No. 896,757. PATENTED AUG. 25, 1908.

J. O. PURVIS.

TURBINE.

APPLICATION FILED SEPT. 23, 1907.

2 SHEETS—SHEET 1.

Fig. 1.

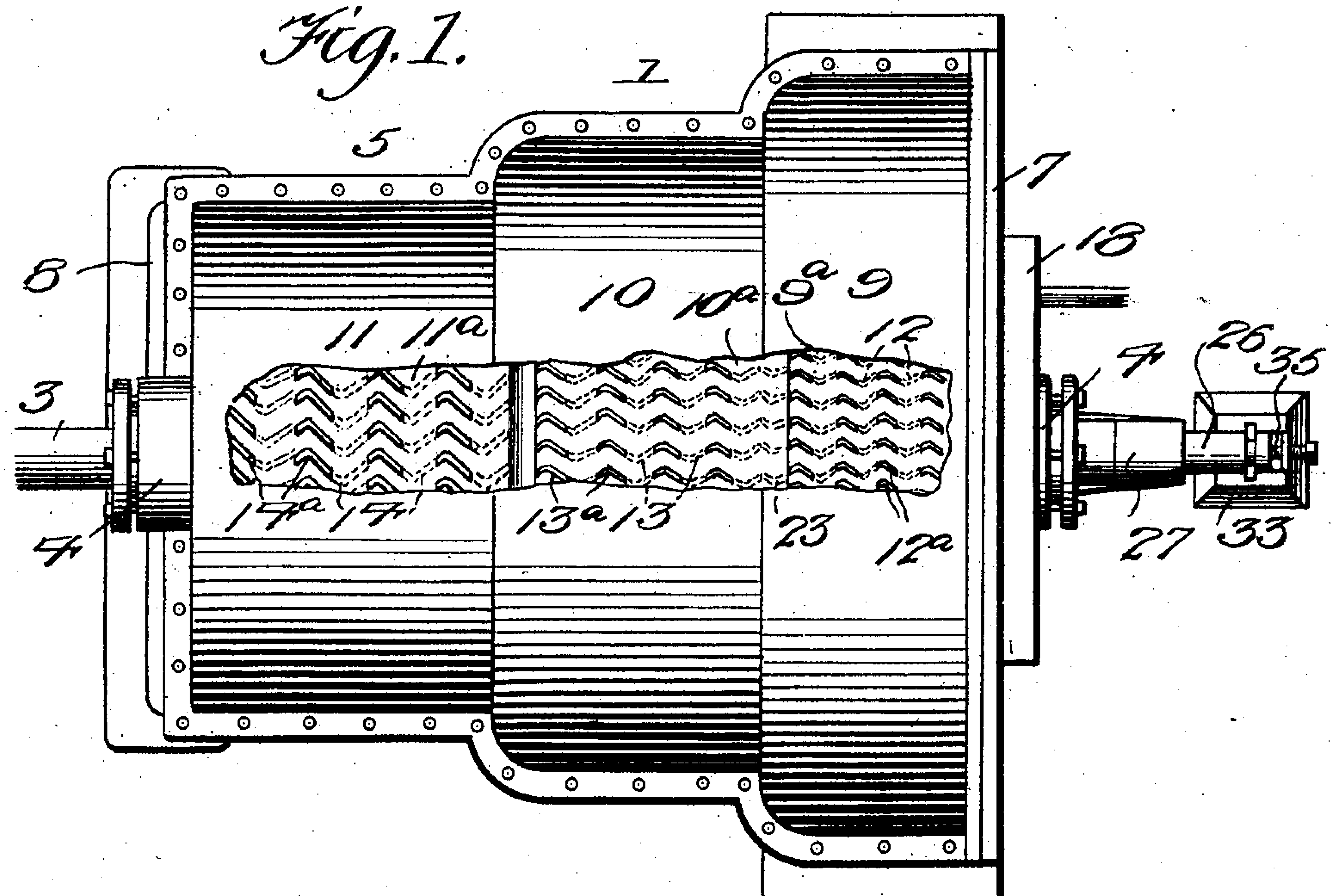
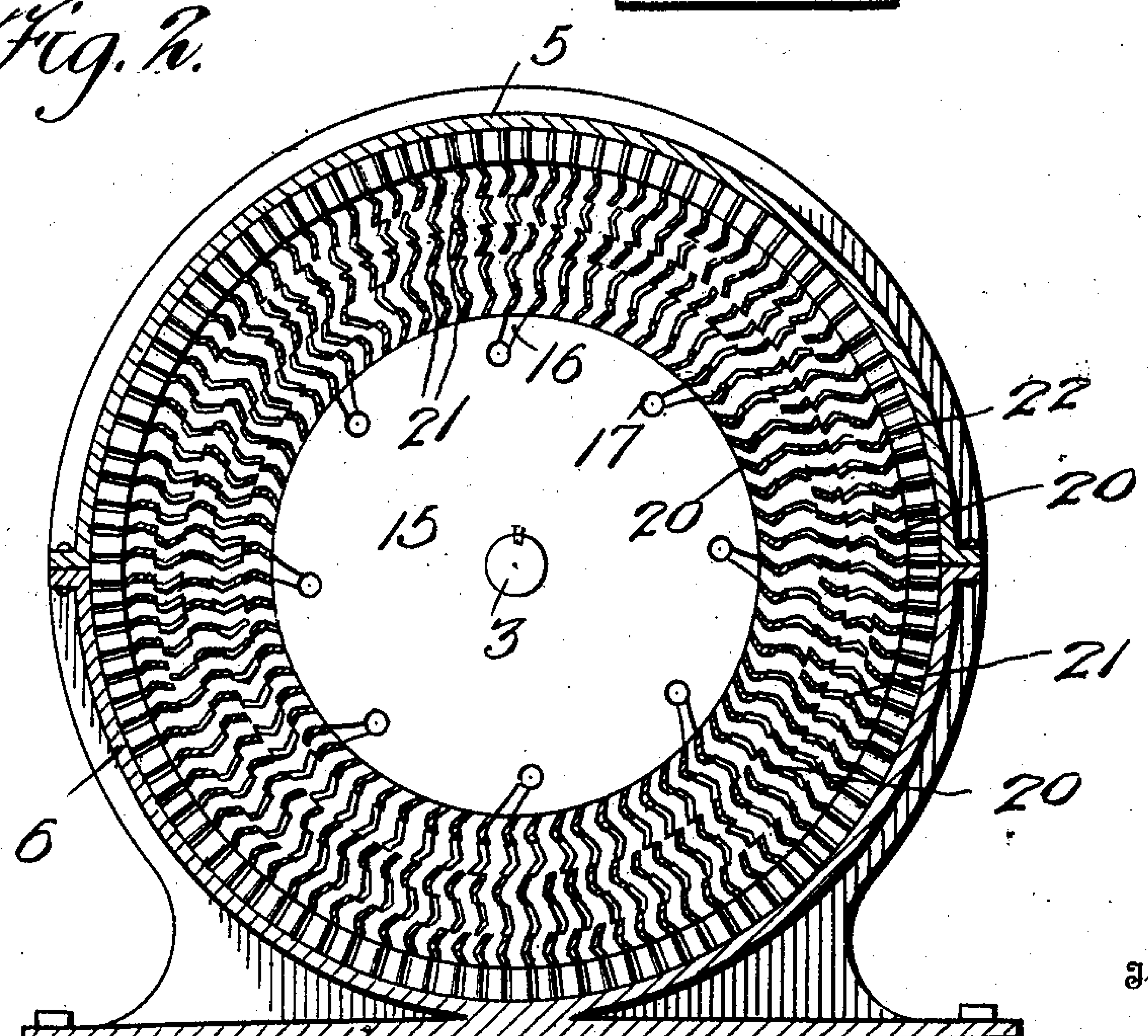


