No. 873,041. PATENTED DEC. 10, 1907.

A. T. GRAY.

CONDENSER FOR ELASTIC FLUID TURBINES.

APPLICATION FILED DEC. 24, 1903.

2 SHEETS—SHEET 1.

Fig. 1.

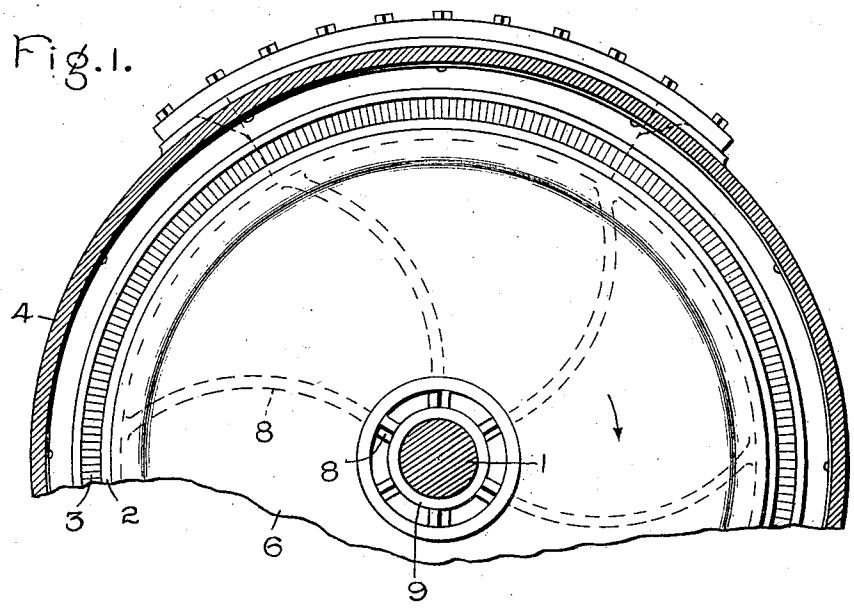


Fig. 2.

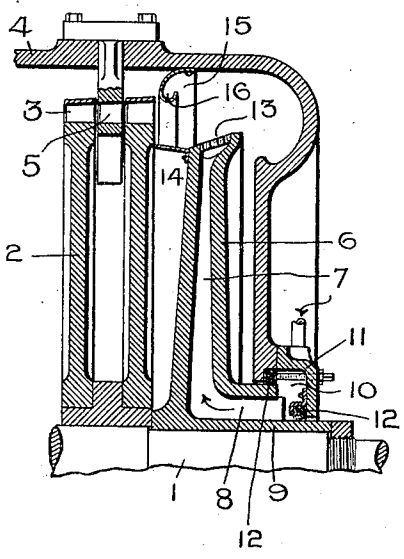
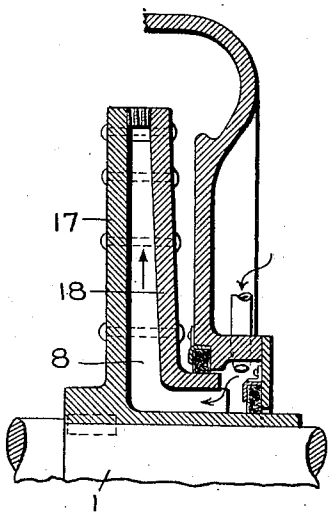


Fig. 3.



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CONDENSER FOR ELASTIC FLUID TURBINES.

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2 SHEETS—SHEET 2.

Fig. 4.

