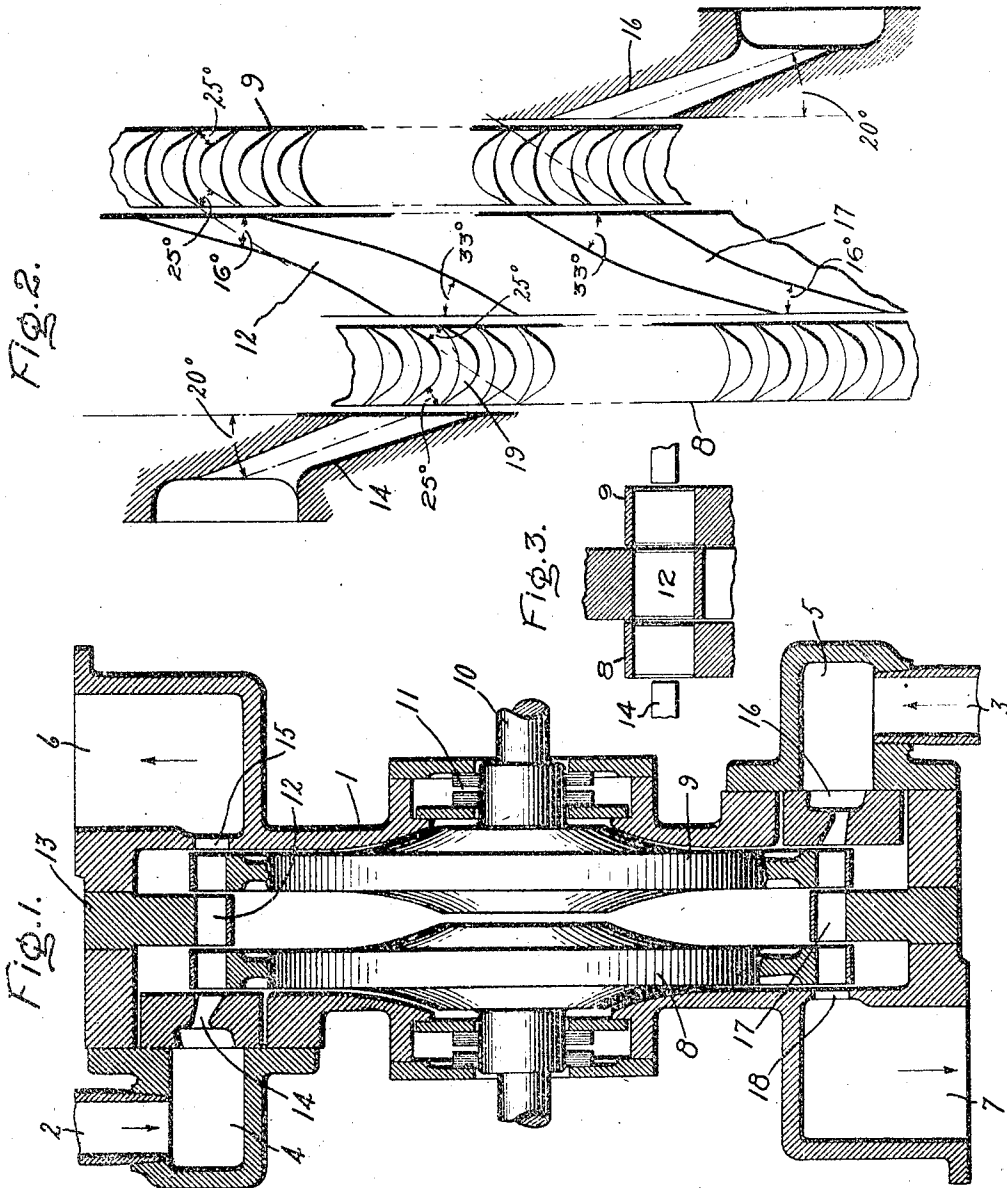


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ELASTIC FLUID TURBINE.
APPLICATION FILED SEPT. 21, 1907.

910,170.

Patented Jan. 19, 1909.



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UNITED STATES PATENT OFFICE.

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A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 910,170.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, JOHN G. CALLAN, a citizen of the United States, residing at Nahant, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

Turbines having independent and oppositely rotating wheels to the buckets of one of which all of the steam or other motive fluid is delivered by suitable nozzles to flow in series through the wheels without reversal of its direction have certain advantages when combined with electric generators in that the combination is highly efficient, and electric generators of the types and sizes best fitted for the work can be employed. There is one disadvantage however in such constructions for certain kinds of service, *i. e.*, that one wheel will do about seventy per cent. of the work and the other about thirty per cent. This I overcome causing the wheels to do equal work by the use of nozzles for both wheels arranged to discharge a region or zone concentric with the axis and in opposite directions.