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

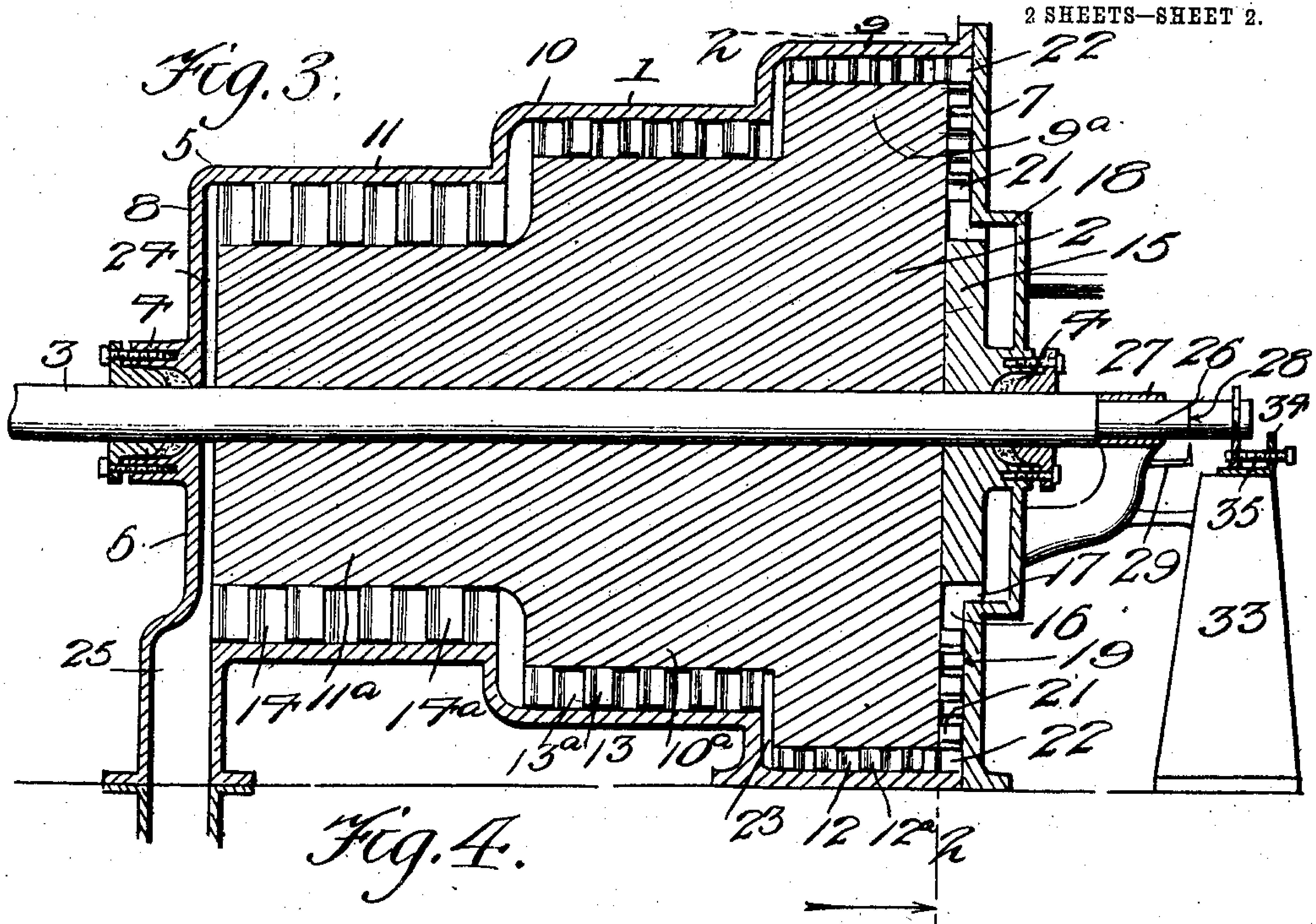


Fig. 4.