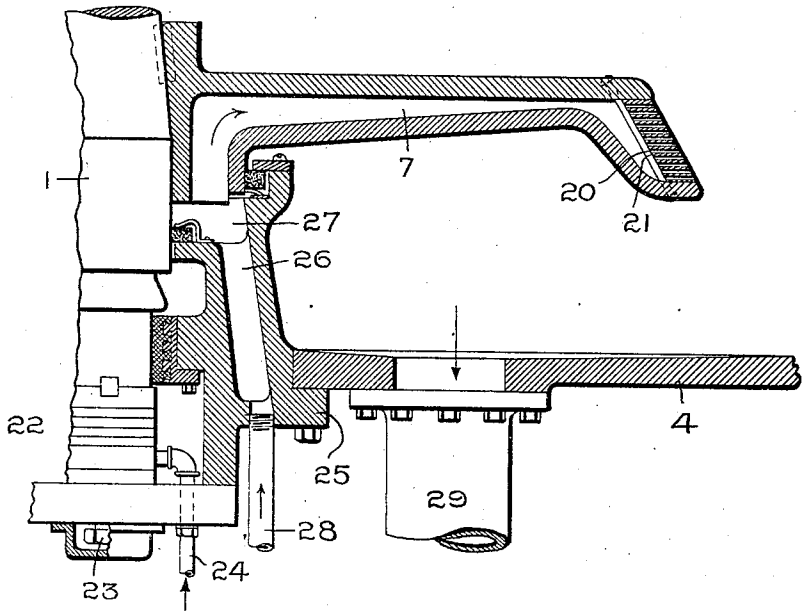


Fig. 5.

Fig. 6.

Fig. 7.

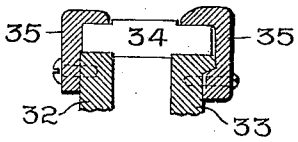


Fig. 8.

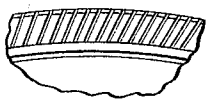


Fig. 9.

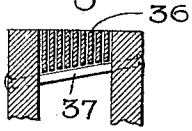
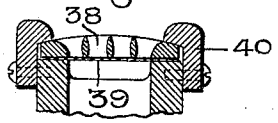


Fig. 10.



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Att'y.

UNITED STATES PATENT OFFICE.

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CONDENSER FOR ELASTIC-FLUID TURBINES.

No. 873,041. Specification of Letters Patent. Patented Dec. 10, 1907.

Application filed December 24, 1903. Serial No. 186,447.

To all whom it may concern:

Be it known that I, ALEXANDER T. GRAY, a subject of the King of Great Britain, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Condensers for Elastic-Fluid Turbines, of which the following is a specification.

The present invention has for its object to provide a turbine-condenser unit of the jet type which shall have a high efficiency, occupy a relatively small space, and contain a minimum number of parts.

In carrying out the invention, a water-distributing means, such as a wheel, is mounted in the turbine casing adjacent to the last bucket wheel, so that the steam or other motive fluid discharged from the working passages between buckets will be caused to mix intimately with the jets or streams of water discharged by the said means. In addition to serving as a part of the condenser the water-discharging wheel, being carried by the turbine shaft, has a fly-wheel effect, which is advantageous in machines having relatively light rotating parts.

The primary or underlying feature of the invention is the employment of a means arranged to discharge water in such a manner that it will mix intimately with the exhaust motive fluid as soon as it leaves the wheel.

As a secondary feature it consists in the use of a hollow disk-wheel revolving at a high speed into which the cooling water flows, either under head or due to the pump-like action of the wheel. As the wheel revolves, it imparts to the water considerable pressure, which pressure may be utilized in a variety of ways.

The invention is applicable to various types of turbines, whether they have one or more wheels per stage, and whether they act on the impact or reaction principle. The motive fluid may flow in an axial or radial direction, or it may flow in a combined axial and radial direction, providing it can be discharged against or into the many streams of water discharged from the wheel. The method of supplying water to the wheel will be governed chiefly by the character of the supply. Where the difference in head between the turbine and source of supply is relatively small the cooling water will flow into the discharging device within the turbine casing due to the vacuum therein, but where considerable difference in head exists it is necessary to include a pump between the source of supply and the points of discharge, and preferably this pump is situated within the casing. As the bucket wheel rotates it imparts a whirling motion to the exhaust motive fluid, and a similar motion is imparted to the small streams of cooling water, which also have a path at substantially right angles to that of the exhaust, thereby causing an intimate mixing of the steam and water, resulting in a high vacuum. As the wheel rotates under relatively high speed, the cooling water is discharged under considerable pressure, and by properly designing and spacing the discharge orifices it issues in a finely divided state.

