No. 838,531. PATENTED DEC. 18, 1906.

U. G. FERNALD.

STEAM TURBINE.

APPLICATION FILED AUG. 16, 1906.

3 SHEETS—SHEET 1.

Fig. 1.

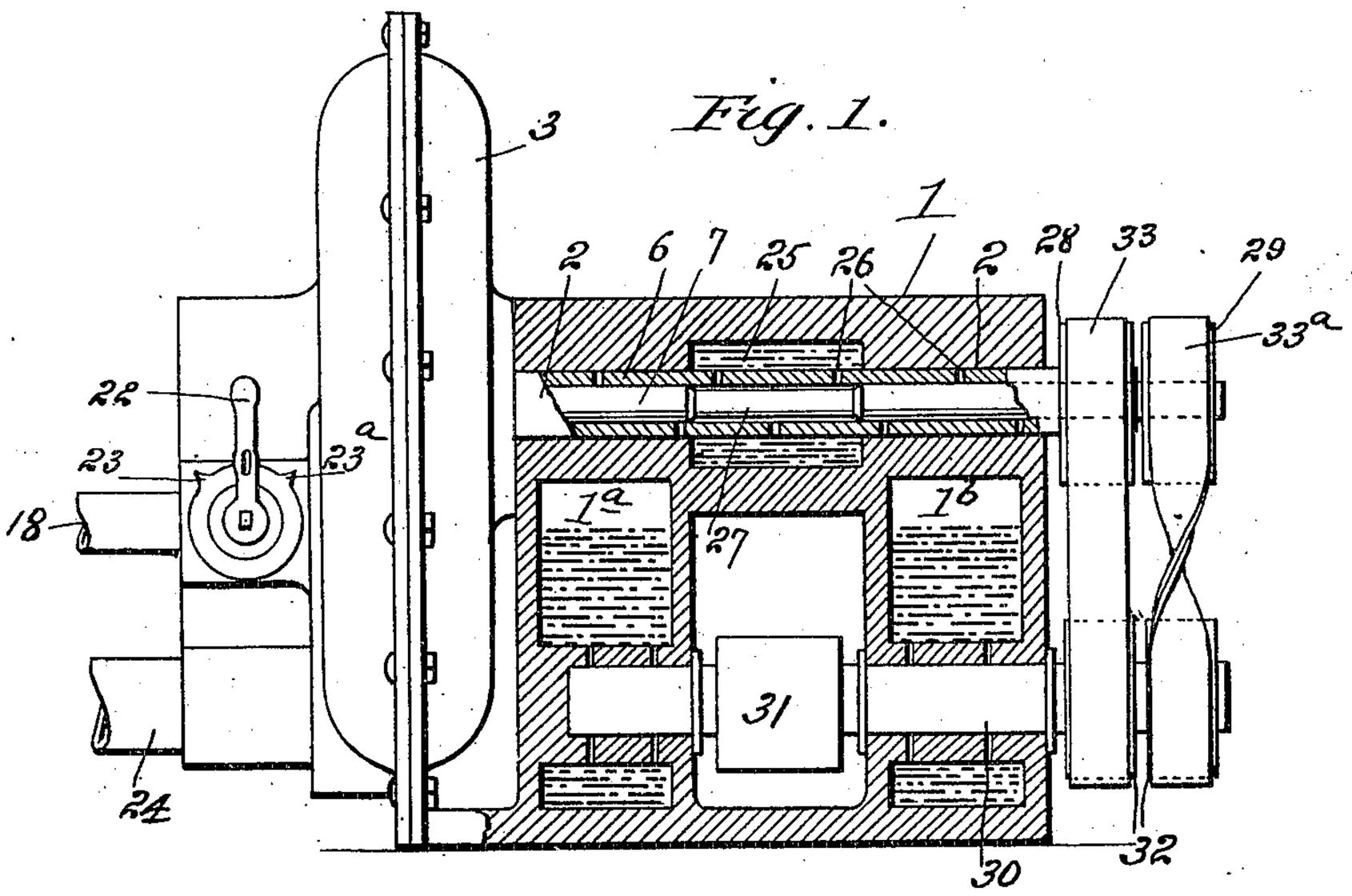
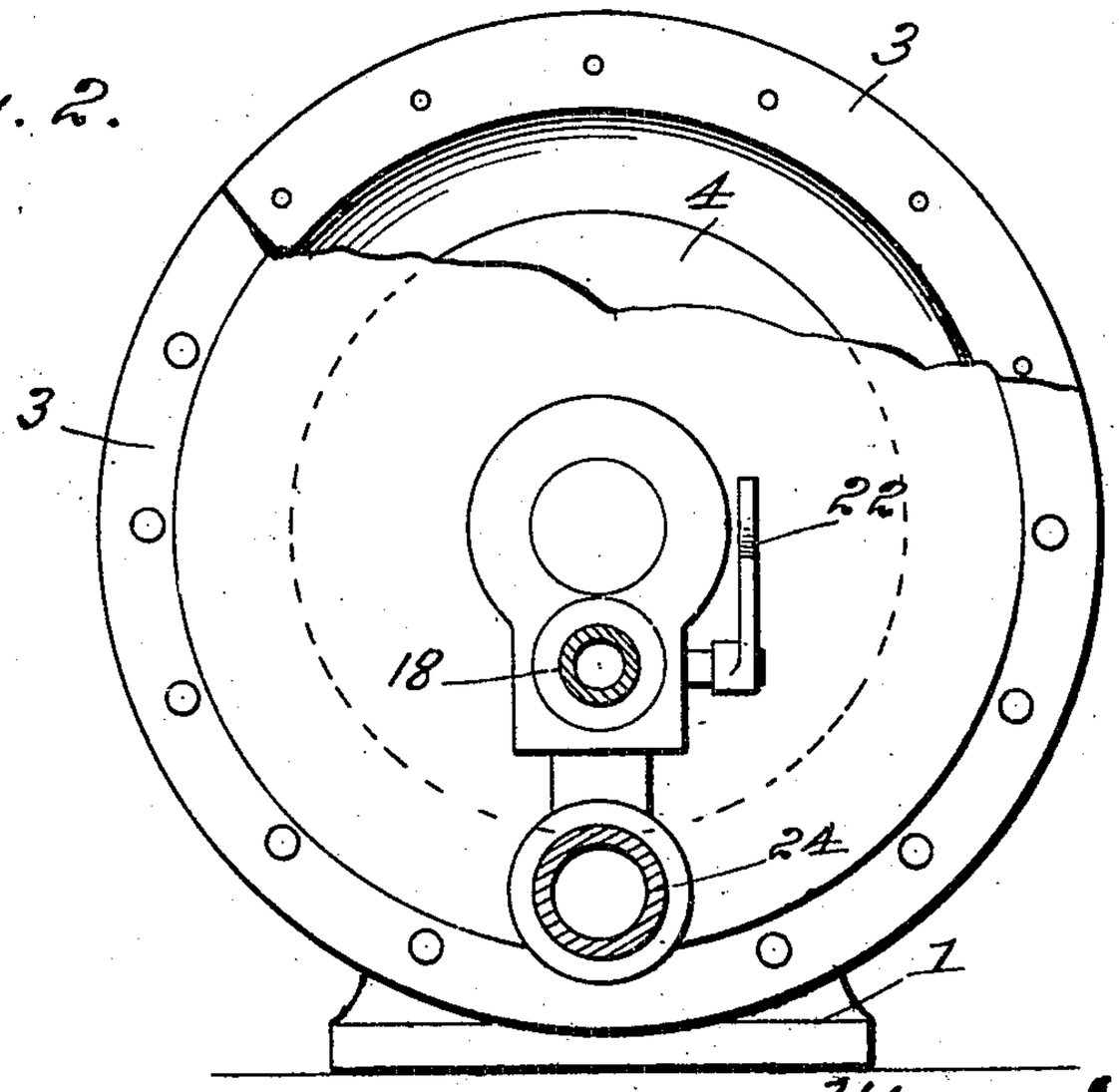


