A. BONOM.

REVERSIBLE STEAM TURBINE.

APPLICATION FILED JUNE 12, 1913.

1,076,865.

Patented Oct. 28, 1913.

3 SHEETS—SHEET 1.

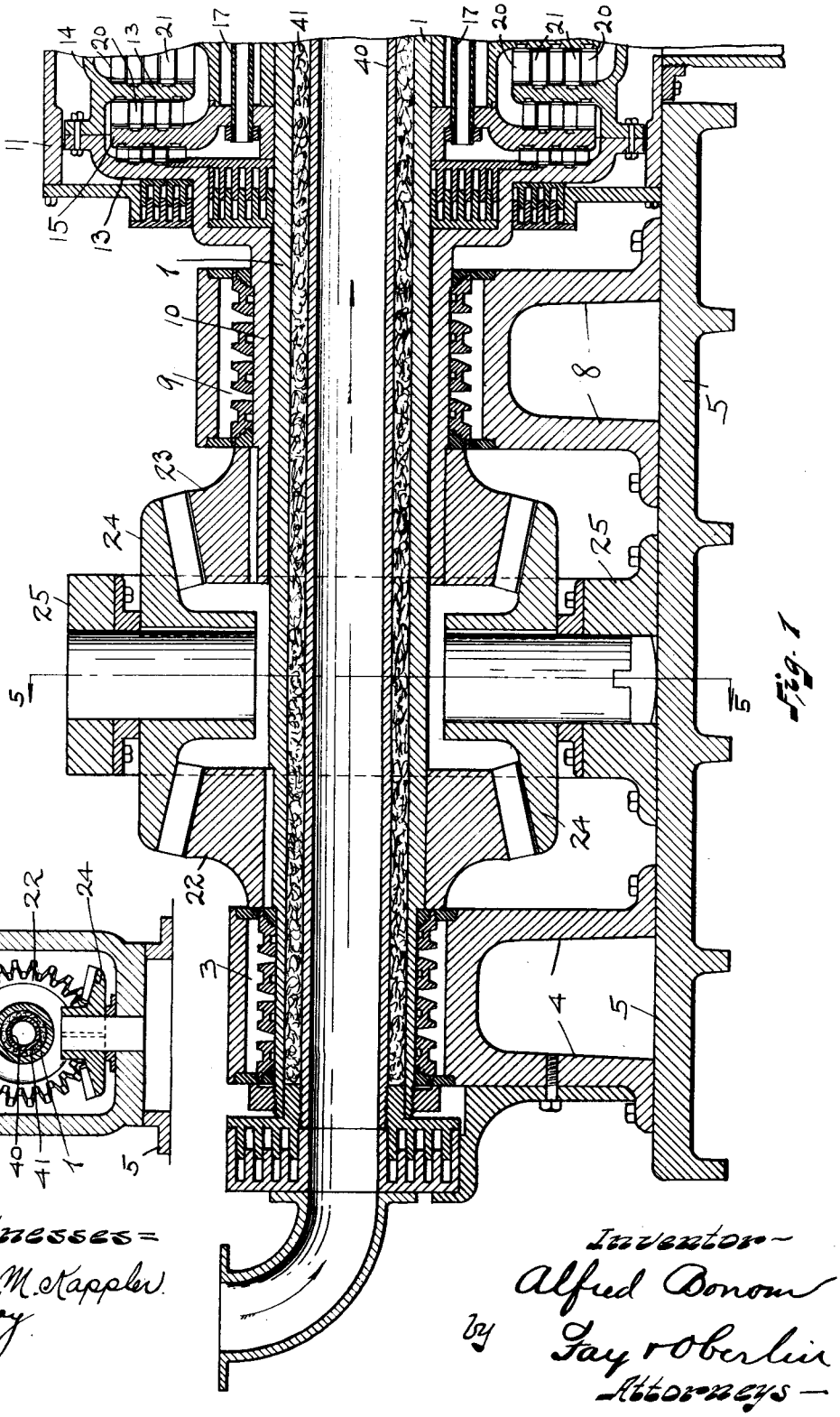


Fig. 1

Fig. 5

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H. B. Fay

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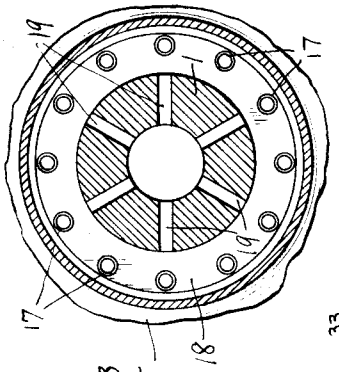


