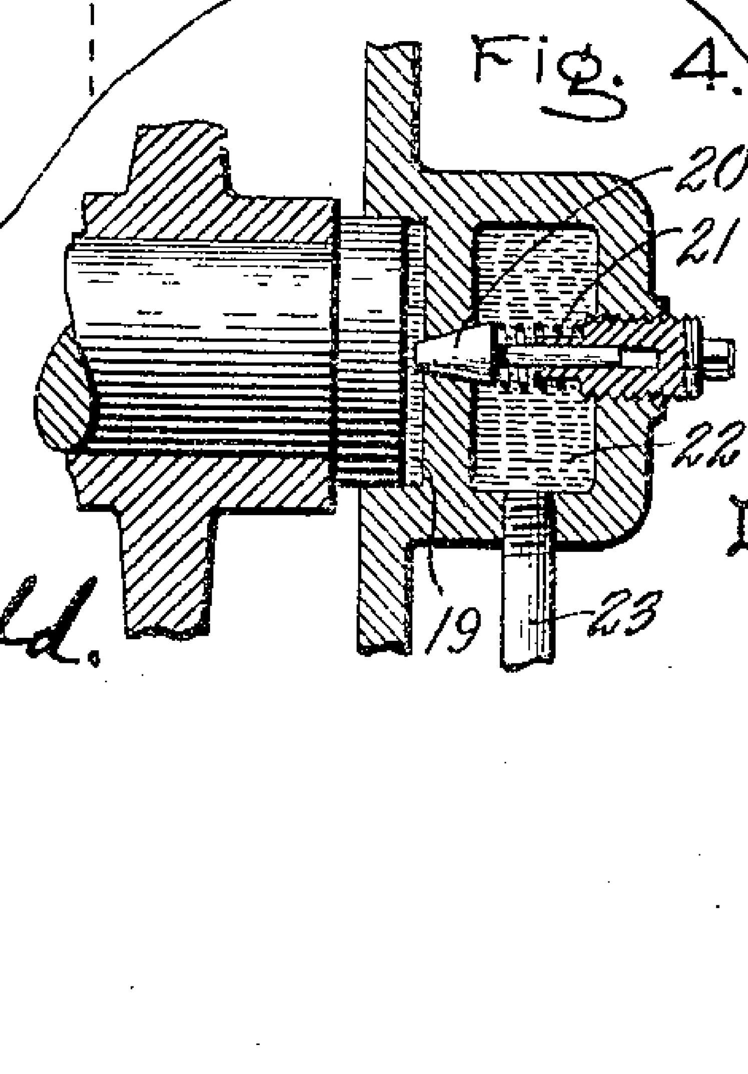


Fig. 4.



Witnesses:

Steven Axford

Alex. F. Macdonald.

Inventor,

Elihu Thomson,

By Albert G. Davis

Att'y.

E. THOMSON.
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2 SHEETS—SHEET 2.

Fig. 2.