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3

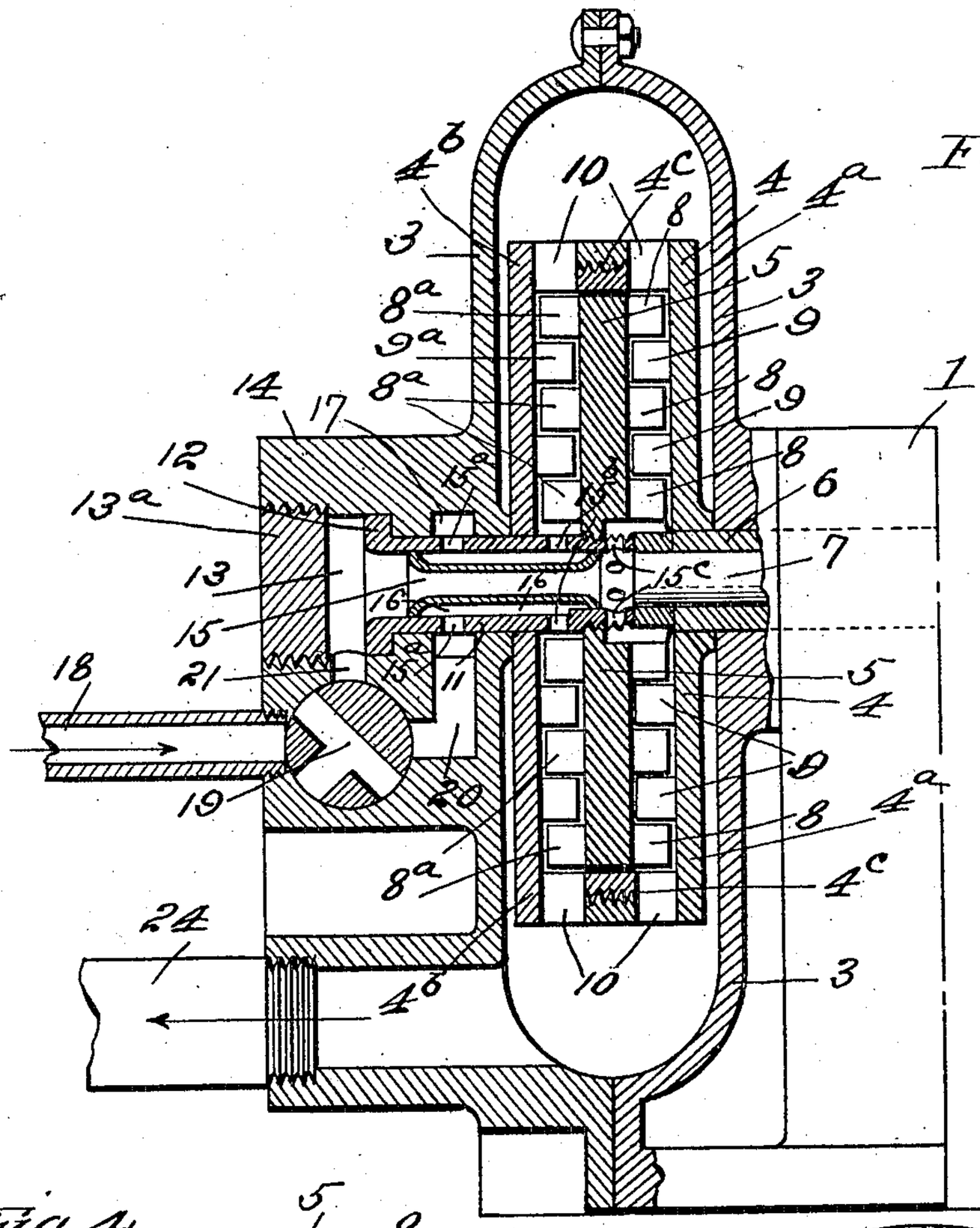


Fig. 4.