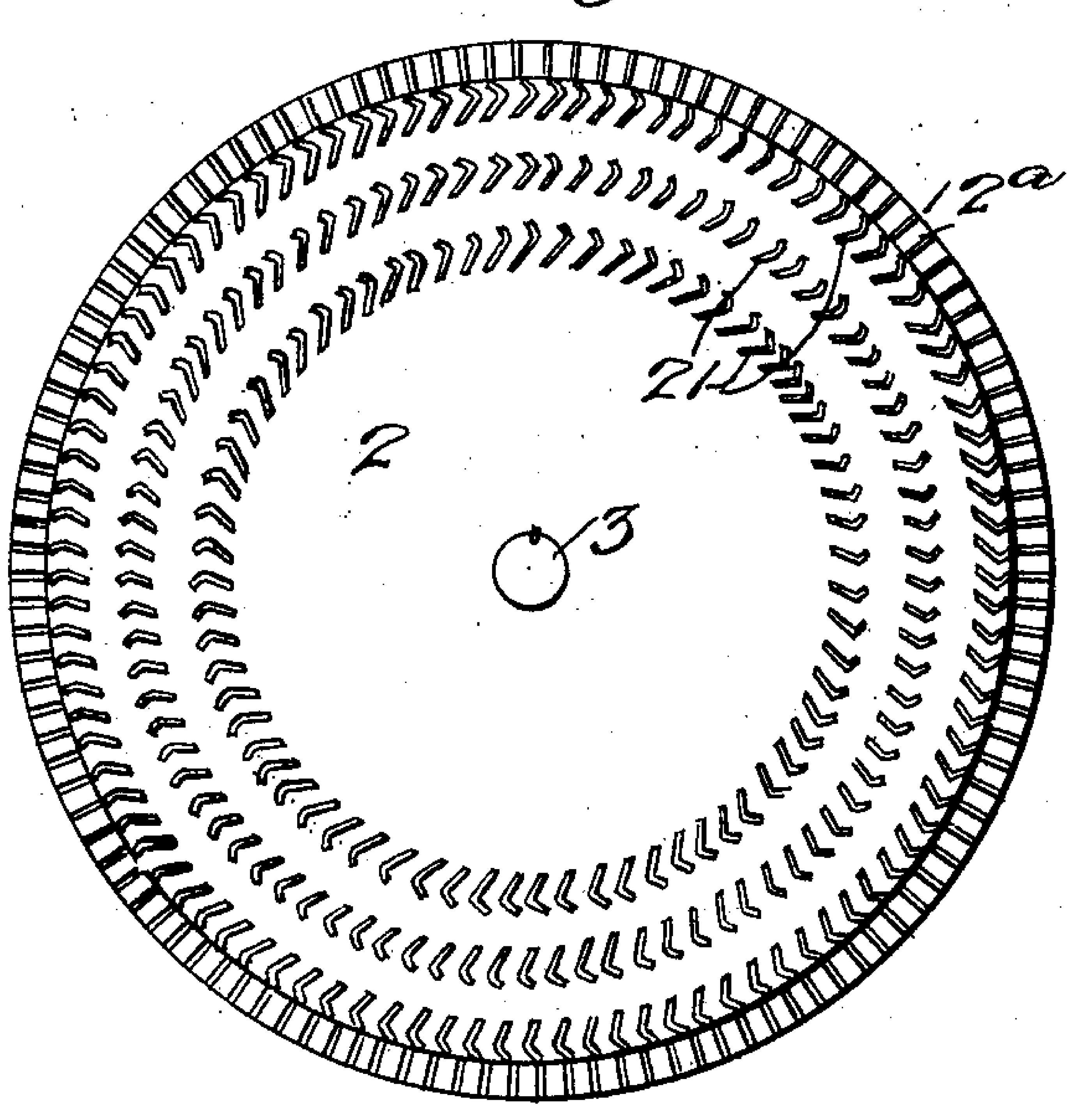
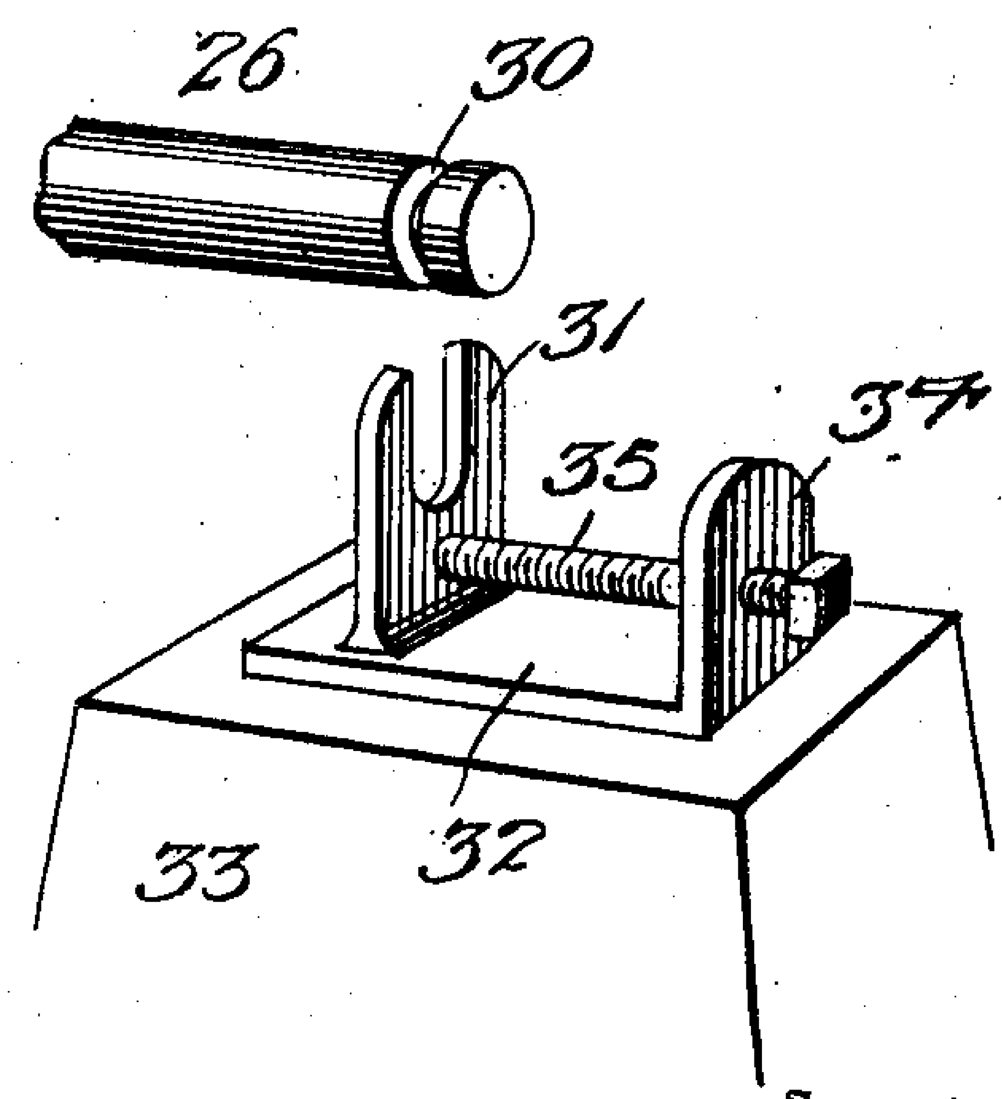