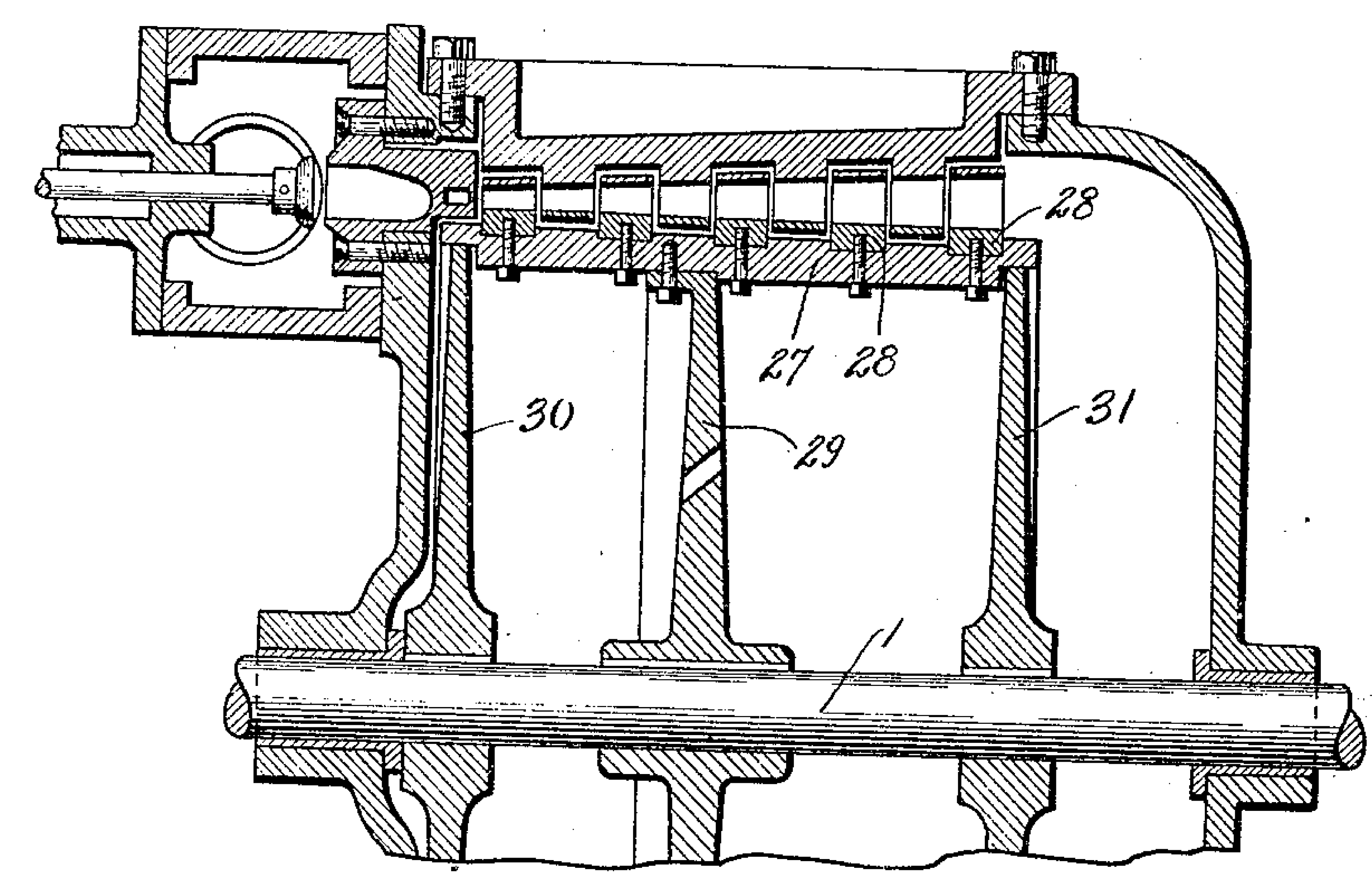
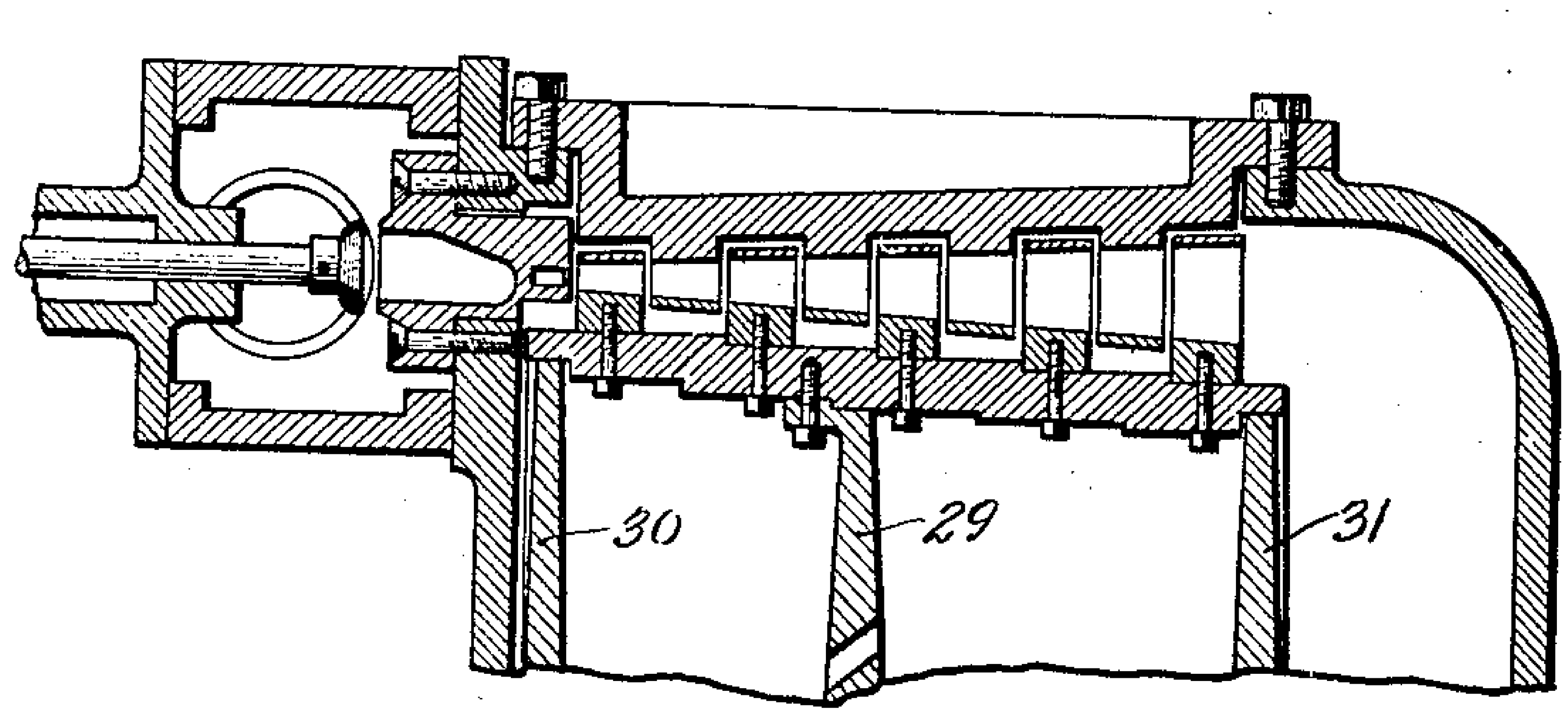


