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HOLLOW BLADE FOR TURBINES

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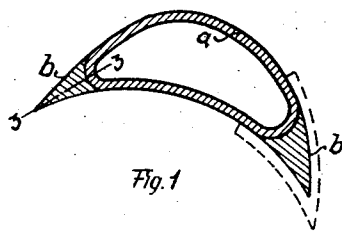


Fig. 1

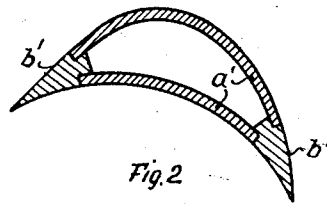


Fig. 2

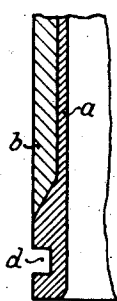


Fig. 3

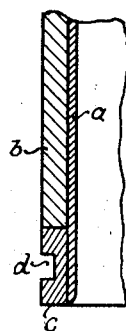


Fig. 4

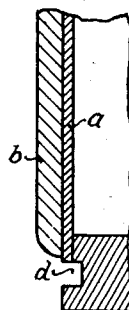


Fig. 5

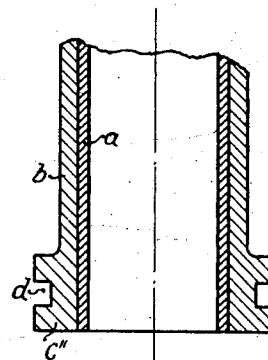


Fig. 6

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UNITED STATES PATENT OFFICE

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HOLLOW BLADE FOR TURBINES

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In certain constructions of steam or gas tur-
 bines there are employed frequently hollow blades,
 which are made either by pressing tubular sheet
 metal blanks into the well-known crescent shape,
 or by joining two blade sections or halves. Since
 sheet metal can not be bent very sharply, these
 old methods do not permit the edges of the blades,
 at the tips of the crescent, to be given such a
 sharpness or slenderness as is desirable in order to
 enable the driving jet of steam or gas to perform
 its action efficiently and without jerks.

For the purpose of overcoming the difficulty
 pointed out above, I have devised the present im-
 provement, according to which the body of the
 hollow blade may still be made of sheet metal, but
 the edges at which the driving medium enters and
 leaves respectively, are made on separate elements
 or strips which are connected with the tubular
 body by soldering, welding, etc., whereupon the
 edges of such strips can be milled, filed or other-
 wise worked to the desired sharpness, shape, and
 smoothness of surface. This improvement also
 enables me to use very thin, soft material for the
 body of the blade, and thus to reduce the cost,
 while the edge strips, where the wear is greatest,
 are made of a material harder and more resistant
 than that of said body. This construction also
 presents the advantage that after the edge strips
 have become worn, the blade may be restored to
 efficiency, by removing the edge strips and substi-
 tuting new ones, thus avoiding a complete renewal
 of the entire blade.

It will be evident that since the edge strips are
 made of solid material and therefore relatively
 heavy, they will cause an increase of the strains
 produced by centrifugal force in the tubular blade
 body during the operation of the turbine. To take
 proper care of these increased strains, I prefer to
 reinforce the tubular body at the inner end or
 foot, either by an increase in the thickness of the
 body material toward the foot, which increase
 may extend over the entire length of the body
 or only part of it, or by the addition of separate
 reinforcing material at the foot, which reinforce-
 ment would be connected with the body of the
 blade (either on the inside or on the outside) in
 any suitable manner, as by welding, soldering, or
 like operations.

The edge strips consisting of solid material may
 also be made integral with the foot, in which case
 the thin sheet metal walls forming the crescent
 shaped portion of the blade would preferably be
 secured to the outer faces of such edge strips.