Between the bucket and water wheels, which are preferably separate structures for convenience in manufacturing, is a deflector or directing plate which serves to prevent steam and water from being caught between them and also serves to direct the steam in the most efficient way against the water-discharging wheel. In order to prevent the cooling water from falling on the turbine wheel, and thereby reducing its temperature, it is preferable to provide a division or separating plate that is carried by the casing or by the bucket wheel itself. I prefer the former arrangement, since the heat from the wheel will not be directly imparted thereto, and there will be a consequent saving in energy.

The water-discharging wheel may be constructed in a variety of ways, depending upon the conditions of operation. It is preferably composed of disks arranged side by side on the turbine shaft, with a chamber formed between them so arranged as to insure an even flow. It is advantageous to place ribs, preferably curved, between the disks to insure good distribution of the cooling water and also to strengthen the wheel. The rim of the wheel can with advantage be flared in order to secure good distribution of the cooling water, and the amount of flare is determined by the quantity of cooling water to be discharged. The rim of the wheel may be made in a variety of ways, for example, of detachable pieces of metal or a solid piece. In the former case, the pieces may be separated one from the other to form discharge spaces; in the latter case the rim is filled with holes of suitable shape. In order to lessen

the work of driving and to give a more effective spray, the holes in the rim, or the spaces between the built-up parts of the rim, may each extend obliquely with respect to a radius. In constructions where the rim has relatively large discharge orifices, it will be found advantageous to place a screen near said orifices to cause the water to be formed into a dense spray.

The invention is applicable both to horizontal and vertical machines. When used in connection with the latter, cooling water may be received through a passage formed in the casing of the step-bearing, the upper end of which is enlarged to form a water-containing chamber.

In most turbines, especially those of large size, where the low-pressure nozzles or discharging devices extend entirely around the last wheel or substantially so, it is satisfactory to have the discharge of the cooling water take place at all points around the bucket. On the other hand, where the nozzles extend only partly around the wheel, it will be found advantageous to check the flow of water by means of a hood except for that arc covered by the nozzles, and in this manner decrease the amount of water used.

In the accompanying drawings, which illustrate one embodiment of my invention, Figure 1 is a cross-section of an elastic-fluid turbine; Fig. 2 is a partial longitudinal section of a jet turbine showing the relation of the bucket and water-discharging wheels; Fig. 3 is a partial longitudinal section showing a modified form of water-discharging wheel; Fig. 4 is a partial vertical section showing the invention applied to a vertical turbine; Fig. 5 is a sectional detail view of a part of the water-discharging wheel, showing the character of the discharge orifices; Fig. 6 is a similar view showing orifices of a modified character; Figs. 7 and 8 are detail views of a modified form of wheel construction; Fig. 9 is a further modification wherein the discharge orifices occupy parallel planes at right angles to the axis of the shaft, and Fig. 10 is a further modification wherein a cast grid forms a part of the wheel rim, with a screen for discharging the water in the form of a spray.

1 represents the shaft of the turbine; and mounted therein are one or more wheels 2 having peripheral buckets 3 of any suitable character. Surrounding the wheel is a casing 4. Where two or more rows of wheel buckets are employed in a single stage, a row of intermediate buckets 5 is provided between each pair of wheel buckets, and these intermediates are supported by the casing 4 in the usual manner. Located at the exhaust end of the turbine and inclosed by the wheel casing, is a wheel 6 that may act as a pump and discharges cooling water for the purpose of condensing the steam. The wheel as shown in Fig. 2 consists of a single casting with a plurality of chambers 7 formed therein and separated one from the other by curved ribs 8. These ribs extend between the two disk-like portions or walls of the wheel and also extend for a short distance parallel to the hub 9. At the point where they extend parallel to the hub they may be slightly spiraled in order to assist in raising the water. Owing to the rapid rotation of this wheel, it acts as a pump, but when the water supplied therefor is not under head it will be necessary to prime the wheel at starting. The inclination of the ribs 8 around the hub is clearly shown in Fig. 1. These ribs enter the water-receiving chamber 10 which is formed in a casting 11 that is bolted to the wheel casing. This chamber is provided with two packings 12 for preventing the water from leaking down the outside of the casing and also from leaking into the wheel casing. The periphery of the wheel is flared, and carried thereby is a rim 13 containing a plurality of perforations through which the cooling water is discharged. Between the water-discharging wheel and the bucket wheel is a cylindrical deflector or directing plate 14. This plate is preferably bolted to the water wheel, and extends under a flange on the bucket wheel.

