

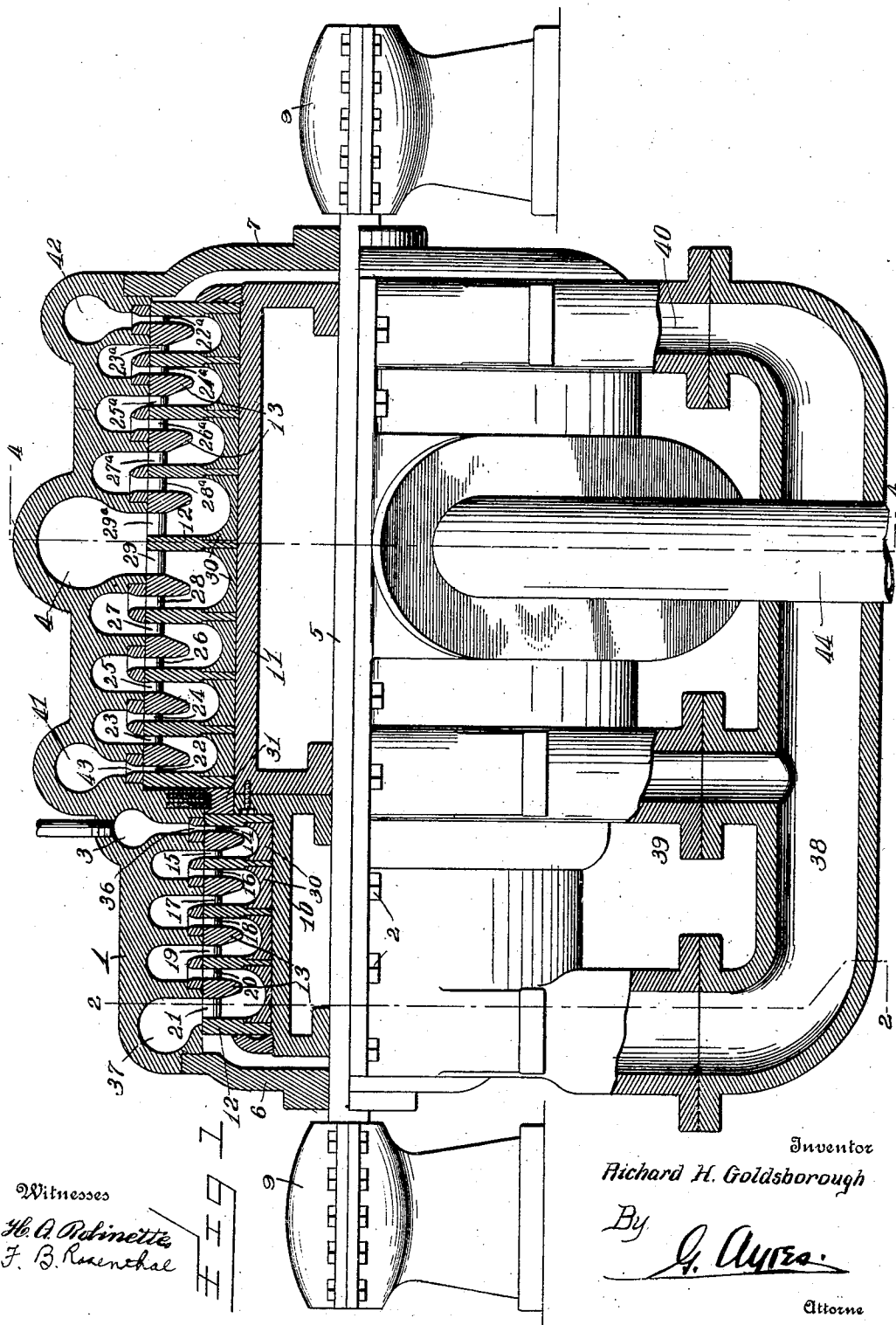
No. 876,710.

PATENTED JAN. 14, 1908.

