Feb. 17, 1925. 1,526,792

A. T. KASLEY

ELASTIC FLUID TURBINE

Filed Jan. 7, 1922 3 Sheets-Sheet 1

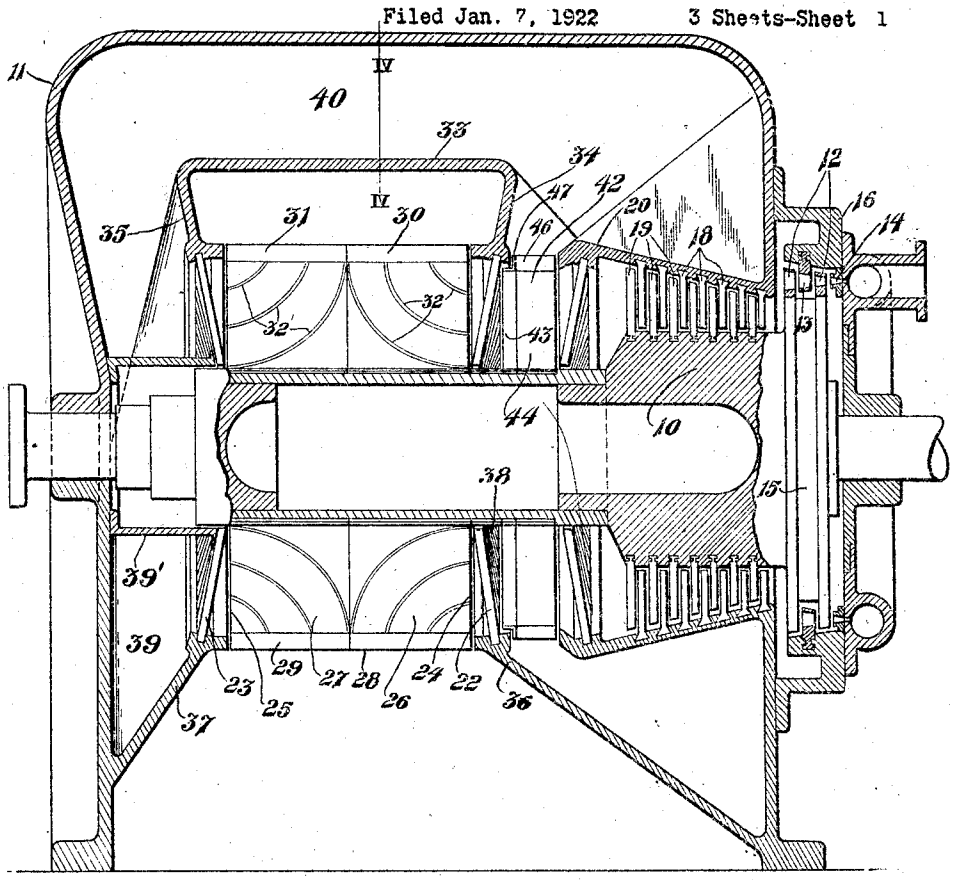


Fig. 1.

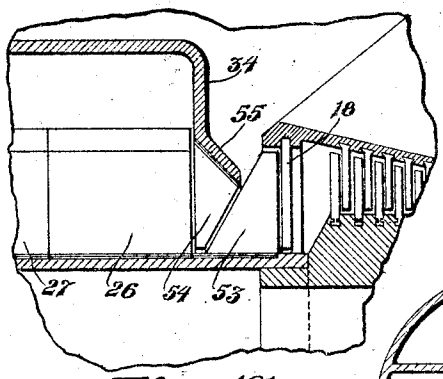


Fig. 13.

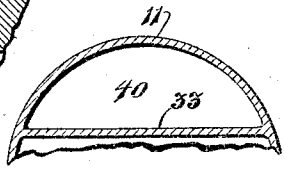


Fig. 4.

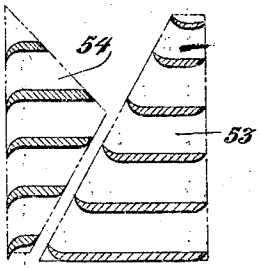


Fig. 14.