Fig. 5.



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TURBINE.

No. 896,757. Specification of Letters Patent. Patented Aug. 25, 1908.

Application filed September 23, 1907. Serial No. 394,180.

To all whom it may concern:

Be it known that I, James Oceola Purvis, a citizen of the United States, residing at Baltimore, in the county of Baltimore City and State of Maryland, have invented new and useful Improvements in Turbine-Engines, of which the following is a specification.

This invention relates to improvements in rotary steam turbines of that class in which provision is made for utilizing both the impact and the expansive force of the steam.

The objects of the invention are, first, to provide for the progressive use in a novel manner of the steam upon the piston or rotary part of the engine in a ratio corresponding throughout to its decreasing ratio of pressure, the high pressure steam acting upon the largest driving surface of the piston, the medium pressure steam upon the next largest surface and the low pressure steam upon the smallest surface, whereby the efficiency of the steam in passing through the engine is greatly increased; second, to provide a novel construction and arrangement of the vanes to secure greater economy of steam consumption and a better action of the steam thereon; third, to provide a piston and cylinder varying progressively in size from the steam admission end to the exhaust end to secure the described action of the steam and to properly proportion the sizes of the vanes thereon to utilize the impact and expansion forces of the steam to the highest degree; and, finally, to generally improve and simplify the construction and increase the practical efficiency of engines of this type.

With these and other objects in view, the invention consists of the features of construction, combination and arrangement of parts hereinafter described and claimed, reference being had to the accompanying drawings, in which:—

Figure 1 is a top plan view of a turbine engine embodying my invention, with a portion of the cylinder broken away and showing in full and broken lines the arrangement of the vanes upon the piston and cylinder. Fig. 2 is a transverse section on line 2—2 of Fig. 3. Fig. 3 is a longitudinal section of the engine. Fig. 4 is a view in elevation of the piston looking toward the large end thereof. Fig. 5 is a detail view of the adjusting device and adjacent portion of the shaft.

Referring now more particularly to the drawings, 1 represents the cylinder or stationary member of the engine, 2 the piston or rotary member, and 3 the engine shaft, which latter passes through stuffing-boxes 4 in the end walls of the cylinder and may be journaled in said walls or in external supports.

The cylinder 1 may be composed of any desired number of sections. In the present instance, I have shown it formed of top and bottom sections 5 and 6 and an end wall 7, bolted or otherwise secured together, the other end wall 8 of the cylinder being formed of two portions integral with the sections 5 and 6. The piston 2 may be either solid or of skeleton formation, and its various portions, hereinafter described, made either integral in a solid casting, of a series of connected solid sections, or of a skeleton frame embodying a rim of one or more parts carried by radial supporting arms keyed or otherwise secured to the engine shaft. I do not, therefore, limit the invention to any particular mode of forming the cylinder and piston in the respects noted, as the essential features may be employed in an engine structure in which the main elements thus far described may be made in any number of parts or in solid or skeleton formation for convenience in assembling and disassembling them and in increasing or decreasing the weight of the engine as occasion may require.

