No. 713,261. Patented Nov. 11, 1902.

M. M. WHITAKER.

STEAM TURBINE.

(Application filed Feb. 23, 1901.)

(No Model.) 4 Sheets—Sheet 1.

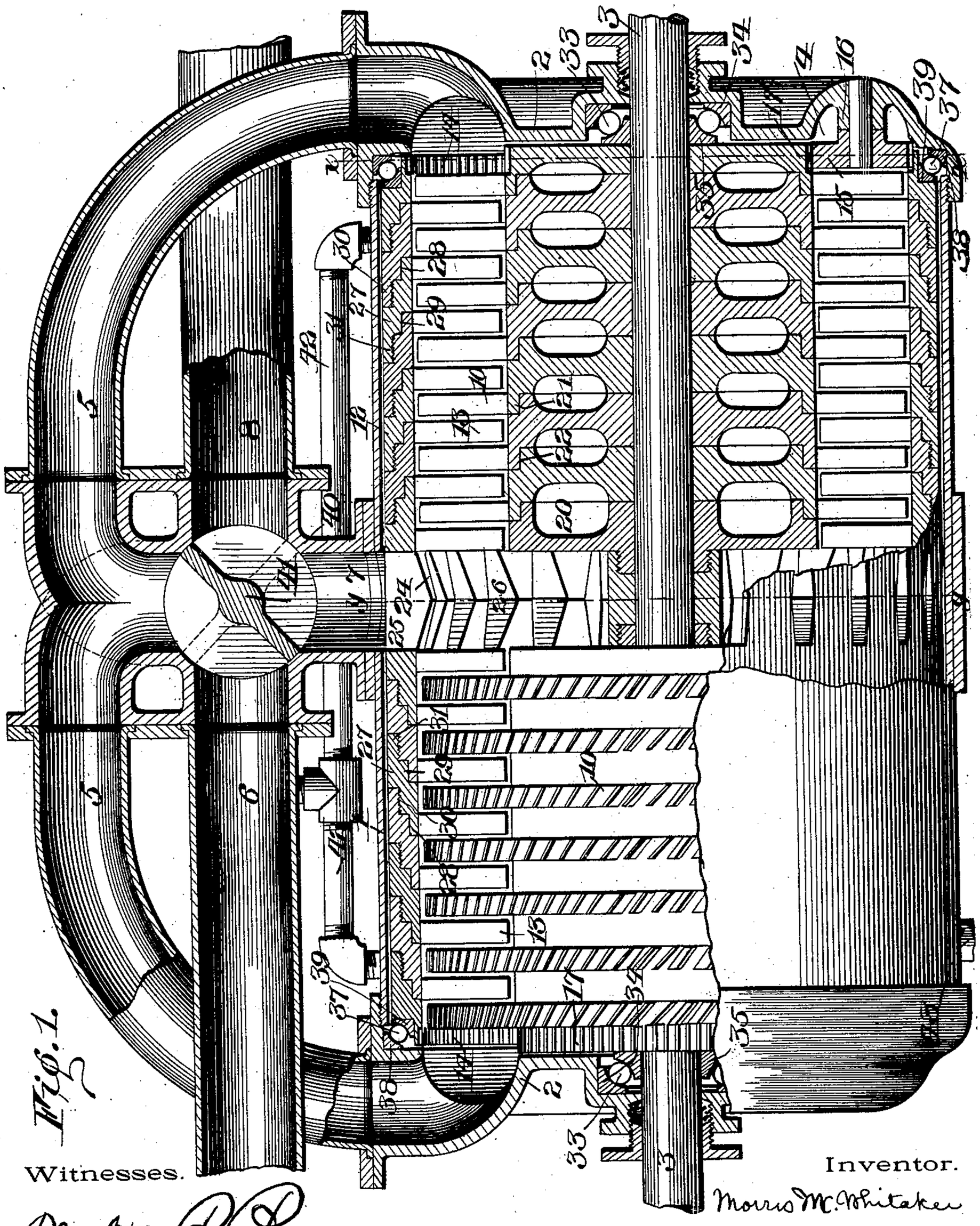

Fig. 1.

Witnesses.

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(No Model.) 4 Sheets—Sheet 2.

