No. 744,727. PATENTED NOV. 24, 1903.

A. R. DODGE.

MEANS FOR IMPROVING THE EFFICIENCY OF TURBINES.

APPLICATION FILED DEC. 13, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

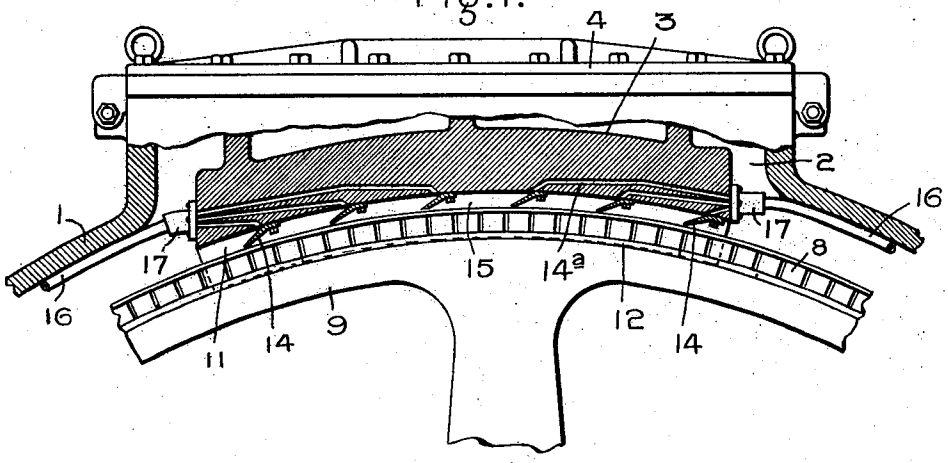
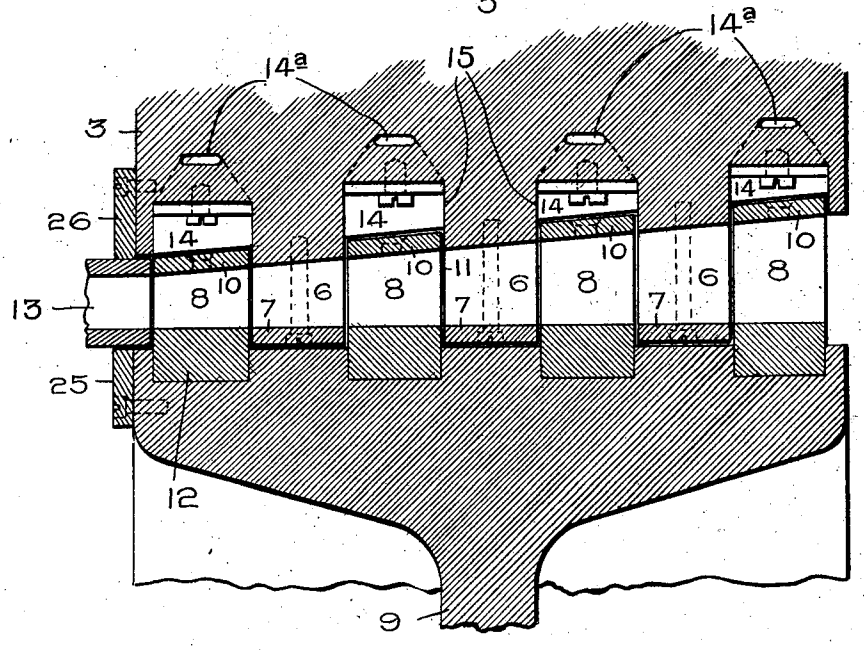


Fig. 2.