R. H. GOLDSBOROUGH.
TURBINE.

APPLICATION FILED MAY 14, 1906.

3 SHEETS—SHEET 1.



Witnesses
H. A. Robinson
F. B. Rosenthal

Inventor
Richard H. Goldsborough

By *G. Ayres*

Attorney

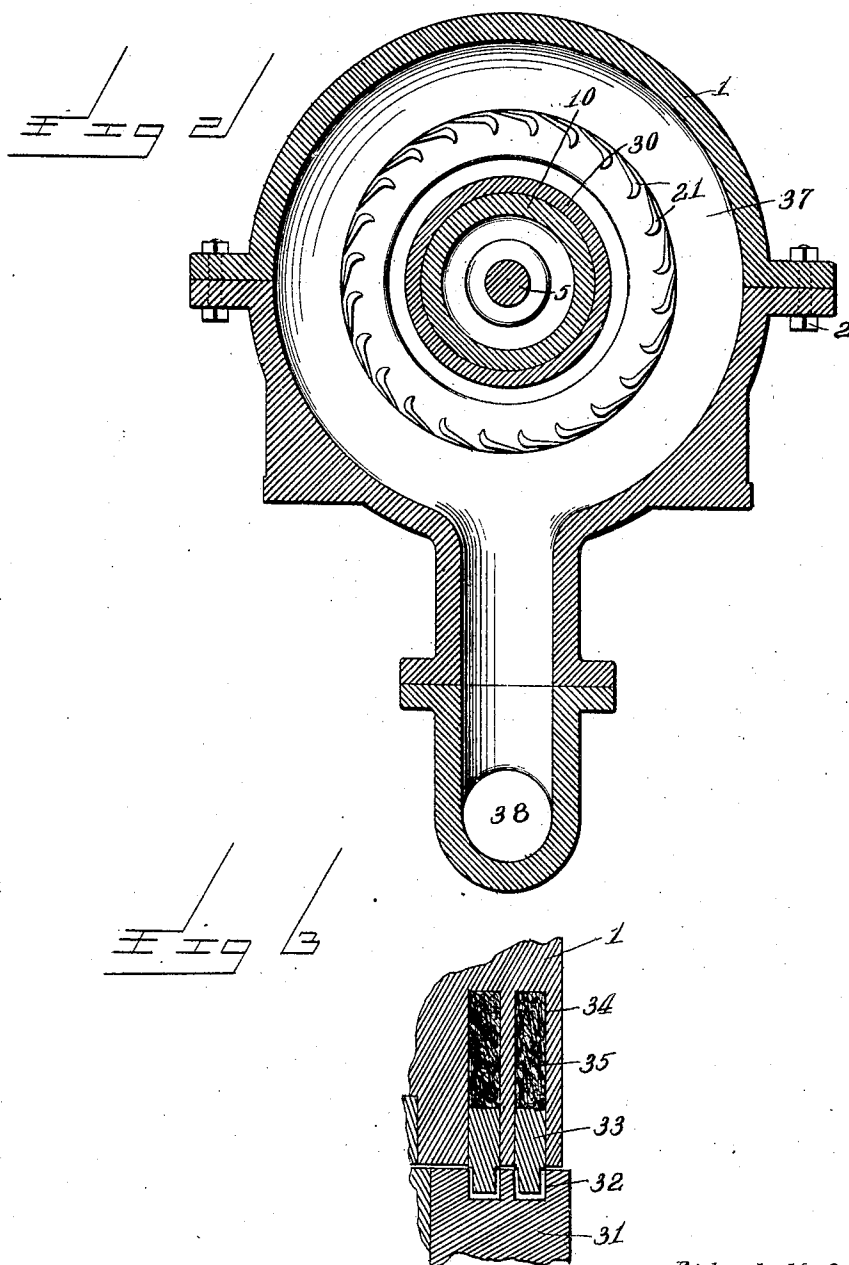
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3 SHEETS—SHEET 2.