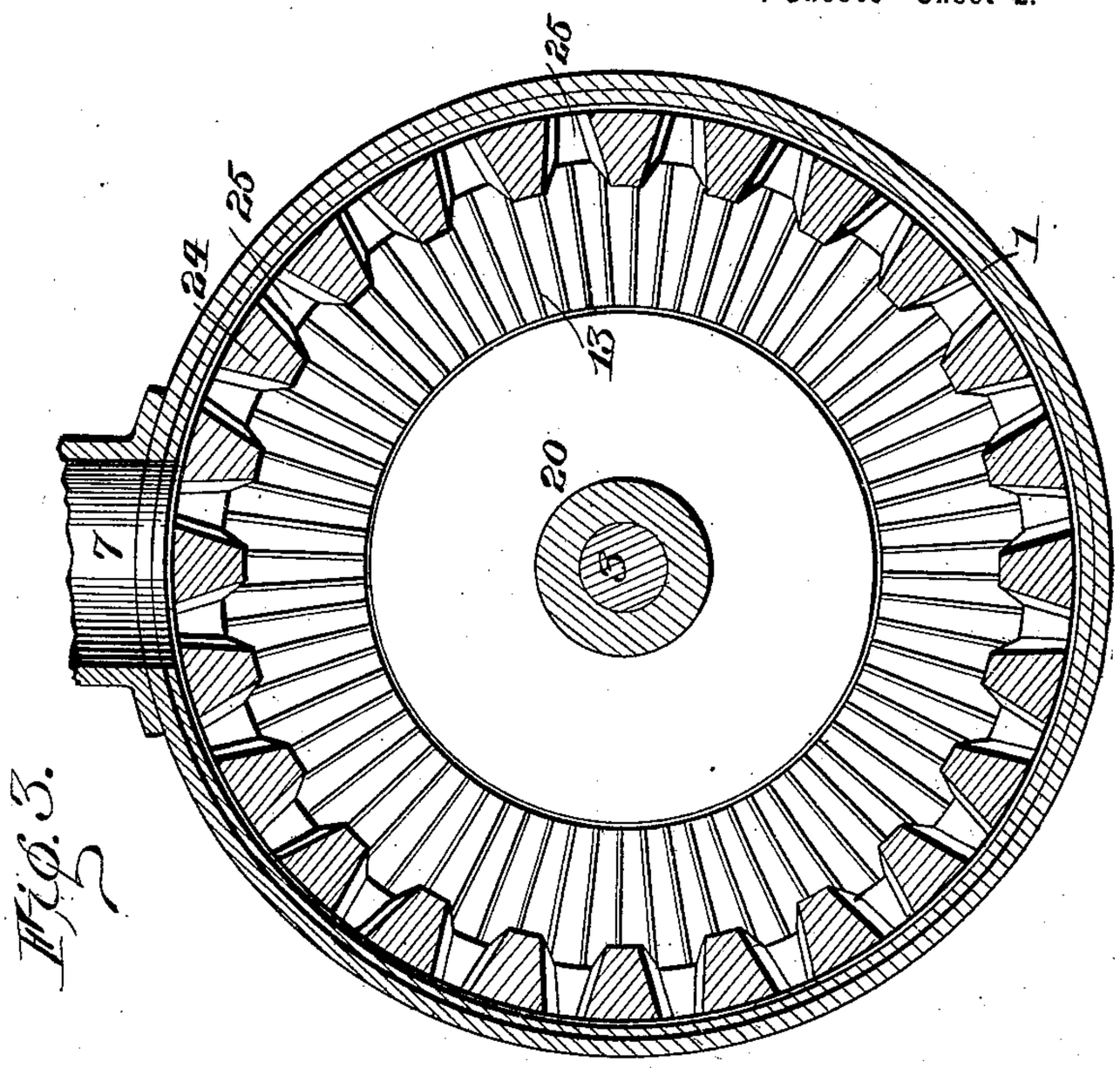

Fig. 3.

Fig. 2.

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(No Model.) 4 Sheets—Sheet 3.

Fig. 4.