Fig. 3

Fig. 2

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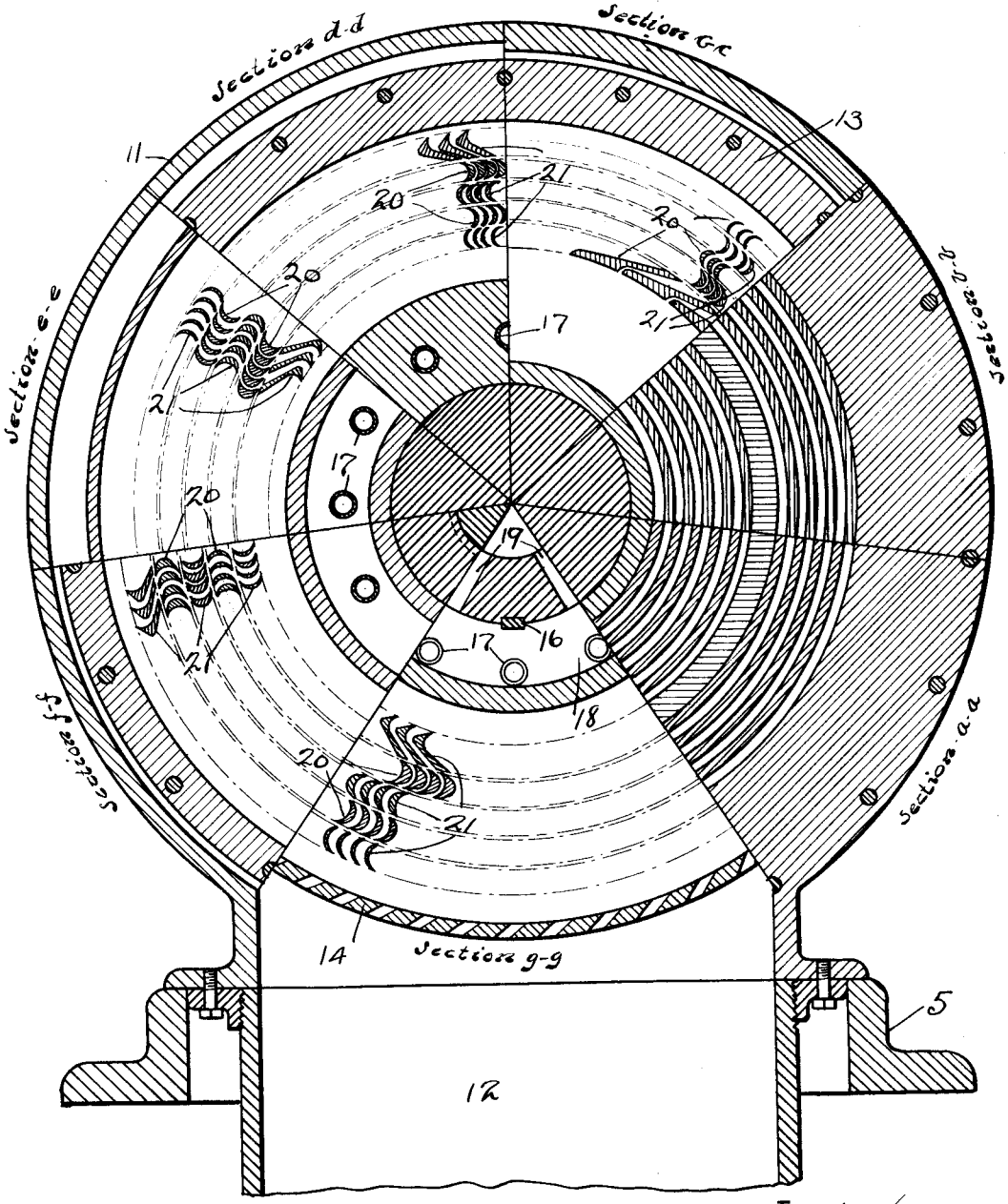
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3 SHEETS—SHEET 3.