Witnesses
H. A. Delmette.
F. B. Rosenthal

Inventor
Richard H. Goldsborough

By

L. Ayres

Attorney

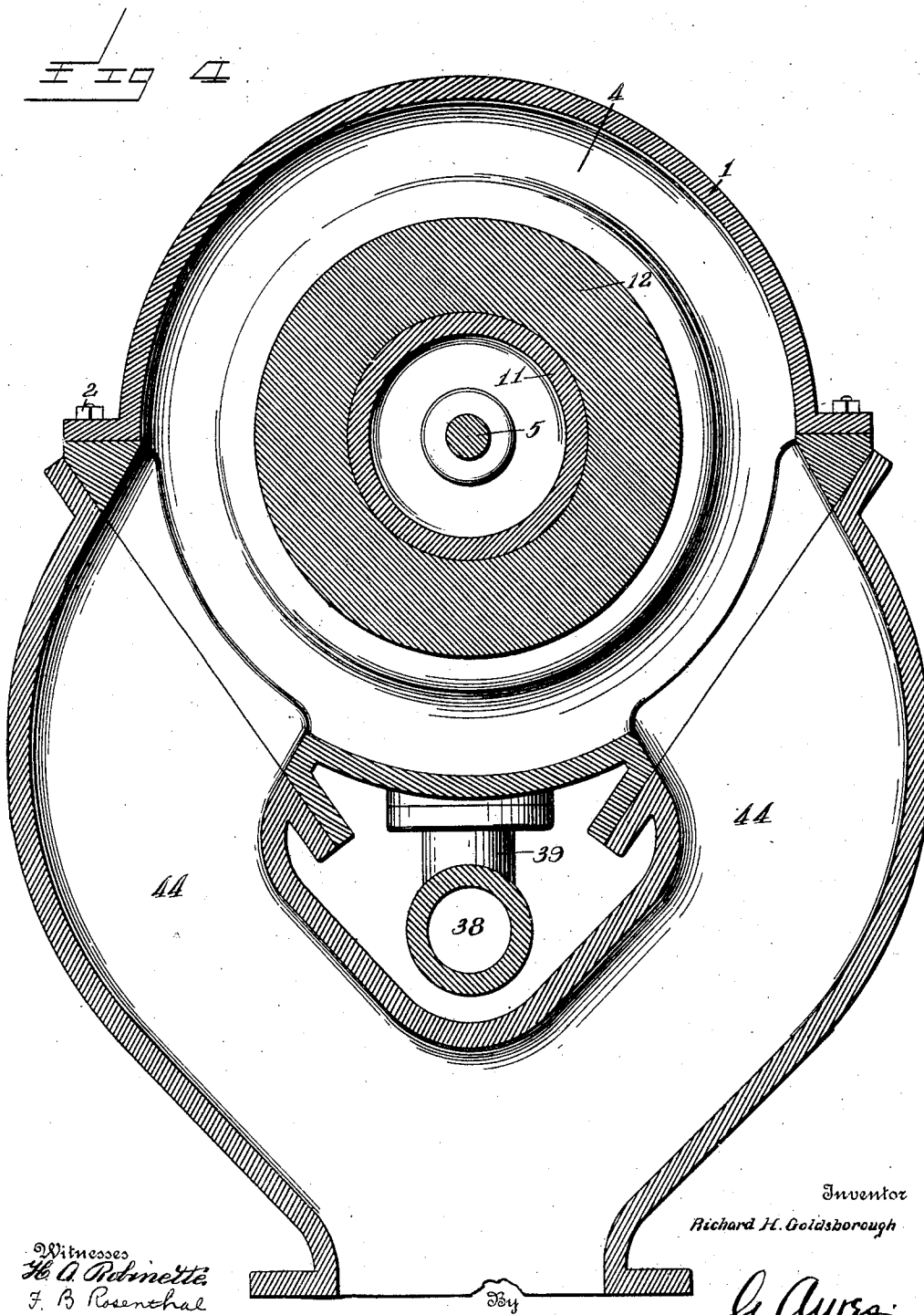
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3 SHEETS—SHEET 3.