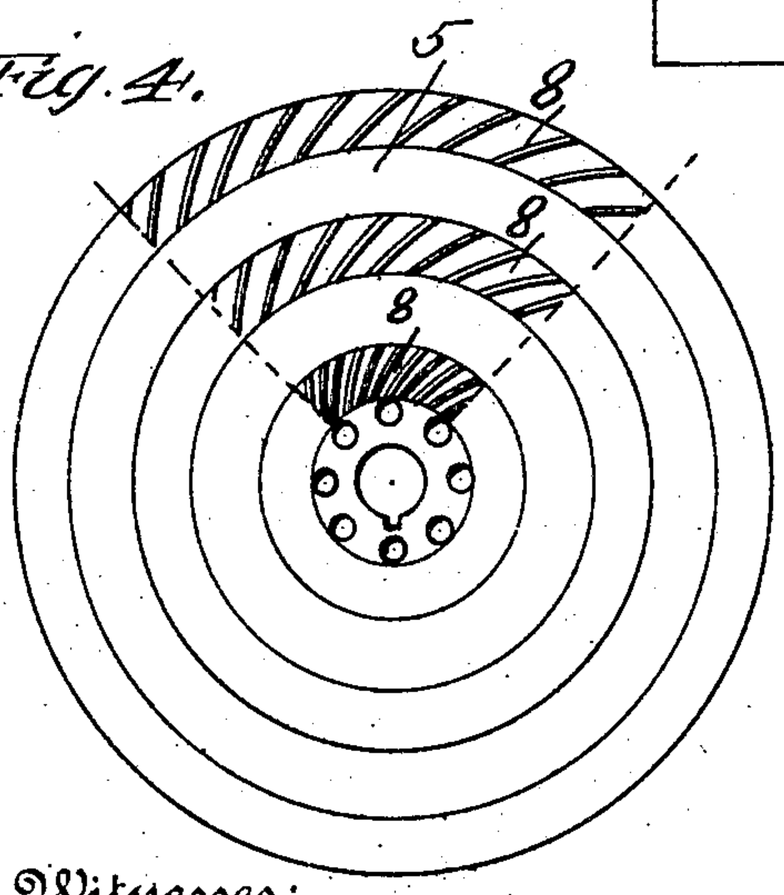
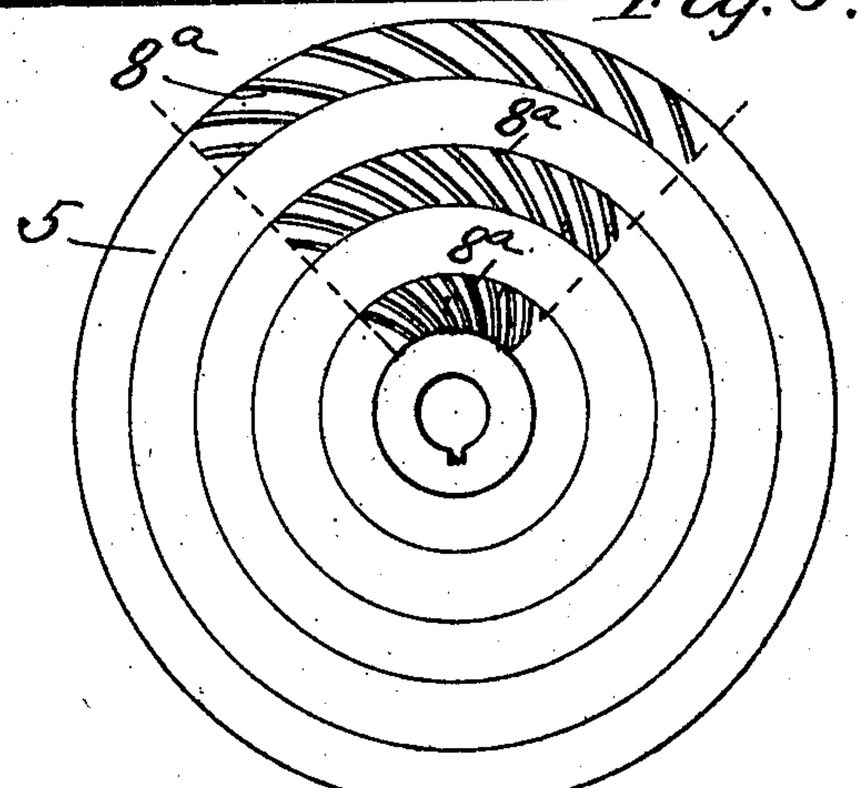


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 6.

