No. 826,885. PATENTED JULY 24, 1906.

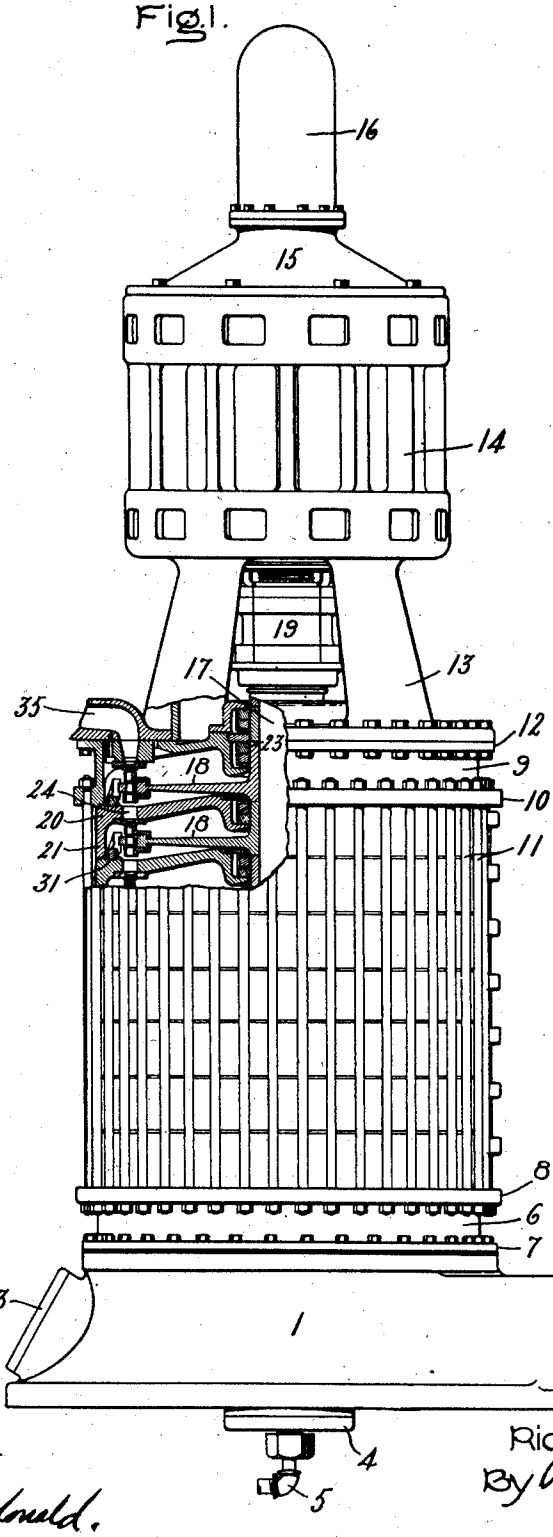
R. H. RICE.

ELASTIC FLUID TURBINE.

APPLICATION FILED JAN. 23, 1906.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
J. Ellis Glen
Alex. F. Macdonald.

Inventor,
Richard H. Rice,
By Albert G. Davis
Att'y.

No. 826,885. PATENTED JULY 24, 1906.

R. H. RICE.

ELASTIC FLUID TURBINE.

APPLICATION FILED JAN. 23, 1906.

2 SHEETS—SHEET 2.

Fig. 2.