A. T. Kasley
INVENTOR

BY D. C. Davis
ATTORNEY

Feb. 17, 1925. 1,526,792

A. T. KASLEY

ELASTIC FLUID TURBINE

Filed Jan. 7, 1922 3 Sheets-Sheet 2

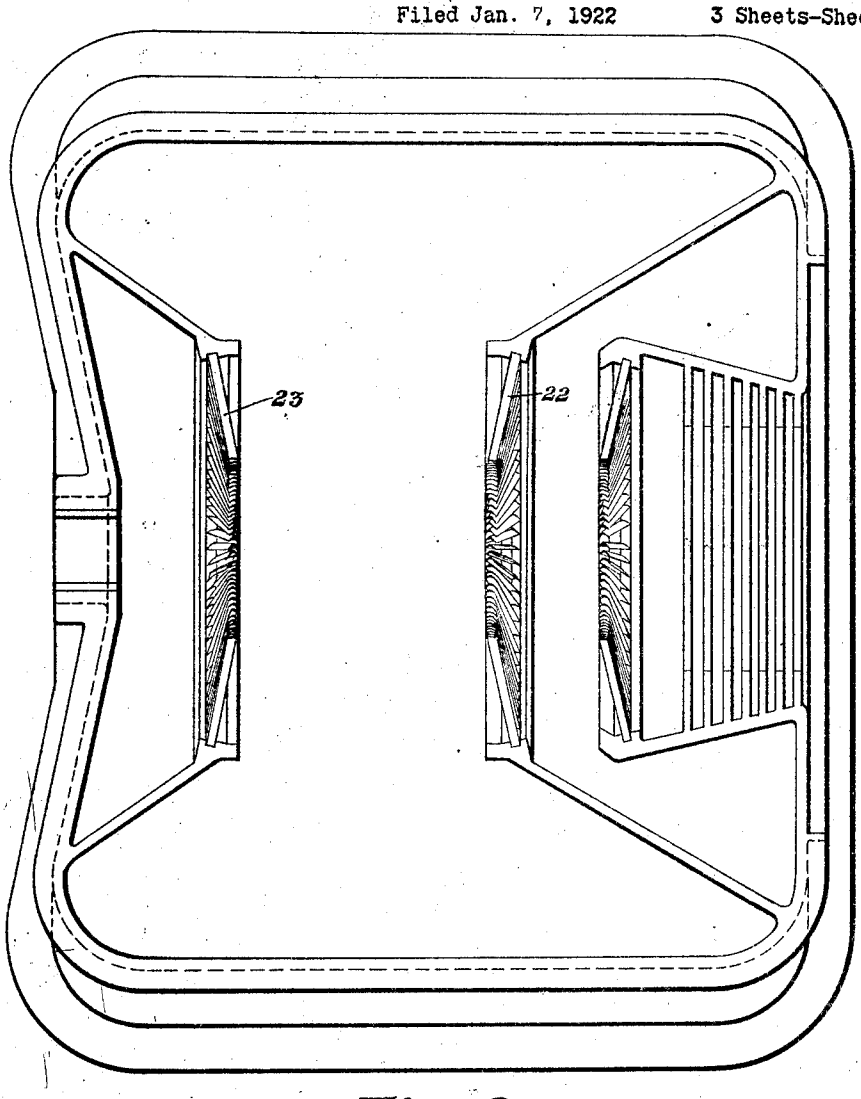


Fig. 2.

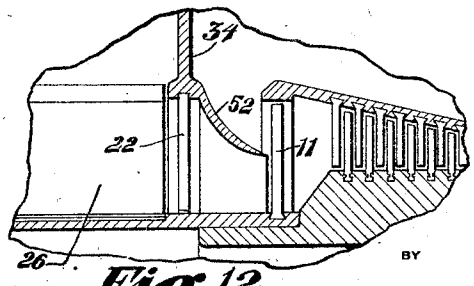


Fig. 12.

