A. BONOM.

STEAM TURBINE.

APPLICATION FILED APR. 10, 1919.

1,331,313.

Patented Feb. 17, 1920.

2 SHEETS—SHEET 1.

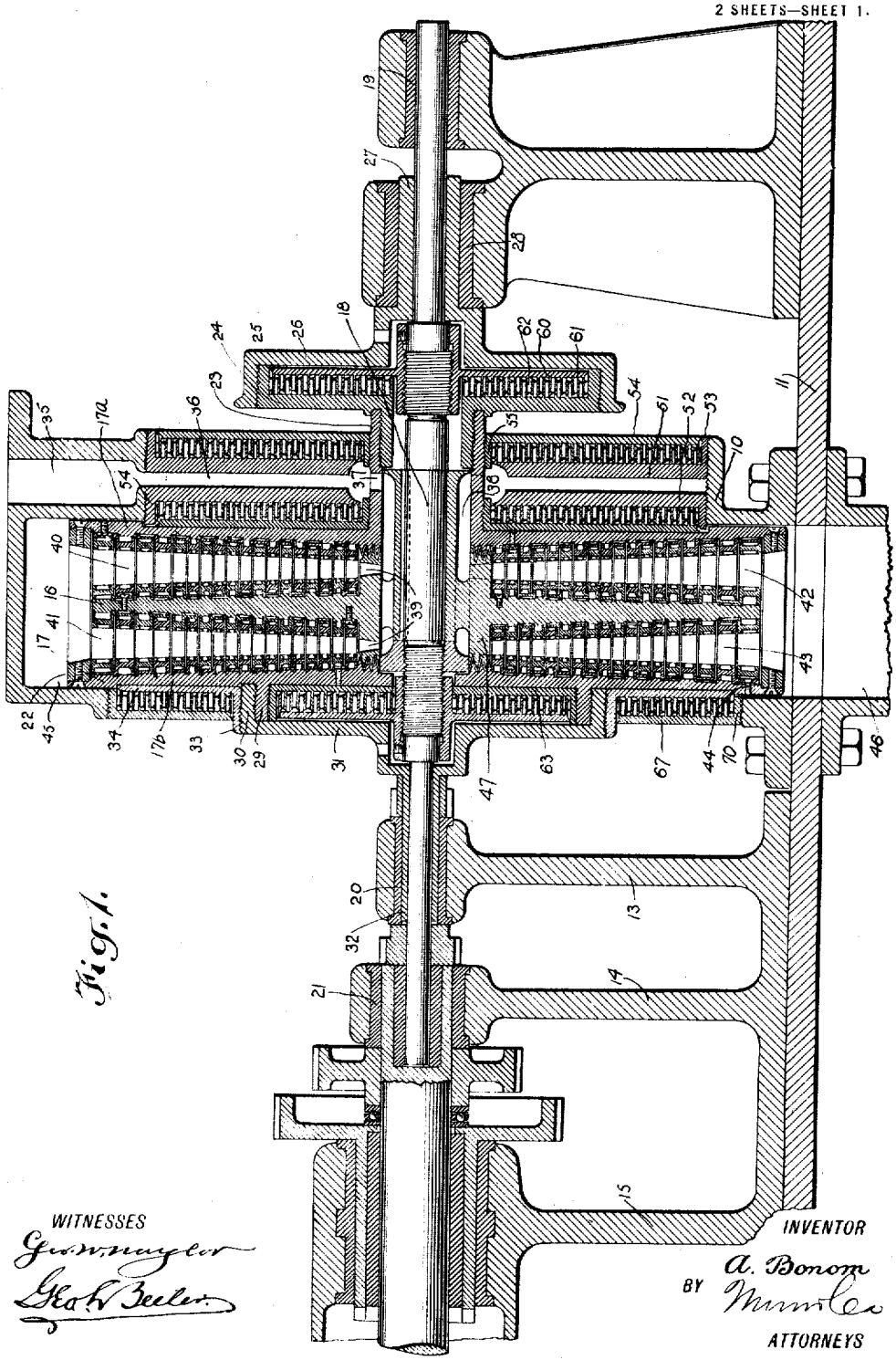


Fig. 1.