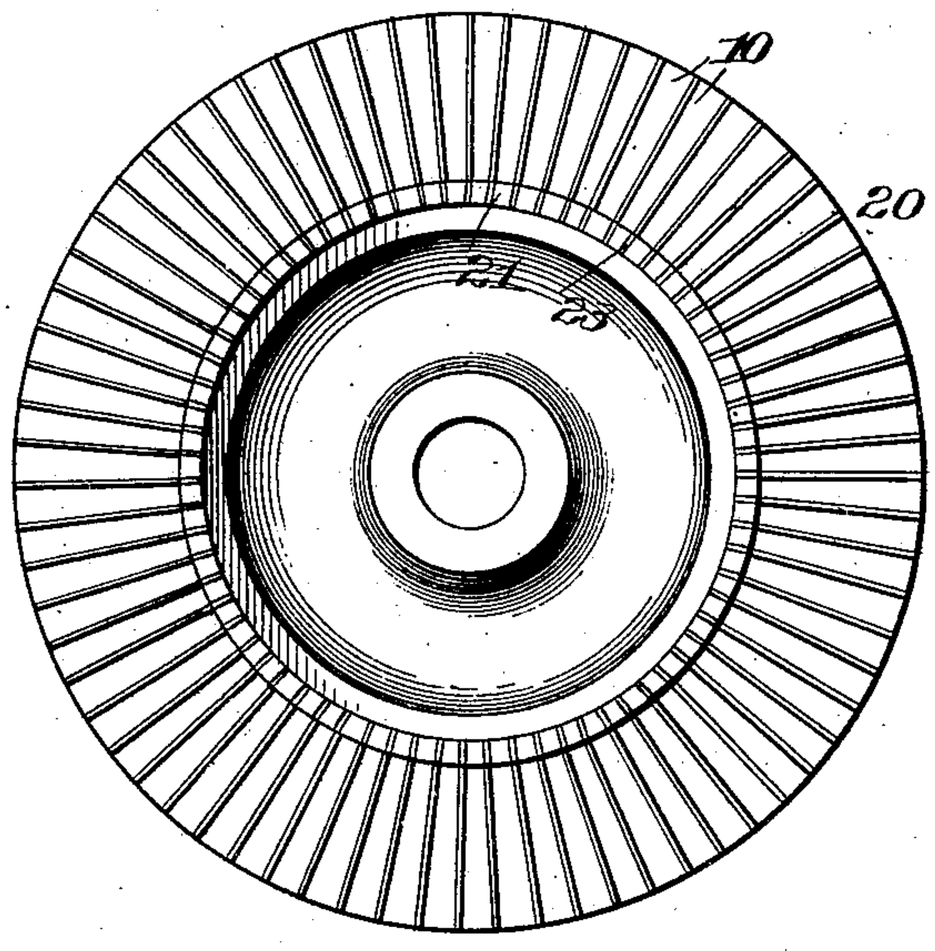


Fig. 5.

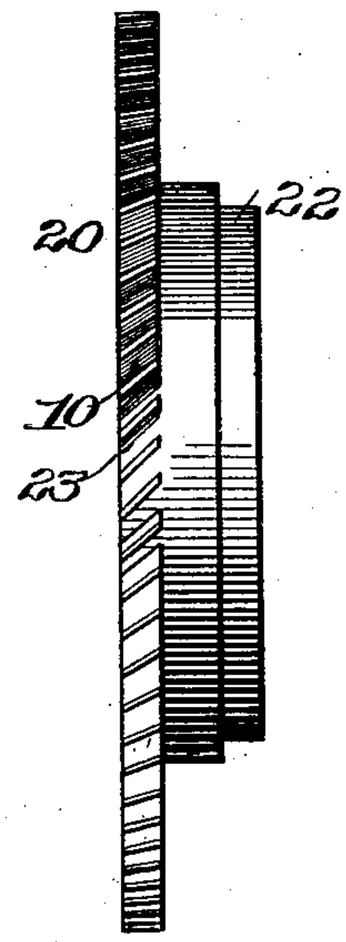


Fig. 6.