Witnesses
H. A. Robinson
J. B. Rosenthal

Inventor
Richard H. Goldsborough

G. Ayres
Attorney

UNITED STATES PATENT OFFICE.

RICHARD H. GOLDSBOROUGH, OF WASHINGTON, DISTRICT OF COLUMBIA.

TURBINE.

No. 876,710.

Specification of Letters Patent.

Patented Jan. 14, 1908.

Application filed May 14, 1906. Serial No. 316,731.

To all whom it may concern:

Be it known that I, RICHARD H. GOLDSBOROUGH, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Turbines, of which the following is a specification.

My invention relates to an improvement in turbines, and it consists in the constructions, combinations and arrangements herein described and claimed.

An object of my invention is to provide a construction which shall be free from any tendency of leakage to or from the turbine casing about the rotor shaft; thereby obviating the necessity of employing a sealing device, such as a labyrinth construction, for the purpose of preventing leakage of air into the turbine casing, or the escape of steam therefrom, about the rotor shaft.

This improvement overcomes one of the principal practical difficulties inherent in existing turbine constructions, since all forms of sealing devices require such close and accurate adjustment that they easily get out of order, and further their close running throws a material load on the turbine even when accurate adjustment is maintained.

A further object of my invention is to provide a compound construction in which the increase in size of the final vanes over that of the initial vanes is maintained within limits insuring a rigid construction and a highly efficient operation.

In compound turbines, especially those of the condensing type, constructors have encountered great practical difficulty in proportioning the successive sets of vanes to accommodate the high degree of expansion of the steam in its passage through the turbine. Such high degree of steam expansion has led to the employment of very narrow initial turbine vanes, in order to maintain the width of the final vanes within the practical limits necessary for a rigid and secure construction; such practice has been found to lower the efficiency of the turbine, largely through the frictional losses incident to the passage of the steam through the excessively narrow initial sets of vanes. My invention overcomes this recognized difficulty in a simple and efficient manner.

In the accompanying drawings forming a part of this application, and in which similar reference symbols indicate corresponding parts in the several views, Figure 1 is a side

elevation, partially in section, illustrating one embodiment of my invention; Fig. 2 is a sectional view on the line 2—2 of Fig. 1; Fig. 3 is a detail sectional view, on a larger scale, illustrating the arrangement of the clearance rings, and Fig. 4 is a sectional view on the line 4—4 of Fig. 1.

Referring to the drawings, 1 indicates a turbine casing, formed of an upper and lower portion secured together by bolts 2, and provided with an initial steam chamber 3, and an annular final exhaust chamber 4.

A shaft 5, extending through the heads 6 and 7 of the casing, is provided with any usual external bearings 9. Secured to the shaft 5 is a rotor comprising two drums 10 and 11 carrying a plurality of annular members 12 and outer rings 13 between which are securely held the several annular series of rotor vanes 14, 15, 16, 17, 18, 19, 20, 21, 22 and 22^a, 23 and 23^a, 24 and 24^a, 25 and 25^a, 26 and 26^a, 27 and 27^a, 28 and 28^a, and 29 and 29^a; annular spacing members 30 being positioned between the successive annular members 12.

Referring especially to Fig. 1, the drum 10 is shown carrying a primary set of vanes 14, 15, 16, 17, 18, 19, 20 and 21; and the drum 11 is shown provided with two secondary sets of vanes 22, 23, 24, 25, 26, 27, 28, 29, and 22^a, 23^a, 24^a, 25^a, 26^a, 27^a, 28^a and 29^a. I have illustrated the primary set composed of annular series of vanes having a diameter considerably less than the annular series of vanes comprising the secondary sets; but, obviously, any desired proportion and relation could be made between such diameters.