Fig. 3.



Witnesses:
Helen Orford
Alex F. Macdonald.

Inventor,
Elihu Thomson,
By Albert G. Davis
Atty.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 920,789. Specification of Letters Patent. Patented May 4, 1909.

Application filed December 14, 1904. Serial No. 236,822.

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.

In the operation of elastic-fluid turbines, more or less difficulty is experienced at times, due to the warping or bending of the wheels or bucket-carrying elements, which in certain types of machines are of relatively large diameter, said warping or bending resulting in a distortion of the buckets from their normal position or plane of operation. In other words, the edge of the bucket instead of being at a given angle to the shaft is at some other angle, either greater or less. This is due to the fact that one portion of the wheel or bucket-carrying element has a different temperature than another portion, and frequently results in serious injury to the buckets or other parts when improperly set or adjusted.

The present invention has for its object to improve the construction of bucket-carrying elements so that the temperature effects thereon, above referred to, can be eliminated or so far reduced that they can be disregarded.

The invention also includes certain other novel features of construction whereby the turbine is improved, as will be hereinafter referred to.

In the accompanying drawings, which illustrate certain embodiments of the invention, Figure 1 is a partial axial section of an elastic-fluid turbine; Fig. 2 is a partial axial section of a slightly modified form of the invention; Fig. 3 is a partial longitudinal section of a further modification; and Fig. 4 is a detail view of a means for opposing end thrust of the shaft.

1 represents the main shaft of the turbine upon which is mounted a driving support 2. This support may be in the form of a disk, spoked wheel, or other construction, as desired. Mounted upon the support is a bucket-carrier 3 of suitable construction, which is subjected to a gradually decreasing temperature toward the exhaust corresponding to the decreasing temperature of the motive fluid as it flows along the carrier and its heat energy is converted into energy of motion by the rotating buckets on the carrier and the coöperating nozzles and intermediate buckets. With a steam supply of substantially constant pressure and temperature and a given load the temperature of the turbine rotor and casing will gradually decrease toward the exhaust end of the turbine, but the temperature of any given region will remain unchanged. When the load changes and the supply of motive fluid is increased or decreased to meet the new conditions, the temperature of said region will change accompanied by corresponding variations in the expansion of its parts. Thus with a decrease in load the exhaust pressure and temperature extend a greater distance toward the admission end of the turbine with a gradation of temperature in the region between the admission and exhaust conditions. With an increase in load the region of exhaust pressure and temperature is moved toward the exhaust end of the turbine with corresponding changes in the more extended portion then lying between said region and the admission end of the turbine. Since the load on an ordinary turbine is subject to frequent variations it follows that its temperature is subject to similar variations, as above described, tending to produce distortion of the turbine parts.