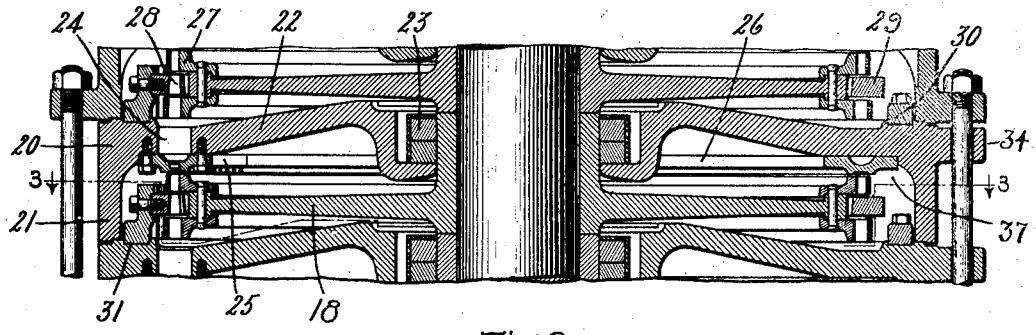
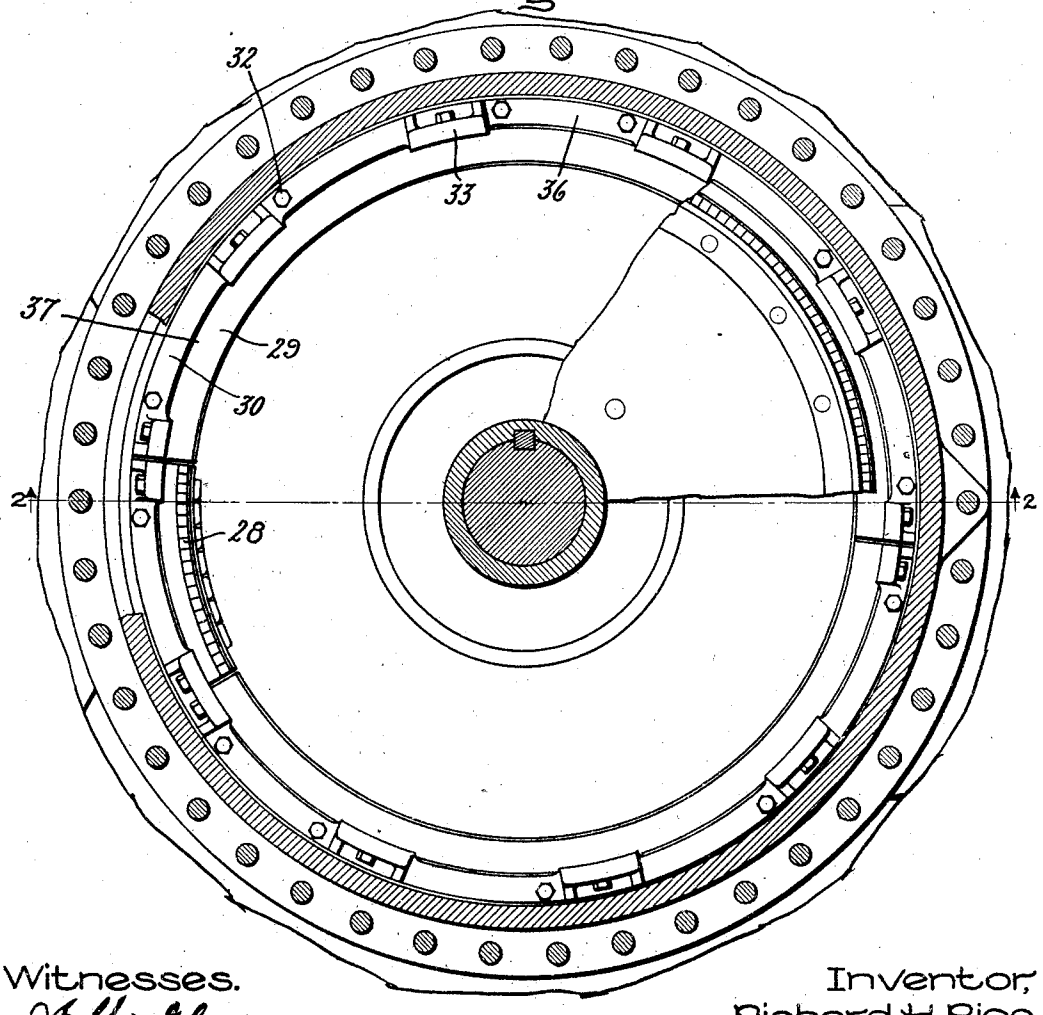


Fig. 3.



Witnesses.
J. Ellis Glen.
Alex. F. Macdonald.

Inventor,
Richard H. Rice,
By Albert G. Davis
Att'y.

UNITED STATES PATENT OFFICE.

RICHARD H. RICE, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 826,885. Specification of Letters Patent. Patented July 24, 1906.

Application filed January 23, 1906. Serial No. 297,396.

To all whom it may concern:

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

The present invention relates to elastic-fluid turbines, and has for its object to improve their construction whereby the parts may be more easily and accurately alined in assembling and more readily taken down.

Other features of novelty will be more fully pointed out in the specification and the claims appended thereto.