Witnesses

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

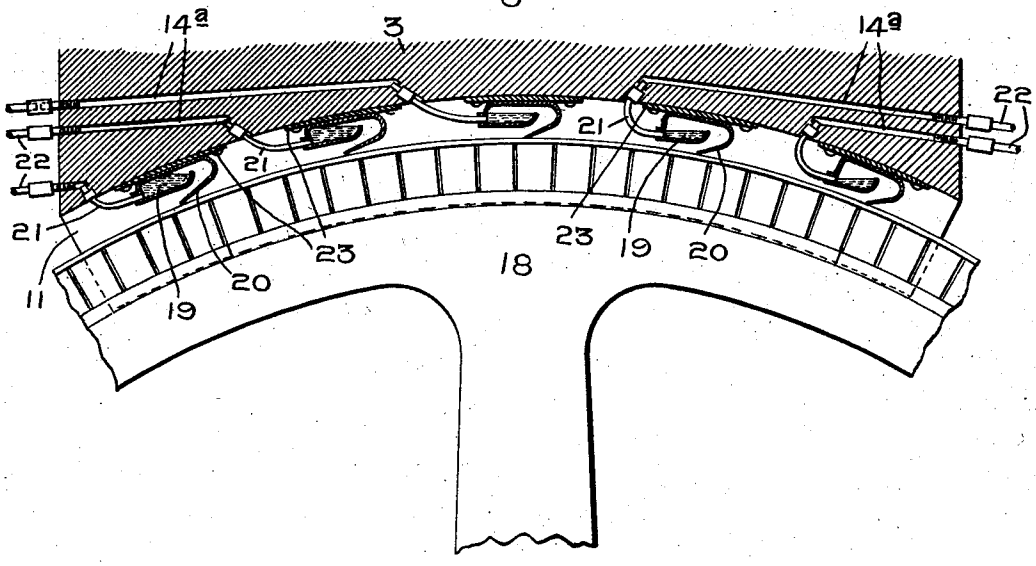
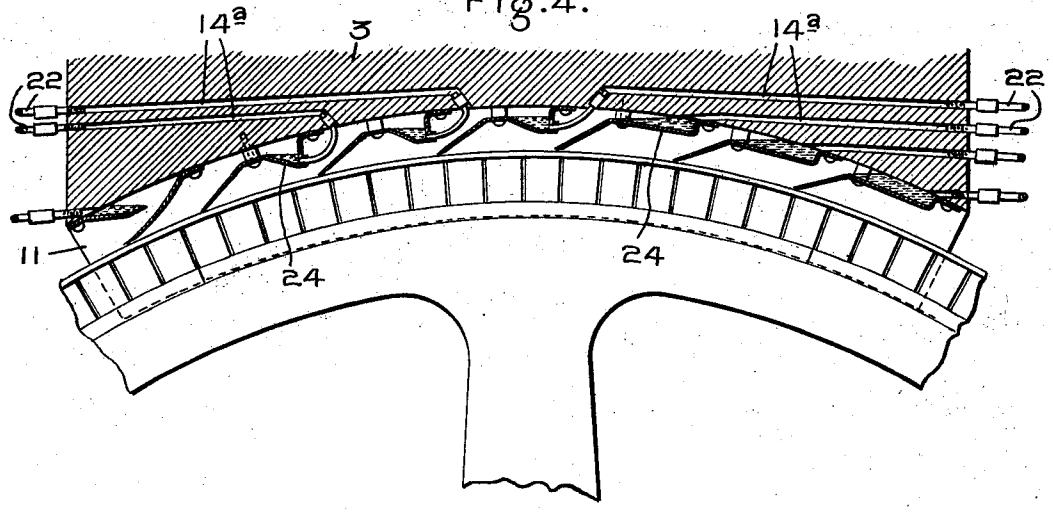


Fig. 4.



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No. 744,727. Patented November 24, 1903.

UNITED STATES PATENT OFFICE.

AUSTIN R. DODGE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MEANS FOR IMPROVING THE EFFICIENCY OF TURBINES.

SPECIFICATION forming part of Letters Patent No. 744,727, dated November 24, 1903.

Application filed December 13, 1902. Serial No. 135,068. (No model.)

To all whom it may concern:

Be it known that I, AUSTIN R. DODGE, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Means for Improving the Efficiency of Elastic-Fluid Turbines, of which the following is a specification.