Witnesses=
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Fig- 4

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UNITED STATES PATENT OFFICE.

ALFRED BONOM, OF PATERSON, NEW JERSEY.

REVERSIBLE STEAM-TURBINE.

1,076,865. Specification of Letters Patent. Patented Oct. 28, 1913.

Application filed June 12, 1913. Serial No. 773,267.

To all whom it may concern:

Be it known that I, ALFRED BONOM, a citizen of the Republic of France, and a resident of Paterson, county of Passaic, and State of New Jersey, have invented a new and useful Improvement in Reversible Steam-Turbines, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

In co-pending application, filed January 24, 1913, Serial No. 743,969, I describe an improved fluid pressure turbine adapted for reversible operation by alternately retaining stationary an inner and outer rotor member. In said improved turbine, the steam or other fluid pressure for operating the same is simultaneously supplied to the respective ends of the machine, thence passing through a corresponding series of annular passages which increase in size progressively from the point of admission of the steam to where it escapes from the machine.

By the present improvements I provide means for introducing the steam from the central axis of the turbine and thence to the respective ends of the rotors, thus doing away with the necessity for separate external steam connections.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of the various mechanical forms in which the principle of the invention may be used.

In said annexed drawings: Figure 1 is an axial vertical section of a part of a steam turbine embodying my present improvement; Fig. 2 is a corresponding section showing the remainder of the same turbine, these two figures complementing each other; Fig. 3 is a transverse sectional view of a detail, as indicated by the section line 3—3, Fig. 2; Fig. 4 is a composite view showing various segmental sections of the turbine, all taken in transverse planes, as indicated by the section lines on said figure and on Figs. 1 and 2; and Fig. 5 is a transverse section on the line 5—5, Fig. 1.

The central shaft of the machine is made up, in effect, of two portions, a tubular section 1 extending from the left, as illustrated in Fig. 1, to a point somewhat beyond the central transverse plane of the turbine proper, and a solid section 2 threaded, or otherwise firmly secured, to said tubular section and projecting beyond the turbine proper to the right. This composite shaft is supported at the left end, as viewed in said Fig. 1, in a suitable bearing 3 carried by a frame 4 rising from the general base 5 of the machine. The other, or right end of the shaft, as viewed in Fig. 2, is journaled within a sleeve 6 forming the corresponding end of a rotary shell that constitutes the exterior rotor of the turbine, such rotor end being, in turn, journaled in a frame 7 similar to frame 4 and rising from the same base 5. A similar frame 8 and corresponding bearing 9 are provided to support the other sleeved end 10 of such exterior rotor member (see Fig. 1). This exterior rotor member is wholly inclosed, save for its projecting ends journaled in the fashion just described, in an outer stationary casing 11 supported upon the same base 5 as the frames 4, 7 and 8, such casing having a substantially steam tight connection with the adjacent rotary parts, whereby the latter are entirely inclosed, save for the exhaust opening 12 from the casing, which is shown as directed downwardly.

The exterior rotor member is built up of a series of disks 13 connected by cylindrical portions 14 so as to form a cylindrical structure within the outer shell or casing, the sleeves 6 and 10, whereby such rotor is supported, being formed on the terminal disks. The several portions of the rotor are rigidly bolted together so as to make of the same a unitary structure, and it may be regarded as a drum having spaced, inwardly directed disks. Within this exterior rotor is an interior rotor likewise including in its structure a series of disks 15 which extend radially outward between the disks 13 of the exterior rotor, being non-rotatably secured to the central shaft of the turbine by keys 16. The sections of this interior rotor are endwise secured together by means of two series of pipes 17 disposed about the shaft, as clearly shown in Figs. 2 and 3, which serve at the same time as a means of communication between an annular chamber 18 formed in the base of the central disk, and the spaces between the ends of the exterior and interior rotors. The tubular section 1 of the central shaft of the turbine is provided with a series