A. T. Kasley
INVENTOR

BY D. C. Davis
ATTORNEY

Feb. 17, 1925. 1,526,792

A. T. KASLEY

ELASTIC FLUID TURBINE

Filed Jan. 7, 1922 3 Sheets-Sheet 3

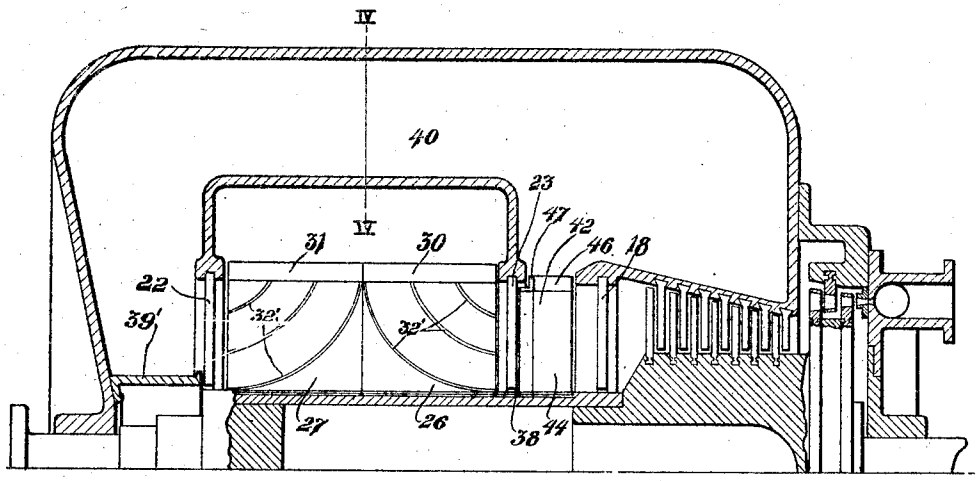


Fig. 3.

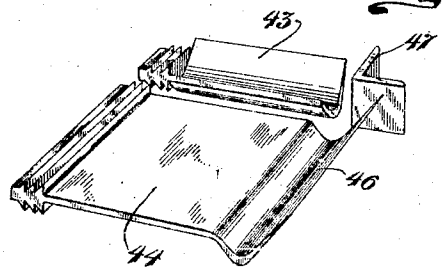


Fig. 5.

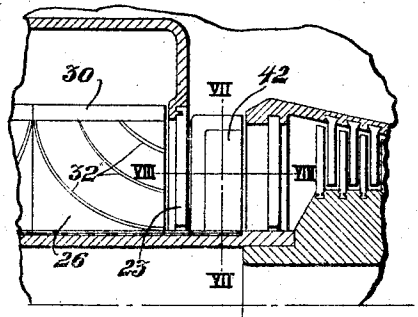


Fig. 6.

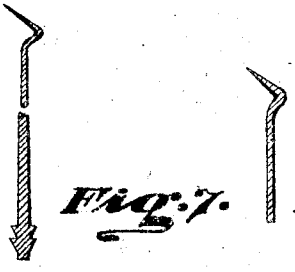


Fig. 7.

Fig. 8.

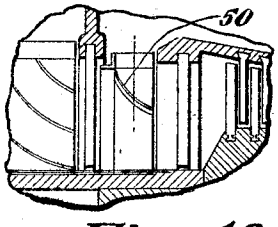


Fig. 10.

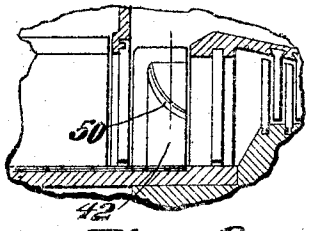


Fig. 9.

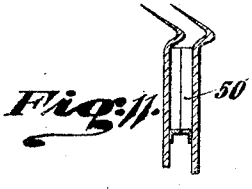


Fig. 11.

A. T. Kasley
INVENTOR

BY D. C. Davis
ATTORNEY

Patented Feb. 17, 1925. 1,526,792

UNITED STATES PATENT OFFICE.

ALEXANDER T. KASLEY, OF ESSINGTON, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ELASTIC-FLUID TURBINE.

Application filed January 7, 1922. Serial No. 527,675.