In the operation of elastic-fluid turbines it is necessary to provide a clearance between the moving and stationary buckets for mechanical reasons. The amount of this clearance determines the leakage at that point. Attempts have been made to reduce the leakage by placing the support or supports for the intermediate buckets in close proximity to the cover of the moving bucket-wheel. When this clearance is made small enough to have any beneficial result, the water of condensation collects between the wheel-cover and support and acts as a water-brake to retard the movement of the wheel. The presence of water in the steam also is of itself a cause for decrease in efficiency. With expanding nozzles the amount of moisture in the steam is sometimes as high as thirteen per cent. This is dependent wholly or largely upon the character as to expansion of the nozzle and working passage. Where the steam which has had its velocity abstracted wholly or in part is collected and by a second nozzle or set of nozzles is discharged against the buckets of the second stage, I have found by test that a very large percentage of the water is reëvaporated. In a case where the water of condensation in the steam amounts to thirteen per cent. at the end of the first stage tests show that eleven per cent. will be reëvaporated and appear as latent heat in the second stage. Of this amount only a small per cent. is recovered. For the purpose of illustration certain figures have been mentioned which I have found to be correct for a particular turbine running under the usual conditions of service; but I do not wish to be understood as stating that all turbines of the general character described have the same losses, for these will vary somewhat with each turbine or type of turbine. The centrifugal action of the wheel throws the water of condensation out of the working passage against the wall of the casing, where it collects to a certain extent, and the water located directly over the wheel drops back and is again thrown against the casing. This action is continually taking place as steam and water pass through the turbine, and it is evident that there is a certain loss in efficiency owing to the energy required to project the particles of water from the wheel.

The present invention has for its object to improve the efficiency of an elastic-fluid turbine by restricting the flow of the motive fluid to its proper working passages and also by providing means for collecting and discharging the water of condensation.

For a consideration of what I consider to be novel and my invention attention is called to the description and claims appended thereto.

In the accompanying drawings, which represent an embodiment of my invention, Figure 1 is a partial horizontal section of a turbine. Fig. 2 is a detail section at right angles to that of Fig. 1. Fig. 3 is a detail view, partly in section, of a slight modification wherein several chambers are provided which contain water; and Fig. 4 is a further modification in the same general line as that shown in Fig. 3.

1 represents a casing of a turbine, which is provided with an opening 2 to receive the support 3 for the intermediates. The opening is provided with a cover 4, that prevents the escape of motive fluid at this point. The number of sets of intermediate buckets can be varied as desired. The support is provided with as many finished surfaces as there are rows of intermediate buckets, and the number of rows of intermediate buckets varies with the velocity of the fluid-jet employed, being less where the speed of the jet is relatively low and more where a high-speed jet is employed. Detachably secured to the support 3 are rows of intermediate buckets 6, each of which is provided with a cover 7.

Situated between the rows of stationary intermediate buckets are rows of buckets 8, which are detachably secured to the wheel 9. In the smaller sizes the buckets may be formed integral with the wheel-flange; but in the larger sizes it is preferable to form them in segmental strips and then attach the

strips to the wheel. Each row of wheel-buckets extends into the groove 11, formed in the support for the intermediate buckets. The ends of the buckets are closed in by a cover 10, and the edges of the cover are in close proximity to the intermediates. The clearances between the moving and stationary buckets are made as small as possible consistent with good operation. It is obvious that for mechanical reasons it is necessary to leave a small amount of clearance between the parts.

It is to be noted that the wheel-buckets are formed on the cylindrical pieces 12 and that these pieces extend somewhat above the face of the wheel and, in effect, form a groove in which the cover 7 of the stationary buckets is located. The water of condensation is thrown outwardly from the wheel due to centrifugal force, and for this reason the clearance between the cover 7 and the wheel periphery can be made small. A different condition of affairs, however, exists between the cover for the wheel-buckets and the stationary support for the intermediates. If the support for the intermediates is situated in close proximity to the peripheral face of the cover of the wheel-buckets, the water due to condensation will be caught between it and the cover and tend to retard the rotation of the wheel by acting as a brake. To overcome this objection, the groove 11 is made deep, measured on a radial line, and its ends are closed in by leakage-blocks, to be described hereinafter.

The motive fluid is supplied to the turbine by a nozzle 13, which may or may not be of the expanding type. When the nozzle is of the expanding type, the percentage of moisture in the steam is greater than where it is of the non-expanding type. From the point of delivery to the bucket-wheel to the exhaust the cross-sectional area of the working passage, comprising the passages between the moving and stationary buckets, gradually expands or enlarges toward the exhaust. This expansion is provided in order to compensate for the increased volume due to the decreased pressure.