WITNESSES

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2 SHEETS—SHEET 2.

Fig. 2.

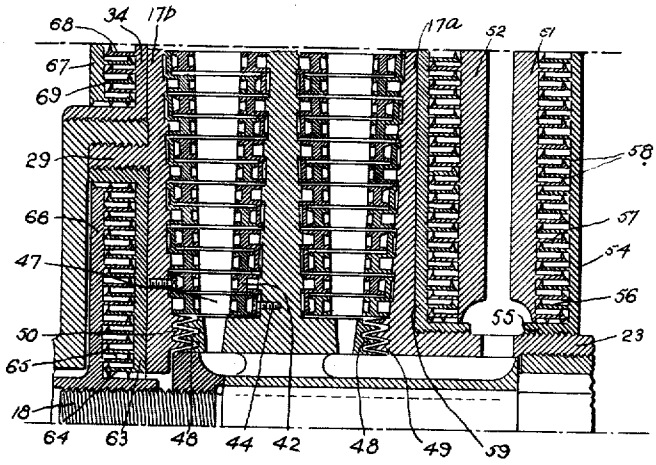
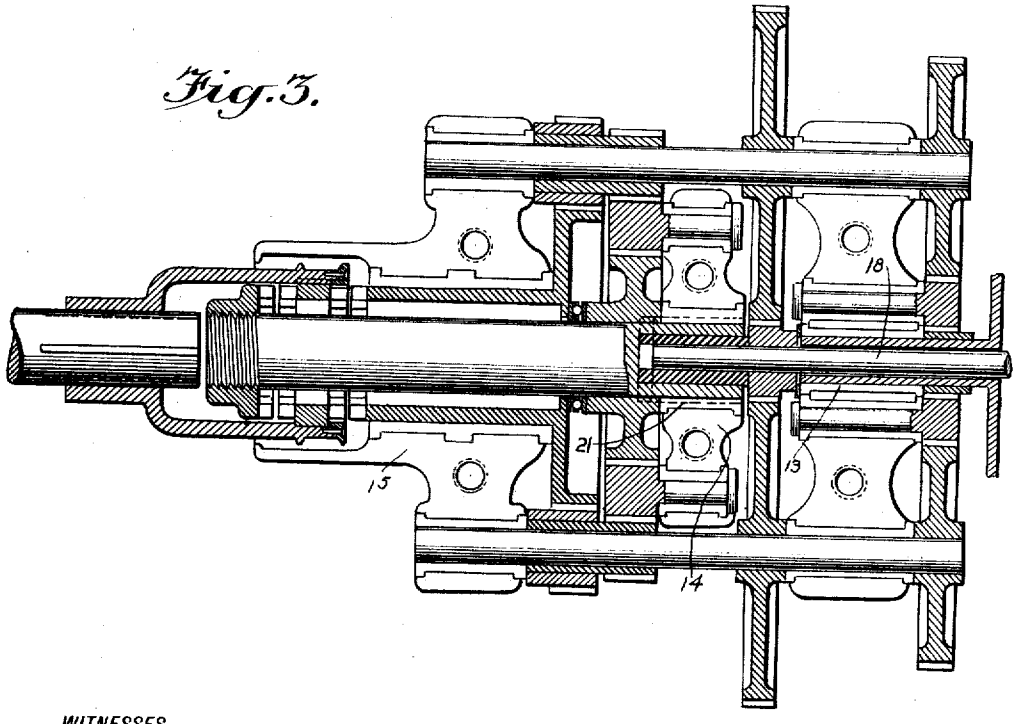


Fig. 3.