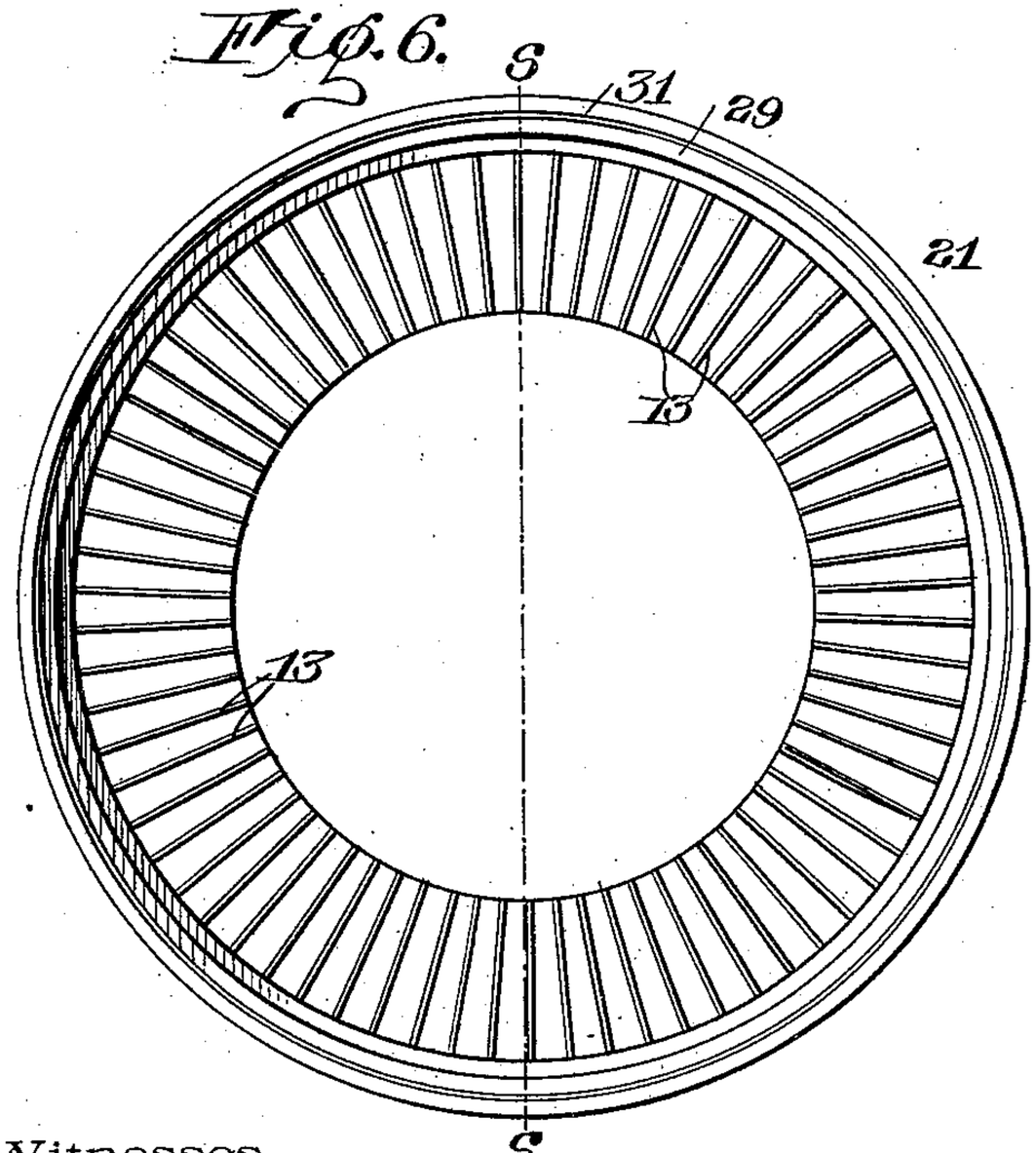
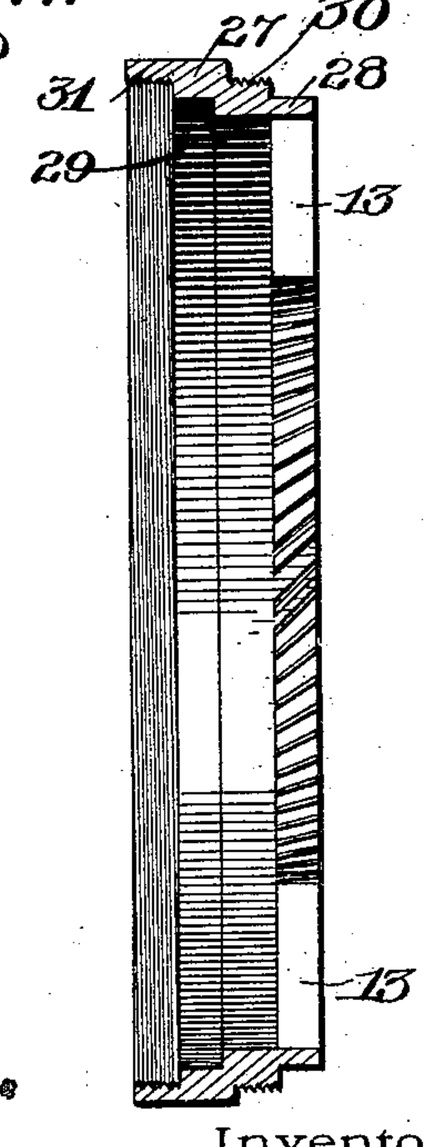


Fig. 7.