In the accompanying drawings, which illustrate one of the embodiments of my invention, Figure 1 is a side elevation, with certain of the parts broken away, of a turbo-generator of the vertical-shaft type. Fig. 2 is an axial section taken on line 2 2 of Fig. 3, and Fig. 3 is a horizontal section taken on line 3 3 of Fig. 2.

1 represents the base of the turbine, which is provided with an outlet 2 and a manhole 3. Supported by the bottom wall of the base is a step-bearing 4, to which lubricant under pressure is supplied by the conduit 5. The upper surface of the base is finished off true, and mounted thereon is a ring 6, having outwardly-extending flanges 7 and 8. The former is bolted to the base, while the latter is arranged to receive the vertically-extending bolts which clamp the parts of the turbine-casing together. By reason of the construction shown the nuts for the bolts or rods are accessible from the outside of the machine, and it is unnecessary in assembling or taking down the machine for work to be done inside of the base. The bolts extending through the lower flange into the base may or may not be provided with nuts, as desired. I prefer to tap the upper surfaces of the base and to tighten the bolts from the outside.

The casing of the turbine is divided into sections, each section being shouldered to receive the adjoining section above and below it. Each section is like every other section both in shape and size. This means that the cost of construction is reduced to a minimum and, further, that the number of stages can be increased or decreased at will. A machine of this type is particularly valuable for experimental purposes where it is desired to make exhaustive tests under different conditions—for example, with various numbers of stages and different character of nozzles or discharging devices and changed bucket shapes. At the upper end of the machine is a ring 9, which is similar in general construction and shape to the ring 6. This ring is inverted with respect to the lower ring—that is to say, the heavy flange 10 is opposed to the heavy flange 8 and is arranged to receive the upper ends of the retaining-bolts 11. The upper flange 12 is adapted to receive the base portion of the stool 13, supporting the electric generator 14. The generator is provided with a cover 15, carrying a dome 16, the latter inclosing a shaft-governor. A vertical shaft 17 is provided that is common to the wheels 18 of the different stages and to the rotating member of the generator. The shaft is supported at the lower end by the step-bearing 4 at an intermediate point above the turbine by the guide-bearing 19 and at the upper end by a bearing (not shown) that is carried by the frame of the generator.

Referring to Fig. 2, the detail construction of the parts will be more fully described. With the exception of the top and bottom rings 6 and 9 the construction of the different stages is identical. Each comprises a section 20, having a cylindrical portion 21 and a diaphragm 22, formed integral therewith. The hub of the diaphragm is provided with a recess to receive the pressure-seated packing 23, the latter resting on the wall at the bottom of the recess and engaging the periphery of the hub of the wheel 18. The diaphragm is provided with one or more openings 24, communicating with the nozzle 25. The latter is bolted to the under side of the diaphragm and may be expanding or non-expanding in character. Preferably the nozzle-sections are closely associated, so as to deliver the fluid in the form of a solid jet or column to the bucket-wheels. As many of these nozzle-sections are provided as are desired, and the space between the nozzle-sections is connected by a ring-like structure 26, located close to the edges of the wheel-buckets to reduce rotation losses. By preference the nozzles are made in a segment separate from the ring 26; but, if desired, they can be made in the same piece. The bucket-wheels are each provided with two rows of buckets 27, secured by any suitable means. While I have shown two rows