15 represents a division or separating plate which is attached to the wheel casing and extends in close proximity to the bucket wheel. This plate is provided with a curved inner edge which forms a trough 16. The object of this plate is to prevent the cooling water from falling on the bucket wheel and thereby lowering its temperature.

Referring to Fig. 3, a slight modification of the water wheel is shown, it being composed of separate disks 17 and 18 which are bolted together in any suitable manner. This construction is more suitable for high speeds. It is provided with the same arrangement of ribs 8 as described in connection with the previous figures. Being intended for high speed work, it can be employed to lift the cooling water from a tank or other source of supply.

Referring to Fig. 4, the invention is shown applied to a vertical type of turbine. For simplicity of illustration the bucket wheel and intermediates have been omitted. 1 represents the shaft of the machine which occupies a vertical position, and keyed thereto is a water-discharging wheel of a construction similar to that shown in Figs. 1 and 2, the chambers 7 in the wheel being of a form to give an even flow and equal distribution of the cooling water at all points of the periphery. The discharge takes place through a plurality of spaces or orifices 20 formed between plates 21 that are situated one below the other, and are held in place by suitable means. The shaft is supported by a step bearing 22 which is adjusted from the

outside of the casing by an adjusting bolt 23. Lubricant is admitted to the bearing blocks by the pipe 24. Situated above the step bearing is a guide bearing. I can with advantage use water as a lubricant for the step and guide bearings, in which case the packing in the chamber 27 may be dispensed with and the water, after lubricating both of the bearings, be permitted to pass into the chamber and thence to the wheel. The space around the shaft will act as a passage for this purpose. The water flowing into the step bearing is under high pressure, in some instances as high as one thousand pounds per square inch, which pressure is gradually decreased as it passes through the bearings. It is impracticable to supply cooling water directly to the wheel under the high pressure mentioned above, and therefore the supply pipe 28 is connected in a manner to give low-pressure service. It will be advantageous to use the same source of supply for both the bearing and the water-discharging wheel. The step and guide bearings are carried by a casting 25 which is detachably secured to the under side of the wheel casing 4. In this casting is formed a passage 26 that communicates with a chamber 27 at the upper end. This chamber is in constant communication with the wheel chamber or chambers 7. Cooling water is supplied to said chamber by the pipe 28. I may use water under pressure for supplying this chamber, or the wheel may be depended upon to raise the water from a tank or other source of supply, in which case it would be necessary to prime the wheel on starting. The cooling water and condensed steam are collected in the wheel casing and are discharged by the pipe 29.

Referring to Fig. 5, a section of the water wheel is shown wherein the rim or flange is provided with discharge orifices 30 which flare outwardly. The object of this arrangement is to insure the formation of spray, as distinguished from small streams of water.

In Fig. 6 the water-discharging orifices 31 are bored straight or substantially so, and each hole is formed obliquely with respect to a radius.

In Figs. 7 and 8 is shown a type of wheel suitable for high-pressure work. 32 and 33 represent disks which are bolted or otherwise secured together, and which are preferably provided with the ribs 8 previously referred to. The periphery of each disk is turned true, and mounted thereon is a plurality of bars 34 which are separated one from the other by small spaces through which the water is discharged. These spaces are preferably located at an angle with respect to a radius. The bars are held in place by clamps 35 which are detachably secured to the disks.

Fig. 9 shows a construction wherein a plurality of thin turned rings 36 are employed, with small spaces between them. This construction is also a desirable one for high pressure work. The rings are held in place by bolts 37 which pass through both disks.

In Fig. 10 is shown a construction which is suitable where large volumes of water are to be employed. The construction comprises a cast-metal grating 38 having relatively large openings formed therein, with a screen 39 placed between it and the periphery of the disks. The grating is held in place by clamps 40 having beveled faces which engage with the face of the grating. In this instance, as in those previously described, the size of the parts and the distribution of the metal therein depends upon the speed of the rotation and also on the load which they are to carry.

