No. 826,927.

PATENTED JULY 24, 1906.

J. W. FERGUSON.

ELASTIC FLUID TURBINE.

APPLICATION FILED MAY 9, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

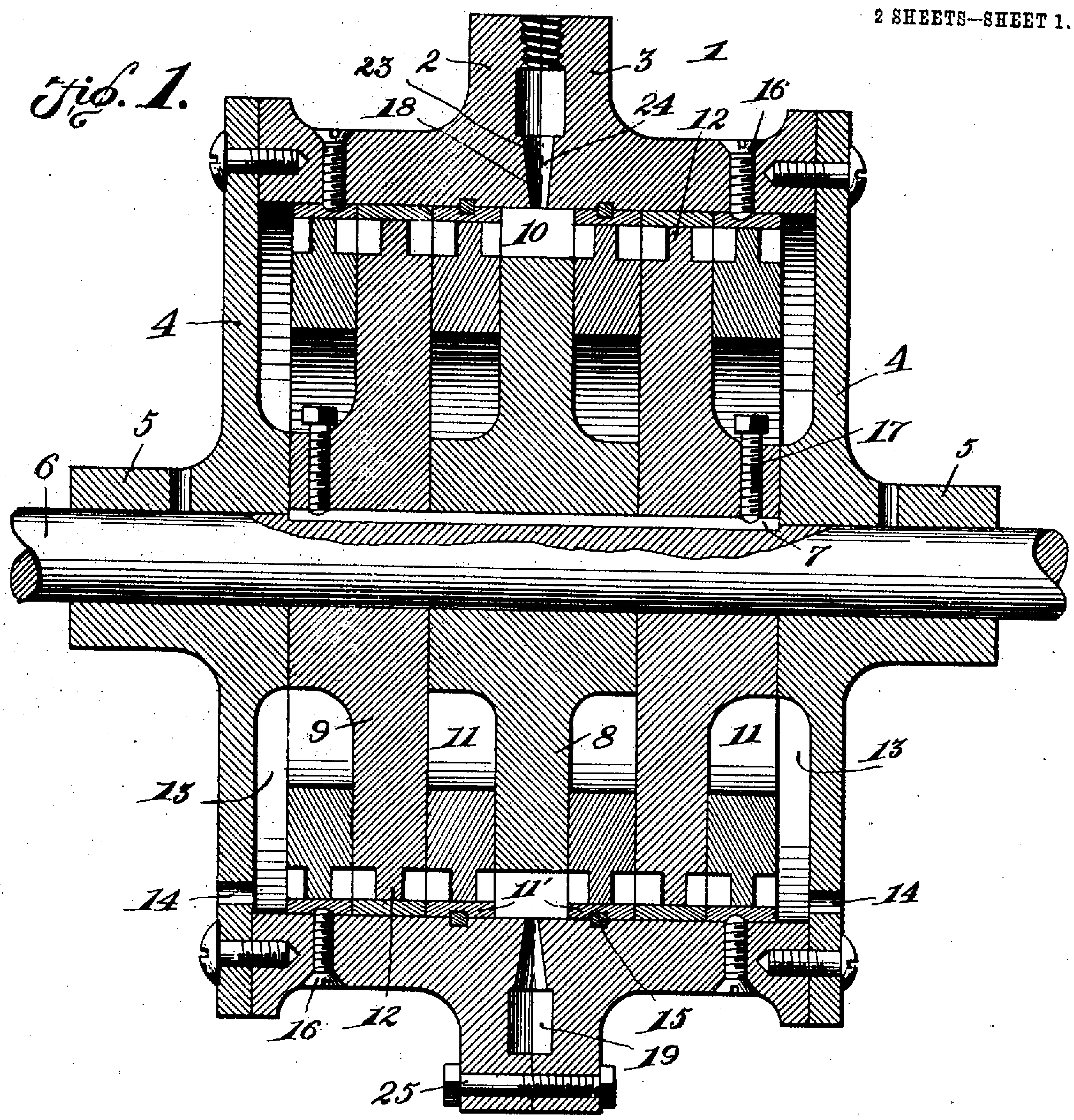
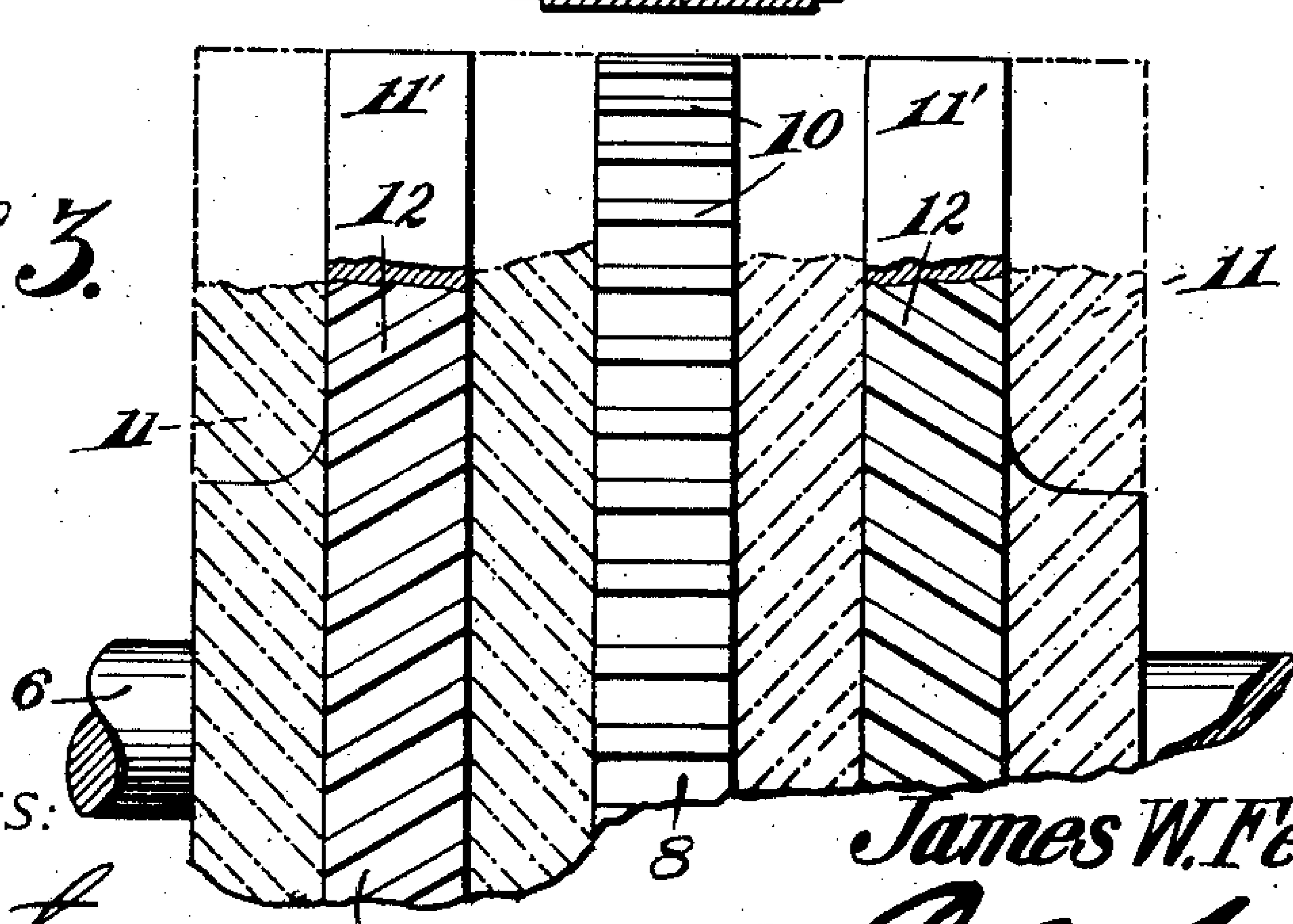