Several typical and satisfactory embodiments
 of my present invention are illustrated by the
 accompanying drawing, in which Figs. 1 and 2 are
 cross sections showing two forms of my improved
 turbine blade, and Figs. 3, 4, 5 and 6 are partial
 longitudinal sections, Figs. 3, 4 and 5, and the left
 hand portion of Fig. 6 being taken in the plane

indicated at 3—3 in Fig. 1, and illustrating four
 different ways of connecting the edge strips with
 the body and the foot of the blade.

According to Fig. 1, the blade body *a* is made
 of sheet metal and forms a complete tube. The
 edge strips *b*, which are preferably of a harder
 and more durable (resistant) metal than the body
a, are secured to the outer faces of the said body,
 at the bends thereof, in any suitable manner, as
 by welding or soldering. These edge strips are
 very sharp at their free ends, much sharper than
 could be formed on the body *a* by bending, and
 thus are considerably more efficient as regards
 guiding the driving medium (steam or gas) and
 insuring its jerkless action. The edge strip may
 be machined or otherwise fashioned to its final
 shape, before attaching it to the blade body *a*;
 or, as indicated by dotted lines at the right of
 Fig. 1, the edge strip may be originally of greater
 thickness, and milled, filed, or otherwise worked
 down to the final shape (shown in full lines) after
 the strip has been attached to the blade body.
 In either event, the edge strip is made with a
 proper groove or concavity to form a seat for
 the bend of the blade body *a*.

According to Fig. 2, the blade body, instead of
 being formed of a tubular member *a*, consists of
 two separate pieces *a'* of sheet metal, of proper
 curvature to form the hollow crescent of the
 blade. The edge strips *b'* are here shown as
 formed with shouldered recesses into which are
 fitted the edges of the two body members *a'*, each
 edge strip *b'* thus having an inner portion pro-
 jecting between the said body members and sup-
 porting or backing them efficiently. The con-
 nection of the edge strips *b'* with the body mem-
 bers *a'* may be effected by soldering or weld-
 ing, as described with reference to Fig. 1.

In both constructions shown in Figs. 1 and 2,
 the convex and the concave outer surfaces of the
 blade body are flush with the adjacent surfaces
 of the edge strips.

As regards the formation of the blade at its
 inner end or foot, the following constructions are
 illustrated in Figs. 3 to 6:

In Fig. 3, the body member *a* is thickened at
 the foot portion, and formed integral therewith,
 the increase in thickness being preferably grad-
 ual, as shown, and the corresponding end of the
 edge strip *b* being tapered to fit. At *d* I have indi-
 cated, in Figs. 3 to 6, a groove adapted to re-
 ceive a corresponding flange or projection on the
 rotor body (not shown) for fastening the blade
 on such rotor body.

According to Fig. 4, the thickening or reinforce-
 ment at the foot is obtained, without thickening
 the body member *a*, by a separate foot portion *c*
 which is applied, as a ring, on the outer surface
 of the body member *a* and is connected therewith,

as well as with the edge strip *b*, in any suitable manner, for instance by soldering or welding.

The construction shown in Fig. 5 has the reinforcing member *c'* applied (as a plate or plug) to the interior of the blade body *a*, instead of externally as in Fig. 4. In Fig. 5, the blade body *a* is therefore interposed between the reinforcing member and the edge strip, and the latter is not in contact with the reinforcing member *c'*.

Fig. 6 illustrates a construction in which the annular reinforcement *c''* (similar to the ring *c* of Fig. 4) is made integral with the edge strip *b*, the blade body *a* being shown as of uniform thickness in Figs. 4, 5, and 6.

It will be noted that the internal reinforcement *c'* shown in Fig. 5 may also function as a closure for the interior of the hollow blade, at the inner end or foot thereof; such closing of the inner blade end may be desirable or necessary in some cases.

While Figs. 3 to 6 show constructions in connection with an arrangement such as illustrated by Fig. 1, where a bend of the body *a* fits into a groove of the edge strip *b*, it will be understood that formations substantially like those shown in Figs. 3 to 6 may also be used in conjunction with a blade construction such as illustrated by Fig. 2. I prefer, however, to use constructions in which the main portion *a* of the body consists of seamless sheet metal tubing as shown in Fig. 1, with the ends of the crescent-shape curved to form convex outer surfaces forming seats for the concave inner surfaces of the edge strips *b*.