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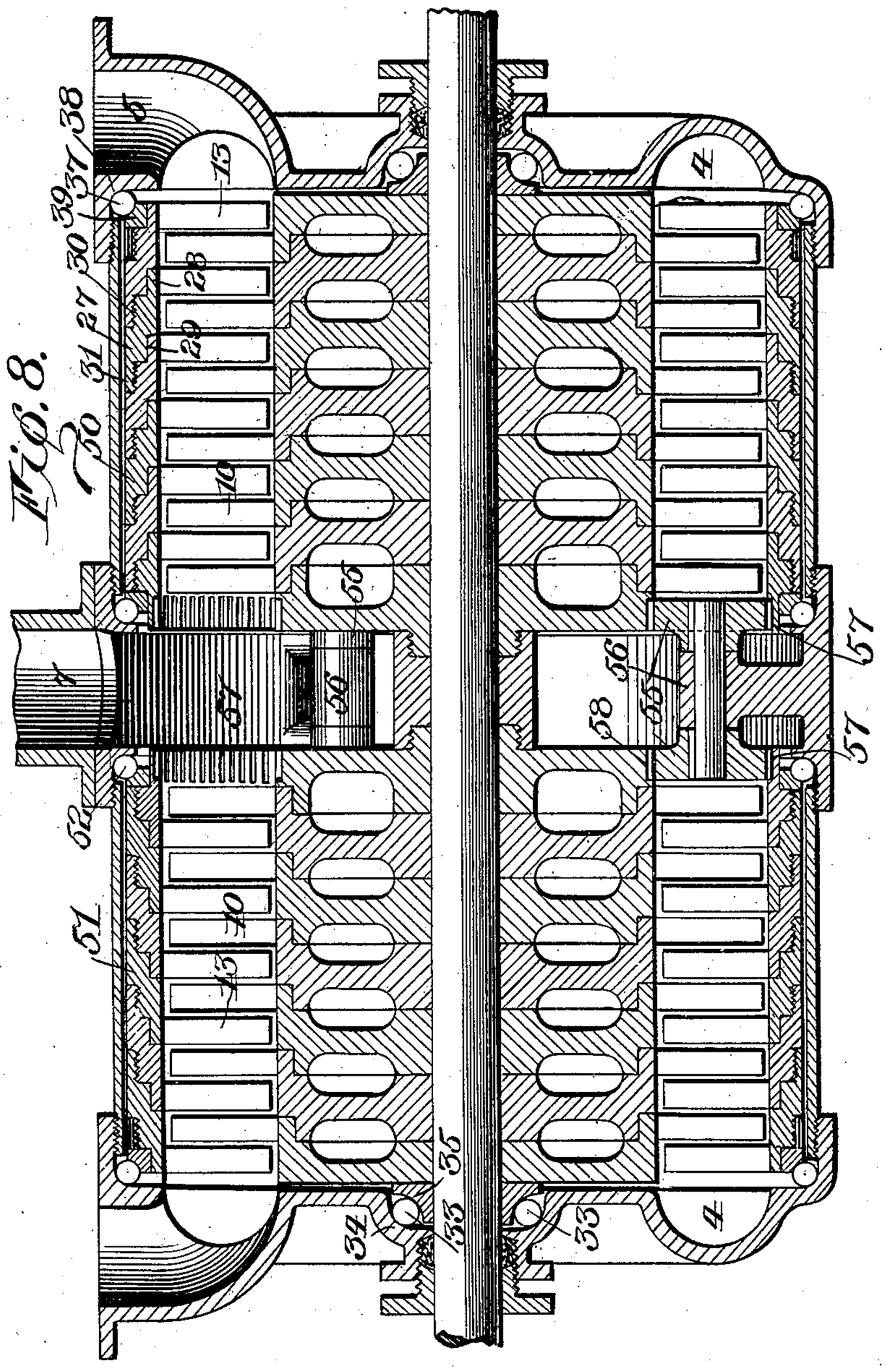

FIG. 8.

Witnesses.

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UNITED STATES PATENT OFFICE.

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STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 713,261, dated November 11, 1902.

Application filed February 23, 1901. Serial No. 48,401. (No model.)

To all whom it may concern:

Be it known that I, MORRIS M. WHITAKER, of Sacket Harbor, in the county of Jefferson and State of New York, have invented certain new and useful Improvements in Steam-Turbines; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the reference-numerals marked thereon.

My present invention has for its object to provide a turbine adapted to be operated by steam or other fluid and consisting of oppositely-revolving elements and connections between them, whereby the power is transferred to a single driving-shaft.

My invention has for its further object to provide such an arrangement of these elements, together with the inlet and exhaust passages, that the shaft and revolving elements will be perfectly balanced against lateral movement or end thrust and capable of operation in either direction by a reversal of the direction of the propelling fluid.

My invention also provides a device which is simple in construction and embodies interchangeable parts which may be easily assembled to construct a turbine of any desired efficiency.

To these and other ends my invention consists in certain improvements in construction and combination of parts, all as will be fully described, and the novel features pointed out in the claims at the end of this specification.

In the drawings, Figure 1 is a longitudinal sectional view of a turbine constructed in accordance with my invention. Fig. 2 is a cross-sectional view on the line $x\,x$ of Fig. 1. Fig. 3 is a sectional view on the line $y\,y$ of Fig. 1. Fig. 4 is a face view of one of the elements of the core. Fig. 5 is a side elevation of one of the elements of the core. Fig. 6 is a face view of an element of the drum. Fig. 7 is a sectional view of one of the elements of the drum, taken on the line $s\,s$ of Fig. 6. Fig. 8 is a view illustrating a modified form of construction of my turbine.

Similar reference-numerals in the several figures indicate similar parts.

In constructing my turbine I employ a casing 1, preferably cylindrical in form, having the heads 2, in which a shaft or axle 3 is journaled. Surrounding the shaft and at the outer edges of the heads are annular passages 4, opening at their inner sides into the casing and with which communicate pipes or passages 5, adapted to be connected with a pipe 6, adapted to serve as a supply or exhaust, and located at the center of the casing is a passage 7, adapted to be connected with a supply or an exhaust pipe 8, as will be presently described.

