Oct. 25, 1927. 1,646,861

H. T. HERR

ELASTIC FLUID TURBINE

Filed March 6, 1925 2 Sheets-Sheet 1

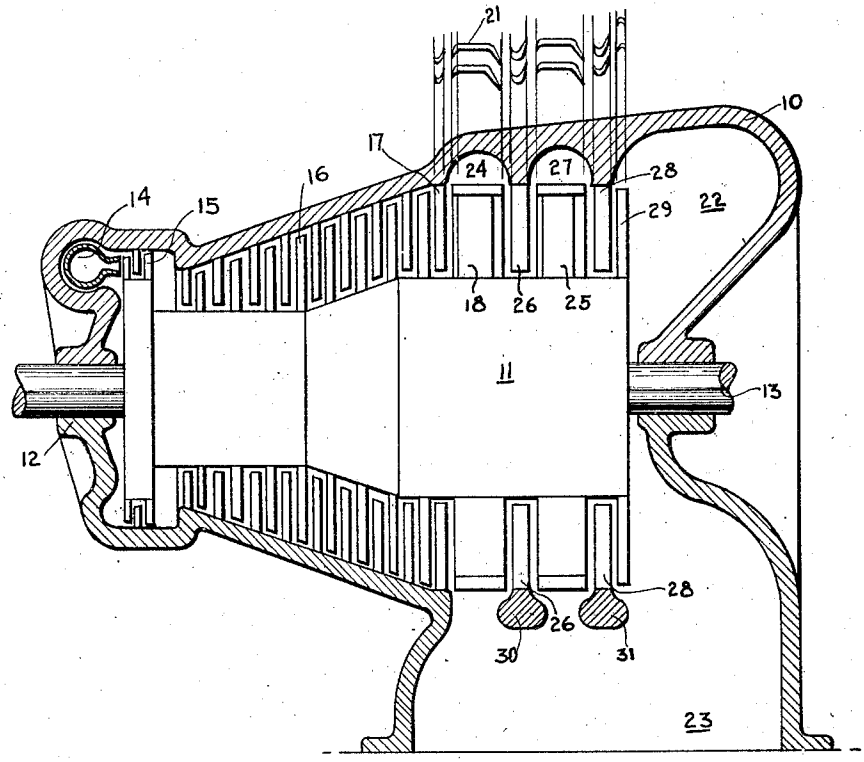


Fig. 1.

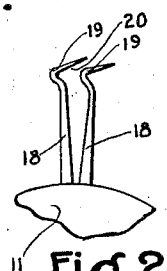


Fig. 2.

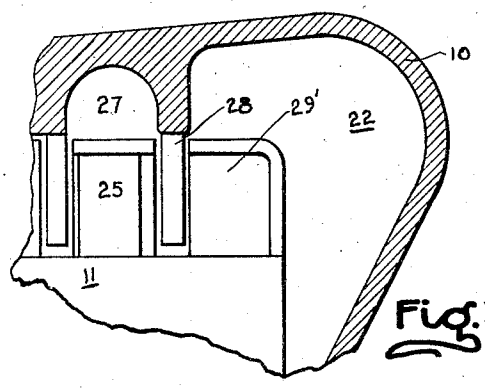


Fig. 3.

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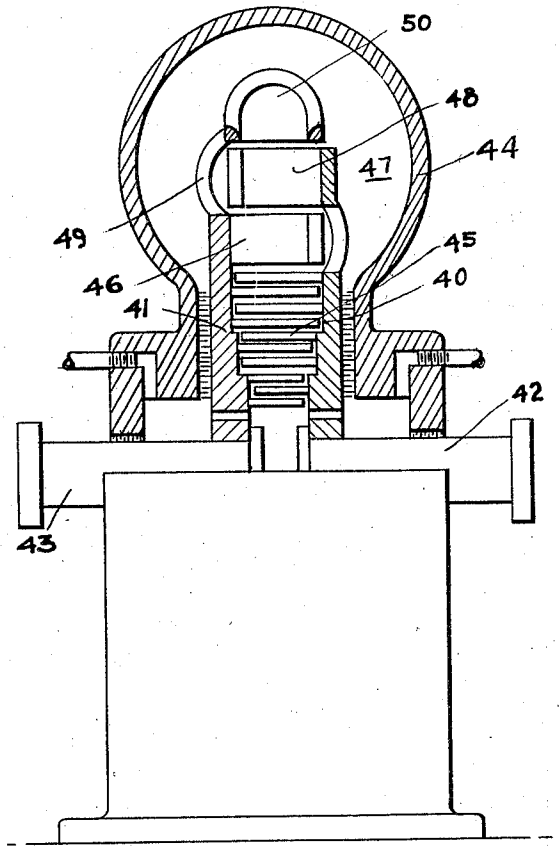


Fig. 4.

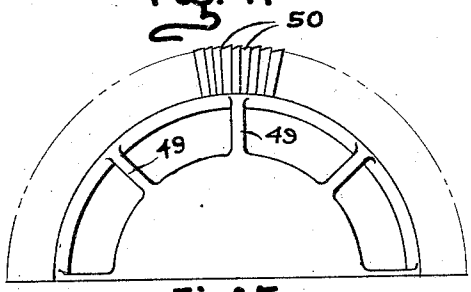


Fig. 5.