The carrier 3 may be formed integrally with the driving support 2 or separate therefrom, as shown in Figs. 2 and 3, and secured in place by bolts. In the present illustration the carrier is made in the form of a cylinder having a smooth periphery to which the bucket-carrying rings 4 are secured by bolts or other attaching means. These rings are provided with one, two or more rows of buckets 5. The base portion of the buckets may be made in the form of a ring or segments thereof as desired. The bucket carrier is provided with one or more non-driving supports 6 which engage a suitable surface on the carrier and serve to center and support it, without, however, constraining its longitudinal movement due to expansion and contraction. The non-driving support may be fixed on the shaft, and in frictional engagement with the bucket carrier, or it may be fixed with respect to the carrier and free to slide on the shaft or part carried thereby.

Situated adjacent to the driving support or otherwise suitably located is a disk 7 of relatively thin metal which is attached to the hub of the main support 2 or to the shaft as desired. Between this plate and the support is a chamber 8 which, when the machine is in operation, will contain more or less steam or other fluid, the fluid being admitted by one, two or more passages 9. The object of this arrangement is to cause the temperatures on opposite sides of the main support to be equalized. Under ordinary conditions enough steam would leak through the clearance between the wheel and the sectionalized nozzle 10 and the wheel casing 11 to fill the chamber. I may however provide one or more additional passages 12 to convey steam to the chamber 8. This passage or passages receives steam after it has acted one or more times on the wheel buckets.

The non-driving support 6 acts simply as a steadying and centering means which keeps the bucket carrier concentric with the shaft, but which in no way constrains it from endwise movement as it expands and contracts. It will therefore be seen that although the carrier may expand and contract the edges of the buckets will still be at right angles to the axis of rotation. In other words the plane or position of each row of buckets remains unchanged.

If desired the non-driving support 6 may be slightly corrugated near its outer edge, and thus give a certain elasticity so that it would be measurably flexible if fitted tightly to the bucket-carrier. It can be made so thin on the edge as to be measurably flexible, and if fitted tightly to the bucket-carrier should not be strong enough to constrain the driving support 2. The casing 13 of the machine should preferably be made of a material having the same coefficient of expansion as the bucket-carrier 3. Mounted within the casing is a cylindrical structure 14 which carries one or more rows of intermediate buckets located between the wheel buckets, and one or more nozzles or other fluid discharging devices 15 which may be secured in place by bolts or be cast integral with said structure. By reason of this construction the nozzles and intermediate buckets can be first assembled and then mounted in the machine it being understood that the casing is suitably divided. By using a separate supporting structure for the stationary buckets and nozzles certain advantages accrue in the manufacture, and it is somewhat simpler to make changes in the nozzles and buckets. Each of the cylinders is provided with a projection dividing the turbine into stages and contains a chamber 16, which chamber receives steam from the preceding bucket wheel and discharges it into the bowl or bowls of the nozzle or nozzles. Located at the end of the machine is an exhaust-carrying conduit 17 that leads to the atmosphere or to a condenser as desired.

Steam is admitted to the turbine from the valve chest 25 by one or more valves 26. Ordinarily a plurality of valves will be employed and they will operate one after the other in a predetermined sequence under the control of any suitable governing mechanism.

In Fig. 2 is shown a slight modification wherein the bucket-carrier 27 is made in the form of a cylinder with a plurality of grooves, each arranged to receive a ring of buckets 28. The latter will be made in segments and secured to the carrier by bolts. The carrier is supported by a driving support 29 that is rigidly bolted thereto and is supported at its outer ends by non-driving supports 30 and 31. The latter are so arranged that they do not constrain the endwise movement of the cylindrical bucket-carrier as it expands or contracts. These non-driving supports may be of the same construction as previously described. The driving support has one or more openings to permit the pressures which may exist on opposite sides thereof to equalize.

In Fig. 3 is shown a further modification wherein the periphery of the bucket-carrier is provided with a series of step-like shoulders adapted to receive the rings of buckets. In this case the buckets may be formed as complete rings and afterward mounted on the carrier, suitable bolts being provided for securing them in place, or they may be made segmental. The driving support 29 is constructed as described in connection with Fig. 2, as are also the non-driving supports 30 and 31. By arranging the bucket-carrier with a series of step-like shoulders the expansion necessary to take care of the increase in volume of the motive fluid in both stationary and moving buckets can be readily attained.