of wheel-buckets per stage, it is to be understood that a greater number may be employed. I may employ two or more rows of wheel-buckets in each of the high-pressure stages and one or more rows in each of the low-pressure stages, or the reverse. In this respect the arrangement shown is exceedingly flexible. When I desire to increase the number of rows of wheel-buckets per stage, the cylindrical portion 21 of a casing-section is lengthened, and since these casing-sections and diaphragms are so designed that the mold can be made with a sweep it is a simple matter to change the dimensions and also to change the number of passages 24 leading to the nozzle. Where two or more rows of wheel-buckets are provided for each stage, it is necessary to provide intermediate or stationary buckets for reversing the direction of steam or other motive fluid in passing from one row of wheel-buckets to the other. In the present illustration 28 represents these intermediate buckets. In the upper or high pressure stages they extend only partially around the wheel, as shown in Fig. 3, the balance of the space between the rows of wheel-buckets being filled with the blank wall or ring 29. The object of this wall or ring is to decrease the rotation losses by preventing or largely reducing the fan-like action of the buckets. These blank walls are more important in the high-pressure stages than in the low, because the rotation losses are greatest where the pressure and density of the motive fluid are high. I may therefore omit the walls in some of the low-pressure stages, if desired. The intermediate buckets and the walls 29 are carried by a ring which is split in two or more segments. In the present construction the ring is split into two parts. The ring is seated in a groove 31, formed in the upper side of the diaphragm, and is anchored by the bolts 32. The upper surface of the ring is provided at intervals with projections 33, to which the intermediate buckets 28 are bolted and also the blank ring 29. This arrangement of parts is of special advantage in alining the nozzles, wheel, and intermediate buckets. Experience has demonstrated that inaccuracies in alinement are not uncommon and that they result in more or less serious losses in efficiency, owing to the fact that the steam or other elastic fluid discharged from one row of buckets does not freely enter the adjacent row of buckets, but strikes either the buckets or the covering, and the result is that more or less steam is discharged through the clearances into the wheel-chamber, and its effect so far as that particular stage is concerned is lost, although it is used in the subsequent stages, with the exception of the last, where it enters the chamber in the base and passes to the condenser or to atmosphere. In order to insure the proper angular relation of the casing, sections, nozzles, intermediate buckets, &c., each section is provided with a projection 34, adapted to receive or engage one of the retaining-bolts 11. When the machine is assembled, these projections are arranged one above the other.

With the arrangement described the following method of procedure is employed in assembling the parts. The base is first mounted in position and afterward the base-ring 6. Then the shaft and one of the wheels are mounted in position. The segmental ring or support 30, with its attached intermediates or intermediates and blank wall, is mounted in place in the grooves 31 on the upper side of the wall of the diaphragm. By looking down through the buckets or using proper measuring instruments the alinement can be accurately determined, and if the parts do not line properly they can be removed and the necessary changes made, such as putting shims between the intermediate buckets and the holding-ring or turning off more or less metal. After the buckets have been mounted in place and properly alined the next casing-section is slipped over the shaft and the packing 23 dropped in place, and then a wheel is mounted on the shaft and the same procedure followed as above stated. After the upper ring 9 is slipped into place over the ends of the bolts 11 the nuts thereon are tightened to hold the various sections of the casing together. The stool for the generator and the generator are then mounted on the ring 9, that contains a wall or head for the upper end of the turbine. Steam or other elastic fluid is admitted to the machine by the conduit 35. The admission of motive fluid to the turbine and to the various stages may be controlled in any suitable manner. It will be noted that between the projections 33 passages 36 are provided which communicate with the chamber 37 surrounding the wheel-buckets. This permits the leakage to freely enter the wheel-chamber and flow with the main body of motive fluid to the nozzles leading to the next stage.

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 apparatus shown is only illustrative and that the invention can be carried out by other means.

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

1. In an elastic-fluid turbine of the multi-stage type, the combination of a member containing an exhaust-chamber, a ring having opposed flanges bolted thereto, a second flanged ring at the opposite end of the turbine, an intermediate casing-section between said rings, a diaphragm formed integral with said section, shoulders between the rings and the section, and a plurality of longitudinal

bolts situated outside of the casing-section which pass through the opposed flanges on the rings for securing the rings and casing-section together.

2. In an elastic-fluid turbine, the combination of a casing made up of sections, the plane of division being at right angles to the axis, a diaphragm for dividing the casing into wheel-compartments, wheels for the compartments having rows of buckets for abstracting the energy of the motive fluid by successive fractions, intermediate buckets between the rows of buckets for reversing the direction of flow of the motive fluid, and a support for the intermediate buckets carried by the diaphragm on the exhaust side of the wheel so that they can be alined with the wheel-buckets before the inclosing casing is mounted in place.

3. In a multistage turbine, the combination of a casing comprising a plurality of sections arranged to be mounted in place one after the other, the plane of division being at right angles to the wheel-shaft, wheels for the sections, rows of buckets on the wheels for abstracting the energy of the motive fluid by successive fractions, intermediate buckets for reversing the direction of flow of the motive fluid between wheel-buckets, diaphragm supported by the casing-sections for separating the wheels and forming stages of expansion, devices discharging motive fluid to the buckets, and supports for the intermediate buckets of each stage that are supported by the diaphragms on the low-pressure sides of the wheels so that they can be successively alined and the turbine assembled by alternately mounting the wheels and casing-sections in place.