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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

Application filed March 6, 1925. Serial No. 13,658.

My invention relates to improvements in elastic fluid turbines, and it has for its object to provide apparatus of the character designated wherein fluid may be expanded directly from certain intermediary moving stages to the exhaust, thus diminishing the volume of fluid traversing the final stage and permitting the use of a smaller and more efficient final stage than has hitherto been possible except at considerable expense and complication.

In the accompanying drawing, Fig. 1 is a side view, partially in section and partially in elevation, illustrating a steam turbine of the axial-flow type, embodying one form of my invention; Fig. 2 is a sectional view of a pair of blades used in the turbine of Fig. 1; Fig. 3 is a fragmentary view similar to a portion of Fig. 1 and illustrating a modified form of final moving blade; Fig. 4 is a side view, partially in section and partially in elevation, showing the application of my invention to a turbine of the double rotation radial-flow type; and Fig. 5 is a back view of one of the rotors of Fig. 4, illustrating the method of carrying the final blade row on a spider.

In the construction and operation of steam turbines, particularly when operating with high vacuum, it has been a difficult problem to efficiently effect the final expansion of the steam because of the relatively enormous volume thereof at modern condenser pressures. An undue blade length in the final rows is not permissible because of the high tip speeds involved and, in order to secure adequate leaving area, it has been necessary to employ a relatively large leaving angle with consequent poor efficiency.

In U. S. Reissue Patent No. 15,092, granted to the Westinghouse Electric and Manufacturing Company on April 26, 1921 on an application filed by Karl Baumann, a structure is described and claimed whereby the above defects are in a sense obviated. The steam is split into two or more annular streams or zones, and these zones are expanded at different rates, thus permitting the provision of an extremely large leaving area.

However. it has been found in the commercial construction of turbines of the Baumann type that, under certain conditions, the decks or baffles employed to split the steam stream into zones set up more or less undesirable eddies with consequent inability to secure the steam flow therethrough which was contemplated in the design.

In accordance with the present invention, as carried out in a turbine of the axial-flow type, I expand the steam in the usual manner until the last stages are reached, and I then insert one or more rows of relatively wide, substantially flat, blades having backwardly hooked tips disposed in operative relation to the exhaust space. The lateral edges of said wide blades are also curved so that a portion of the steam passes directly thereacross to succeeding stages and is expanded in the usual manner, whereas the remainder of the steam is completely expanded under said hooked tips and escapes to the exhaust space. Thus, the volume of steam to be handled in the final stages is materially diminished with the consequent possibility of securing extremely high efficiency in the last stages with an appreciable gain in the overall efficiency of the turbine.

Referring to the drawing for a more detailed understanding of my invention, I show a turbine casing at 10 in Fig. 1, this casing enclosing a spindle 11 operating in suitable bearings 12 and 13. The turbine is provided with the usual admission nozzle 14 and steam is first expanded through impulse stages indicated at 15. The steam then flows through blading 16 of any desired type, finally passing a fixed row of blading 17 and being discharged into a moving row of blades 18 of a form similar to that shown in U. S. Patent No. 1,469,965 issued to the Westinghouse Electric and Manufacturing Company October 9, 1923 on an application filed by Henry F. Schmidt. Briefly speaking, the blades 18 are relatively wide as compared with their height and, as shown more specifically in Fig. 2, they are forwardly and then rearwardly bent at the tips to form a hook portion 19, adjacent portions 19—19 together forming a throat 20 adapted to efficiently expand steam. The blades 18 are furthermore curved at the edges as indicated in section at 21 in Fig. 1 so as to receive and discharge steam in an axial direction, as is well-known in the art.

The casing 10 embodies an exhaust chamber 22 in direct communication with an exhaust pipe 23, and the casing 10 further en-

bodies a space or chamber 24 also in direct communication with the exhaust pipe 23 so that any steam expanding through the throat 20 passes directly to the exhaust.

The steam leaving the lateral edge of the blades 18 is passed to a similar row of blades 25 after reversal in suitable blades 26 and steam escaping over the tips of the blades 25 passes to the exhaust in a similar manner through a chamber 27.

Steam leaving the lateral edge of the blades 25 passes through final blade rows 28 and 29 to the main exhaust chamber 22.

In order to suitably support the fixed blading 26 and 28 at the bottom of the turbine and to, at the same time, permit free flow of steam from the spaces 24 and 27 to the exhaust 23, I mount blades 26 and 28 on grid bars or beams 30 and 31, respectively.

The operation of the device will be obvious from the foregoing description. Steam expands in the usual manner through the blade row 17 and is delivered to the blade row 18, at which point its volume has attained such magnitude that it is desirable to reduce the same. A portion of the steam within the blade row 18 escapes through the throat 20 to exhaust, the size and proportion of the throat 20 being such as to most efficiently expand the steam from the pressure obtained in the row 18 to exhaust pressure.