Fig. 3.



WITNESSES:

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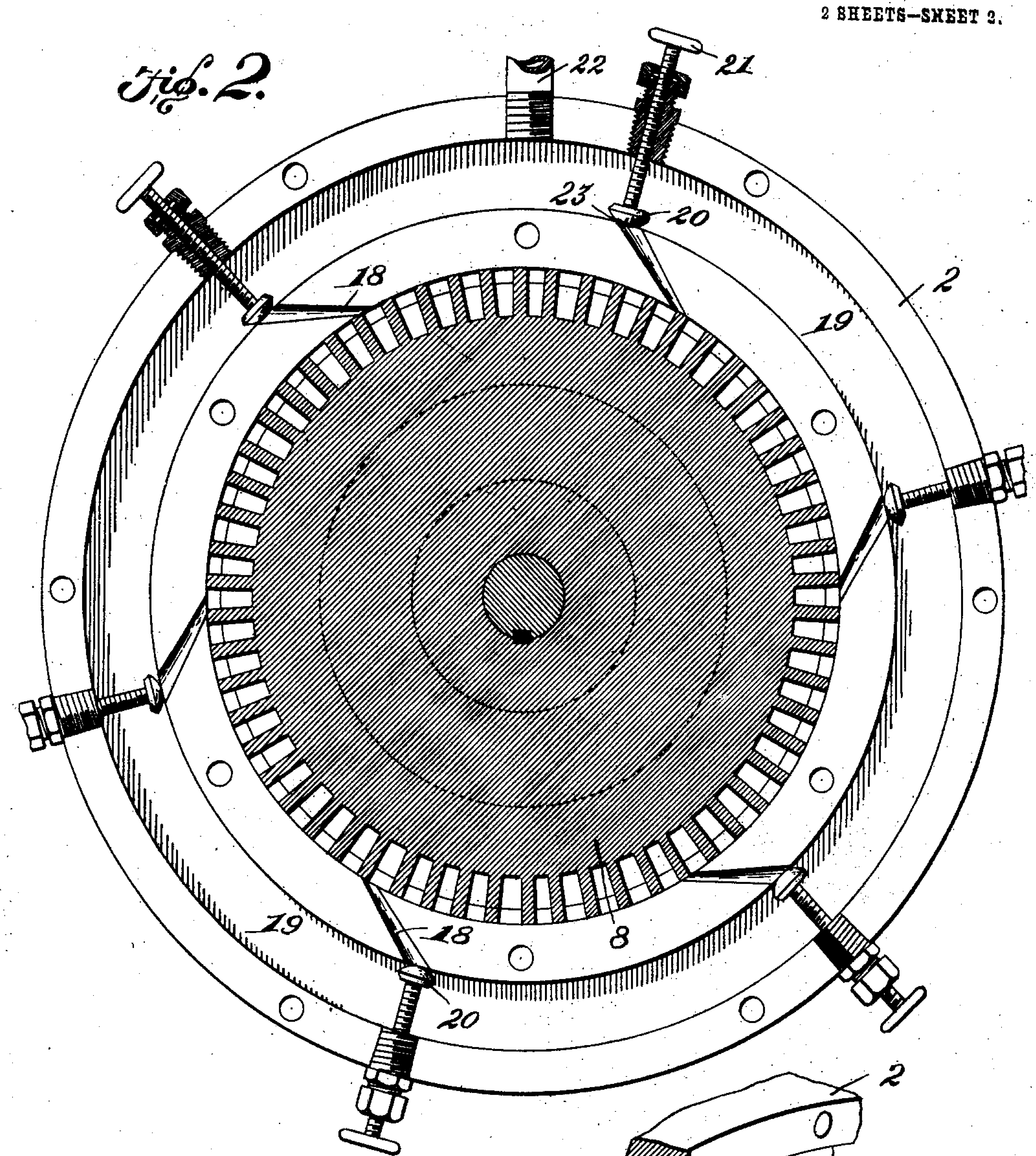
Fig. 2.



