B. LJUNGSTRÖM & E. A. FORSBERG.

TURBINE.

APPLICATION FILED MAY 10, 1907.

911,662. Patented Feb. 9, 1909.

3 SHEETS—SHEET 1.

Fig. 1

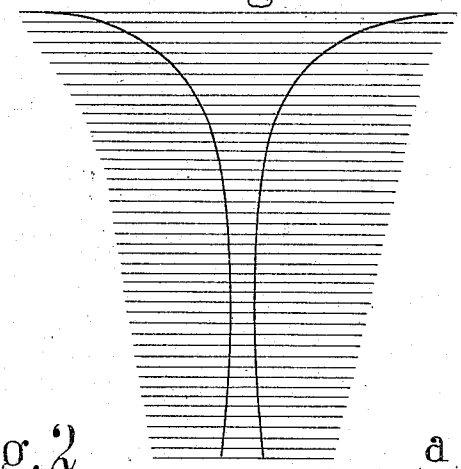
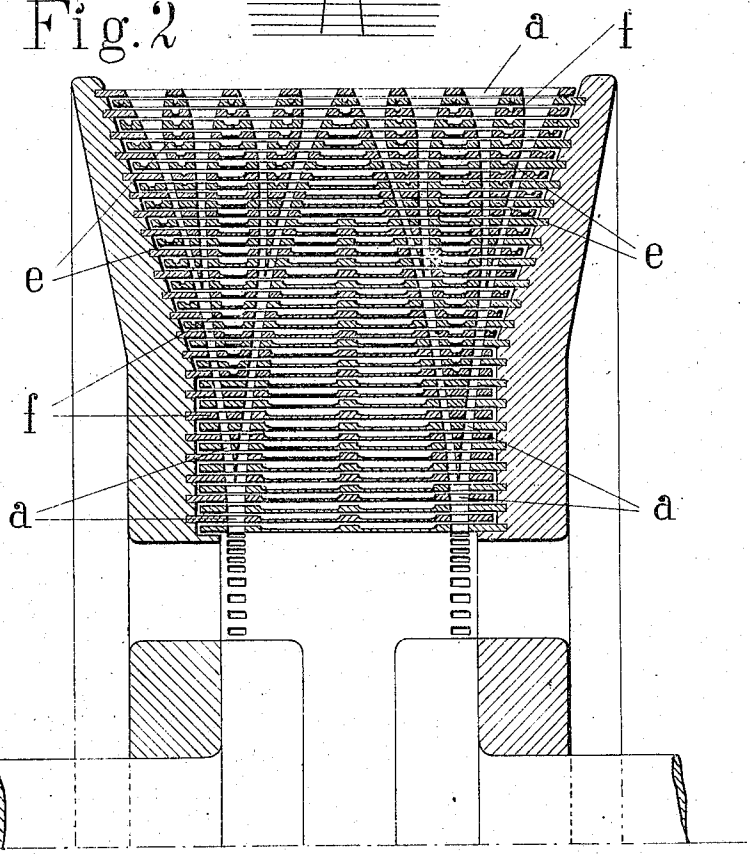


Fig. 2



WITNESSES:

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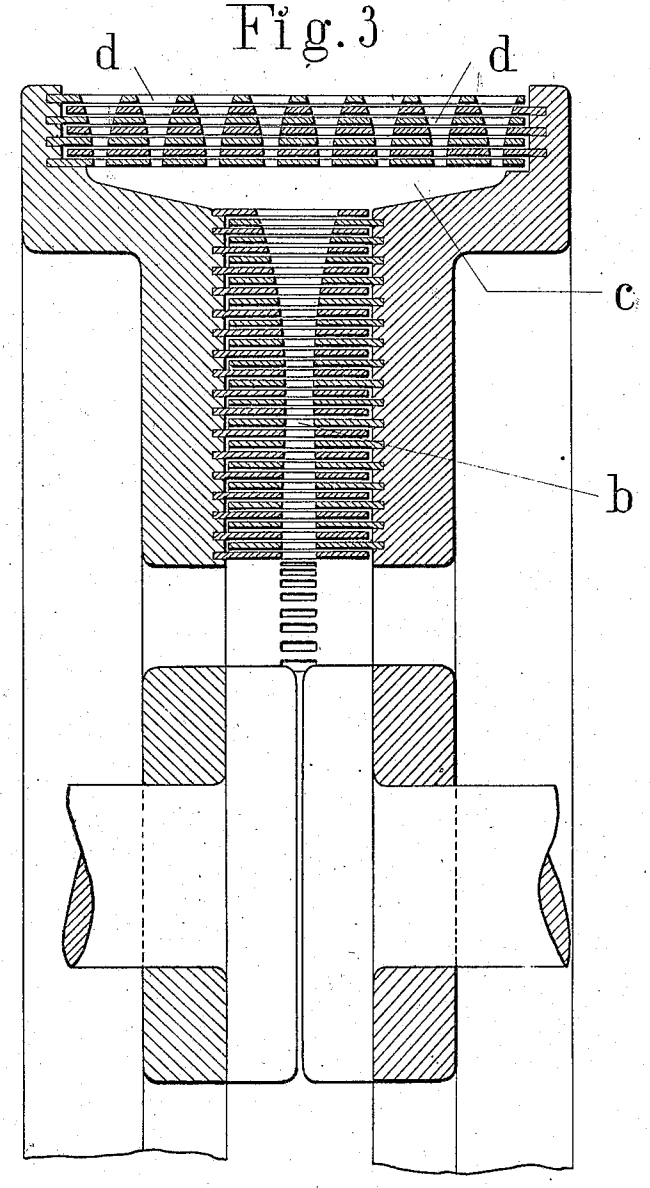
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3 SHEETS—SHEET 2.