In conformity with my invention, the cylinder is gradually reduced in diameter from the steam inlet end to steam exhaust end by stepping it to provide portions 9, 10 and 11, forming communicating cylindrical chambers. These chambers 9, 10 and 11 respectively serve as high pressure, medium pressure and low pressure chambers, for the progressive action of the steam upon the portions of the piston therein according to the pressure of the steam at different stages in its passage through the engine.

The piston 2 is in form similar to the cylinder and provided with portions 9^a, 10^a and 11^a varying gradually in diameter, and serving as high, medium and low pressure portions, these being shown as integral in the present instance. On each section 9, 10 and 11 of the cylinder are rows or series of stationary vanes 12, 13 and 14, and upon the peripheries of the corresponding portions 9^a, 10^a and 11^a of the piston are coacting vanes 12^a, 13^a and 14^a. These respective sets of coacting stationary and rotary vanes progressively increase in area and pitch, one or both, to compensate for the varying diminishment in pressure and increase in volume of the steam in its flow through the chambers 9, 10, and 11, in which the high, medium and low pressure portions of the piston rotate.

The head 7 closing the outer end of the high pressure chamber 9 of the cylinder is formed with an inwardly extending central circular boss or enlargement 15, provided with one or more tangential steam nozzles 16 communicating at their inner ends with steam inlet ports 17 extending transversely through the head. Steam may be supplied to the passages 17 through independent pipe connections connecting with a common main leading from the steam generator, or said passages may communicate with a steam box or chest 18 from which the steam is supplied to all the nozzles, which box in practice is connected with the conductor leading from the generator. The boss or enlargement bears against the outer end of the high pressure portion 9^a of the piston, and by this arrangement an annular passage 19 is formed beyond the boss and between the piston and head 7. Projecting into this passage are rows or sets of stationary vanes 20 on the head 7 and coöperating sets of vanes 21 on the adjacent end of the piston. These vanes are arranged in annular rows, so that the rows of vanes upon the head 7 are disposed between and alternate with the rows of vanes 21 upon the piston, as respectively shown in section and full lines in Fig. 2. These sets of vanes are of the form and construction hereinafter described and provide passages for the circulation of the steam through the space 20, the steam on its radial outward passage through said space to the chamber 9 acting upon the vanes 21, so that the primary impact thereof will be utilized to assist in imparting rotary motion to the piston.

The stationary vanes 12, 13 and 14 and the coacting vanes 12^a, 13^a and 14^a upon the respective high, medium and low pressure portions of the cylinder and piston correspond in form and relative arrangement to the form and arrangement of the vanes 20 and 21, except that they are disposed for the circulation of the steam from chamber to chamber longitudinally from the high pressure to the low pressure end of the engine, as will be readily understood. In general, all of the vanes, which may be formed or fixed upon the cylinder and piston in any preferred manner, are L-shaped, each having a long limb and a short limb arranged at an oblique angle to each other, the vanes upon the piston being set reversely to the vanes upon the cylinder for the propelling action of the steam thereon, and so arranged relative thereto as to form when in alinement passages by which the steam in acting upon the piston vane is also directed in its movement to flow across the portions of the piston in a general direction longitudinally thereof.

In order to guide the steam in its passage from the space or chamber 19 to the vanes in the chamber 9, and from the chamber 9 to the vanes in the chamber 10, annular rows of stationary guide vanes 22 and 23 are respectively arranged at the angle of intersection of the space 19 and chamber 9 and the angle of intersection of the chamber 9 and chamber 10, the latter named vanes extending inwardly the full radial extent of the inner face of the piston portion 9^a. These vanes guide the steam in its flow upon the vanes 20 and 21 to the vanes 12 and 12^a, and from the latter to the vanes 13 and 13^a, thus preventing any retardation or retrogression of the steam in its circulation. If desired, similar guide vanes or flanges may be arranged in the chamber 10 at its point of intersection with the chamber 11 to direct the steam in its flow from the vanes 13 and 13^a to the vanes 14 and 14^a. The reduced end of the piston is spaced a sufficient distance from the head 8 to provide a clearance space or chamber 24 into which the spent low pressure steam finally passes and thence exhausts through a communicating exhaust port 25.

It is well known that in the construction of turbines now in common use, wherein the piston is provided with surfaces of different area or formed of sections of different diameter, it has been the general practice to have the steam act first upon the surface of the smallest diameter and thence upon the surfaces of progressively increasing diameters, with a view of providing successively larger areas for the contact of the steam as it increasingly expands in passing through the turbine. Hence, when the steam has its greatest pressure it acts upon that portion of the piston which rotates at the lowest surface speed, and when it has its least pressure and greatest volume acts upon that portion of the piston which rotates at the highest surface speed.