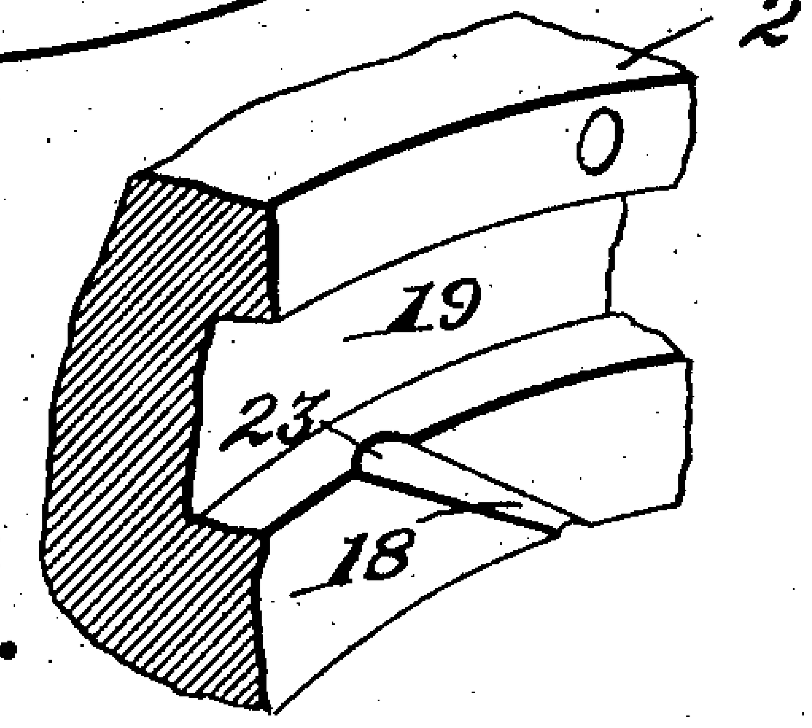


Fig. 4.

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ELASTIC-FLUID TURBINE.

No. 826,927. Specification of Letters Patent. Patented July 24, 1906.

Application filed May 9, 1906. Serial No. 315,972.

To all whom it may concern:

Be it known that I, JAMES WILLIAM FERGUSON, a citizen of the United States, residing at Sandusky, in the county of Erie and State of Ohio, have invented a new and useful Elastic-Fluid Turbine, of which the following is a specification.

The present invention relates to elastic-fluid turbines, and it relates more particularly to a turbine of that type in which the motive fluid is discharged approximately tangentially upon certain of the buckets and then discharges axially in opposite directions upon successive rows of buckets to entirely abstract the energy of the motive fluid, the opposite axial flow of the fluid equalizing the endwise thrust common in single axial flow turbines.

The objects of the invention are to improve, simplify, and cheapen the construction of turbines of this character.

In carrying out the invention I provide one or more rows of buckets adapted to receive the motive fluid discharged approximately tangentially upon the same, the buckets being uncovered at one or both of their side ends, so that the fluid can discharge in an axial direction against one, two, or more successive rows of buckets. According to one embodiment of the invention the buckets that receive the motive fluid tangentially are radial in one direction and axial in another direction, and their front or fluid impinging surfaces are preferably flat. On one or both sides of these buckets are arranged in alternate order rows of stationary, intermediate, and rotary buckets through which the steam passes successively from the tangentially-receiving buckets. The faces of the intermediate and rotary buckets are also flat and extend radially in one direction. The intermediate buckets are arranged at an angle of forty-five degrees, more or less, with respect to the axis of rotation or to the tangential-receiving buckets, while the rotary buckets that receive fluid from the intermediates are disposed at an angle of thirty degrees, more or less, to the axis of rotation. By arranging the buckets in this manner greater expansion of the steam or other motive fluid is obtainable, giving the turbine more power and a higher velocity and economy in the use of steam. Furthermore, as the buckets are flat they can be cut in solid disks or segments by a simple milling operation, thereby cheapening and expediting the manufacture of the buckets. The nozzles or fluid-discharging devices for delivering the fluid tangentially may be of any desired construction.

With these and other objects in view, as will appear as the nature of the invention is better understood, the invention comprises various features of construction and arrangement of parts to be more fully described hereinafter and set forth with particularity in the claims appended hereto.

In the accompanying drawings, which illustrate one of the embodiments of the invention, Figure 1 is a longitudinal sectional view of the turbine. Fig. 2 is a central transverse section. Fig. 3 is a partial side view of the rotating element of the turbine, and Fig. 4 is a detail view of one of the nozzle-passages.

Corresponding parts in the several figures are indicated throughout by similar characters of reference.