WITNESSES

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UNITED STATES PATENT OFFICE.

ALFRED BONOM, OF PATERSON, NEW JERSEY.

STEAM-TURBINE.

1,331,313. Specification of Letters Patent. Patented Feb. 17, 1920.

Application filed April 10, 1919. Serial No. 289,037.

To all whom it may concern:

Be it known that I, ALFRED BONOM, a citizen of France, and a resident of Paterson, in the county of Passaic and State of New Jersey, have invented a new and Improved Steam-Turbine, of which the following is a full, clear, and exact description.

This invention relates to reversible steam turbines and has particular reference to the general type of turbines described and claimed in my co-pending application Serial No. 268,362, filed December 26, 1918.

Among the objects of the present improvement are to simplify the construction and make the apparatus more compact than has heretofore been possible; to provide a perfect balancing of the several independent rotors with a single admission port for the steam or other motive fluid; to provide a turbine in which there are no pistons as distinguished from the parts carried by the rotors; to prevent to a substantially complete degree leakage of steam or other motive fluid by the use of labyrinth packings which are essentially frictionless, and finally to construct a practical high speed simple, light, true running and efficient turbine.

With the foregoing and other objects in view the invention consists in the arrangement and combination of parts hereinafter described and claimed, and while the invention is not restricted to the exact details of construction disclosed or suggested herein, still for the purpose of illustrating a practical embodiment thereof reference is had to the accompanying drawings, in which like reference characters designate the same parts in the several views, and in which—

Figure 1 is a vertical longitudinal section showing the main parts of my improvement.

Fig. 2 is an enlarged section of a portion of the same structure giving a better illustration of the joints between one rotor and the other and between the rotors and the stationary parts; and

Fig. 3 is a longitudinal sectional view of a preferred form of transmission gearing employed in connection with the turbine through which the relative speeds of rotation of turbine rotors may be controlled as well as variation in direction of the rotation thereof.

Referring now more specifically to the drawings I show my turbine as comprising a casing or drum 10 which for the purpose of this description may be regarded as being held stationary in upright position on a base 11 and between bearing standards 12 at one side and other standards 13, 14 and 15 on the other side. This drum 10 is preferably cylindrical and of relatively short form, and within it are arranged the principal power developing parts of the improvement.

The parts just referred to include inner and outer rotors 16 and 17 respectively. The inner rotor 16 consists essentially of a single disk like body fixed concentrically on a shaft 18 journaled in a bearing 19 at one side of the standard 12 and journaled indirectly in the two standards 13 and 14 in bearings 20 and 21 on the opposite side. This disk 16, however, is widest or thickest adjacent to the shaft and is tapered outward therefrom toward its periphery.

The outer rotor comprises two spaced and substantially parallel disks 17^a and 17^b whose peripheries are connected by a crown 22 which sweeps around the periphery of the inner rotor.

The disk 17^a includes a laterally projecting hub portion 23 having a pulley extension 24 constituting practically one side portion of the power transmission or controlling member 25, the other half of which 26, is provided with a hollow shaft or hub extension 27 journaled directly in the bearing 28 in another portion of the standard 12 and through which the shaft 18 projects. The extension 27 in the bearing 28 constitutes a support for one side of the outer rotor. The opposite disk 17^b is provided with an annular flange 29 having inner and outer threads and to the outer surface of this flange is connected the flange 30 of a disk 31 having a hub extension 32 journaled in the bearing 20 and in which the shaft 18 is journaled. Upon the outer surface of the flange 30 is threaded the hub 33 of an annular plate 34 which is countersunk into the outer face of the disk 17^b and because of the connections with the disk flange 30 the two parts 17^b and 34 rotate together. The disks 17^a and 17^b are preferably stiffer and thicker at their hub portions than at their peripheries and hence they are shown as being divergent somewhat from each other at their peripheries.