To all whom it may concern:

Be it known that I, ALEXANDER T. KASLEY, a citizen of the United States, and a resident of Essington, in the county of Delaware and State of Pennsylvania, have invented a new and useful Improvement in Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to elastic-fluid turbines, more particularly to that type employing a double-flow, low-pressure section, and it has for its object to provide apparatus of the character designated which shall have relatively wide low-pressure blading adapted to receive elastic fluid therebetween and to discharge it peripherally or at the tips, whereby ample discharge area, small leaving angles, and the application of the energy of the elastic fluid to portions of the blades moving at high effective speeds may be provided, whereby high over-all efficiency may be maintained and the construction of turbine units of larger size and higher speed rendered possible.

Another object of my invention is to provide a novel arrangement of blading and casing structure to assure the division of elastic fluid for flow through the blade portions of the double-flow section.

These and other objects are accomplished by the structure disclosed in the following specification and in the drawings in which Fig. 1 is a longitudinal sectional view of my improved form of turbine; Fig. 2 is a plan view of the lower portion of the turbine cylinder or casing; Fig. 3 is a longitudinal sectional view of a modified form of my invention; Fig. 4 is a sectional view taken along lines IV—IV of Figs. 1 and 3; Fig. 5 is a separated perspective view of one of the blades employed in Figs. 1 and 3; Fig. 6 is a detail sectional view showing a further modified form of my invention; Figs. 7 and 8 are sectional views taken along the lines VII—VII and VIII—VIII respectively of Fig. 6; Figs. 9, 10 and 11 are detail views showing further modified blade structure; Fig. 12 is a detail sectional view showing a further modified form of my invention; Figs. 13 and 14 are detail views showing a further modified form of my invention.

In accordance with my invention, I provide relatively wide blading for the low-pressure, double-flow section which is adapted to receive elastic fluid between the sides thereof and to discharge such fluid at the tips or peripherally. Blading of this character is advantageous for many reasons, among which may be mentioned ample discharge area for the low-pressure elastic fluid, discharge at small angles, in view of the fact that ample discharge area is provided, and the application of the energy to portions of the blades moving at high effective speeds, the type of blade used being more fully disclosed in an application of Henry F. Schmidt, Serial No. 482,768, filed July 6, 1921, and assigned to the Westinghouse Electric & Manufacturing Company and in my application, Serial No. 487,517, filed July 21, 1921, and also assigned to the Westinghouse Electric & Manufacturing Company. It is, therefore, possible to construct a turbine having a double-flow section to operate more efficiently, if blading of this character is used.

Referring now to the drawings for a more detailed description of my invention, I show a turbine including a rotor 10, a cylinder or casing 11, and blading carried thereby constituting the single-flow and double flow sections to be more particularly hereinafter described.

The single-flow section of the turbine may include blading or energy-abstracting elements of any suitable type. For example, I show an impulse stage of the multi-velocity type comprising a plurality of moving rows of blades or vanes 12, reversing or redirecting guide blades or vanes 13 interposed between the moving rows of blades, and a plurality of nozzles 14 for discharging steam at high velocity into the first row of moving blades. The vanes or blades 12 are carried by a suitable drum portion 15 of the rotor 10, the latter being inclosed by a supplemental casing 16 supporting the expanding nozzles 14. The casing 16 is secured to the turbine casing 11 in any suitable manner.

The impulse blading is followed by a plurality of fractional expansion stages, each of which comprises a stationary row of blades 18 and a moving row of blades 19 carried, respectively, by means of a shell portion 20 of the casing 11 and by the rotor 10. After passage through the rows of blades 18 and 19, the elastic fluid is divided into a

plurality of portions, as will be more fully hereinafter described, for passage through suitable guide blades or vanes 22 and 23 for directing elastic fluid between the sides 24 and 25 of the relatively wide blades 26 and 27, respectively, of the double-flow section. The elastic fluid enters between the sides 24 and 25 of the relatively wide blades and is discharged from between the peripheral edges 28 and 29 thereof. Preferably, the blades 26 and 27 have outer curved, hook or trough-like portions 30 and 31 so as to provide for the discharge of elastic fluid at small angles as well as to provide for a better distribution of the mass of each of the blades, in a manner more fully set forth in my application aforesaid. Ample discharge area is provided by suitably choosing the blade width. The blades 26 and 27 are preferably provided with a plurality of guides 32 and 32′ in order to assist in changing the direction of the elastic fluid received between the sides of the blades 26 and 27 toward the peripheral edges 28 and 29 thereof as well as to reinforce the blading structure.