Referring to the drawings, 1 represents the turbine-casing, which is composed of two sections 2 and 3, separably connected and divisible on a central transverse plane. These annular sections may, if desired, be made of segments and suitably connected together for convenience in manufacture and assembling. At the ends of the casing 1 are the heads 4, bolted or otherwise suitably secured around their peripheries to the annular casing 1, and which are provided with bearings 5 for shaft 6 of the turbine. Secured to the shaft 6 by means of a key 7 are a plurality of disks or bucket-wheels 8 and 9. The disk 8, arranged centrally of the turbine, is provided with radially and axially extending buckets 10, as shown more clearly in Fig. 3. These buckets are uncovered at their peripheral ends and also at their side ends, so that motive fluid can be discharged tangentially against them and then flow therefrom in opposite axial directions into the stationary intermediate buckets 11. These intermediate buckets are cut in annular members or segments, and after the ends of the buckets are covered by rings or covers 11′, shrunk or otherwise secured thereon, they are suitably secured to the turbine-casing after the buckets have been cut. The intermediate buckets operate to give to the motive fluid the proper angle of delivery for discharging upon the succeeding rotary buckets 12 on the wheels 9. I find in practice that the angle of delivery of the intermediates is very satisfactory at forty-five degrees to the buckets 10 or the axis of rotation. To get the best results from such an angle of delivery, the buckets 12 on the wheels 9 are preferably arranged at thirty degrees to the axis of rotation. The working passages from the inlet to the point of final exhaust may be non-expanding, as shown, or expanding by increasing the radial depth of the buckets or otherwise, as may be found best. At the ends of the casing are exhaust-chambers 13, into which the fluid discharges after the energy thereof has been abstracted by the successive rows of buckets and discharges therefrom to the atmosphere or the condensing system through the exhaust-ports 14.

The buckets of the character shown are simple and inexpensive to construct, since they can be cut in solid stock at the desired angles by a suitable milling-machine. The segments or rings 11′ of the intermediate buckets are constructed to snugly fit the interior wall of the casing, and they may be secured in place in any desired manner—as, for instance, the adjacent walls of the casing and segments are provided with registering grooves that receive segmental keys 15, as clearly shown in Fig. 1, to prevent relative axial displacement between the casing and intermediate buckets, or they may be secured in place by means of bolts 16, Fig. 1, that extend through radial openings in the casing 1 and screw inwardly from the outside of the casing into tapped openings in the rings or segments of the intermediates. Since the casing snugly fits around the intermediate segments or rings, it holds the latter in fixed concentric position with respect to the rotating buckets. The wheels are prevented from endwise movement on the shaft by means of the set-bolts 17, Fig. 1.

The motive fluid is discharged upon the central buckets 10 by one or more nozzles 18. When a plurality of nozzles are employed, they are preferably angularly displaced around the bucket-wheel at suitable distances. These nozzles may be constructed on any approved principle, expanding, non-expanding, or contracting in the direction of discharge. The nozzles receive motive fluid from the annular chest 19, extending centrally around the casing, and the supply of motive fluid from the chest to the nozzles is controlled by individual nozzle-valves 20, operated from a point without the casing by the hand-wheel 21 or any other suitable means. The steam-inlet is indicated at 22.

The nozzles are arranged to lie in the plane of division between the sections 2 and 3 of the casing, and the passages can be arranged wholly in one section, thereby forming three walls of the nozzle, while the other section forms the fourth wall, or they may be made half in one section and half in the other section and arranged so that any two halves register when the sections are secured together. By this arrangement the work of cutting, filing, and scraping the walls of the passages can be easily done from the open sides thereof instead of from the ends of the passages, as has been the case heretofore. This is an advantageous feature of the present construction, since the nozzles can be thereby expeditiously and inexpensively constructed. As shown in Figs. 1 and 4, one half of the nozzle-passage is shown at 23 in section 2 and the other half at 24 in section 3 of the casing.

If desired, the nozzles can be arranged in supports, such as a ring or segments, which are independent of the turbine-casing and suitably supported therein. As shown in Fig. 1, the steam-chest 19 is also arranged partly in each of the two sections of the casing, and the two sections are secured together by bolts or other devices 25.