In some cases there may be a considerable end thrust on the main shaft due to the action of the motive fluid on the buckets. In vertical shaft machines the weight of the revolving parts has to be considered as well as the effects of thrust. Fig. 4 shows an arrangement which may be used in a horizontal or vertical shaft machine, and is one that is economical in the use of lubricating or other fluid. The end of the shaft, or an enlargement on the end of the shaft, is located in a suitable chamber 19 containing fluid under a pressure which is more or less great depending upon the amount of the end thrust or the weight of the parts or both, and the pressure of the fluid supply. Projecting through the wall of the chamber, or located in a position to be acted upon by the endwise movement of the shaft is a valve 20 that is normally urged against its seat by fluid pressure or an adjustable spring 21, or both. Fluid such as oil or water, and preferably the latter where steam is the motive fluid, is admitted to the chamber 22 by the pipe 23 from a pump, accumulator or other source of high pressure. The pressure in the chamber 22 must be somewhat above that in the chamber 19 so that as soon as the shaft moves endwise sufficiently to open the valve a certain amoun of fluid will rush into the chamber, push the shaft away from the valve and permit the latter to close. This action will take place intermittently, and obviously since the valve will be closed a portion of the time the amount of fluid required is less than where an unvalved passage is used. It is desirable to place the valve in line with the axis of the shaft to prevent excessive wear. The end of the valve and shaft may be provided with removable wearing plates.

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 by other means.

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 a shaft, a cylindrical carrier, a row of buckets mounted thereon, a driving support for the carrier connected with the shaft, means for equalizing the temperatures on different portions of the driving support, and a non-driving support for the carrier mounted on the shaft which permits expansion and contraction of the parts under temperature changes without distorting the buckets from their normal plane or position.

2. In an elastic-fluid turbine, the combination of a carrier mounted on the shaft, a row of buckets mounted on the carrier, a support for the carrier which permits expansion and contraction of the parts under temperature changes without distorting the buckets from their normal plane, and means for equalizing the temperatures on different portions of the support.

3. In an elastic-fluid turbine, the combination of a bucket carrier, a shaft, a means connecting the carrier and the shaft for transmitting motion from one to the other, a device for equalizing the temperatures on different portions of said means, and a non-driving means mounted on the shaft which permits the parts to expand and contract under temperature changes, at the same time preserving the proper relation of the buckets.

4. In an elastic-fluid turbine, the combination of a bucket-carrier, a shaft, a driving support which connects the carrier with the shaft, means for equalizing the temperatures on opposite sides of the driving support, and a non-driving support on the shaft which serves to center the carrier with respect to the shaft but does not constrain its endwise movements.

5. In an elastic-fluid turbine, the combination of a bucket-carrier, a shaft, a driving support which connects the carrier with the shaft, means for equalizing the temperature on opposite sides of the support, and a non-driving support which centers the carrier without constraining its movements.

6. An elastic fluid turbine comprising a bucket carrier, a shaft, a casing, and fluid discharging devices, in combination with a driving support for the carrier connected with the shaft, means for equalizing the temperatures on opposite sides of the driving support, and a non-driving support on the shaft which prevents distortion of the bucket-carrier but permits it to expand and contract longitudinally under changes in temperature.

7. In an elastic fluid turbine, the combination of a shaft, a cylindrical carrier having rows of buckets mounted thereon, a driving support for the carrier connected to the shaft and to the carrier intermediate its ends, and non-driving carrier supports extending between the shaft and carrier adjacent its outer ends which permit it to expand and contract longitudinally under changes in temperature.

8. In an elastic fluid turbine, the combination of a shaft, a cylindrical bucket carrier having a driving support mounted on the shaft, and a steam-tight disk extending between the shaft and carrier at one side of the support.

9. In an elastic fluid turbine, the combination of a shaft, a cylindrical member having a driving support mounted on the shaft, a steam-tight disk extending between the shaft and the inner surface of the member, which disk is free to distort without transmitting the distortion to said support, and a chamber between the disk and support to which motive fluid has access for the purpose of equalizing the temperatures on opposite sides of the driving support.

10. In an elastic fluid turbine, the combination of a casing, a rotor located therein, a shaft, means for connecting the rotor rigidly to the shaft at one place, means for supporting the remainder of the rotor upon the shaft without confining it longitudinally so as to allow for unequal expansion and contraction of the turbine parts under the varying heating effect of the motive fluid flowing along the surface of the rotor within the casing, rows of buckets carried by the rotor for driving it, buckets arranged in rows and car-

ried by the casing which receive motive fluid and discharge it against the rows of buckets on the rotor, means for initially admitting fluid to the buckets including a nozzle device mounted on the casing which converts the pressure of the motive fluid into velocity and discharges it against certain of the buckets on the rotor, and mechanism for controlling the supply of motive fluid to said nozzle device.

In witness whereof I have hereunto set my hand this twelfth day of December, 1904.

ELIHU THOMSON.

Witnesses:

JOHN A. McMANUS, Jr.,

DUGALD McK. McKILLOP.