Steam is admitted through the port 35 through the stationary drum 10 toward the axle or shaft 18, the steam passing around the axle in a flat disk-like chamber 36 whence it passes inward through the hub

extension 23 through ports 37 into longitudinal distributing ports 38 with equal force through the ports 39 into the two pressure chambers 40 and 41 on the right and left sides respectively of the inner rotor or between the inner rotor and the right and left disks 17ª and 17ᵇ respectively of the outer rotor. These pressure chambers 40 and 41 flare outward toward their peripheries where they merge into the crown 22.

The active face of each rotor disk has secured to it a plurality of wings which cooperate in alternation with similar wings carried by the opposing face of the other rotor and so provide abutments through which the circumferential expansive force of the steam acts to drive the rotors in relatively or actually opposite directions. The wings 42 are connected to the inner rotor and the alternately arranged wings 43 are connected to the outer rotor. The connections between the wings and the rotors may be effected in any suitable manner such as by screws 44.

The force of expansion of the steam in directions parallel to the axis of the turbine is received against the side walls so to speak of the pressure chambers 40 and 41, and since this species of pressure is the same in both pressure chambers and the force thereof acting against each rotor acts in two opposite directions there is a perfect balance and hence no tendency to endwise movement of any parts. More specifically stated the pressure within the chamber 40 acting parallel to the axis of the turbine is exerted equally against the disk 17ª and that face of the inner rotor opposing it, while the equal expansive force in the chamber 41 is exerted equally against the disk 17ᵇ and the inner rotor opposing it. Consequently the pressure against the disk 17ª tending to force the outer rotor toward the right is counterbalanced exactly by a similar force acting in the opposite direction against the disk 17ᵇ. Likewise the pressure against the right hand face of the inner rotor is counterbalanced by a similar pressure on the opposite face and in the opposite direction.

The wings 42 and 43 increase in area both longitudinally and radially as they approach the crown 22. Consequently the steam pressure is exerted against the most closely adjacent abutments at the time that the expansive force thereof is at its maximum and while the steam is expanding outward radially and becoming rarefied it is exerted against the widest wing surfaces. The exhaust of the steam from the drum 10 is through an annular passageway 45 terminating in an exhaust port 46 below the base 11.

Instead of employing friction producing packing glands to prevent leakage of the steam along the joints between adjacent parts which have movement in relatively opposite directions I provide a peculiar and effective system of labyrinth packings having coöperating interengaging surfaces, which even though there is little or no actual contact between the relatively movable parts the leakage of steam is practically negligible. The hub 47 of the inner rotor is provided with a series of annular V-shaped ribs 48 which project into a close nesting position with respect to similar ribs 49 formed on the hub extension 29 of the outer rotor disk 17ª, and on the opposite side into communication with similar ribs 50 formed on the inner or hub portion of the disk 17ᵇ. The amount of leakage, therefore, of steam between the two hub portions of the rotors is relatively slight.

The steam chamber 36 is bounded on opposite sides by two disks 51 and 52 locked in stationary position within the drum end by screw threaded connection at their peripheries, the threaded parts being oppositely directed flanges 53 and 54 of the respective disks. Coöperating with the disk 51 is a disk 54 having a hub flange 55 having threaded engagement with the outer surface of the hub extension 23 and overlapping the plane of the disk 51. The main portions of these disks 51 and 54 are spaced laterally and the space is filled by means of coöperating annular projections 56 carried by the disk 54 and similar projections 57 carried by the disk 51, as clearly shown in Fig. 2. Each of these annular flanges carries radially disposed flange projections 58 each of which coöperates with the main flange of the opposing member. The disk 52 coöperates in the same way with a disk 59 secured to and carried with the outer rotor disk 17ª. These features are all circular and concentric and consequently there is little possibility of any material leakage of steam between the steam admission ports or chambers and the atmosphere passed to the rotor. The wheel or pulley member 25 which constitutes a sort of coupling between the hub extension 23 of the outer rotor and the trunnion support therefor 27, constitutes by virtue of its hollow interior a labyrinth packing in connection with a disk 60 fixed to the main shaft 18, to prevent leakage of steam along the shaft at the right side of the turbine. The pulley extension 24 and said disk 60 are provided with coöperating annular flanges 61 and 62 respectively which are or may be of the same character as above described at 56 and 57. The periphery of the wheel 25 obviously may be employed either as a brake wheel to control the rotation of the outer rotor or as a power transmitting device if the inner rotor is held stationary.