of slots 19 (see Fig. 3), that register with the annular chamber 18 so that steam may be admitted by a pipe 40 extending lengthwise through said tubular shaft and then by way of said slots, annular chamber, and the pipes, to the respective ends of the turbine. Thence the steam finds its way through the successive annular spaces or expansion chambers that are formed between the opposing faces of the disks of the interior and exterior rotors. As clearly shown in Figs. 1 and 2, the location of these disks is such that said successive annular spaces gradually increase in size from either end of the turbine to the center, it being observed that the right and left halves of the turbine proper are substantial duplicates of each other. Asbestos packing 41 is interposed between pipe 40 and the shaft section 1 to act as heat insulation for the former. Attached to the opposed disk faces of the interior and exterior rotors alternately, are a series of blades or vanes 20 and 21, the size and form of such blades differing in the several annular spaces, as shown in the different sectional views of Fig. 4.

The tubular end 1 of the central shaft extending to the left as shown in Fig. 1, and the corresponding sleeved end 10 of the exterior rotor are connected by reversing gearing whereby rotation of either rotor in the direction of operation determined therefor by the disposition of the blades carried by it, will produce a rotation in the opposite direction on the part of the other rotor. The gearing in question may take on various forms, but will preferably consist of two beveled or miter gears 22 and 23 mounted on the shaft and sleeve ends, respectively, with which beveled gears mesh one or more stationary, idler bevel gears 24. The latter, shown as two in number in the illustrated structure (see Fig. 5), are carried in a suitable frame work 25 mounted on the general base of the machine. Instead of two of such gears, either one, or three, or four, or more may be utilized if desired, or found necessary under operative conditions, such conditions, of course varying with the size of the machine and the service for which it is designed.

In operation, either the interior or exterior rotor is temporarily connected with the driving shaft 26 by means presently to be described, and the steam or equivalent pressure fluid for operating the turbine as it passes through the annular spaces between the disks 13 and 15 of the rotors is guided by the blades of the one rotor so as to react against those on the rotor. As it passes from one space to the other, the steam is permitted to expand by reason of the increased cross sectional area of the spaces, until finally it passes to the exhaust opening 12 and thus escapes from the machine. At the opposite end of the turbine, the central shaft which carries the interior rotor and the sleeve of the exterior rotor surrounding such shaft end, terminate in closely adjacent vertical planes and are respectively provided with exterior lugs or teeth 28 and 29 similar to gear teeth, such teeth forming part of a clutch mechanism for connecting either of such shafts, as desired, with the driving shaft 26, by means of which power is communicated from the turbine to any machinery which it is desired to operate. The abutting end of the driving shaft 26 is provided with lugs or teeth 30 similar to the clutch teeth 28 and 29, and a sleeve 32 with interior teeth 33 is mounted in slidable engagement with the teeth on said driving shaft. Said sleeve also has interior teeth 34 at its other end adapted to engage with the teeth 28 or 29 depending upon the position of the sleeve longitudinally of the axis of the shaft, it being understood that the sleeve remains at all times in engagement with the driving shaft 26.

Suitable means are desirably employed for collecting any water of condensation that may escape past the packing at the right hand end of the machine as illustrated in Fig. 2. With this in view a collar 35 is provided on the interior solid shaft section adjacent to an internal groove 36 in sleeve 10, such groove being connected by a series of openings 37 with a collecting trough 38 without the sleeve as shown in Fig. 2. From such collecting trough a suitable conduit 39 carries the liquid away from the machine.