In order to obtain the highest efficiency, the entrance angle of the buckets receiving steam from the nozzles must bear a certain definite relation to the spouting velocity of the steam and the bucket speed. The discharge angle must also bear a certain definite relation to the velocity of the fluid stream and the bucket speed. This means that the discharge angles of a given row of wheel buckets are such that they will not properly serve as entrance angles for steam going the other way owing to the loss of velocity as energy is imparted to the wheel. To overcome this I employ intermediate buckets of such shape that they will receive fluid at whatever angle it issues from one row of buckets and discharge it at the proper angle and velocity against the adjacent buckets on the other wheel. With such a construction the intermediates do not reverse the direction of flow of the steam as they do in common constructions, but serve only to guide it so that the proper angular relation is preserved and so that wheels having similar bucket angles may be employed, and this with wheels which rotate in opposite directions. The nozzles located on opposite sides of the wheels are offset so that the fluid jets will not interfere, and the intermediates are

similarly offset, each set of intermediates being arranged to receive all the steam discharged by its cooperating nozzle. When nozzles are employed which discharge fluid in opposite directions in the manner stated, the intermediates cooperating with the nozzle or nozzles on one side are reversely disposed with respect to those on the other side.

The general arrangement of nozzles, buckets and intermediates is also such that the entrance angle of the buckets receiving steam from the nozzles serves in an efficient manner as the discharge angle for the steam coming in the opposite direction.

It sometimes happens with turbines having oppositely rotating wheels that it is desirable to use very high bucket speeds. Such constructions result in hubs for the wheels that are so long in the axial dimension that the buckets cannot be placed close enough together to permit the fluid to flow from one to the other without excessive leakage. In such cases I place my improved form of intermediate buckets between the rows of wheel buckets and by making them of proper width any length of hub can be employed that is desired. In so far as this feature of my invention is concerned I may employ nozzles for one wheel or both as previously described.

In the accompanying drawing which illustrates one of the embodiments of my invention, Figure 1 is an axial section of a turbine having oppositely rotating wheels and nozzles discharging in opposite directions; Fig. 2 is a diagrammatic view of the same showing the relation of the nozzles, wheels and intermediate buckets; and Fig. 3 is a section of the rims of the wheels and the intermediates showing the relation of the nozzles thereto.

1 indicates the casing of the turbine which may be divided in any suitable manner to give success to the interior. It is provided with inlets 2 and 3 which communicate with steam chests 4 and 5. It is also provided with conduits 6 and 7 through which steam or other elastic fluid may be discharged to the atmosphere or to a condenser. Mounted within the casing are oppositely rotating bucket wheels 8 and 9 having symmetrical peripheral buckets. It is to be noted that the buckets have the maximum height required to accommodate the steam at the exit; this is necessary because the entrance for one nozzle is the exit for the other. Each of these

wheels is provided with an individual shaft 10 and overhangs its bearing (not shown). Where the shaft projects through the casing a suitable packing 11 is provided to prevent the escape of steam or the entrance of air. Located between the wheels are intermediate buckets 12. In the present instance these buckets are formed in a ring 13 that constitutes a part of a wheel casing but other arrangements may be employed. Steam is admitted to the first wheel by steam chest 4 through a sectionalized nozzle 14, from which it passes through the wheel 8, and after being guided and directed by the walls of the intermediate it is discharged against the buckets of wheel 9, and exhausts through the orifice 15 communicating with the exhaust conduit 6. On the other side of the wheels and diametrically opposite the nozzle 14 for the purpose of illustration is a sectionalized nozzle 16 for discharging fluid in an axial direction opposite to that discharged by the nozzle 14. The steam then passes through the intermediate buckets 17 and wheel 8, from which it passes through the orifice 18 that conforms in shape to that of the column of steam escaping from the wheel, and leaves by conduit 7.

Referring to Fig. 2, I show buckets 19 having corresponding angles of entrance and exit so as to eliminate end thrust on the shafts. The buckets for both wheels have the same angles, in the present illustration 25° . The angles of the nozzles 14 and 16 with respect to the wheels are also identical, in the present illustration 20° . The intermediates 12 are so shaped that the virtual angle of the steam leaving them will be the same, or substantially the same, as the entrance angles of the buckets on wheel 9. In calculating the angle of entrance of these buckets the velocity of the moving steam and the speed of the bucket must be taken into consideration. They are so designed as to receive the emergent steam from one wheel with the minimum steam shock and deliver to the other wheel in the same manner. These conditions are fulfilled when the mean direction of the steam jet is coincident with a tangent to the entering edge of the receiving buckets whether they be the stationary buckets of the intermediates or the moving buckets of the wheels. As shown the virtual angle of the steam issuing from the intermediates is 25° and the entrance angle of the buckets is therefore the same. The actual discharge angle of the nozzle is 16° , and the actual entrance angle is 33° . The intermediates 17 cooperating with the nozzle 16 are oppositely disposed with respect to the intermediates 12 and receive steam from the right-hand wheel 9 and direct it in the opposite direction against the buckets on wheel 8 in such a manner that the virtual angle of the fluid is 25° . I have mentioned the angle of

25° as a specific embodiment of my invention but do not wish to be understood as limiting myself thereto as changes in velocity of the fluid or the bucket speed will require changes in the bucket angles. The passages of the intermediates are so proportioned that the fluid discharged into their inlet ends at a velocity less than the velocity of discharge from the nozzles is delivered from the exit ends of said passages at substantially the nozzle discharge velocity.

