No. 819,616. PATENTED MAY 1, 1906.

J. STUMPF.

MULTISTAGE STEAM TURBINE.

APPLICATION FILED OCT. 15, 1903.

Fig. 1.

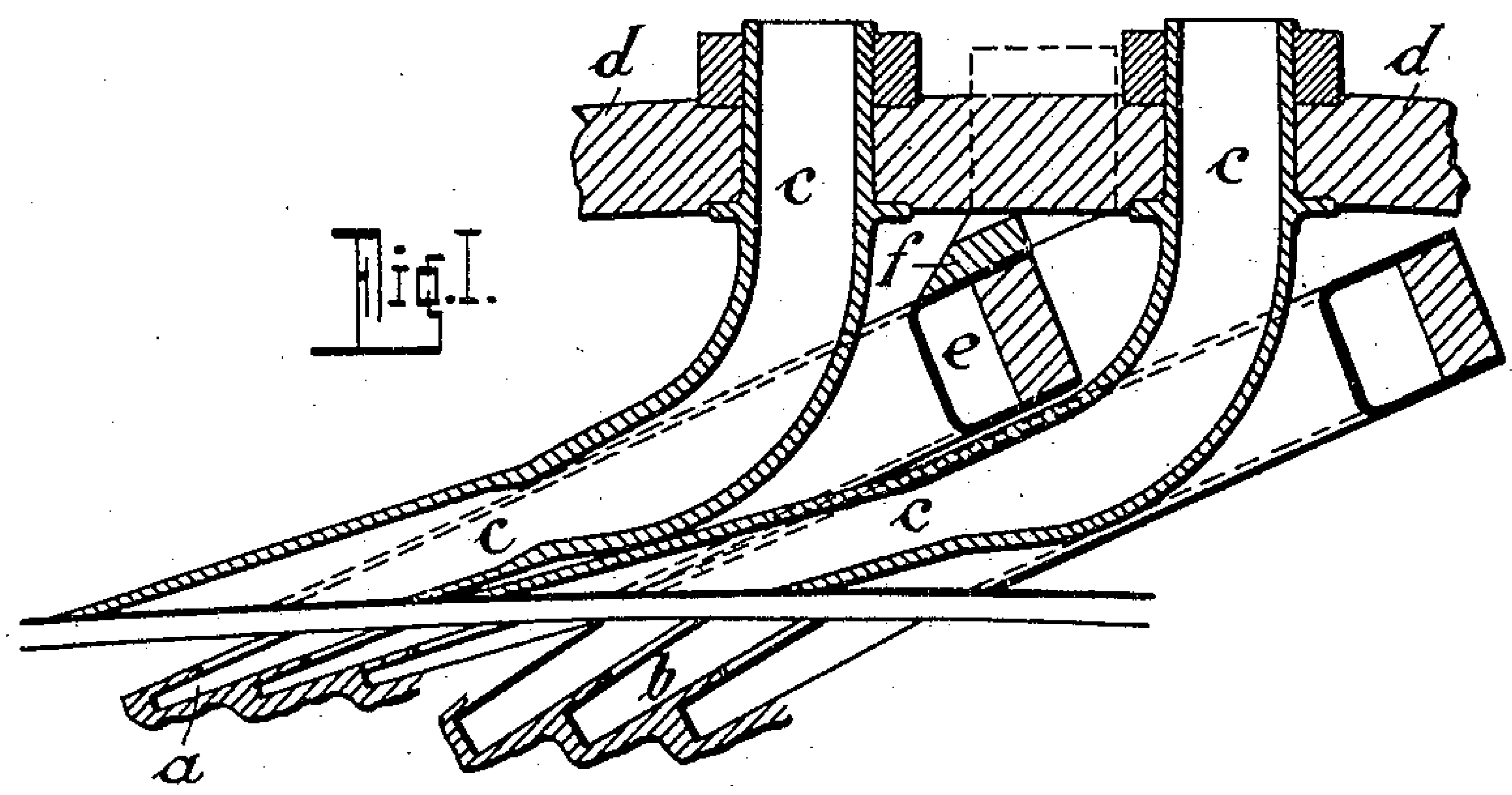
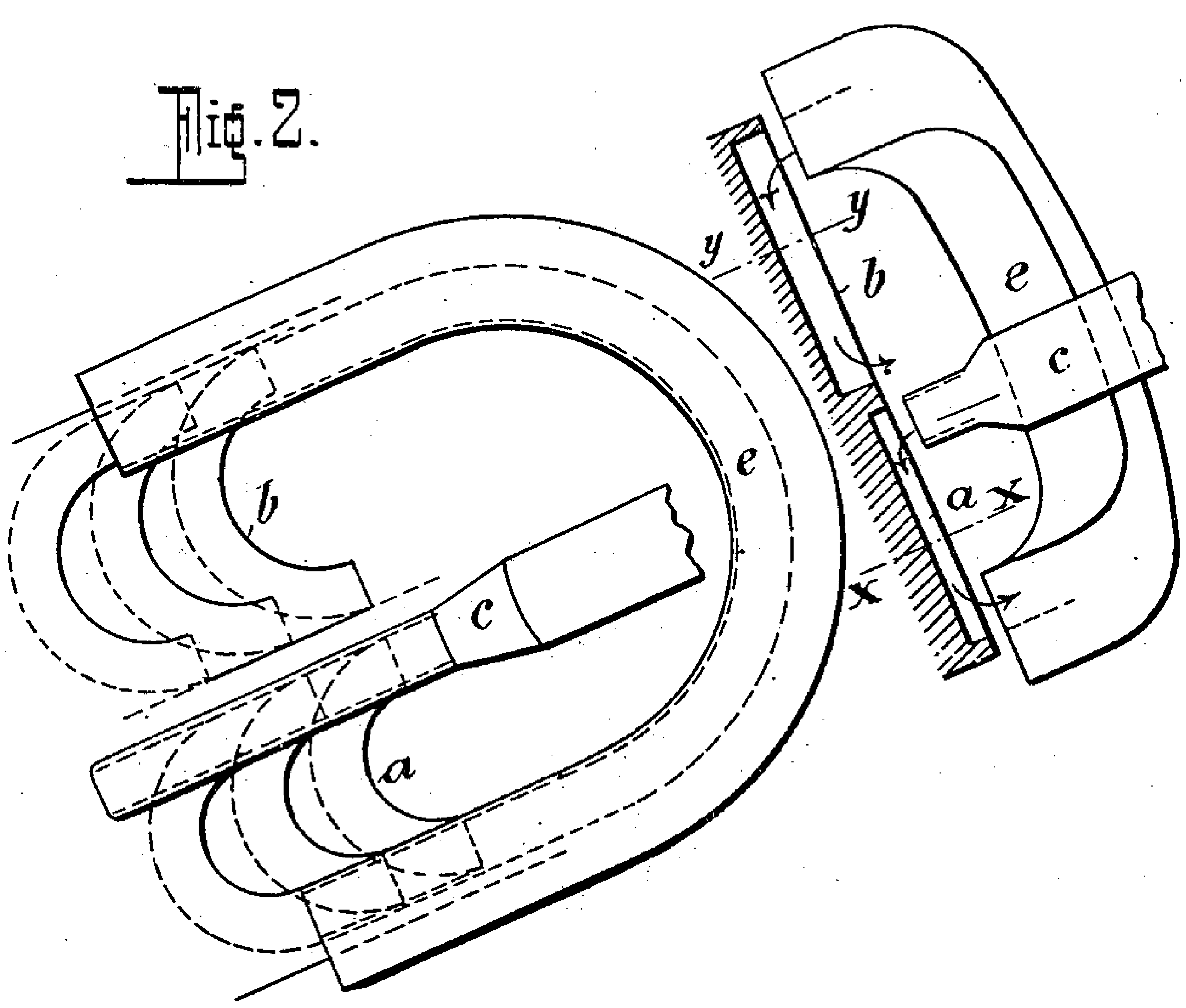


Fig. 3.

Fig. 2.



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MULTISTAGE STEAM-TURBINE.

No. 819,616. Specification of Letters Patent. Patented May 1, 1906.