4. In a turbine, the combination of a casing arranged in sections, a diaphragm between sections, a wheel having rows of buckets for abstracting the energy of the motive fluid by successive fractions, intermediate buckets between the rows of wheel-buckets for reversing the direction of the motive fluid, and a support for the intermediate buckets which is mounted on a diaphragm and extends longitudinally of the turbine-axis to permit alinement of the intermediate and wheel buckets before one of the casing-sections is mounted in place.

5. In a turbine, the combination of a casing arranged in sections, a diaphragm between sections, a wheel having rows of buckets for abstracting the energy of the motive fluid by successive fractions, intermediate buckets between the rows of wheel-buckets for reversing the direction of the motive fluid, a blank wall located between the wheel-buckets in the space not occupied by the intermediate buckets to reduce rotation losses, and a support common to the intermediates and the walls which is mounted on a diaphragm and extends longitudinally of the turbine-axis to permit alinement of the buckets and walls before one of the casing-sections is mounted in place.

6. In a multistage turbine, the combination of a casing made in sections, a diaphragm coöperating with the sections to form wheel-chambers, wheels for the compartments having rows of buckets, intermediate buckets between the rows of wheel-buckets, a blank wall located between the wheel-buckets in the space not occupied by the intermediate buckets to reduce rotation losses, means for supporting the intermediate buckets and blank wall carried by a diaphragm, the said means being provided with passages communicating with the wheel-chamber through which motive fluid leaking from the clearances is free to pass to a wheel-chamber.

7. In a multistage turbine, the combination of a casing made in sections, a diaphragm coöperating with the sections to form wheel-chambers, wheels for the compartments having rows of buckets, intermediate buckets between the rows of wheel-buckets, a blank wall located between the wheel-buckets in the space not occupied by the intermediate buckets to reduce rotation losses, a ring mounted on the diaphragm, projections on the ring to which the intermediate buckets and the wall are secured, and passages between the projections communicating with a wheel-chamber to discharge leakage from the clearances thereto.

8. In a multistage turbine, the combination of a casing made in sections, a diaphragm coöperating with the sections to form wheel-chambers, wheels for the compartments having rows of buckets, intermediate buckets between the rows of wheel-buckets, a blank wall located between the wheel-buckets in the space not occupied by the intermediate buckets to reduce rotation losses, a nozzle having passages arranged to discharge motive fluid against a portion only of the wheel-buckets, a blank wall forming a continuation of the nozzle and covering the idle-wheel buckets and situated between the wheel-buckets and in line with the nozzle, a blank wall situated between the rows of idle-wheel buckets and in line with the first-mentioned wall to further decrease the rotation losses, and a means for supporting the intermediate buckets and their adjacent blank wall from a diaphragm on the low-pressure side of the wheel to permit alinement of the buckets before a casing-section is mounted in place.

9. In an elastic-fluid turbine, the combination of a wheel, rows of buckets on the wheel, a casing for the wheel comprising a surrounding wall, a wall on the high-pressure side, and a wall on the low-pressure side of the wheel, a nozzle located on the high-pressure side of the wheel, intermediate buckets between the rows of wheel-buckets, and a support for the intermediate buckets which is carried by the

wall on the low-pressure side, substantially as and for the purpose described.

10. In an elastic-fluid turbine, the combination of a wheel, rows of buckets on the wheel, a casing for the wheel comprising a surrounding wall, a wall on the high-pressure side, and a wall on the low-pressure side of the wheel, a nozzle carried by the wall on the high-pressure side of the wheel, a nozzle carried by the wall on the low-pressure side, intermediate buckets between the rows of wheel-buckets, a groove formed in the wall on the low-pressure side of the wheel, a support mounted in the groove, a groove in the support to receive the base portion of the intermediate buckets, and means for attaching the buckets to the support.

11. In a multistage turbine, the combination of a plurality of casing-sections, each comprising a cylindrical portion and a diaphragm, the said sections being arranged to fit loosely one on the other, retaining-bolts that extend longitudinally of the casing for clamping them together, fluid-discharging devices for the sections, and a projection on each of the sections which engages a bolt to insure the proper angular alinement of the discharging devices when the sections are assembled.

In witness whereof I have hereunto set my hand this 20th day of January, 1906.

RICHARD H. RICE.

Witnesses:
JOHN A. MCMANUS, Jr.,
CHARLES K. TRIPP.