The double-flow wide blades 26 and 27 are arranged within the exhaust chamber. It is, therefore, necessary to segregate the exhaust space from the motive fluid supply space in order to provide for the proper arrangement of blading and the proper control of the motive fluid. I, therefore, provide the casing or cylinder with interior diaphragm or partition elements for this purpose. The upper portion of the cylinder or casing 11 is provided with a chordal diaphragm or partition element 33, see Fig. 4, which is continuous with inwardly-extending partition or diaphragm elements 34 and 35, the latter partition or diaphragm elements registering with diaphragm elements 36 and 37 carried by the lower portion of the casing. The blades 22 and 23 are supported by the diaphragm or partition elements 34, 35, 36 and 37. It will, therefore, be seen that the cylinder or casing 11 is divided interiorly by means of the diaphragm or partition elements 33, 34, 35, 36 and 37, and the blades or vanes 22 and 23 into motive fluid supply spaces 38 and 39 connected by means of the sector space 40 included between the top of the casing or cylinder 11 and the chordal diaphragm 33. Motive fluid is discharged from the blading 18, 19 already referred to and is divided in any of the ways herein described for passage to the steam supply spaces 38 and 39, from whence it flows through the guide vanes or blades 22 and 23 for entry between the sides 24 and 25 of the relatively wide blades 26 and 27. A cylindrical packing member 39′ is carried by the casing and cooperates with the tips of the blades 23 to prevent steam leakage about the adjacent turbine bearings.

It is necessary to divide the motive fluid discharged from the blading of the single-flow section into a plurality of portions for passage through the guide vanes or blades 22 and 23 to act upon the relatively wide blades 26 and 27. In the Figs. 1, 3, 6, 9 and 10, I show a row of blades 42, which are relatively wide and are adapted to discharge motive fluid both laterally and peripherally, the laterally discharged portions entering the guide vanes or blades 22 to be directed between the wide blades 26 and the peripherally discharging portion passing through the passageway 40 and entering the supply space 39 from which it flows between the guide vanes or blades 23 and thence between wide blades 27 in the manner already referred to.

In Figures 1, 3 and 5, I show a convenient way of making the wide blades 42, that is, to provide a separate leaving side, energy-abstracting portion 43 which is preceded by a portion 44 which is relatively longer than the portion 43 and is provided with an outer curved or hook-like portion 46. The inner portion of the blade portion 44, beneath the hook-like portion, is substantially flat and is of a height substantially equal to that of the leaving side portion 43. The leaving side portion 43 and the hook or curved-like portion 46 may be made of any suitable design so as to discharge motive fluid at a suitably small angle so that the reactive effort of the velocity energy of the motive fluid may be applied both laterally and peripherally, The corner left, due to the fact that the blade portion 43 is shorter than the portion 44, may conveniently receive an annular angle bar section 47 which may be spot-welded, soldered, or secured in any other suitable manner to the tips of the blade portions 43 and to the sides of the hook portions 46 of the blade portions 44. By making the leaving side portion 43 separately from the portion 44, it is possible to simplify and cheapen the manufacture of the blade members 42.

The angle section 47 affords ample space for a corner of the blade-holding means carried by the inwardly-extending diaphragm element 34 so that the leaving edge of the portion 43 may be arranged close to the guide blades or vanes 22.

In Figs. 6, 7 and 8, I show a further modified form of blade element 42 wherein each blade is made in one piece, with lateral and peripheral curved or hook-like discharge edges whereby the motive fluid may be discharged at a small angle both laterally and peripherally for passage through the blading of the double-flow section in the manner already referred to.

In some cases it may be advantageous to employ guide vanes or ribs in connection with the blades 42. Accordingly, in Figs. 9, 10 and 11, I show ribs 50 in connection

with blades of the type already described, the ribs being suitably located and curved so as to positively assure the division of elastic fluid into laterally and peripherally-discharging portions. The ribs 50 may be made of angle sections and spot-welded to the blades; and, in order to more rigidly hold the assembled blade structure in place, as well as to diminish vibration, the adjoining edges of the angle sections may be welded or brazed together.