An annular spacing member 31 is carried by the rotor between the primary set of vanes and the adjacent secondary set, and provided with grooves 32 on its periphery for receiving clearance rings 33. The rings 33 are positioned in annular channels 34 in the casing and extend freely within the grooves 32; the portions of the rings within the grooves 32 being formed with a reduced axial thickness for permitting slight axial adjustment of the rotor. These clearance rings efficiently prevent the leakage of steam between the initial series of vanes 14 of the primary set and the initial series of vanes 22 of the adjacent secondary set, without the necessity of employing a dangerously close clearance about the periphery of the rotor between said series of vanes.

The channels 34 are preferably formed of a

considerably greater depth than the radial width of the rings 33 therein, thereby providing space for a packing of asbestos, or other suitable non-conducting material, 35; such non-conducting packing acting to prevent conduction of heat through the casing from the initial steam chamber 3.

In the operation of my invention, steam is maintained at any desired pressure within the initial annular steam chamber 3. An annular series of admission ports 36 are constructed to receive the steam from the initial chamber 3 and direct it at an efficient angle inwardly through the initial annular series of vanes 14; the steam then being directed alternately outwardly and inwardly through the successive remaining series of the primary set of vanes 15, 16, 17, 18, 19, 20 and 21. Such primary set of vanes is constructed to provide a sufficient expansion of the steam to cause its discharge at substantially atmospheric pressure from the final series of vanes 21 into the primary annular exhaust chamber 37 at the end of the turbine casing. This provides a very efficient construction, since it minimizes all tendency of the steam to leak from the annular chamber 37 past the end of the rotor. Further, any slight leakage which might occur past the end of the rotor would be at atmospheric pressure, and there would be no escape of steam outward from the turbine casing, or leakage of air thereinto, about the rotor shaft.

The steam is conducted from the primary exhaust chamber 37 by a conduit 38 and branch passages 39, 40 to the annular initial steam chambers 41 and 42 of the two secondary sets of vanes; such steam chambers 41 and 42 may be made of sufficient capacity to constitute receivers, if desired. It will be noted that the steam is maintained at substantially atmospheric pressure in the annular chamber 42 at the end of the casing, thereby minimizing all tendency of the steam to leak from said annular chamber past the end of the rotor. Further any slight leakage which might occur past the end of the rotor would be at atmospheric pressure, and there would be no escape of steam outward from the turbine casing, or leakage of air thereinto, about the rotor shaft.

The steam is conducted from the annular chamber 41 by a series of ports 43, which direct it at an efficient angle inwardly through the initial annular series of vanes 22 of one of the secondary sets. The steam is then directed alternately outwardly and inwardly through the successive remaining series of such secondary set 23, 24, 25, 26, 27, 28 and 29; and is finally discharged at condenser pressure from the final series of vanes 29 into the final annular exhaust chamber 4. The steam is directed in an exactly similar manner from the annular

chamber 42 through the other secondary set of vanes 22^a, 23^a, 24^a, 25^a, 26^a, 27^a, 28^a and 29^a, and discharged at condenser pressure in the final exhaust chamber 4; conduits 44 being provided for maintaining the annular final exhaust chamber 4 in free communication with a suitable condenser.

From the above description, it will be seen that my invention provides a simple and efficient construction free from the defects caused by the leakage losses of steam, and in which an efficient degree of condenser vacuum can be maintained without danger of leakage of air or of steam under pressure thereinto. Further, my invention provides an improved construction for conducting the initial portion of the steam expansion in a single primary set of vanes, and completing the remaining portion of the steam expansion in two secondary sets of vanes. This splitting of the actuating steam after its passage through the primary set of vanes enables the vane width of such set to be doubled for a given width of the secondary vanes; thereby providing a compound construction in which the initial series of vanes can be given sufficient width to obviate frictional and other losses, while maintaining the width of the final series of vanes within the practical limits necessary for a rigid construction and efficient operation.

I have illustrated and described my invention adapted to a radial-flow type of turbine, but, obviously, it could be adapted to an axial-flow turbine; and changes could be made within the spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a turbine, the combination of a casing, a rotor therein, a plurality of annular series of vanes on said rotor, means for directing steam through a primary portion of said series of vanes and discharging it at one end of the casing, means for conducting such discharge simultaneously to the two end series of the remaining series of vanes, and means for directing the discharge in opposite directions through said remaining series of vanes, substantially as described.