Fig. 3



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3 SHEETS—SHEET 3.

Fig.6

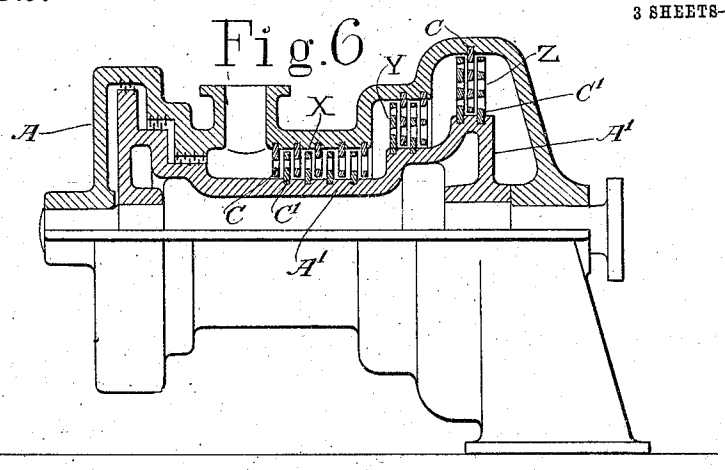


Fig.7

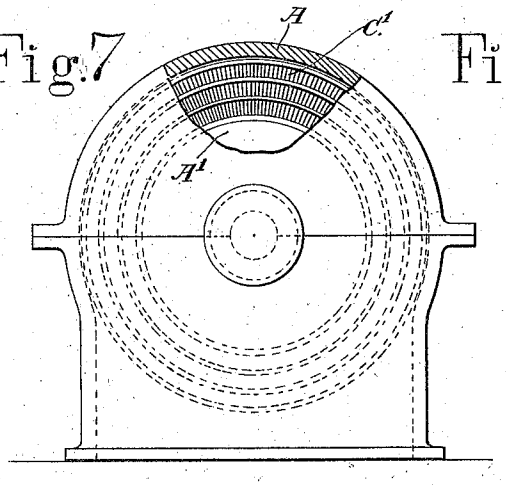


Fig.5

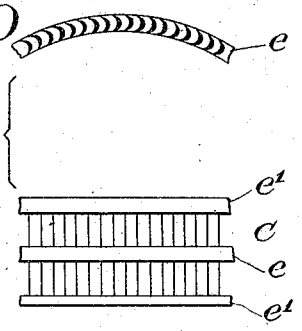
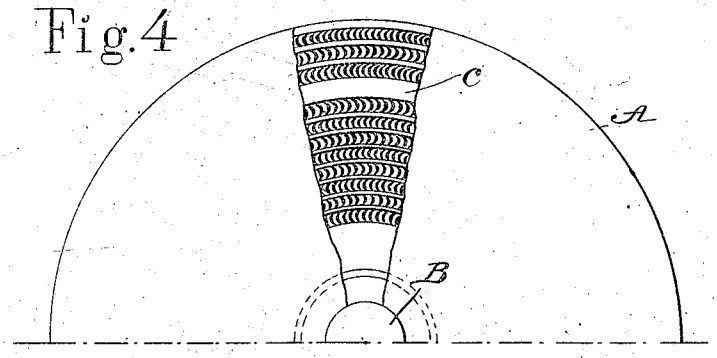


Fig.4



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UNITED STATES PATENT OFFICE.