On the opposite side of the machine I provide a pair of labyrinth packings lying essentially in the same plane, the inner of which is made up of a disk 63 fixed within

the flange 29 and having annular flanges 64 coöperating with similar flanges 65 of a disk 66 fixed to the main shaft. This labyrinth is similar in function to that formed by and between the disks 24 and 60. The other labyrinth in the same plane is formed by and between the annular plate 34 and a stationary plate 67 fixed within the drum casing. These annular plates 34 and 67 have interengaging annular flanges 68 and 69 respectively. This labyrinth prevents leakage of steam between the outer rotor disk 17ᵇ and adjacent side of the stationary drum casing. The several labyrinth packings are delicately and easily adjustable in order to maintain the proper contact or interval between the coöperating annular flanges constituting the labyrinths. This adjustment is effected by the threaded engagement between each labyrinth disk or plate and the part that supports it and may be secured by set screws, lock nuts, or their equivalent, by any well known mechanical means.

Any suitable clutches, gears, or other mechanical appliances may be employed to control the relative rotation of the two rotor shafts or supports and thereby control the speed and direction of rotation of the rotors. The rotors are so constructed that while one operates clockwise the other rotates counterclockwise and unless acted upon or controlled by some extraneous means such rotations will be substantially at equal speeds. If now one of the rotors be retarded in its rotation there will be an immediate tendency for the other rotor to be accelerated until the speed of the retarded rotor may be reduced to zero, at which time the other rotor will have its maximum rotation. This description obviously is applicable to the control of either rotor and therefore the actual direction of the driven member in either case will be determined by the control of the rotors.

I claim:

1. In a steam turbine, the combination of a shaft, an inner rotor comprising a single disk tapered outward toward its periphery and having a hub surrounding said shaft, an outer rotor comprising two disks of equal diameters spaced on opposite sides of the inner rotor disk and forming two similar outwardly flaring pressure chambers between the disks and the opposing side faces of the inner disk, means to deliver steam with equal force into the hub portions of said chambers on opposite sides of the inner disk, said delivering means including longitudinal passages formed in said hub parallel to the shaft and from which passages radial ports lead to the two chambers aforesaid, the steam moving thence outward radially into the expanding or flaring portions of the chambers, coöperating abutment wings carried by the opposing faces of the several disks, and means to support the several rotors for independent rotation in relatively opposite directions.

2. In a steam turbine, the combination of a stationary casing, a shaft journaled therein, an inner rotor disk fixed to said shaft within the casing, an outer rotor comprising two spaced disks of equal diameters on opposite sides of the first mentioned disks and likewise within the casing, means to admit steam at equal pressures within the inner disk and the several outer rotor disks, and means to prevent the escape of steam between the casing and all rotatable parts, said means including on one side of the turbine two labyrinth packings surrounding the shaft and in substantially the same plane, one of which packings acts between the outer rotor and the shaft and the other of which acts between the outer rotor and the casing.

3. In a steam turbine, the combination of inner and outer rotors, a shaft to which one of the rotors is secured and around which the other rotor rotates in the opposite direction, means to admit steam between the rotors, and packing means to prevent the escape of steam along the shaft, said means including a disk fixed to the shaft and a hollow wheel fixed to the part rotatable around the shaft, said wheel and disk having coöperating annular packing flanges.

ALFRED BONOM.