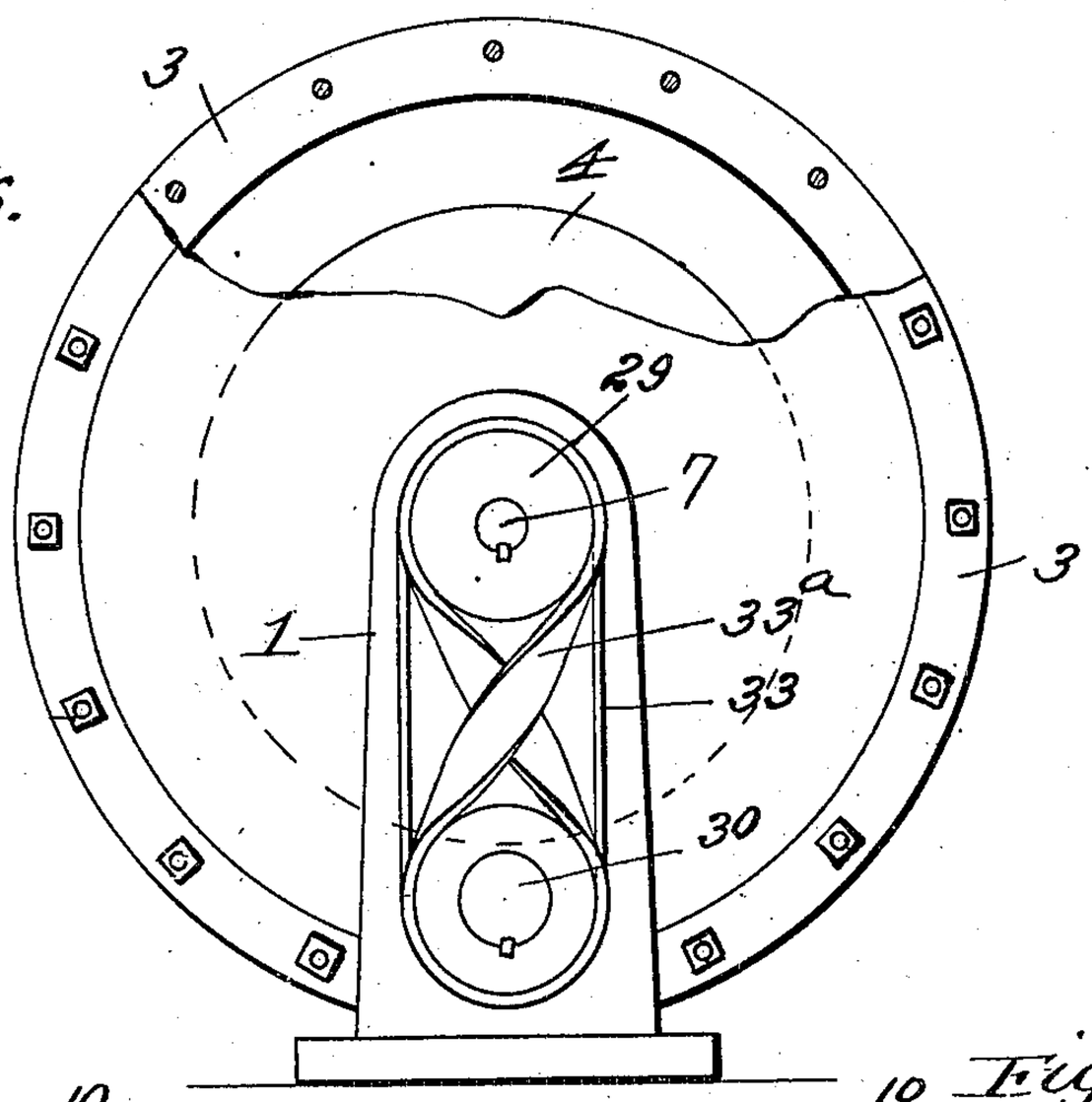


Fig. 7.

Fig. 8.

Fig. 9.

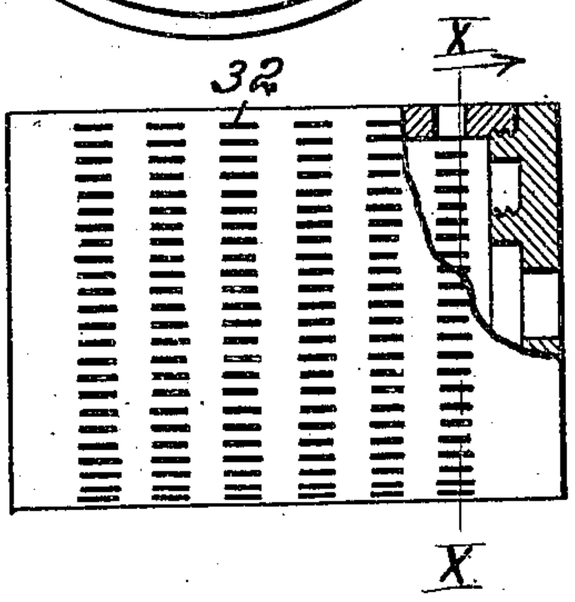
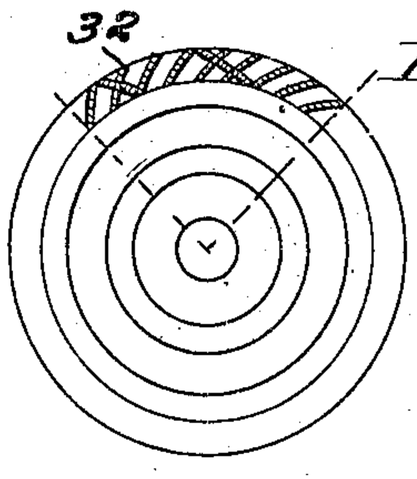


Fig. 10.