Application filed October 15, 1903. Serial No. 177,214.

To all whom it may concern:

Be it known that I, JOHANN STUMPF, a subject of the German Emperor, residing at 27 Rankestrasse, Berlin, Germany, have invented certain new and useful Improvements in Multistage Steam and Gas Turbines, of which the following is a specification.

In utilizing the energy of steam or gas under pressure in multiple stages the motive fluid is led from one driving-wheel to the other by means of guide-blades which bridge over the intermediate spaces between the respective wheels in such a manner that the motive fluid flows through the respective driving and guiding blades of the different stages one after the other in a serpentine course. In traversing this serpentine course the motive fluid naturally undergoes deflections of its direction of motion corresponding to the number of blades; but now, especially with the ordinary high speeds of flow, there takes place in the blades a compression of the steam which is not uniform throughout the entire cross-sectional area or thickness of the steam-jet. By reason of the centrifugal forces which occur in the curved pockets of the blades there takes place at or along the walls of the blades—that is to say, always at the outer side of the "steam-arc"—a compression which in some cases may amount to several atmospheres, while this pressure diminishes gradually toward the inner side of the steam-arc. As soon as steam (for the sake of simplicity the motive fluid is hereinafter referred to always under the designation of "steam") reverses its direction of motion in the next blades—that is to say, when the course of movement comes to a turning point—a compression again takes place there, but now in such a manner that the streams of steam which were situated on the inner side in the previous blade and were not compressed at all, or only slightly compressed, now undergo the greatest compression. While now the want of uniformity in the compression in flowing through the first blade produces of itself a dispersion or spreading of the steam, in consequence of the fact that the steam which passes out of the nozzle in a compact uniform jet onto the blade is caused to expand again ununiformly to an equal extent by reason of the compression that takes place in the blade, this phenomenon is repeated not only in each successive blade, but the conditions are also rendered especially unfavorable by reason of the fact that the compression takes place always alternately on two sides of the steam-jet. The dispersion or spreading of the steam-jet is rendered thereby extremely great, and in these conditions an important reason is to be sought why in practical working with multiple-expansion turbines the use of such turbines has been limited to turbines of a few stages.

The well-known turbines in which the steam is repeatedly returned by means of what are known as "counter-blades" or "return-blades" into the same wheel does actually avoid the above-stated drawbacks, but such turbines cannot comply with the requirements of a proper utilization of the steam, because it is necessary to effect the repeated utilization of the steam in the same blades, whereas blades of successively-increasing capacities should be used to correspond with the progressive expansion or diminished velocity of the steam.

The new method obviates the aforestated drawbacks of the known constructions in a simple and reliable manner.

The method consists in causing the steam to do work first in the usual manner in the first stage and then on leaving this first stage to be conveyed to the second driving-wheel in such a manner that the direction of the deflection is not altered either in the guide-blades or in the pockets of the blades of the second wheel. The constructional execution of the method may also be effected in a very simple manner. If two driving-wheels having simple curved—for instance, U-shaped—pockets are arranged side by side, the steam is led into the first wheel at the edge which faces the second wheel—that is to say, as it were, in the middle of the two wheels—so that it leaves the wheel at one outer edge. Then the guide-blades extend from this outer edge of the first wheel to the outer edge of the adjacent wheel, so that the steam leaves this wheel again, as it were, at the middle of the two wheels—that is to say, at that edge of the second wheel which is adjacent to the first wheel. All reversal of the direction of motion is avoided, and, moreover, the construction and dimensions of the several steam-passages are not limited in any way.

The method may also be applied without

difficulty to that kind of turbine in which the first wheel is fitted with double blades in accordance with the Pelton system, where the steam-jet issuing from the nozzle is split up into two portions which pass through the system of blades in opposite directions. The partial jet which passes through one-half of the first double wheel is in this case let to the outer edge of the two-stage wheel adjacent to the other half of the first wheel and leaves the said two-stage wheel at the inner edge—that is to say, by the side of the first wheel that is fitted with double blades. Then the steam may be let further in the manner stated in the same direction of curvature to any desired number of further wheels. In a turbine having double blades of the first-stage wheel the first guide-blades must therefore extend over three rings of guide-blades instead of over only two such rings.