In order to prevent the leakage of steam or other elastic fluid at the ends of the bucket-receiving grooves or chambers 11 formed in the intermediate bucket-support, leakage-blocks 14 are provided, which are situated at or near the ends of the grooves. These blocks are bolted or otherwise secured to the intermediate support and extend toward the wheel, but are separated from the wheel-cover by a small clearance. The ends of the blocks present such a small surface to the wheel-cover that the brake action due to water between the surfaces can be disregarded.

From the construction specified it will be observed that a chamber 15 is formed over each row of wheel-buckets, the top and side walls of which are formed by the intermediates and the support for the intermediates, the other wall being formed by the cover of the wheel-buckets. The ends of the chamber are closed in by the leakage-blocks 14. The clearances between the leakage-blocks and the wheel-covers and between the wheel and stationary buckets being limited affords only a restricted passage for the steam or other elastic motive fluid. Hence the stream or streams will take the path of the least resistance and flow through the working passage or passages formed between the buckets.

The leakage-blocks in addition to acting as a means for preventing the escape of steam have another useful purpose—namely, that of collecting and discharging the water of condensation. In order that water may be collected at a number of points, a number of additional leakage-blocks are provided and situated at suitable points between the end blocks. I have found it desirable to space these blocks equally; but any other arrangement can be employed, if desired.

Formed in the intermediate bucket-support 3 are a plurality of fluid-carrying passages 14^a, each communicating with the groove 11 at a point adjacent to one of the leakage-blocks. These passages preferably, although not necessarily, extend toward a common point, where they discharge into a pipe 16, which communicates with the outside of the casing 1. The pipe is provided with an enlarged head 17, that is bolted to the end of the support 3. The leakage-blocks are inclined to the wheel-periphery, as shown, so that the water discharge through the clearance-space between the discharge end of the bucket and the adjacent intermediate will be collected and delivered to the passages 14^a.

Referring to Fig. 2, it will be seen that the leakage-blocks are given the same inclination as that of the covers on the wheel-buckets. This is done so as to provide as great a restriction for the motive fluid as possible at this point. It is evident that I may operate the turbine without using leakage-blocks except at the ends, and these need not necessarily be arranged to discharge water of condensation to the outside of the turbine-casing; but I prefer to use the passages and the extra leakage-blocks in the manner described. It is also evident that the leakage-blocks can be used in connection with turbine-wheels having other forms of working passages than the one shown.

Referring to Fig. 3, I have shown a slight modification of the invention wherein small collection-chambers are provided to facilitate the collection and discharge of the water. The intermediate support is provided with one or more grooves or chambers 11, as before, and suitably mounted with respect to this groove are the rows of buckets on the wheel 18. Situated at the ends of the groove and also at intermediate points are leakage-blocks comprising a bent strip of metal having a chamber 19 and an inclined wall 20, that is arranged to discharge water collected from

the wheel into the chamber. The chamber itself is connected by a short piece of pipe 21 with the fluid-carrying passages 14^a, the latter being connected by one or more pipes 22 with the outside of the casing. The leakage-blocks are mounted on small supports 23, which in turn are secured to the support 3 by screws. By reason of this construction the leakage-blocks can be readily attached to or detached from their support. In all cases the chambers should be so related to the wheel that they will receive and hold water. The chambers are useful in collecting and delivering the water to the fluid-carrying passages 14^a. The same general construction and arrangement of collection-chambers and leakage-blocks is followed in Fig. 3 as that described in connection with Fig. 1, the only essential difference between the two being the introduction in Fig. 3 of the collection-chambers.

Referring to Fig. 4, I have shown a slight modification of the collection-chambers shown in Fig. 3. In this figure the leakage-block comprises a continuous piece of sheet metal having a depression 24 formed in one end, which depression contains a small amount of water.

In the operation of a turbine fitted with my improved leakage-blocks certain of the fluid-passages 14^a would be drained of their contents by gravity; but owing to the fact that a pressure always exists in the shell the water will be blown out from the collection-chambers and passages by the steam in the wheel-casing. The leakage-blocks can be used in the first or in any subsequent stage, and when the subsequent stages are below atmospheric pressure means will be provided to prevent the entrance of air.

In order to decrease the leakage around the nozzle, a ring 25, Fig. 2, is mounted on the wheel, which runs in close proximity to the nozzle. A second ring 26 is also provided for the same purpose, which is segmental in form and rests directly on the nozzle.