From the foregoing description, it will be observed that in my improved engine the steam, when at its highest pressure, first acts upon the vanes of the high-speed, high-pressure, portion of the engine, then with diminished pressure and when partially expanded against the lower-speed, medium-pressure, portion of the engine, and finally when at its lowest pressure and greatest expansion against the vanes of the lowest-speed, low-pressure portion of the engine. The sets of vanes upon the different portions of the engine referred to progressively increase in area and pitch, one or both, to utilize the impact and expansive forces of the steam to the fullest extent and in the most effective manner. It is believed that by thus bringing the steam when at its highest temperature and greatest pressure upon that part of the piston which rotates at the highest surface speed, and then successively bringing it into contact with progressively reduced portions (when by friction and cooling it has less pressure but greater volume) rotating at progressively less surface speeds, substantial advantages are obtained in point of increased efficiency of action of the steam, a more uniform application of power to the different portions of the piston and the prevention of the energy of the high pressure steam from being dampened or retarded by the low pressure steam. These advantages are due to the fact that nearly the full impulse of the steam is secured against a surface of the largest diameter and affording the greatest leverage, while the balance of the impulse and a portion of the expansive action is directed against a smaller surface yielding a lower leverage, and practically the full expansive force directed against the smallest surface yielding the least leverage, the vanes being proportioned and arranged upon the respective parts so that the applied powers will be practically equalized and rendered uniform along the entire length of the piston. The construction described also permits of the use of the vanes 21 upon the larger end of the piston for coaction with the vanes 20 to secure a primary effective impulse action of the steam on the piston radially toward its periphery and before the action of the steam on the latter. Furthermore, comparatively large but not unduly large vanes may be employed on the small low pressure section, a feature of advantage in preventing leakage, since in the use of small vanes upon a large low pressure surface leakage is liable to occur between the tips of the vanes.

It will be understood in practice that the speed of the engine and the admission of steam will be controlled by a governor of suitable construction, which need not be herein described. In practice also steam may be admitted to the cylinder through an annular passage adjacent to and simultaneously to all of the high pressure vanes, in lieu of supplying it radially at the high pressure end of the cylinder, which would render it necessary to employ smaller vanes and result in the production of a lower rate of speed. The guide vanes 23 may be omitted with like results. It is preferred to admit steam through the nozzles, as set forth, at a desired distance from the circumference of the piston, as by this action and the use of the guide vanes larger vanes may be employed and steam at a lower boiler pressure used with advantage.

The arrangement of the parts is such as to work the steam at high pressure to a practical limit, then at medium pressure to the limit, and then finally at low pressure to the limit—three stages of action, but the number of stages may be varied by correspondingly varying the number of working portions of the engine.

In practice, the relative disposition of the portions of the cylinder and piston is such as to accord with the ratio between the velocity of the steam at different stages and the velocity of the piston as a whole, thus equalizing the action without the use of compensating means, whereby resistance of the low pressure steam to the action of the high pressure steam will be prevented.

In order to provide for the adjustment of the piston to set the vanes thereon in proper relation to the vanes of the cylinder, as well as to indicate when the vanes are out of proper relation, I employ a thrust-bearing which is adjustable when the engine is running to enable this result to be obtained. As shown in Fig. 3, one end of the shaft is reduced, as at 26 and journaled in a stationary bearing 27 and provided with a gage mark 28 adapted, when the parts are in proper relation to lie in registry with a stationary pointer or indicator 29. The portion 26 of the shaft is formed at its outer end with an annular groove 30 which is received within and engaged by a slotted bearing-plate 31. The plate 31 is slidably mounted on a supporting plate 32 arranged upon a pillow-block or standard 33 and having an outer end upright 34, which upright carries an adjusting screw 35 working in a threaded opening therein and swiveled to the bearing-plate 31, whereby the latter may be moved back and forth. If through wear or other cause the piston should shift outwardly under the action thereof, the mark 28 will move out of register with the pointer 29, thus indicating that the vanes are out of proper working relationship and the extent to which they are.

Through the action of the adjustable bearing the piston may be adjusted back to normal position, as will be readily understood.