In the drawings which illustrate blades of a two-stage turbine, Figure 1 is a longitudinal section. Fig. 2 is a plan, and Fig. 3 is a cross-section. Fig. 3 shows that instead of two separate wheels there may be two rings of blades *a* and *b*, provided on a common wheel-rim.

Some blades *a* are shown in the left-hand portion of Fig. 1 and some blades *b* are shown in the right-hand portion of the same figure, so that the figure shows in its lower portion two partial sections on the planes *x x* and *y y*. From the drawings it will be seen that the blades of the two rows or series *a* and *b* are differently designed not only as regards size, but also as regards the angle of inclination to the periphery of the wheel. The nozzles *c* are curved at their upper parts, where they are fixed in an annular part *d*.

As will be seen from Figs. 2 and 3, the nozzles open out above the inner edge of the row of blades *a*. Between the nozzle-bodies there are left spaces through which guide blades or passages *e* are placed with their orifices overlapping the outer edges of the series of blades *a* and *b*. These guide-blades are shown in the example given as being solely independent separate parts, which, as is indicated at *f* in Fig. 1, may likewise be attached to the annular part *d*.

The steam issuing from the nozzles *c* passes now first through the blades *a* and then after leaving the said blades it enters the guide passages or blades *e*. These passages or blades lead the steam at the outer side into the blades *b*, which in turn discharge the steam at the middle of the blade system. When additional or further stages are to be connected, the steam on leaving the blades *b* must be again caught up by guide-blades which guide the steam to the next driving-wheel or to the next guide-blade wheel in the same manner as has been explained with reference to the blades *a* and *b*.

It may be repeated here that the drawings show a construction merely by way of example. The shape of the steam-passages may be varied as desired so long as they comply with the condition that the direction of deflection of the motive medium is not altered or that the curves of the course of the motive fluid does not comprise any turning or reversing points—that is to say, a location of the centers of curvature alternately on either side of the curve.

It will be understood that by "blades" is meant any equivalent, such as a series of recesses suitably provided in the periphery of the rotating part.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In an elastic-fluid turbine, the combination of a fluid-discharging device, a series of blades which receive fluid from said device and impart to it a circular movement, a guide which receives the fluid from the blades and continues the circular movement in substantially the same plane it traversed in passing through the blades, and a series of blades which receive fluid from the guide.

2. In an elastic-fluid turbine, the combination of rows of blades arranged side by side, with means which receive motive fluid from the outer or delivery ends of the blades of one row and conveys it over the blades and discharges it against the outer or inlet ends of the succeeding row.

3. In an elastic-fluid turbine, the combination of the plurality of sets of blades, means arranged between the outer ends of two adjacent sets for discharging fluid against one set, and a plurality of means connecting the outer ends of the blades for guiding the fluid over one set and discharging it against a succeeding set of blades.

4. In an elastic-fluid turbine, the combination of a plurality of sets of blades arranged side by side, means for discharging fluid against one set of blades at a point to cause the fluid to flow in a direction away from the adjacent set, and means for receiving the fluid delivered by the first set of blades and discharging it against the adjacent set at a point to cause the fluid to flow toward the first set.

5. In an elastic-fluid turbine, the combination of a series of sets of curved blades, a nozzle for discharging fluid under a predetermined velocity against the blades, and means so arranged with respect to the blades of adjacent sets that the fluid flowing from the inlet of the turbine to the exhaust traverses an unbroken curved path whereby the compression is maintained on but one side of the fluid stream.

6. In an elastic-fluid turbine, the combination of a wheel, the plurality of sets of blades of substantially semicircular form arranged

in the periphery thereof, means receiving fluid and discharging it at the inner side of one set of curved blades, a means arranged to receive the fluid exhausting from the outer side of said set of curved blades and discharging it against the further side of the curved blades of an adjacent set.

7. In fluid-pressure turbines a plurality of sets of blades, and a fixed guide-blade or conveying-passage whose inlet is disposed adjacent to the outlet from one set of blades and whose outlet is adjacent to the inlet of a second set of blades, the said guide-blades crossing the plane of a set of blades.