Various modifications may be made without departing from the nature of my invention as defined in the appended claims.

I claim:

1. A hollow turbine blade having a body of thin metal, and an external solid reinforcing strip connected with said body forming an external longitudinal operative surface therefor and said strip having means thereon for securing the blade to the turbine.

2. A hollow turbine blade having a sheet metal body of general crescent shape, external solid reinforcing strips connected with said body and forming two external longitudinal edge strips therefor at the ends of the crescent shape, said strips forming operative surfaces for the blade and a reinforcing member, integral with said edge strips, secured to the blade body and located at the inner end or foot thereof, and means on said member for attaching the blade to the turbine.

3. A hollow turbine blade having a body of thin metal, an external solid reinforcing strip connected with said body and forming an external longitudinal edge strip therefor, said strips forming operative surfaces of the blade and a reinforcing member integral with said edge strip and located at the inner end or foot of the blade, and a flange on said member for attaching the blade to the turbine.

4. A hollow turbine blade having a body of seamless metallic tubing, and an external solid reinforcing strip integrally connected with said body and forming an external longitudinal edge therefor, said strip forming a working surface for the blade and also forming means for attachment to the turbine.

5. A hollow turbine blade having a body of relatively soft thin metal, and an external rela-

tively hard reinforcing strip connected with said body and forming an external longitudinal operative edge therefor, said strip having means for securing the blade to the rotor of the turbine.

6. A hollow turbine blade having a body of relatively soft thin metal, and an external relatively hard reinforcing strip connected with said body and forming an external longitudinal operative edge therefor, said strip having an external groove for securing the blade to the rotor of the turbine.

7. A hollow turbine blade having a sheet metal body of general crescent shape, and external solid reinforcing strips connected with said body and forming two external longitudinal operative edges therefor at the ends of the crescent-shape, said strips having means for securing the blade to the rotor of the turbine.

8. A hollow turbine blade having a sheet metal body of general crescent shape, and external solid reinforcing strips connected with said body and forming two external longitudinal operative edges therefor at the ends of the crescent-shape, said strips having external grooves for securing the blade to the rotor of the turbine.

9. A hollow turbine blade having a sheet metal body of general crescent shape, and an external solid reinforcing strip connected with said body and forming an external longitudinal operative edge therefor at an end of the crescent shape, the outer surfaces of said strip being flush with the adjacent outer surface portions of the body, said strip having means for securing the blade to the rotor of the turbine.

10. A hollow turbine blade having a relatively soft sheet metal body of general crescent shape, and an external relatively hard reinforcing strip connected with said body and forming an external longitudinal operative edge therefor at an end of the crescent shape, the outer surfaces of said strip being flush with the adjacent outer surface portions of the body, said strip having an external groove for securing the blade to the rotor of the turbine.

11. A hollow turbine blade having a body of thin metal, an external solid reinforcing strip connected with said body and forming an external longitudinal edge strip therefor constituting a working surface of the blade, and an annular reinforcing member located at the inner end or foot of the blade and having means for securing the blade to the rotor of the turbine.

12. A hollow turbine blade having a body of thin metal, an external solid reinforcing strip connected with said body and forming an external longitudinal edge strip therefor constituting a working surface of the blade, and an annular reinforcing member located at the inner end or foot of the blade and having an external groove for securing the blade to the rotor of the turbine.

13. A hollow turbine blade having a body of metallic tubing of general crescent-shape with bends at the ends of the crescent-shape, the outer surfaces of said bends being convex, and external solid reinforcing edge strips having concave surfaces fitted against the said convex surfaces of the body and secured thereto and forming two external longitudinal working edges for said body at the ends of the crescent-shape.

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