In Fig. 3, the guide blades 22 and 23, as well as the last row of stationary blades 18, are arranged radially, whereas, in Figs. 1 and 2, the last row of stationary blades 18 and guide vanes or blades 22 and 23 are inclined so as to give the motor fluid a radial component of direction so that said fluid may be more readily passed toward the peripheral edges of the blades 42, 26 and 27.

A further way of dividing the elastic fluid into a plurality of portions for passage through the blading of the double-flow section is shown in Fig. 12. In this view, the elastic fluid discharged from the last row of moving blades 19 is divided into a plurality of portions by means of a suitably curved annular member 52 of a conical or cup-shape contour, the outer portion being guided thereby to the pasageway 40 for passage therethrough and thence to the end space 39.

In Fig. 13, there is shown a further modified form of my invention in which the last row of stationary blades 18 is followed by a moving row of blades 53 and a row of stationary guide blades 54 of substantially triangular contour, which is advantageous for the reason that the row of blades 53 may be made relatively long and increased in cross-sectional area toward the roots, in order to strengthen them and increase the area subject to centrifugal stresses. Fig. 14 shows diagrammatically how sections of the blades 53 and 54 of Fig. 13 would appear. The blades 53 and 54 have substantially straight portions followed by suitably curved leaving edges. The guide blades 54 are secured in any suitable manner to the specially formed right-hand portion 55 of the diaphragm or partition element 34, the inwardly projecting partition element 35 at the other side being like that of the other views. One advantage of the construction last described is that the last row of moving blades 53 may be made relatively long with the preservation of sufficient strength, due to the tapered formation.

The operation of apparatus made in accordance with my invention will be apparent from the foregoing description. Energy is abstracted from the steam by the moving rows of blades 12 and 19 until a low pressure and large volume is reached. Thereafter, the steam is divided into two portions for action on the rows of wide blades 26 and 27, the latter being peculiarly capable of handling large volumes with high blade efficiency.

From the foregoing, it will be apparent that I have devised a turbine of the semi-double-flow type in which the double-flow low-pressure portion includes moving rows of blades or energy-abstracting elements which are capable of handling large quantities of low-pressure motive fluid with high blade efficiency. The particular type of low-pressure blading provides for high over-all efficiency as well as permits of the construction of larger high-speed turbine units than heretofore.

While I have shown my invention in a plurality of 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. In an elastic-fluid turbine, a double-flow section including a pair of rows of moving blades adapted to receive elastic fluid laterally and to discharge it peripherally or at the tips.

2. In an elastic-fluid turbine, the combination, with a single-flow portion, of a double-flow portion including a pair of moving rows of blades adapted to receive elastic fluid laterally and to discharge it peripherally or at the tips and means for dividing the elastic fluid passing from the single-flow portion into a plurality of portions for cooperation with said rows of blades.

3. In an elastic-fluid turbine, the combination of a plurality of energy-abstracting elements constituting a single-flow section and a plurality of rows of energy-abstracting elements constituting a double-flow section, the moving rows of said latter section adapted to receive elastic fluid laterally and to discharge it peripherally or at the tips.

4. In an elastic-fluid turbine, the combination of a plurality of rows of energy-abstracting elements constituting a single-flow section, a plurality of rows of energy-abstracting elements constituting a double-flow section, the moving rows of energy-abstracting elements of said latter section adapted to receive elastic fluid laterally and to discharge it peripherally, and means arranged between the single- and the double-flow sections to divide the elastic fluid discharged from the single-flow section into a plurality of portions for cooperation with the energy-abstracting elements of the double-flow section.

5. In an elastic-fluid turbine, the combi-

nation of a single-flow section, a double-flow section including a plurality of rows of moving blades, and a row of moving blades arranged between the single- and the double-flow sections adapted to divide the elastic fluid passing therebetween into a plurality of portions for cooperation with the moving blades of the double-flow section.