The general operation of the machine as a whole may now be briefly set forth. Depending upon the direction of rotation it is desired to impart to the driving shaft, the clutch is shifted to connect the latter with the adjacent end either of the exterior rotor sleeve 56, or the solid shaft-section, that carries the interior rotor. Steam, being now admitted into the machine through the pipe 40 that extends longitudinally of the tubular shaft-section, will pass simultaneously from the respective ends of the turbine toward the center, as previously described. The reaction of the expanding vapor on the turbine blades will tend to rotate the rotors in opposite directions, such direction of rotation in the case of the particular rotor connected with the driving shaft being that which it is desired to impart to said driving shaft. The other rotor, by reason of the reversing gear connected between it and the first rotor, if it moves at all, will add its rotative effect to the first and thus increase the torque on the driving shaft.

By the foregoing arrangement of parts, I may readily obtain a reverse movement of the driving shaft by simply shifting the clutch which connects it with one or the other of the two rotors. The machine has

the additional advantage of permitting the steam to be centrally introduced therein, thus doing away with the necessity of separate exterior steam connections to the respective ends of the turbine and reducing the loss from radiation, while at the same time rendering the machine more compact and convenient of access from without.

The utility of the various details of structural improvement has been incidentally brought out in the foregoing description of the same.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In a turbine, the combination of a central shaft; spaced, outwardly directed disks carried by said shaft and constituting an interior rotor; an exterior rotor surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; reversing gear connections between said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

2. In a turbine, the combination of a central shaft; spaced, outwardly directed disks carried by said shaft and constituting an interior rotor; an exterior rotor surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor, the spaces between the opposing disk-faces of said interior and exterior rotors successively increasing in size from the intake to the exhaust; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; reversing gear connections between said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

3. In a turbine, the combination of a central shaft; spaced, outwardly directed disks carried by said shaft and constituting an interior rotor; an exterior rotor surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor, the spaces between the opposing disk-faces of said interior and exterior rotors successively increasing in size from the ends of the turbine to a central transverse plane; connections for supplying pressure fluid to the end-spaces and for exhausting the same from the central spaces; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; reversing gear connections between said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

4. In a turbine, the combination of a central shaft; spaced, outwardly directed disks carried by said shaft and constituting an interior rotor; an exterior rotor surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor, the spaces between the opposing disk-faces of said interior and exterior rotors successively increasing in size from the ends of the turbine to a central transverse plane; connections for supplying pressure fluid to the end-spaces and for exhausting the same from the central spaces, such supply connections including a passage in said central shaft, an annular chamber in said interior rotor having communication with such passage, and ducts leading from such chamber to the respective ends of said interior rotor; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; reversing gear connections between said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

5. In a turbine, the combination of a central shaft; spaced outwardly directed disks carried by said shaft and constituting an interior rotor, a section of said shaft from one end to a point within said rotor being tubular and said interior rotor having an annular chamber in communication with such tubular shaft section; pipes extending parallel with said shaft, said pipes securing the disks of said interior rotor together and providing ducts from such chamber to the respective ends of said interior rotor; an exterior rotor surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; reversing gear connections between said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

6. In a turbine, the combination of a central shaft; spaced outwardly directed disks carried by said shaft and constituting an interior rotor, a section of said shaft from one end to a point within said rotor being tubular and said interior rotor having an annular chamber in communication with such tubular shaft section; a pipe for supplying pressure fluid extending through such tubular shaft section and heat-insulated therefrom; other pipes extending parallel with said shaft, said pipes securing the disks of said interior rotor together and providing ducts from such chamber to the respective ends of said interior rotor; an exterior rotor

surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; reversing gear connections between said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

7. In a turbine, the combination of a central shaft; spaced, outwardly directed disks carried by said shaft and constituting an interior rotor; an exterior rotor surrounding said shaft and carrying inwardly directed disks alternating with the disks of said interior rotor; alternating series of blades carried by the opposing disk-faces of said interior and exterior rotors; oppositely disposed bevel gears carried by said rotors, respectively; an idler bevel gear having a fixed axis of rotation and connecting the gears on said rotors; a driving shaft; and means for connecting either of said rotors with said driving shaft, as desired.

Signed by me this 7th day of June, 1913.

ALFRED BONOM.

Attested by—
D. T. DAVIES,
I. PHELPS.