April 28, 1931. R. WAGNER 1,803,223

BLADING FOR STEAM AND GAS TURBINES

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Fig. 1.

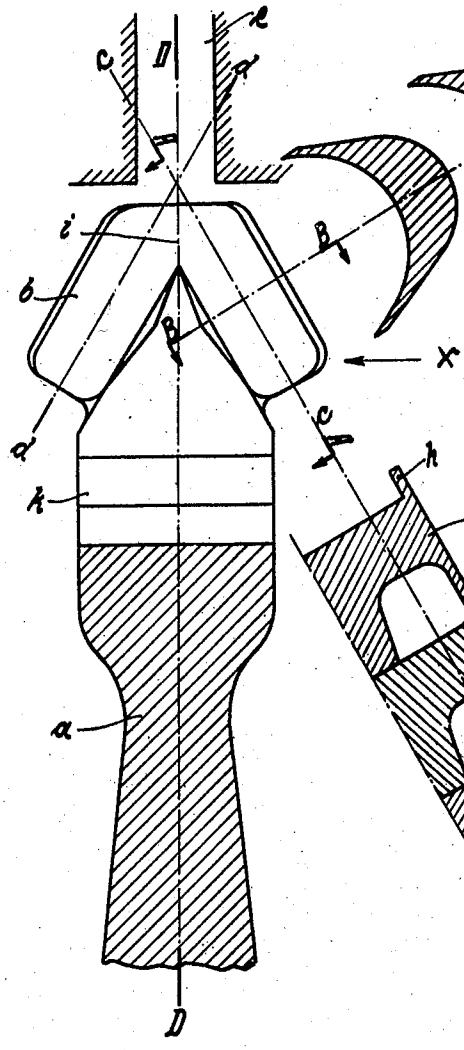


Fig. 2.

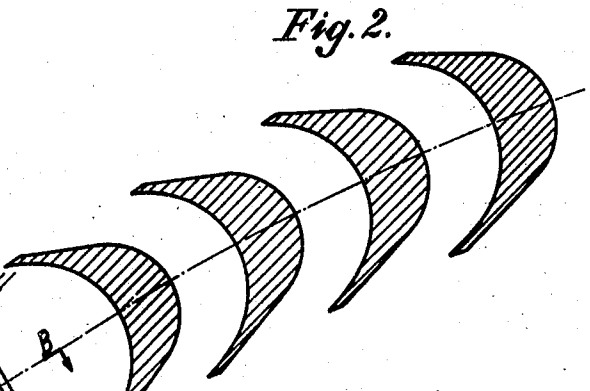
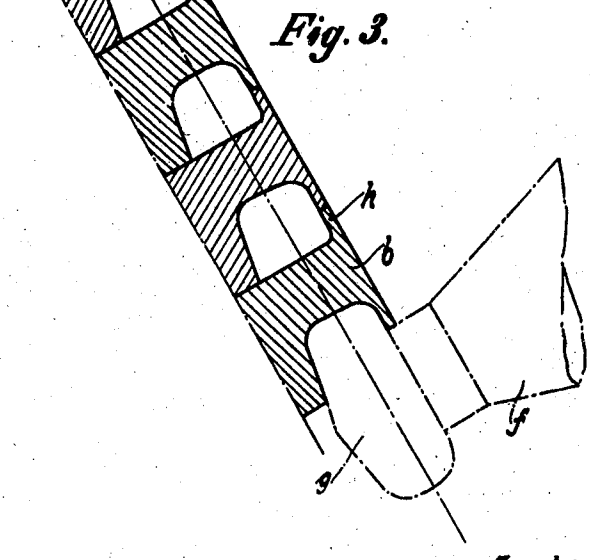


Fig. 3.



Inventor
Rudolf Wagner
By
Lamport, Petty, Kent & Lamport
Attorneys

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Fig. 4.