Mounted upon the shaft 3 upon each side of the center of the casing is a core provided on its surface with parallel rows of radially-extending blades 10, arranged with their faces at an angle to the center of the shaft, said blades, however, upon the two cores being arranged to extend angularly in opposite directions. Surrounding these cores is a drum 12, revolubly supported in the casing and provided upon its inner surface with inwardly-projecting rows of blades 13, adapted to extend between the rows of blades 10 on the cores, but having their faces arranged at an angle thereto and adapted to move the drum in an opposite direction from that of the cores. In order to transfer the motive force from the drum to the shaft, I provide at opposite ends of the drum internal gears having teeth 14, with which mesh a series of pinions 15, supported in brackets 16 on the heads 2 and engaging gear-wheels 17 on the shaft. By employing a series of the pinions 15 and disposing them at equal distances around the gears 17 at each end of the turbine it will be seen that the shaft and drum will be centered and that these parts may be carried on the pinions irrespective of their bearings in the casing.

To provide a simple construction for the cores on the shaft, I have shown the latter as composed of a series of elements or collars 20, each of which is provided at one side with an overhanging rim or flange 21 and at the opposite side with an annular rim 22, adapted to receive the corresponding flange 21 upon the next succeeding element, as shown in Figs. 2 and 3. The ends of the blades 10 are upset or otherwise secured in notches 23, provided in the rim 21, and the elements thus formed

are slipped into position on the shaft forming the core heretofore referred to and secured thereon by keys or other suitable locking device. The drum 12 is constructed sectionally in a similar manner, commencing with a central section 24, located opposite the passage 7, provided with a series of apertures 25, through which the steam is exhausted, and compensation is made for the material removed by increasing the thickness of the remaining portions or bars 26, and by tapering the latter upon their inner side, as shown in Fig. 3, the outward passage of the steam is facilitated and the strength of the section is also increased. Each of the sections composing the drum consists of a ring 27, having at one side the projecting rim 28 and at the other the corresponding annular rim 29, of about the same diameter, beyond which and out of line with the face of the outer side of the edge 28 is a threaded extension 30, engaging a corresponding threaded portion 31 upon the proximate edge of the next succeeding ring and forming a means whereby the rings are united into a solid drum; but it will be understood that other methods may be employed for securing the rings or elements to form a solid drum. The inwardly-projecting blades 13 may be secured to the rim 28 in a manner similar to that in which the blades 12 are attached to the collars 20. This sectional method of building up the cores and drum permits the blades to be rigidly secured in each and the corresponding sections to be secured alternately in place on the drum and cores.

The friction is greatly reduced by supporting the shaft upon balls 33, arranged in bearings consisting of cups 34 and cones 35 on the shaft, and by providing similar bearings upon each end of the drum 12, embodying the balls 37, rotating between bearing-surfaces 38 and 39, said surfaces being preferably formed of hardened steel and set into annular sockets on the stationary and movable parts. Any of the usual means for adjusting the bearings to take up wear between the parts may be employed.

From the foregoing description it will be seen that the operation of the turbine is accomplished by the steam or other fluid, which enters the passages 4 through the supply-pipes 5 and passing inwardly from the ends of the casing toward its center engages the first or outer row of blades 10 on each core, then as it passes through these impinges against the first row of blades at opposite ends of the drum, which overlap the former and are arranged at an angle thereto, and so on, operating against the alternately-arranged rows of blades on the cores and drum as it flows between them, causing the inner and outer revolving parts to be moved in opposite directions. The number of rows of blades determining the length of the drum and cores are arranged to obtain the most economic use of the steam as it passes through the turbine and when its force is spent to allow the steam to be freely exhausted. By having both the drum and core revolve the full force of the steam is imparted to the shaft, giving a turbine of the greatest economy and power.

It will be understood that a successfully-operating turbine can be constructed embodying but one core and drum, which would be in all respects similar to one end of the structure I have shown in Fig. 1; but by employing the double arrangement of cores upon a single shaft and the drum having the oppositely-arranged blades I am enabled to introduce the steam simultaneously at opposite ends of the casing, thereby obviating the excessive end thrust on the parts and causing the shaft and drum to be perfectly balanced in their bearings.

In Fig. 1 I have shown a convenient valve mechanism arranged in a head or casing 40, from which lead the pipes 5, exhaust-passage 7, and supply and exhaust pipes 6 and 8, respectively, the two latter being arranged in line and the pipes 5 and 7 leading from either side thereof. Located in the center of the head 40 is a reversing-valve 41, adapted to be moved to connect the supply-pipe 6 with the pipes 5, opening the exhaust through the passage 7 and pipe 8, or to be adjusted to the position shown in dotted lines, when the passages will be reversed and the steam being admitted to the center of the casing and exhausting through the passages 4 at the ends of the casing causes the turbine to be operated in the opposite direction.