BIRGER LJUNGSTRÖM AND ERIK AUGUST FORSBERG, OF STOCKHOLM, SWEDEN.

TURBINE.

No. 911,662. Specification of Letters Patent. Patented Feb. 9, 1909.

Application filed May 10, 1907. Serial No. 372,993.

To all whom it may concern:

Be it known that we, BIRGER LJUNGSTRÖM and ERIK AUGUST FORSBERG, subjects of the King of Sweden, residing at Fleminggatan 8, Stockholm, Sweden, have invented certain new and useful Improvements in Vane Series for Gas-Turbines or other Machines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

This invention relates to that class of radial or axial turbines wherein a plurality of cooperating vane systems are mounted and arranged in alternate order so as to be rotatable relatively to each other; the systems in certain types of apparatus being rotatable in opposite directions to each other, and in other types one of the systems being stationary and the other system rotatable.

As heretofore constructed, turbines of the class mentioned have been of comparatively large diameter or length, owing to the size and number of vane series required to effect and insure the efficient utilization of the expansive force of the elastic fluid, as for example, the well-known "Parson" and "Rateau" turbines.

In order to lessen the length of the axial, or the diameter of the radial, turbine, it is necessary to reduce the width of the vanes, thereby correspondingly shortening the passage way for the elastic fluid; and inasmuch as the increase of the passage area for the fluid from one vane series to another is as essential with narrow as with wide vanes, on account of the expansion of the elastic motive fluid (as steam) the length of the narrow vanes must be increased so rapidly outwards that in the absence of suitable provisions to obviate the same, side deflections of the fluid will occur with consequent inefficiency of the apparatus.

The object of our invention is to provide, in a turbine having its vanes reduced in width, as stated, a novel construction and organization of elements whereby the injurious influence of such side deflections of the fluid shall be effectually avoided, as will be hereinafter fully described and claimed.

In the drawings—Figure 1 is a diagram of two series of narrow vanes for a radial turbine, indicating the abrupt increase of their length. Fig. 2 is a transverse vertical section through a portion of a radial turbine embodying one form of our invention. Fig. 3 is a similar section showing a modification of the same. Fig. 4 is an end view, partly in section, of a radial turbine of substantially the character illustrated in Fig. 3. Fig. 5 illustrates detail views of a portion of a vane series for a radial turbine. Fig. 6 is a side elevation, partly in section, of an axial turbine embodying our invention. Fig. 7 is an end elevation of the same, partly in section.

Referring to the drawings—The diagram, Fig. 1, indicates the vane systems of a radial turbine of, for example, 2000 horse power, wherein two heads or bodies are equipped with two coöperating systems of vanes rotating in opposite directions to each other, at, say, 2000 revolutions each per minute. In this diagram the parallel lines indicate the interspaces between the alternating vanes of the respective systems. It will be observed that in this construction the successive vanes are increased abruptly outward in length (as indicated at the points where the outwardly curved side lines intersect the parallel lines) in order to afford the requisite area for the passage of the elastic fluid in its progressive expansion from one vane series to the other. As above pointed out, this construction, while reducing the diameter of the turbine, possesses certain inherent defects, which it is the purpose of our invention to overcome.

In the form of embodiment of the invention illustrated in Fig. 2, A, A′ represent the vane heads or bodies of the respective vane systems, and B the shafts therefor, one of which systems may be fixed and the other rotatable, or both may be rotatable in opposite directions to each other.

C, C′ are the vane series for the respective heads or bodies, which series are arranged in alternate order, as shown. These series embody relatively spaced rings *e*, constituting concentric baffling devices or interruptions of varying widths which define the increase of width in the passage area for the elastic fluid from vane series to vane series. The openings or passages between the rings are indicated at *a*, such openings or passages increasing in number from the innermost to the outermost vanes; that is to say, each of the in-

ner or ingress openings indicated at 1, diverges at a suitable point, as at 2, to constitute the double branch opening 3, and the branch openings again diverge at 4 to constitute the quadruple branch openings 5. All these openings or passages, by varying the width of the concentric baffling devices or interruptions as indicated, are relatively proportioned from vane series to vane series, to afford for the fluid a passage area that is progressively increased proportionately to the expansion of the fluid during its course from the point of admission to the point of discharge. The number, size and form of the openings are, of course, determined by the character and capacity of the apparatus.