In Fig. 3 is shown the preferred arrangement of the nozzles and buckets. In this figure the radial height of the buckets is considerably greater than that of the nozzles. This is made necessary by the fact that each row of wheel buckets acts as a primary wheel and as a secondary, and the area of the bucket spaces must be great enough to convey the fluid without choking. To state the matter in another way the radial height of the wheel buckets is determined not by that of the adjacent nozzle as is usually the case but by the volume of steam passing through them and received from the nozzle or nozzles adjacent the opposite wheel.

By reason of my improved construction I am enabled to make a turbine wherein the steam acts with full efficiency on the buckets and both wheels can be made to perform equal amounts of work, instead of unequal amounts as would be the case if only one wheel received steam directly from the nozzle or nozzles. The use of the intermediates insures the proper relation between the virtual angle of the steam and the actual angle of the buckets. I prefer to make the intermediate buckets as short as possible so as to reduce the friction to a minimum. It is to be noted that these intermediates do not reverse the direction of steam as is the case with the intermediates ordinarily employed, and since they do not reverse the direction of the steam the losses due to friction, compression and eddies is not as great as with prior constructions. By using the oppositely rotating wheels and driving independent electric generators electrically geared together, the advantages of high bucket speeds are obtained without unduly high shaft speeds. It is evident that by slightly changing the shape of the intermediate buckets I can distribute the work unevenly between the two wheels if such distribution be desired for any reason. If the speeds at which the turbine is to be run require for mechanical strength wheels having hubs of the type illustrated in Fig. 1 it is evident that without the intermediates the steam could not be effectually conducted from one wheel to the other even though they were placed side by side and in the same casing.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together

with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the invention can be carried out by other means.

5 What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an elastic fluid turbine, the combination of a casing, bucket wheels mounted therein, curved intermediate buckets which
10 receive motive fluid at such an angle from a wheel revolving in one direction and discharge it without reversal at such an angle against the buckets of the adjacent wheel that the mean direction of the stream of
15 fluid is tangent to the entering edge of the intermediate buckets and of the wheel buckets against which it is discharged to cause said wheel to revolve in the opposite direction, a device admitting fluid to one of the
20 wheels, and a similar device admitting fluid to the adjacent wheel in the opposite direction.

2. In an elastic fluid turbine, the combination of a casing, a bucket wheel mounted
25 therein, a shaft for the wheel, a second bucket wheel also mounted in the casing, a shaft for the second wheel that is independent of the first, intermediate buckets supported by the casing and so curved that they
30 receive motive fluid from one wheel and discharge it against the other at such angles that the mean direction of the stream of fluid is tangent to the entering edge of the intermediate buckets and of the wheel buckets
35 against which it is discharged, a device for discharging fluid from a source of supply against one of the wheels, and a similar device for discharging fluid against the other wheel in the opposite direction.

3. In an elastic fluid turbine, the combination of a casing, oppositely rotating bucket wheels mounted therein, simultaneously operating curved intermediate buckets common to the wheels and arranged in sets
40 between them, one set discharging fluid in one direction and the other set in the opposite direction, and devices receiving fluid from a source of supply and located on opposite sides of the wheels which discharge

the fluid against the buckets in opposite
50 directions.

4. In an elastic fluid turbine, the combination of a casing, bucket wheels mounted therein, sets of intermediate buckets which receive motive fluid from a wheel revolving
55 in one direction and discharge it against the buckets of the adjacent wheel and cause said wheel to revolve in the opposite direction, the said sets of buckets being reversely disposed with respect to each other, and nozzles
60 located on opposite sides of the wheels which discharge fluid in opposite directions in a region or zone concentric with the axis and cooperate with the sets of intermediates to cause rotation of the wheels.

5. In an elastic fluid turbine, the combination of a casing, oppositely rotating wheels mounted therein and having similar receiving and discharge angles, nozzles located on
70 opposite sides of the wheels and having similar discharge angles, and intermediate buckets arranged in sets between the wheels one set being reversely curved with respect to another set, the said sets modifying the direction of flow of the fluid without reversing
75 ing it.

6. In an elastic fluid turbine, the combination of a casing, oppositely rotating wheels mounted therein having rims provided with buckets, elongated hubs which project beyond the side of the rims and cause the
80 wheels to be spaced apart, and webs between the hubs and rims, nozzles arranged on opposite outer sides of the wheels to deliver motive fluid thereto, and intermediate
85 buckets arranged in sets in the space between the wheel rims to modify the direction of flow of the fluid without reversing said direction, the buckets of one set being reversely curved with respect to those of
90 another.

In witness whereof, I have hereunto set my hand this thirteenth day of Sept., 1907.

JOHN G. CALLAN.

Witnesses:

JOHN A. McMANUS, Jr.,
ALVARADO L. R. ELLIS.