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UNITED STATES PATENT OFFICE.

ULYSSES GRANT FERNALD, OF CAMDEN, MAINE.

STEAM-TURBINE.

No. 838,531. Specification of Letters Patent. Patented Dec. 18, 1906.

Application filed August 16, 1906. Serial No. 330,910.

To all whom it may concern:

Be it known that I, ULYSSES GRANT FERNALD, a citizen of the United States, residing at Camden, in the county of Knox, State of Maine, have invented certain new and useful Improvements in Rotary Motors of the Steam-Turbine Type, of which the following is a specification, reference being had therein to the accompanying drawings, in which—

Figure 1 is a side elevation, partly in section; Fig. 2, a front elevation, part of the motor-casing being broken away; Fig. 3, a vertical longitudinal sectional view of the motor; Figs. 4 and 5, views of opposite sides of the disk member of the motor; Fig. 6, a view of the motor, part of the outer casing being broken away; Figs. 7 and 8, elevations of the two parts of the cylindrical member of the motor; Fig. 9, a side elevation, partly in section, of a slightly different form of one of the driven members of the motor; and Fig. 10, a sectional view taken on the line *x x* of Fig. 9.

One of the main objects of the invention is to provide a simple reversible rotary motor adapted to be driven by an expansive fluid under pressure.

A further object of the invention is to provide such a motor wherein two driven members or parts are employed, said parts being each mounted upon an independent shaft and adapted to be rotated in opposite directions under the pressure of the expanding fluid, means being provided whereby the power of these oppositely-rotating shafts will be transmitted to a main driving-shaft.

Another object of the invention is to so construct the motor that it may be used with any expansive fluid under pressure, which will be simple in construction, easily operated, and in which the driven members will be so mounted as to be nicely balanced and capable of high speed.

Referring to the various parts by reference-numerals, 1 designates the main frame of the motor, which is formed with bearings 2 to receive the shafts of the driven members of the motor. To the forward end of this frame is secured a two-part casing 3, which is adapted to contain the motor members. The driven members of the motor consist of the outer cylindrical member 4 and the inner disk member 5. The cylindrical member consists of two circular parts 4^a and 4^b, which are screwed together, as at 4^c, and this member is adapted to contain and inclose disk member 5. The cylindrical member is mounted upon the forward end of a tubular shaft 6 and of course is within the casing 3. The disk member 5 is mounted upon the forward end of shaft 7, which fits within the tubular shaft 6. The disk member 5 is provided on each of its faces with three annular rows of blades, the blades 8 being on the rear face of said disk and the blades 8^a being on the forward side thereof. These blades are slightly curved from their inner toward their outer edges and are not radial. The blades of the inner rows are arranged closer together than the blades of the outer rows, and the inclination of the blades with respect to a radial line is least in the inner rows and greatest in the outer rows, the inclination varying from the said inner rows to the outermost rows, and the distance between the blades in the various rows is increased uniformly from said inner rows to the outer rows. The blades 8 and 8^a correspond identically in the number of blades, the number of rows of blades, and the varying inclination between the blades of each row, the only difference being that the blades 8^a incline in a direction opposite to the inclination of the blades 8, as shown clearly in Figs. 4 and 5, in order that when expansive fluid is directed against one set of blades its force will rotate the disk in one direction, and when it is directed against the other set of blades it will rotate the disk in the opposite direction.

The parts 4^a and 4^b of the cylindrical member are provided on their inner surfaces with annular rows of blades 9 and 9^a, the rows of blades 9 lying between the rows of blades 8 on the disk 5 and the rows of blades 9^a lying between the rows of blades 8^a on said disk. The annular rows of blades 9 and 9^a correspond to the adjoining blades on the disk. It is obvious that the expansive fluid which is directed against the innermost row of blades 8 or 8^a will in its outward course engage the innermost row of blades 9 or 9^a and then pass outward to the next outer row of blades, and so on through all the series. By inclining the blades 9 and 9^a in a direction opposite to the inclination of the adjoining blades of the disk it is obvious that the cylinder 4 will be driven in a direction opposite to the rotation of the disk. It will therefore be seen that the expansive fluid will act directly upon two rotating members and that said members will be driven in opposite directions.