2. In a turbine, the combination of a casing, a rotor therein, a plurality of annular series of vanes on said rotor, means for directing steam through a primary portion of said series of vanes and discharging it at one end of the casing, means for conducting such discharge simultaneously to the two end series of the remaining series of vanes, means for directing the discharge in opposite directions through said remaining series of vanes, and a common exhaust arranged intermediate of said remaining series for receiving the discharge therefrom, substantially as described.

3. In a turbine, the combination of a cas-

ing, a rotor therein, a plurality of annular series of vanes on said rotor, means for directing steam through a primary portion of said series of vanes and discharging it at one end of the casing, and means for conducting such discharge simultaneously to the series of vanes at the other end of the turbine casing and to the series of vanes adjacent such primary portion, substantially as described.

4. In a turbine, the combination of a casing, a rotor therein, a plurality of annular series of vanes on said rotor, means for directing steam through a primary portion of said series of vanes and discharging it at one end of the casing, means for conducting such discharge simultaneously to the series of vanes at the other end of the turbine casing and to the series of vanes adjacent such primary portion, and means for directing the discharge in opposite directions through the remaining series of vanes, substantially as described.

5. In a turbine, the combination of a casing, a rotor therein, a plurality of annular series of vanes on said rotor, means for directing steam through a primary portion of said series of vanes and discharging it at one end of the casing, means for conducting such discharge simultaneously to the series of vanes at the other end of the turbine casing and to the series of vanes adjacent such primary portion, means for directing the discharge in opposite directions through the remaining series of vanes, and a common exhaust arranged intermediate of said remaining series for receiving the discharge therefrom, substantially as described.

6. In a turbine, the combination of a casing, a rotor therein, an axially-arranged plurality of annular series of vanes on said rotor, means for directing steam through a portion of said series of vanes and discharging it at one end of the casing, means for conducting such discharge to the two end series of the remaining series of vanes, and means for directing such discharge from said two end series toward the medial portion of the remaining series of vanes, substantially as described.

7. In a turbine, the combination of a casing, a rotor therein, an axially-arranged plurality of annular series of vanes on said rotor, means for directing steam through a portion of said series of vanes and discharging it at one end of the casing, means for conducting

such discharge to the two end series of the remaining series of vanes, and means for directing the discharge from each of said end series of vanes successively through the interposed series of vanes to the medial portion of said remaining series, substantially as described.

8. In a turbine, the combination of a casing, a rotor therein, a primary set and two secondary sets of vanes carried by said rotor, means for directing steam through said primary set and discharging it at one end of the turbine casing, and means for conducting said discharge to said two secondary sets of vanes, substantially as described.

9. In a turbine, the combination of a casing, a rotor therein, a primary set and two secondary sets of vanes carried by said rotor, means for directing steam through said primary set and discharging it at one end of the turbine casing, means for conducting said discharge to said two secondary sets of vanes, and means for directing the steam in opposite directions through said two secondary sets of vanes, substantially as described.

10. In a turbine, the combination of a casing, a rotor therein, a primary set and two secondary sets of vanes carried by said rotor, means for directing steam through said primary set and discharging it at one end of the turbine casing, means for conducting said discharge to said two secondary sets of vanes, means for directing the steam in opposite directions through said two secondary sets of vanes, and a common exhaust arranged intermediate of said two secondary sets for receiving the discharge therefrom, substantially as described.

11. In a turbine, the combination of a casing, a rotor therein, a primary set of rotor vanes constructed to discharge at one end of the turbine casing, two secondary sets of rotor vanes constructed to receive steam, respectively, adjacent said primary set and at the end of the turbine casing furthest removed therefrom, means for directing steam through said primary set, and means for directing the discharge from said primary set through said two secondary sets, substantially as described.

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

RICHARD H. GOLDSBOROUGH.

Witnesses:

ALEX. L. STEUART,
G. AYRES.