While I have described the invention as applied to what may be termed a "single-stage" turbine, I desire to have it understood that the invention can be carried into effect in connection with a multistage turbine. Furthermore, instead of arranging the nozzles at the center of the turbine and causing the fluid to flow toward the exhaust at the ends thereof this arrangement may be reversed and still eliminate the end thrust and produce satisfactory and efficient results otherwise.

I have described the principle of operation of the invention, together with the apparatus which I now consider to be the best embodiment thereof; but I desire to have it understood that the apparatus shown is merely illustrative and that various changes in the construction and arrangement of parts and proportions can be resorted to without sacrificing any of the principles or advantages of the invention.

What is claimed is—

1. In an elastic-fluid turbine, the combination of radially and axially extending buckets open at their circumferential and side ends and arranged to receive fluid tangentially at their circumferential end and to discharge the fluid equally from the side ends in an axial direction, with buckets arranged to receive the fluid from the side ends of the first bucket to further abstract energy from the fluid.

2. In an elastic-fluid turbine, the combination of buckets which receive the motive fluid delivered in a tangential direction, and are open at their circumferential and side ends, with successive rows of buckets constructed to form passages of uniform cross-section and arranged to receive the motive fluid axially from the first-mentioned buckets, the cross-section of the buckets of alternate rows being different from the cross-section of the intermediate rows.

3. In an elastic-fluid turbine, the combination of radial and axially-extending buckets

adapted to receive fluid discharged tangentially against them, intermediate buckets arranged at an angle to the first for receiving fluid flowing from the latter in an axial direction, and rotary buckets arranged adjacent and at an angle to the intermediate buckets to receive the fluid discharged thereby, the cross-section of the fluid passages of the intermediate buckets being uniform and less than the cross-section of the passages between the said rotary buckets.

4. In an elastic-fluid turbine, the combination of radially and axially-extending buckets adapted to receive fluid discharged tangentially, rows of intermediate buckets forming passages of uniform cross-section disposed at an angle to the passages between the first buckets, and rotary buckets arranged in coöperative relation to the intermediate buckets which form passages of different uniform cross-section and disposed at an angle to the first buckets different from the angle of the intermediate buckets.

5. In an elastic-fluid turbine, the combination of radially and axially extending buckets rotatably mounted and adapted to receive fluid tangentially and deliver it axially, rows of intermediate buckets forming passages of uniform cross-section and disposed at an angle to the axis of rotation, and rows of rotating buckets forming passages of greater cross-section than the aforesaid passages and disposed at a less angle to the axis of rotation.

6. In an elastic-fluid turbine, the combination of a rotatable element, radially and axially extending buckets arranged thereon which are uncovered at their circumferential and side ends to deliver fluid axially therefrom, tangentially-discharging nozzles angularly displaced around the element, and alternately-arranged stationary and rotary buckets forming axially-extending passages, the passages between the stationary bucket being of less cross-section than those of the rotary buckets and disposed at a greater angle to the axis of rotation than the passages of the rotary buckets.

7. In an elastic-fluid turbine, the combination of a casing having annular grooves on its internal surface, rows of rotating buckets mounted therein, rows of intermediate buckets, externally grooved arc-shaped members supporting the intermediate buckets and engaging the interior wall of the casing, and a key fitted in the grooves of said members and the casing for preventing relative axial displacement between the intermediate buckets and the casing.

8. In an elastic-fluid turbine, the combination of a casing, rows of rotating buckets mounted therein, rows of intermediate buckets, annular members for supporting the intermediate buckets which are held circumferentially in engagement with the interior wall of the casing, registering keyways in the said members and casing, and keys in said ways for preventing relative axial displacement of the members and casing.

9. In an elastic-fluid turbine, the combination of buckets having flat fluid-impinging faces and arranged to receive the motive fluids delivered in a tangential direction, the passages between the buckets being of substantially uniform cross-section and open at their circumferential and side ends; with buckets having flat fluid-impinging faces and arranged to receive the fluid delivered from the side ends of the first buckets.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

JAMES WILLIAM FERGUSON.

Witnesses:
George W. Ferguson.
Winton W. Ferguson