The parts 4^a and 4^b of the cylindrical mem-

ber 4 are each provided in its periphery with blades 10, which are engaged by the expansive fluid as it passes out from said cylindrical member and into the casing 3.

Secured centrally to the disk 5 is a forward-extending delivery-tube 11, which is provided with an outward-extending annular flange 12 at its forward end. This flange lies within a chamber 13, formed in a forward-extending enlargement 14 on the front side of the casing 3. Within this delivery-tube is arranged a second tube 15, smaller in diameter than the interior of the delivery-tube, except at its enlarged ends, so that said second tube forms a chamber 16, which is closed at its ends and does not communicate with the interior of the delivery-tube. The said delivery-tube is formed with perforations 15^a, 15^b, and 15^c. Perforations 15^a and 15^b communicate with the passage 16, and perforations 15^c, being near the extreme inner end of the delivery-tube, communicate with the interior of said tube. The perforations 15^b are adapted to deliver fluid under pressure to the innermost row of blades 8^a of the disk, while the perforations 15^c deliver fluid under pressure to the innermost row of blades 8, as clearly shown in Fig. 3 of the drawings. The perforations 15^a communicate with an annular chamber 17, and the forward end of the delivery-tube is in open communication with the chamber 13. Fluid under pressure is admitted through delivery-pipe 18 and is controlled by a three-way valve 19, suitably mounted in the casing. One of the ports of said valve is adapted to place the delivery-pipe in communication with a passage 20, which is connected to chamber 17, and said valve in its other position is adapted to place passage 21 in communication with the delivery-pipe, and said passage 21 opens into chamber 13. The three-way valve 19 is provided with an operating-handle 22, and suitable indicating-marks 23 and 23^a are provided on the outer side of the casing to enable the operator to properly place the valve for delivering motive fluid to either chamber 13 or to chamber 17, according to the direction which he desires to give to the driving-shaft. The expansive fluid is exhausted from the casing 3 through the exhaust-pipe 24.

As shown in the drawings, if the handle 22 is moved toward the left to the mark 23 the motive fluid will be delivered from the pipe 18 through passage 20 into the chamber 17 and from there through chamber 16 to the blades 8^a and 9^a of the motor-disks or driven members, thereby driving the disk 5 in one direction and the cylindrical member in the opposite direction. To reverse the motor, it is only necessary to move the operating-handle 22 toward the right to a point 23^a. This will so place the valve that the motive fluid will be delivered into chamber 13, and from there it will pass through tube 15 and perforations 15^c to the innermost row of blades 8 and thence in succession through the rows of blades 8 on the disk and 9 on the cylindrical member, thereby driving the disk and the cylindrical member in directions opposite to the movements given them by the motive fluid impinging on the blades 8^a and 9^a.

The supporting-frame is provided with an oil-chamber 25, surrounding the shaft 6, and the shaft 6 is provided with perforations 26, through which the oil may pass to the inner shaft 7. The shaft 7 is provided with a reduced portion 27 within the shaft 7 to form an oil-chamber within said shaft. It is obvious that oil from the shaft 7 will pass outward to the perforations 26 and shaft 6 to the bearings 2. On the rear end of shaft 6 is secured a belt-pulley 28, and on the rear end of shaft 7 is secured a belt-pulley 29. Near the bottom of the supporting-frame the main driving-shaft 30 is mounted in suitable bearings, said shaft being provided with a driving-pulley 31. Said driving-pulley is located between the standards 1^a and 1^b of the supporting-frame, the shaft 30 being mounted in suitable bearings formed in said standards. These standards are preferably hollow to form oil-reservoirs, suitable means being provided whereby said oil may pass to the bearings of the main shaft. Pulleys 32 are mounted on the end of the driving-shaft, and said pulleys are connected by belts 33 and 33^a to the pulleys on the shafts 6 and 7. The belt 33^a is crossed, as shown in Fig. 1, in order that the two belts will work to drive the main shaft 30 in the same direction. This is necesssary, because the pulleys 28 and 29 are driven in opposite directions, the pulley 29 being rotated by the disk 5 and the pulley 28 by the cylindrical part 4.

It will be noted that the delivery-tube 11 forms a bearing for the forward part of the cylindrical member 4 and also as a support for the disk 5, said tube rotating with the disk 5 and maintaining it in alinement and preventing any undue lateral vibration thereof.