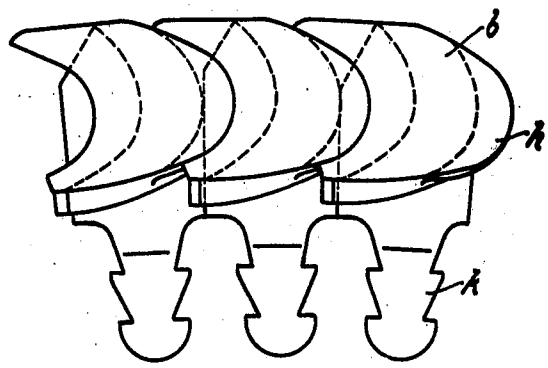
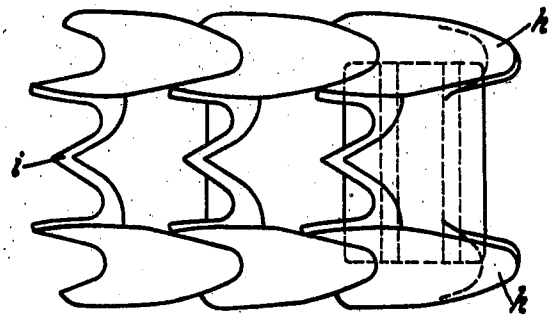


Fig. 5.



Inventor
Rudolf Wagner
By
Lanjouw, Berry, Card & Hampson
Attorneys

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BLADING FOR STEAM AND GAS TURBINES

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Fig. 6.

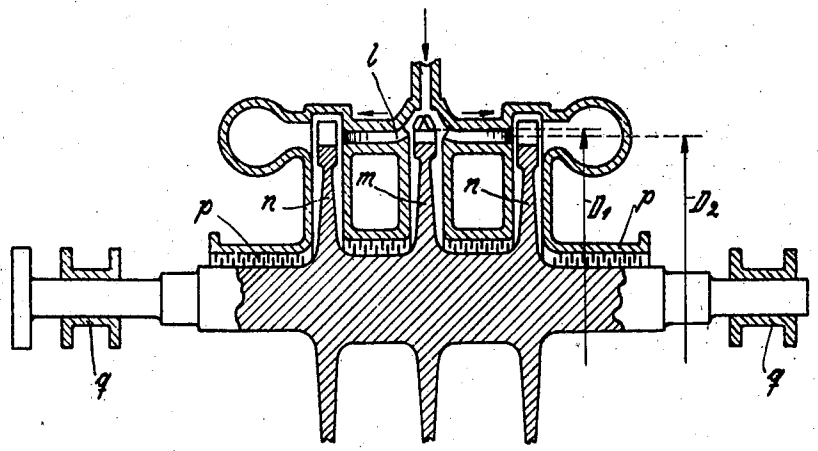
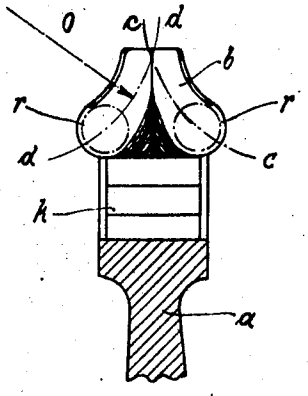


Fig. 7.



Inventor
Rudolf Wagner
By
Lacey, Lacey, Reid & Thompson
Attorneys

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UNITED STATES PATENT OFFICE

RUDOLF WAGNER, OF HAMBURG, GERMANY

BLADING FOR STEAM AND GAS TURBINES

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This invention has for its object to provide turbine blading which appears to be best adapted particularly for the first stage of high speed, high and highest pressure steam or gas turbines with a view to great safety of operation and also gives with turbines for relatively small quantities of steam and small outputs a higher efficiency than bladings used heretofore.

For the solution of this problem the present invention makes use of a Pelton-like blading in the double bucket form with radial outer admission as is already known in water turbines and also in steam turbines, for example, in the Riedler-Stumpf-turbine or a similar recently proposed construction (by Zagorski) with radial outer admission and axial flow through a double bucket, the buckets on the outside partially shrouded by two end-rings.

By the use of this type of blading the object aimed at is to introduce the hot fluid medium at the middle of the turbine casing, so that a considerably less flow of heat takes place through the rotor and the casing to the bearings than with axial admission from one end of the turbine. This is particularly important with the use of high superheated steam and high numbers of revolution of the turbine such as necessarily result with high pressure steam. Also the double flow Pelton-blading permits convenient attainment of lower stuffing box pressures by a following second stage on both sides of the Pelton-wheel than with a single flow turbine, whereby on the one hand the safety of operation is further increased and on the other hand the loss of steam from the stuffing boxes is diminished.