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, the combination of wheel-buckets, intermediate buckets, a support for the intermediate buckets, and a means which is secured to the support for decreasing the leakage between moving and stationary buckets.

2. In an elastic-fluid turbine, the combination of wheel-buckets, intermediate buckets, a support for the intermediate buckets, and leakage-blocks which are detachably secured to opposite points on the support.

3. In an elastic-fluid turbine, the combination of a nozzle, wheel-buckets, intermediate buckets situated between the wheel-buckets, a support for the intermediate buckets having a groove into which the wheel-buckets extend, and means for closing the ends of the groove.

4. In an elastic-fluid turbine, the combination of a nozzle, a wheel having a plurality of working passages formed therein, a cover for the wheel, intermediate buckets situated between the wheel-buckets, a support for the intermediates having a groove into which the cover of the wheel-buckets extends, and means that extend into close proximity to the cover for closing the ends of the groove.

5. In an elastic-fluid turbine, the combination of rows of buckets having inclined peripheral surfaces, intermediate buckets situated between the wheel-buckets, a support for the intermediates which is chambered to receive the wheel-buckets, and leakage-blocks situated in the chamber, each of said blocks being provided with an inclined edge that is presented to the wheel-bucket.

6. In an elastic-fluid turbine, the combination of a nozzle, a driving-shaft, a wheel having a plurality of working passages formed therein, a cover for the wheel which presents a peripheral surface that is inclined slightly with respect to the wheel-shaft, stationary intermediates, and blocks for reducing leakage of the motive fluid, each of which presents an inclined surface to the wheel, the said incline corresponding to that of the wheel-cover.

7. In an elastic-fluid turbine, the combination of a nozzle, a rotating bucket-wheel having working passages formed therein, a chamber into which a portion of the wheel projects, and means located in the chamber for collecting the water of condensation as it is projected from the working passage and discharging it at a point outside of the casing.

8. In an elastic-fluid turbine, the combination of a nozzle, a rotating bucket-wheel having working passages formed therein, and a collecting device situated in proximity to the wheel-buckets for collecting the water of condensation and preventing it from dropping back on the wheel.

9. In an elastic-fluid turbine, the combination of a fluid-discharge passage, a bucket-wheel situated in front of said passage, intermediate buckets, a support for the buckets, fluid-carrying passages formed in the support, and means for delivering fluid into the passages.

10. In an elastic-fluid turbine, the combination of a fluid-discharge passage, a wheel having a row of buckets situated in front of the passage, a support, and means carried by the support for collecting the water of condensation from the wheel and discharging it at a point remote from the wheel.

11. In an elastic-fluid turbine, the combination of wheel and intermediate buckets, a

nozzle for discharging motive fluid against the wheel-buckets, and a means for reducing the leakage of motive fluid between moving and stationary buckets and also for collecting the water of condensation.

12. In an elastic-fluid turbine, the combination of a nozzle, a bucket-wheel, intermediate buckets, and means which confine the motive fluid to the working passages in the wheel and also collect the water of condensation.

13. In an elastic-fluid turbine, the combination of a bucket-wheel, a wheel-casing, a plurality of water-collecting devices which are presented to the ends of the wheel-buckets, a passage for conveying fluid from the devices to the outside of the casing, and a water-collecting chamber which is adjacent to the passage.

14. In an elastic-fluid turbine, the combination of a bucket-wheel, a wheel-casing that works under pressure, a nozzle, means presenting a thin edge to the wheel for collecting the water of condensation, a fluid-carrying conduit for conveying water to the outside of the casing, and a water-collecting chamber situated between the collecting means and the conduit.

15. In an elastic-fluid turbine, the combination of a wheel having a row of buckets with passages between them which extend axially from one side of the wheel to the other, a support containing a circumferential chamber into which a part of the wheel-buckets extend, the ends of the buckets being separated from the wall of the chamber, and means extending across the plane of the wheel for closing the chamber at its ends.

16. In an elastic-fluid turbine, the combination of a wheel having a plurality of rows of buckets, a support containing a plurality of chambers into which a part only of the wheel-buckets project, and means for closing in the ends of the chamber which present a thin edge to the wheel.

In witness whereof I have hereunto set my hand this 12th day of December, 1902.

AUSTIN R. DODGE.

Witnesses:
EDWARD WILLIAMS, Jr.,
ALEX. F. MACDONALD.