Having thus described the invention, what I claim as new is:—

1. In a turbine engine, a casing having an exhaust outlet at one end and an annular series of tangential steam inlets at its opposite end, a piston spaced from the steam inlet end of the casing to provide an annular radial passage, said steam inlets being arranged to admit currents of steam at and around the inner portion of the passage for outward flow toward the peripheries of the cylinder and piston, peripheral vanes upon the cylinder and piston, and vanes upon the cylinder and piston within said passage, whereby the steam first flows radially and acts upon the vanes within the passage and then flows longitudinally between the cylinder and piston and acts upon the peripheral vanes prior to its escape through the said exhaust outlet.

2. A turbine engine comprising a casing

stepped in diameter from one end to the other to provide communicating chambers decreasing progressively in size, vanes upon the peripheries of the respective chambers varying progressively in area, guide vanes upon the casing extending inward radially between the initial and secondary sets of vanes arranged at the point of junction between the first and second chambers, means for admitting live steam to the chamber of greatest diameter and exhausting the spent steam from the chamber of least diameter, a rotary piston stepped to provide corresponding portions moving in the respective chambers and provided with peripheral vanes coacting with the peripheral vanes therein, and coacting radial vanes upon the portions of greatest diameter of the cylinder and piston arranged in the path of the steam in the flow of the latter to the primary peripheral vanes.

3. A turbine engine comprising a casing, and a piston operating therein, said casing and piston being stepped to provide communicating chambers and piston portions decreasing progressively in diameter from one end thereof, a steam inlet space being provided between the end wall of the largest portion of the casing and the adjacent end of the piston, coöperating sets of vanes upon the peripheries of the respective chambers and the coacting portions of the piston, coacting vanes upon the casing and piston within the said steam inlet space, said space being provided with one or more steam inlet nozzles and communicating with the chamber of largest diameter for the supply of steam to the vanes therein, and an exhaust leading from the chamber of smallest diameter.

4. A turbine engine comprising a casing provided with communicating high, medium and low pressure chambers progressively decreasing in diameter, the low pressure chamber having an exhaust outlet, a rotary piston provided with high, medium and low pressure portions progressively decreasing in diameter and moving in the respective chambers, the casing being provided between the piston and the outer end of its high pressure chamber with an annular steam space having inlets and communicating radially with the high pressure chamber, vanes upon the casing and piston within said steam space, vanes upon the peripheries of the respective chambers and coöperating portions of the piston, the sets of vanes within the respective chambers progressively increasing in area, and guide vanes upon the casing between the steam space and vanes in the high pressure chamber and between the latter named vanes and the vanes in the medium pressure chamber.

5. A turbine engine comprising a casing provided with a plurality of communicating chambers of progressively decreasing diameter, the chamber of least diameter being provided with an exhaust port, stationary vanes upon the peripheries of the respective chambers progressively increasing in area, a rotary piston provided with portions corresponding substantially in diameter to the respective chambers and arranged to rotate therein, vanes upon the portions of the piston corresponding in area to the coacting sets of vanes upon the casing, a head closing the chamber of largest diameter and provided with a central annular boss spacing the body of the head from the adjacent end of the piston to form a steam space, said boss having tangential nozzles communicating with inlet ports in the head, annular rows of radial vanes upon the head, annular rows of coöperating vanes upon the piston, said rows of vanes extending into the steam space and arranged to direct the steam radially into the largest steam chamber, and guide vanes upon the casing between the steam space and vanes in the chamber of greatest diameter and between the latter named vanes and the vanes in the next adjacent chamber.

6. In an elastic-fluid turbine, a cylinder and piston, a steam passage being provided between one end of the cylinder and the adjacent end of the piston, coöperating vanes upon the peripheries of the cylinder and piston, steam inlet and exhaust passages, the former communicating with said first-named steam passage, and vanes upon the ends of the cylinder and piston within the steam passage, whereby the steam on its flow through said passage acts upon the vanes therein prior to its action upon the peripheral vanes.

7. In an elastic-fluid turbine, a cylinder and piston stepped to provide coöperating portions decreasing progressively in diameter from the inlet to the exhaust end of the cylinder, a radial steam passage being provided between the inlet end of the cylinder and the adjacent end of the piston, vanes upon said portions of the cylinder and piston extending into said steam passage, coöperating vanes upon the peripheries of the portions of the cylinder and piston, the sets of vanes increasing progressively in area, and guide vanes upon the cylinder at the point of junction between the portion of greatest diameter and the adjacent portion of smaller diameter, said vanes extending radially inward toward the coöperating surface of the piston.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES OCEOLA PURVIS.

Witnesses:

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GEORGE W. WEEDY.