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. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a means which discharges cooling water in a divided state across the body of vapor at the point where it issues from the wheel.

2. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a means which surrounds the shaft and discharges cooling water in a divided state across the vapor body issuing from the wheel.

3. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a water-discharging wheel mounted on the same shaft with the bucket wheel for discharging water in a finely divided state into the body of vapor discharged by the wheel.

4. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a wheel which has a plurality of orifices located adjacent to the exhaust side of the bucket wheel that discharge cooling water into the body of vapor after it passes through the bucket wheel.

5. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a wheel which has a plurality of discharge orifices that discharge cooling water at substantially right angles to the plane of movement of the vapor from the bucket wheel.

6. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a wheel which has a plurality of orifices having axes that cross the path of the vapor and which discharge cooling water in a di-

vided state into the body of vapor after it passes through the bucket wheel to cause rapid condensation of the vapor, and means for supplying water to the wheel at a point near the hub.

7. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a wheel which increases the pressure of the cooling water and discharges it in a finely divided state across the path of the exhaust vapor from the wheel.

8. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a wheel having a water-containing chamber and a peripheral means containing a plurality of discharge orifices which are common to and communicate with said chamber.

9. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a wheel having a water-containing chamber and a perforated rim through which the cooling water is discharged into the body of vapor from the bucket wheel.

10. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a means surrounding the wheel shaft, which is provided with orifices that discharge the cooling water in the form of a spray.

11. An elastic-fluid turbine comprising a casing and a bucket wheel, in combination with a means for discharging cooling water into the motive fluid after it exhausts from the wheel, and a device for directing the exhaust against said means.

12. An elastic-fluid turbine comprising a casing and a bucket wheel, in combination with a means for discharging cooling water at the place where the motive fluid exhausts from the wheel, and a cylindrical deflector which extends between the bucket wheel and said means.

13. An elastic-fluid turbine comprising a casing and a bucket wheel, in combination with a means for discharging cooling water at the place where the motive fluid exhausts from the wheel, and a device for preventing the cooling water from falling on the bucket wheel.

14. An elastic-fluid turbine comprising a casing and a bucket wheel, in combination with a means for discharging cooling water at the place where the motive fluid exhausts from the wheel, and a division plate or separator which is carried by the casing to prevent the cooling water discharged by said means from falling on the wheel.

15. An elastic-fluid turbine comprising a casing and bucket wheel, in combination with a water-discharging means for condensing the exhaust vapor, a plate for causing the vapor to mingle with the cooling water, and a division plate or separator to prevent the water from falling on the wheel.

16. An elastic fluid turbine comprising a casing and bucket wheel, in combination with a wheel having chambers therein, a peripheral means carried by the wheel and containing a plurality of small orifices which communicate with the chambers and through which liquid from the chambers pass, and a suction chamber for the wheel.

17. An elastic-fluid comprising a casing, relatively moving buckets, and a bearing for the wheel shaft, in combination with a condenser for condensing the vapor exhausted from the turbine which receives its cooling water after it passes through and lubricates the bearing.

18. An elastic-fluid turbine comprising a casing, relatively moving buckets, and a bearing for the wheel shaft, in combination with a condenser, and a conduit for supplying water to the bearing for lubricating purposes and cooling water to the condenser.

19. An elastic-fluid turbine comprising a casing, relatively moving buckets, and a bearing for the wheel shaft, in combination with a condenser, a conduit for supplying water to the bearing for lubricating purposes, and a passage conveying water from the step-bearing to the condenser.

20. An elastic-fluid turbine comprising a casing, relatively moving buckets, and a bearing for the wheel shaft, in combination with a condenser, a conduit for supplying water under high pressure to the step bearing, a passage which conveys the exhaust from the bearing to the condenser, and a conduit which discharges water under a relatively low pressure directly into the condenser.

In witness whereof I have hereunto set my hand this 22nd day of December, 1903.

ALEXANDER T. GRAY.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.