The forward end of chamber 13 is closed by a screw-plug 13^a, so that the delivery-tube may be easily reached and, if desired, unscrewed from the disk 5. When this is done, the entire forward side of the casing 3 may be removed, giving complete access to the driven members.

The form of motor members shown in Figs. 1 and 3 are adapted, preferably, for use in engines of small power. In engines of large power I prefer to use concentric cylinders 32, secured to the disk and to the inner faces of the cylinder member, said cylinders being formed substantially as shown in Figs. 8 and 9.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A rotary motor comprising a casing, two rotary members within said casing, one of said members being in cylindrical form and the other being in disk form and within the cylindrical member, annular rows of driving-blades on both sides of the disk member, annular rows of driving-blades carried by the cylindrical member on each of its sides, said driving-blades fitting between the rows of blades on the disk member, the blades on opposite sides of the disk member being inclined in opposite directions, and the blades on the cylindrical member being inclined in a direction opposite to the inclination of the blades on the adjoining side of the disk member, shafts for the disk member and the cylindrical member, and power-transmitting devices connected to said shafts, a delivery-tube connected to the disk and provided with apertures at its inner end to deliver the motor fluid to the inner side of the disk, and with apertures to deliver the fluid to the outer side of said disk, and means for independently controlling the flow of fluid to said apertures, whereby the direction of rotation of the members may be controlled.

2. A rotary motor comprising a casing, two rotatable members therein, one of said members being a disk and the other a cylinder, the disk being within the cylinder, a plurality of annular rows of driving-blades on each side of said disk, a plurality of annular rows of blades on the inner side of each face of the cylindrical member, said rows of blades fitting in between the rows on the disk, a delivery-tube connected to the disk and provided with apertures at its inner side to deliver the motive fluid to the inner side of the disk and with apertures to deliver fluid to the outer side of said disk, an inner tube within said delivery-tube and separating the apertures at the inner end of the tube from those adapted to deliver fluid to the outer side of said disk, and a single valve adapted to deliver motive fluid within the inner tube or to the delivery-tube, whereby said fluid may be directed against the vanes on the inner side of the disk or against those on the outer side of said disk, to control the direction of rotation of the two rotatable members.

3. A rotary motor comprising a casing, two rotatable members therein, one of said members being a disk and the other a cylinder, the disk being within the cylinder, a plurality of annular rows of driving-blades on each side of said disk, a plurality of annular rows of blades on the inner side of each face of the cylindrical member, said rows of blades fitting in between the rows on the disk, means for admitting motive fluid on either side of the disk, near the center thereof, whereby the fluid will pass outward through the various rows of blades, and a valve for controlling the admission of said motive fluid, a tubular shaft for the cylindrical member formed with perforations therein, a shaft for the disk member within said tubular shaft and formed with a reduced portion to form an oil-well, means for supplying oil around the perforated part of the tubular shaft, and power-transmitting devices connected to the shafts.

4. A rotary motor comprising a casing, two rotatable members therein, one of said members being a disk and the other a cylinder, the disk being within the cylinder, a plurality of annular rows of driving-blades on each side of said disk, a plurality of annular rows of blades on the inner side of each face of the cylindrical member, said rows of blades fitting in between the rows on the disk, a delivery-tube connected to the disk and provided with apertures at its inner end to deliver the motive fluid to the inner side of the disk, and with apertures to deliver the fluid to the outer side of said disk, said tube serving as a support for said disk and for the forward side of the cylindrical part, and a valve controlling a supply of motive fluid to the tube.

5. A rotary motor comprising a casing and a base or support, two rotatable members within the casing, means for driving said members in opposite directions, shafts for said members, one of said shafts being within the other, the outer shaft being perforated to permit oil to pass to the inner shaft, and the inner shaft having a reduced portion to form an oil-well, oil-reservoirs formed in the base surrounding the shaft-bearings to supply oil around the perforated shaft, a driving-shaft mounted in said base, and power-transmitting devices connecting the two driven shafts to said driving-shaft, whereby the power from both of the driven shafts will be transmitted to the driving-shaft to rotate said shaft in one direction.

In testimony whereof I hereunto affix my signature, in the presence of two witnesses, this 14th day of August, 1906.

ULYSSES GRANT FERNALD.

Witnesses:
M. T. CRAWFORD,
GEO. H. TALBOT.