It will be seen that by the construction just described, the total length of each vane series is maintained without the serious objection incident to the side deflections of the fluid above mentioned; and that at the same time, owing to the increased passage area of the outer vane series, a sufficiently slow and a more economical passage of the fluid through the vane systems is insured.

The vanes may be each constructed of an integral piece with the appropriate openings or passages formed therein, but preferably the interruptions or baffles between the openings or passages comprise rings *e*, soldered, welded or otherwise affixed to the body of the vanes to constitute bonds which serve effectually to take up the centrifugal strain on the vanes. In the case where such rings, in the carrying out of our invention, are of great length, as for instance, in radial turbines, the rings may be made hollow or channeled, as indicated at *f*, in Fig. 2, or may be otherwise reduced in weight in order to minimize the vibratory strain upon the vanes. This construction of the vanes permits the use of comparatively long vane systems with correspondingly increased passage areas, and thus insures the maximum efficiency of the elastic fluid employed.

By virtue of the oblique directions of the openings or passages throughout the vane systems, it is sometimes advisable to vary the angles of the vanes in the successive series in order to insure a uniform expansive action of the fluid in the various passages.

In Fig. 3 is shown a modification of my invention wherein the vane heads or bodies are provided with alternating vane series of equal length, or substantially so, having openings or passages *b* leading to an enlarged chamber *c*, which opens into several passages *d* in a series of vanes of increased length on the respective heads, the concentric baffles or interruptions of the respective vane series being of varying widths to insure the increase of width in the passage area for the elastic fluid from vane series to vane series, with the advantages hereinbefore explained.

In Fig. 4 the reverse forms of the adjacent alternating vane series, as mounted within the turbine, are shown in cross section.

In Fig. 5 a plan of a portion of a vane series (C) with its interrupting ring member *e* and side rings *e'* is shown; and also a vertical section through a portion of the vane series.

In Figs. 6 and 7 our invention is illustrated as applied to an axial turbine, one series of vanes C in the form selected being fixed to the stationary body A, and the other series C', to the rotatable body A'. In this construction the vanes with their interrupted passages are arranged in sets, as X, Y and Z, the size, form, number and location of the vane passages therein being relatively proportioned to insure the highest utilization of the expansive force of the elastic fluid.

As illustrated in Fig. 6, the diameters of the respective sets of vanes are progressively increased, and hence, in view of the varying peripheral speeds thereof, the angles of the respective vanes should be arranged to insure a uniform expansive action of the fluid throughout the various passages.

It is to be noted that our invention may be advantageously employed in compressors, pumps, or analogous apparatus equipped with vane systems, whether the motive fluid be directed toward or from their axes of rotation.

We claim as our invention—

1. A machine having coöperating vane systems whereof the respective vane series are provided with relatively spaced rings of varying widths which define the increase of width in the passage area for the elastic fluid from vane series to vane series.

2. A machine having coöperating vane systems whereof the respective vane series are provided with relatively spaced channeled rings of varying widths which define the passage area for the elastic fluid.

3. A machine having coöperating vane systems whereof the respective vane series are provided with relatively spaced baffles or interruptions to afford a progressively increased passage area for the fluid.

4. A machine having coöperating vane systems whereof the respective vane series are provided with relatively spaced interruptions to afford a progressively increased passage area for the fluid, the total length of said interruptions in each vane series being increased outwardly from vane series to vane series.

In testimony, that we claim the foregoing as our invention, we have signed our names in presence of two subscribing witnesses.

BIRGER LJUNGSTRÖM.
ERIK AUGUST FORSBERG.

Witnesses:
T. L. KJELLBERG,
E. RABERG.

Corrections in Letters Patent No. 911,662.

It is hereby certified that in Letters Patent No. 911,662, granted February 9, 1909, upon the application of Birger Ljungström and Erik August Forsberg, of Stockholm, Sweden, for an improvement in "Turbines," errors appear requiring correction as follows: In the drawings, sheet 1, the reference characters A, A^1, B, C, C^1, c^2, f, *1*, *2*, *3*, *4*, *5*, should appear upon Fig. 1 and A, A^1, B, C, C^1, upon Fig. 2 to indicate the several parts referred to in the specification; and that the drawings should be read as herein set forth that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of July, A. D., 1909.

[SEAL.]

C. C. BILLINGS,

Acting Commissioner of Patents.