The residue of steam traversing the blade row 18 is reversed in the blade row 26 and supplied to the blade row 25 where still another portion thereof is completely expanded through the blade tips and passes off through the exhaust, it being obvious that a slightly different throat configuration is necessary at the tips of the blades 25 than at the tips of the blades 18 in order to efficiently expand steam from a lower initial pressure to the same exhaust pressure.

The residual steam escaping from the lateral edge of the blades 25 is completely expanded through the blade rows 28 and 29 and passes to the exhaust in the usual manner.

Referring to the form of my invention shown in Fig. 3, similar parts are numbered the same as in Fig. 1 but the last row of moving blades, instead of being of the usual type indicated at 29 in Fig. 1, is of the clam shell or shovel type as shown at 29′; that is to say, these blades are of relatively great width as compared with their height and they are further adapted to expand steam efficiently over the entire tip and leaving edge thereof, thus giving an enormous leaving area as clearly shown in Fig. 2 of the aforementioned Patent No. 1,469,965, or as further shown in U. S. Patent No. 1,469,925 issued to the Westinghouse Electric and Manufacturing Company on October 9, 1923 on an application filed by Alexander T. Kasley.

Obviously my invention is not limited in its application to turbines of the axial-flow type but may also be applied to turbines of the radial-flow type with single rotation or double rotation. A turbine of the latter type is indicated in Fig. 4, having wheels 40 and 41 mounted on shafts 42 and 43, respectively, for opposite rotation, these wheels being placed within a casing 44 and having interleaving blading 45, all as is well-known and understood in the art in connection with the so-called Ljungstrom turbine.

The wheel 41 carries a row of relatively wide blades 46 provided with hooked tips as indicated in Fig. 2, the wheel 40 being formed as a spider opposite the tips of the blades 46 so as to permit steam to escape from said tips directly into the exhaust space 47 as will be readily understood.

Similarly the wheel 40 carries a row of blades 48 having hooked tips, steam escaping therefrom through a spider 49 formed on the wheel 41. Fig. 5 is a back view of the wheel 41, clearly indicating the spider 49—49 whereby steam is permitted to escape from the tips of the blades 48—48.

The final row of blading is shown at 50, being carried by the spider 49—49, and is of the general type illustrated and claimed in U. S. Patent No. 1,488,117 issued to the Westinghouse Electric and Manufacturing Company on March 25, 1924 on an application filed by the applicant, the blade being of a general semi-circular plan, with the exhaust edge running entirely around the curved periphery thereof.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:—

1. A multi-stage elastic fluid turbine provided with an exhaust chamber, the moving blades of an intermediate stage thereof having an inlet edge, a leaving edge curved in the form of reaction blading and exposed directly to the exhaust chamber, whereby a portion of the fluid supplied to said blades is completely expanded to exhaust pressure, and a leaving edge disposed adjacent to a succeeding stage, curved in the form of reaction blading, and adapted to partially expand the fluid passing thereover and to supply said fluid to said succeeding stage.

2. A turbine as defined in claim 1 wherein the row of blading preceding the said moving blades provides undivided passages between adjacent blades.

3. A turbine as defined in claim 1 wherein

the said moving blades of the intermediate stage provide undivided passages between adjacent blades.

4. A turbine as defined in claim 1 wherein the blades of the said preceding and intermediate stages provide undivided passages between adjacent blades.

5. A multi-stage elastic fluid turbine of the axial flow type provided with an exhaust chamber, an intermediate moving stage thereof embodying substantially flat blades of relatively great width as compared with their length, the tips of said blades being curved backwardly in the form of reaction blading and being exposed directly to said exhaust chamber, whereby a portion of the fluid supplied to said blades is completely expanded to exhaust pressure at a small angle, the lateral leaving edge of said blades also being curved to partially expand the fluid passing thereover and to supply said fluid to a succeeding stage.

6. A multi-stage elastic fluid turbine provided with an exhaust chamber, the blades of a moving intermediate row thereof having inlet edges adjacent to the preceding row of blades, leaving edges adjacent to the succeeding row, and leaving edges exposed directly to said exhaust chamber formed to provide intervening nozzle passages adapted to expand elastic fluid to exhaust pressure, the adjacent blades in said intermediate row providing an undivided passage.

7. A multi-stage elastic fluid turbine provided with an exhaust chamber, the blades of a moving intermediate row thereof having inlet edges adjacent to the preceding row of blades, leaving edges adjacent to the succeeding row, and leaving edges exposed directly to said exhaust chamber formed to provide intervening nozzle passages adapted to expand elastic fluid to exhaust pressure, the adjacent blades in said preceding row providing an undivided passage.

8. A multi-stage elastic fluid turbine provided with an exhaust chamber, the blades of a moving intermediate row thereof having inlet edges adjacent to the preceding row of blades, leaving edges adjacent to the succeeding row, and leaving edges exposed directly to said exhaust chamber formed to provide intervening nozzle passages adapted to expand elastic fluid to exhaust pressure, the adjacent blades in said preceding and in said intermediate row providing an undivided passage.

In testimony whereof, I have hereunto subscribed my name this eleventh day of February, 1925.

HERBERT T. HERR.