The space between the casing 1 and the outside of the drums 12 may be connected to the supply-pipe 6 by pipes 42 and the live steam allowed to circulate around the drum to prevent condensation of steam within, when it may be exhausted or returned to the supply through pipes 43.

A modified form of constructing my turbine is shown in Fig. 8 and differs from the turbine heretofore shown in that the drum is divided into two separate drums 50 and 51, arranged upon opposite sides of the passage 7 and supported in separate bearings at the ends of the drums having the balls 52, and the faces of the blades on the respective drums are arranged to extend in opposite directions. The motive force is imparted to the shaft by means of two or more intermediate pinions 55, mounted upon brackets 56 and arranged to coöperate with an internal gear 57 on the inner or proximate ends of the drums 50 and 51 and with gears 58 on the shaft. The number of parts is reduced and their construction simplified by securing the pinions 55 that are in alinement and which engage the separate drums on the ends of arbors 59, mounted in bearings on the brackets 56, as by this arrangement it is only necessary to employ a single gear 58 on the shaft.

The economy of a steam-turbine depends largely upon the speed at which the blades

pass each other, and in my device by having the blades on the different parts revolve in opposite directions I secure greater speed in proportion to the speed of the shaft, resulting in the same economy at a low shaft speed or greater economy at the same shaft speed compared with a turbine having only one movable part. The construction of my device is such that the clearance between the blades on the cores and drums and other clearances may be reduced to the smallest limit of practical construction, thus reducing the loss of steam through clearances to a minimum.

Turbines constructed in accordance with my invention may be arranged in line with and connected directly to a shaft to be driven, and by proportioning the difference in sizes or areas of the blades for steam under various working pressures several of the machines may be compounded upon the same or different shafts and the steam allowed to exhaust from one turbine into another. Furthermore, the sectional construction of the interchangeable parts forming the cores and drums permit the construction of a turbine of any desired efficiency, as I am enabled to extend or decrease the length of the operating parts, as occasion may require.

I claim as my invention—

1. In a turbine the combination with a casing having inlet and outlet passages, and a shaft journaled in the casing, of a revoluble core mounted on the shaft having blades arranged at an angle thereto, a drum journaled in the casing, surrounding the core and provided with blades extending between those upon the core and extending at an angle to said blades, gear-wheels upon the revoluble parts and pinions arranged within the casing and between said parts.

2. In a turbine, the combination with a casing having inlet and outlet passages at opposite ends thereof, and a shaft journaled in the casing, of a core mounted on the shaft, a revoluble drum concentric with said core, blades on the core and drum, the alternating rows of blades upon the revolving members being arranged at an angle to each other and at an angle to the line of flow between the inlet and outlet passages, gear-wheels on the core and drum, and pinions arranged within the casing coöperating with the two gear-wheels.

3. In a turbine, the combination with a casing, heads upon opposite ends thereof having annular passages open upon one side into the casing, and a shaft journaled in the heads, of a core on the shaft, a drum surrounding the latter and journaled in the casing, and blades arranged in rows alternately upon the core and drum, said rows of blades being located with their faces at an angle to each other and to the line of flow between the passages at the ends of the casing, an internal gear on the drum, a corresponding gear-wheel on the shaft and an intermediate pinion mounted in stationary bearings and coöperating with the gear-wheels on the shaft and drum.

4. In a turbine embodying a casing having inlet and outlet passages, and a shaft journaled therein, the combination with a series of core elements or collars secured to the shaft and provided with radially-extending blades arranged at an angle to the direction of flow between the inlet and exhaust passages, of a rotary drum provided with inwardly-projecting blades arranged between those on the shaft and at an angle thereto, bearings supporting the drum independently of the shaft-bearings and driving connections between the drum and shaft arranged within the casing.

5. In a turbine embodying a casing having inlet and outlet passages, and a shaft journaled therein, the combination with a series of collars secured to the shaft, and a row of radially-extending blades on each of said collars having their faces extending at an angle to the line of flow between the inlet and outlet passages, of a series of rings provided with inwardly-projecting blades lying between the rows of blades on the shaft and having their faces extending at an angle to said blades, connections between the separate rings uniting them to compose a drum, bearings supporting the latter revolubly in the casing, and driving connections between the shaft and drum.

6. In a turbine embodying a casing having inlet and outlet passages, and a shaft journaled in the casing, the combination with a core composed of a series of collars mounted on the shaft, each of said collars having a row of radially-extending blades arranged with their faces at an angle to the line of flow between the inlet and outlet passages, of a drum surrounding the core constructed of a series of rings each of which is provided with a row of inwardly-projecting blades lying between the rows of blades on the core and having their faces arranged at an angle to those of said core-blades, means between the separate rings for securing them together to form the solid drum, bearings for the latter, and driving connections between the shaft and drum.