The above mentioned Pelton-like blading arrangements have, however, on the other hand, the drawback that in consequence of the open pockets, as, for example, in the Riedler-Stumpf-turbine, where they overlie one another at the periphery of the rotor in roof-tile fashion, they cause excessive loss of work by formation of eddies. On the other hand with the afore-said Riedler-Stumpf-turbine and also with the above mentioned construction by Zagorski the fluid medium endures from the exit from the nozzle up to the blade in the longitudinal section of the turbine a sudden deviation of 90° (tangential inlet and axial outlet), so that naturally very large losses result in the blade due to shock and eddies.

These drawbacks are overcome by the present invention by reason that the centre lines of the two channels for the fluid medium formed by the double bucket diverge towards the centre of the shaft, preferably at an acute angle to the plane of the wheel and at the same time the passages are closed at the sides in such wise that the outer sides of the blading form a closed smooth rim, i. e. the pockets are not open as in the Riedler-Stumpf-turbine and no rivet heads project as in the Zagorski-turbine.

This form of construction at the same time offers conveniently the possibility of producing the shrouds- or end-rings integral with the blades, the individual sections of the shroud-rings being milled on the blades and so formed that they fit one another without leaving gaps.

In the accompanying drawings there are shown in Figs. 1 to 7 several embodiments of the invention.

Fig. 1 is a section through the wheel rim and the nozzle.

Fig. 2 shows a development of a section of the rim through the blades on the line A—A of Fig. 1.

Fig. 3 shows a development of a section of the periphery on the line B—B of Fig. 1.

Fig. 4 is a side elevation looking in the direction of the arrow X in Fig. 1.

Fig. 5 is a top plan showing the blading.

Fig. 6 shows diagrammatically in longitudinal section one embodiment of a double flow turbine with Pelton-blading on the first stage connected with two axial admission rotors as second stage.

Fig. 7 shows a modification of the new form of bucket in cross section through the rim of the rotor.

In Fig. 1 *a* denotes the rotor disc, *b* the blade according to the invention, *c—c* and *d—d* the centre lines of the two passages for the operating fluid. These centre lines are in the present instance positioned preferably

at an acute angle to the plane of the wheel, diverging in the direction towards the centre of the shaft so far that the outlet of the passage is free laterally at the wheel rim. Greater spreading of the two streams permits a certain spacing of the outlet from the wheel rim so that a direct connection of guide passages to the second stage is facilitated, but necessitates a greater lateral deviation of the jet on issuing from the nozzle *e* and entering in the blades. Theoretically a parallel position of the two centre lines *c—c* and *d—d* would be most favorable, but in this case the formation of an unimpeded exit from the blades presents difficulties.

In the example illustrated the two passages formed by two succeeding blades from the inlet point of the operating fluid, exiting from the nozzle *e*, are united for a certain part of their length to a single channel, while beyond this point up to the outlet of the passages they extend apart. There is thus formed on the pressure side of the blade a central edge *i* by which division of the stream of the operating fluid is effected and promoted. The purpose of this arrangement is to diminish the friction losses as far as possible as compared with a construction in which the two passages for the fluid medium are separate from the beginning. Also the total breadth of blade and accordingly the ventilation loss is somewhat diminished.

In the construction illustrated the pressure sides of the blades present surfaces of rotation, being milled out by a milling tool *f* with a bulbous head *g* (shown by chain-dotted lines in Fig. 3), the axis of which miller is guided perpendicularly to the central plane of the fluid passages. The rear side of the blades may also be worked by a similar milling tool with a bulbous head for forming the extensions *h*.

It is advantageous for the flow of the operating fluid to well round off the bulbous head of the milling tool at the corners (even to complete semi-circular form) so that the passages for operating fluid are of rounded cross section especially on the pressure side of the blades and therefore offer less skin frictional resistance than passages of angular form.

To facilitate the construction of the double bucket, the buckets can be divided in the central plane D—D of the wheel. With the use of a blade root *k* disposed perpendicularly to the plane of the wheel, and shaped, for example, like a saw-tooth, as indicated in the drawing and as shown in Figs. 1–4, the two half-blades can be conveniently inserted independently into the wheel rim.

The root *k* disposed perpendicularly to the plane of the wheel is especially adapted for the present type of blading for the reason that the wheel rim is subject for the whole breadth to the centrifugal action of the blades, necessitating a less breadth of the wheel-rim and less spreading of the two passages for the fluid medium towards the centre of the shaft than with the use of the more usual hammer head root to be inserted longitudinally in the rim. In order to diminish the spreading of the passages for the operating fluid, the root can be tapered on top at both sides as shown in Fig. 1.