6. In an elastic-fluid turbine, the combination of a single-flow section, a double-flow section including a pair of rows of relatively wide moving rows of blades adapted to receive elastic fluid laterally and to discharge it peripherally or at the tips, a row of relatively wide moving blades arranged between the single- and double-flow sections and adapted to discharge elastic fluid both laterally and peripherally, means for directing the laterally discharged portion of elastic fluid between one moving row of wide blades of the double-flow section and means for conducting the peripherally discharged portion of elastic fluid to the other row of relatively wide moving blades of the double-flow section.

7. In an elastic-fluid turbine, a double-flow section comprising a pair of rows of moving blades adapted to receive elastic fluid laterally and to discharge it peripherally or at the tips, whereby adequate discharge area, small leaving angles, and application of the energy to those portions of the blades moving at high effective speeds may be provided, and full peripheral admission means for guiding the elastic fluid for entry between said moving blades.

8. In an elastic-fluid turbine, the combination of a cylinder or casing, means carried by the casing for dividing the latter into an elastic-fluid supply space and an exhaust space, a pair of rows of blades arranged in the exhaust space, each row adapted to receive elastic fluid at one side and to discharge it peripherally or at the tips, and guide means carried by said means for guiding the elastic fluid for entry between the blades.

9. In an elastic-fluid turbine, the combination of a cylinder or casing, diaphragm or partition elements arranged therein and dividing the space thereof into an exhaust chamber and connected end supply chambers, a plurality of rows of relatively wide moving blades adapted to receive elastic fluid laterally and to discharge it peripherally or at the tips arranged in said exhaust space, and guide means carried by the partitions or diaphragm members defining the inside walls of end supply chambers for guiding elastic fluid for entry between the relatively wide moving blades.

10. In an elastic-fluid turbine, the combination of a single-flow section, a double-flow section, and a row of moving energy-abstracting elements adapted to discharge elastic fluid both laterally and peripherally, and means for conducting the laterally and peripherally discharged portions of elastic fluid to separate portions of the double-flow section for further energy abstraction.

11. In an elastic-fluid turbine, the combination of a single-flow section, a double-flow section, and a row of relatively wide blades arranged between the sections having lateral and peripheral energy-abstracting portions and adapted to discharge elastic fluid both laterally and peripherally, and means for conducting the lateral and peripheral portions of elastic fluid to separate energy-abstracting elements of the double-flow section.

12. In a turbine, a row of relatively wide moving blades each of which is composed of a front portion having a curved- or hook-like energy-abstracting tip followed by a separate curved hook-like energy-abstracting element.

13. In a turbine, a row of wide blades composed of front portions having outer curved- or hook-like portions followed by shorter portions made separately and suitably curved for discharge laterally at a small angle, and lashing means secured to the tips of the blade portions.

14. In an elastic-fluid turbine, the combination of a row of moving blades adapted to receive elastic fluid laterally and to discharge it peripherally, and a row of stationary guide blades inclined with respect to the moving blades so as to give to the elastic fluid a component of motion in a radial direction to assist in the peripheral discharge.

15. In an elastic-fluid turbine, a single-flow section, a row of moving blades adapted to discharge elastic fluid both laterally and peripherally, the last row of stationary blades of said single-flow section being suitably inclined to give to the elastic fluid a radial component of motion to assist in the peripheral discharge, a double-flow section including a pair of rows of moving blades, means for conducting the laterally discharged portion of elastic fluid to one row of blades of the double-flow section, and means for conducting the peripherally discharged portion to the other row of blades of the double-flow section.

16. In an elastic-fluid turbine, a single-flow section, a row of moving blades adapted to discharge elastic fluid both laterally and peripherally, the last row of stationary blades of said single-flow section being inclined to give to the discharged elastic fluid a radial component of motion to assist in the peripheral discharge, a double-flow section including a pair of rows of relatively wide moving blades adapted to receive elastic fluid at the sides and to discharge it peripherally and a pair of rows of guide blades inclined with respect to said wide

blades so as to give to the elastic fluid a radial component of motion to assist in the radial discharge, the laterally discharged portion of elastic fluid from said first row of moving blades passing to one of said rows of guide blades, and means for conducting the peripherally-discharged portion of elastic fluid from said first row of blades to the other row of guide blades.

In testimony whereof, I have hereunto subscribed my name this 4th day of January, 1922.

ALEXANDER T. KASLEY.