8. In fluid-pressure turbines a plurality of sets of blades and a fixed guide-blade or conveying-passage which crosses one set of blades, and whose inlet is adjacent and opposite to the outlet from one set of said blades and whose outlet is parallel with its inlet and is adjacent and opposite to the inlet to the second set of blades.

9. In fluid-pressure turbines a plurality of sets of curved blades and a fixed guide-blade or conveying-passage whose curvature is such as to guide the motive fluid from the outlet of one set of blades to the inlet of the second set of blades in a circular path in the same direction imparted to it by the blades substantially as described.

10. In fluid-pressure turbines a plurality of sets of curved blades and a fixed guide-blade or conveying-passage whose curvature is such as to guide the motive fluid from the outlet of one set of blades to the inlet of the second set of blades in a circular path in the same direction imparted to it by the blades, and whose inlet and outlet respectively overlap the outlet and inlet respectively of the first and second set of blades.

11. In fluid-pressure turbines, a plurality of wheels and a corresponding number of sets of blades, a guide-blade or conveying-passage which crosses the planes of the blades, and whose inlet is adjacent and opposite to the outlet from one set of blades upon one wheel and whose outlet is adjacent and opposite to the inlet of the second set upon the second wheel, substantially as described.

12. In fluid-pressure turbines in which a plurality of curved blades are employed, a plurality of guide-blades or steam-passages which cross the plane of the blades and convey the steam discharged in one direction from one set of blades and admit it in an opposite direction to the second set of blades, substantially as described.

13. In fluid-pressure turbines in which a plurality of sets of blades are employed, a plurality of sets of guide-blades or steam-passages which cross from the outer edge of one row of blades to the outer edge of another row of blades for conveying steam discharged from the outlet of one set of blades in one direction and admitting it in the opposite direction to the inlet of another set of blades, substantially as described.

14. In an elastic-fluid turbine, the combination of a series of blades, a nozzle which discharges fluid against the blades in such manner that compression takes place on one side of the fluid column, a second series of blades, and guides which receive fluid from the first series of blades and discharge it against the second in such manner that the compression will take place on the same side of the fluid column.

15. In an elastic-fluid turbine, the combination of rows of blades, nozzles for discharging fluid against one row of blades, and a guide for the fluid exhausting from one row of blades and passing to another row which passes between nozzles.

16. In an elastic-fluid turbine, the combination of rows of blades, closely-associated nozzles for discharging fluid against a row of blades, and guides which are located between each two adjacent nozzles that receive fluid from one row of blades and carry it across the plane of the first row of blades and discharge it against a second row.

17. In an elastic-fluid turbine, the combination of a wheel having a row of blades, a perforated nozzle-support, and closely-associated nozzles which discharge motive fluid in the form of a solid column against the blades, the said nozzles passing through the perforations in the support and extending from the latter in a direction substantially at right angles thereto and gradually bending in a direction to deliver fluid against the blades at the desired angle.

18. In an elastic-fluid turbine, the combination of a wheel having a row of blades, a perforated nozzle-support, closely-associated nozzles which discharge motive fluid in the form of a solid column against the blades, the said nozzles passing through the perforations in the support, and guides for conveying fluid from one row of blades to another which are arranged over the blades and have corresponding ends closely associated.

19. In an elastic-fluid turbine, the combination of a wheel having a row of blades, a perforated nozzle-support, closely-associated nozzles which discharge motive fluid in the form of a solid column against the blades, the said nozzles passing through the perforations in the support, and U-shaped guides located between nozzles, which receive fluid delivered as a solid column from one row of blades and discharge it as a solid column against another.

20. In an elastic-fluid turbine, the combination of a perforated support, tubular nozzles located in the perforations in the support, means for securing the nozzles in place, rows of blades, and guides for conveying fluid from one row of blades to another which are also secured to the support.

21. The combination of sets of blades, a

plurality of discharging devices, a plurality of intermediate passages connecting the delivery and inlet ends of successive sets of blades, and a common support upon which the said devices and passages are closely nested in a position over the blades.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHANN STUMPF.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.