The mode of fixing the blades shown in Figs. 1 and 4 has also the advantage that the otherwise usual lock at the point where the blades are introduced, which is particularly dangerous with high numbers of revolution is dispensed with in that in general each blade can be inserted independently of the others.

For the purpose of attaining a laterally closed smooth periphery there are milled in the example illustrated on the backs of the blades extensions *h* (Figs. 3, 4 and 5), which fit exactly to the recesses in the side wall of the blades behind the same. After insertion of the blades in the wheel rim they can be ground at the sides in order to attain an absolutely smooth surface and to diminish the friction losses to a minimum.

In the example of construction of a double-flow steam turbine according to Fig. 6, *m* denotes the rotor of the first stage provided with the present Pelton-blading, behind which on each side is or are a rotor *n* or several rotors in order to diminish as far as possible the pressure before the stuffing boxes *p*. It will be recognized that for this purpose the new type of blading not only on account of its above mentioned advantages, besides which may be included the absence of axial thrust, constitutes a very suitable means for constructing such a double-flow turbine especially for high superheated-high pressure steam and for high numbers of revolution, operating up to the highest steam-temperatures, to be safe in operation and with high efficiency, because for such a turbine a minimum flow of heat towards the bearings is an indispensable condition.

The transference of the operating medium from the first to the second stage is facilitated if the diameters of the circles D_1 formed by the outlet openings of the Pelton-blades are larger than the mean diameters D_2 of the following stage, is that gentler curves into the guide-passages *l* result.

The subsequent rotors *n* may be provided with blades in usual manner, for example, with radially disposed blades with axial admission, as shown in Fig. 6; further they may be combined also with velocity stages using reversing blades, such velocity stages may be also directly connected with the Pelton-wheel *m*.

Besides the example shown in Figs. 1 to 5 the present system of Pelton-blading can be constructed also otherwise and can be combined with other types of blading without de-

parture from the scope of the invention.

Thus, for example, the centre lines *c—c* and *d—d* of the two passages for fluid according to the examples in Fig. 7 can be curved according to a certain radius from the external point *o* in order to divert the fluid quicker towards the sides, or to make the beginning of the passages for the operating fluid exactly or approximately radial. Of course in this case the construction of the blades is more difficult than in the examples shown in Figs. 1 to 5, in that for milling the pressure side there will be used instead of disc miller a head miller *r* with a head rounded in accordance with the transverse profile of the passages for the operating medium, which miller is moved according to a templet against the pressure side of the blade and whose axis is moved at the same time on the arc about the centre *o*.

I claim:—

1. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft and the passages are so formed that the outer sides of the blade present a closed smooth rim.

2. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, said two passages being united for a part of their length so as to form a single panel and extending apart beyond this point to their outlets and the said passages being so formed in the blade that the outer sides of the blade present a closed smooth rim.

3. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, said passages being located one upon each side of the central plane of the turbine wheel and the passages being so formed that the outer sides of the blade present a closed smooth rim.

4. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid are disposed at an inclination to one another and diverge towards the axis of the turbine shaft and said passages are so formed that the outer sides of the blade present a closed smooth rim.

5. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, said passages being curved in cross section upon the pressure side of the blade and said passages being so formed that the outer sides of the blade present a closed smooth rim.

6. A turbine in which the first stage has blades with curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, said passages being so formed that the outer sides of the blade present a closed smooth rim and the subsequent stages in said turbine have blades which are acted upon with axial admission.

7. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, said blade being provided with a saw-toothed root adapted to be inserted transversely into the rim of the wheel and the passages in said blade are so formed that the outer sides of the blade present a closed smooth rim.

8. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, the portion of the blade in back of the pressure contacting surfaces being formed so as to provide a cooperating surface with said passages in an adjacent blade and the passages being so formed that the outer sides of the blades present a closed smooth rim.

9. A blade for steam or gas turbines having curved double passages for radial outer admission in which the center lines of the two passages for the operating fluid diverge towards the axis of the turbine shaft, the passages being so formed that the outer sides of the blade present a closed smooth rim and said outer sides being extended rearwardly to form portions of the sides in an adjacent blade so as to form complete passages.

In testimony whereof I have signed my name to this specification.

RUDOLF WAGNER.