7. In a turbine having passages at each end, and a passage arranged intermediate thereof, the combination with a shaft journaled in the casing, and a plurality of rows of radially-extending blades secured to the shaft between each of the outer passages and the inner passage, of a drum surrounding the shaft extending between the end passages and provided with apertures arranged opposite the intermediate passage, and a series of blades on the drum arranged in rows and projecting inwardly between the rows of blades on the shaft and having their faces arranged at an angle to those on the shaft and at an angle to the lines of flow between the passages.

8. In a turbine embodying a casing having

the heads, the passages leading thereto, and a passage located intermediate the latter, the combination with a shaft journaled in the heads and a core secured to the shaft upon each side of the outlet-passage having radially-extending blades arranged at an angle to the line of flow between the respective outer passages and the inner passage, of a drum surrounding said cores provided with inwardly-projecting blades extending between the rows of blades on the cores and having their faces extending at an angle thereto, bearings for the drum, and driving connections between it and the shaft and arranged within the casing.

9. In a turbine the combination with a casing, a shaft therein having the core provided with the blades, and a drum surrounding the core and provided with the blades thereon, of internal gears at the ends of the drum, gear-wheels upon the shaft, and a series of intermediate pinions journaled on the casing and arranged on opposite sides of the center of the shaft and operating between the gears on the drum and shaft to center the parts relatively.

10. In a turbine the combination with a casing, a shaft therein having the cores, a revoluble drum surrounding the cores and provided with the blades and internal gears at the ends of the drum, of the gear-wheels on the shaft, a series of intermediate pinions journaled on the casing on opposite sides of the center of the shaft and supporting the shaft and drum, and means for preventing the longitudinal movement of the parts in the casing.

11. In a turbine the combination with a casing having inlet-passages at the ends, and an intermediate passage in the casing, a shaft having the cores provided with the radially-extending blades having their faces set at an angle to the line of flow between the respective outer passages and the inner passage, and a drum surrounding the cores provided with the inwardly-projecting blades having their faces extending at an angle to the blades on the cores, of internal gears at the ends of the drum, gear-wheels on the shaft, and a series of pinions revolubly mounted on the casing on opposite sides of the centers of the gear-wheels and coöperating between the gear-wheels on the drum and shaft to cause their simultaneous operation.

12. In a turbine embodying a casing having the heads, the inlet-passages leading thereto, and a passage located intermediate the latter, the combination with a shaft, and a drum surrounding the latter and supported independently thereof having apertures arranged opposite the intermediate passage in the casing, of blades extending radially from said shaft and arranged in rows, said rows being alternately connected to the shaft and drum, having the faces of the blades in the alternate rows extending at an angle to each other and at an angle to the lines of flow from each of the outer passages to the inner passage, gear-wheels upon the drum and shaft, pinions extending between the said gear-wheels, and bearings on the casing supporting the pinions.

13. In a turbine embodying a casing having the heads, passages leading thereto, a passage located intermediate the heads, supply and exhaust passages, and a valve mechanism for controlling the connection of the supply and exhaust passages with the inner and outer passages to govern the direction in which the steam is admitted to the casing, the combination with a shaft, cores thereon, and a drum surrounding the latter and revolubly supported in the casing independently of the shaft and having the apertures opposite the intermediate passages in the casing, of the blades extending radially from the shaft and arranged in alternate rows upon the cores and drums, the blades in said rows having their faces arranged at an angle to each other and to the line of flow from their respective inlet-passages to the outlet-passage, and driving connections between the drums and shaft.

14. In a turbine the combination of a casing, a shaft revolving therein and having blades thereon inclined to the plane of rotation, and an outer rotary member formed of a series of annular sections secured together at their proximate edges, each having inclined blades thereon arranged between the blades on the shaft, and driving connections between the shaft and member.

15. In a turbine the combination with the casing, of a shaft therein, and a series of similar and interchangeable annular sections thereon each having radially-extending blades at the periphery inclined to the plane of rotation, of an outer revoluble member composed of a series of annular sections united to form a drum, each of the separate sections having the inwardly-extending blades inclined to the plane of rotation and arranged between the blades on the shaft, and connections between the shaft and member located within the casing allowing their rotation in opposite directions.

16. In a turbine, the combination with a casing having inlet and outlet passages, and a shaft supported therein, of a revoluble core attached to the shaft consisting of a series of collars having faces, provided upon one side with an extended flange or rim, and upon the other with an annular recess adapted to receive the flange of a succeeding section, and radially-extending blades mounted on the flange.

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