July 2, 1935. U. MEININGHAUS 2,006,684

BLADE RING FOR RADIAL FLOW MACHINES

Filed July 26, 1933 2 Sheets-Sheet 1

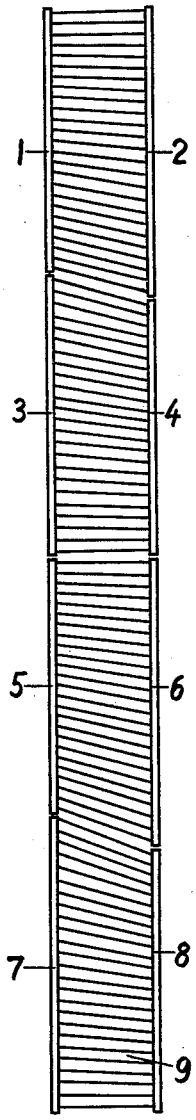


Fig. 1

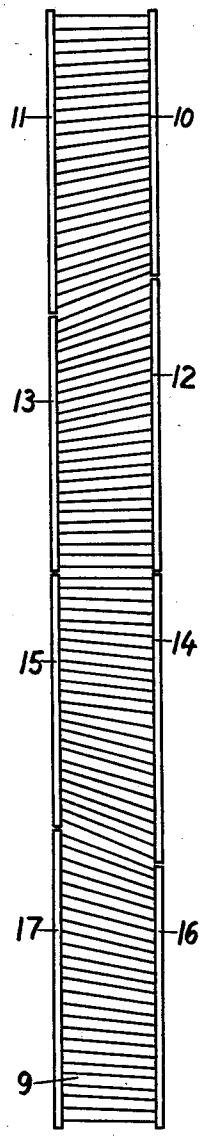


Fig. 2

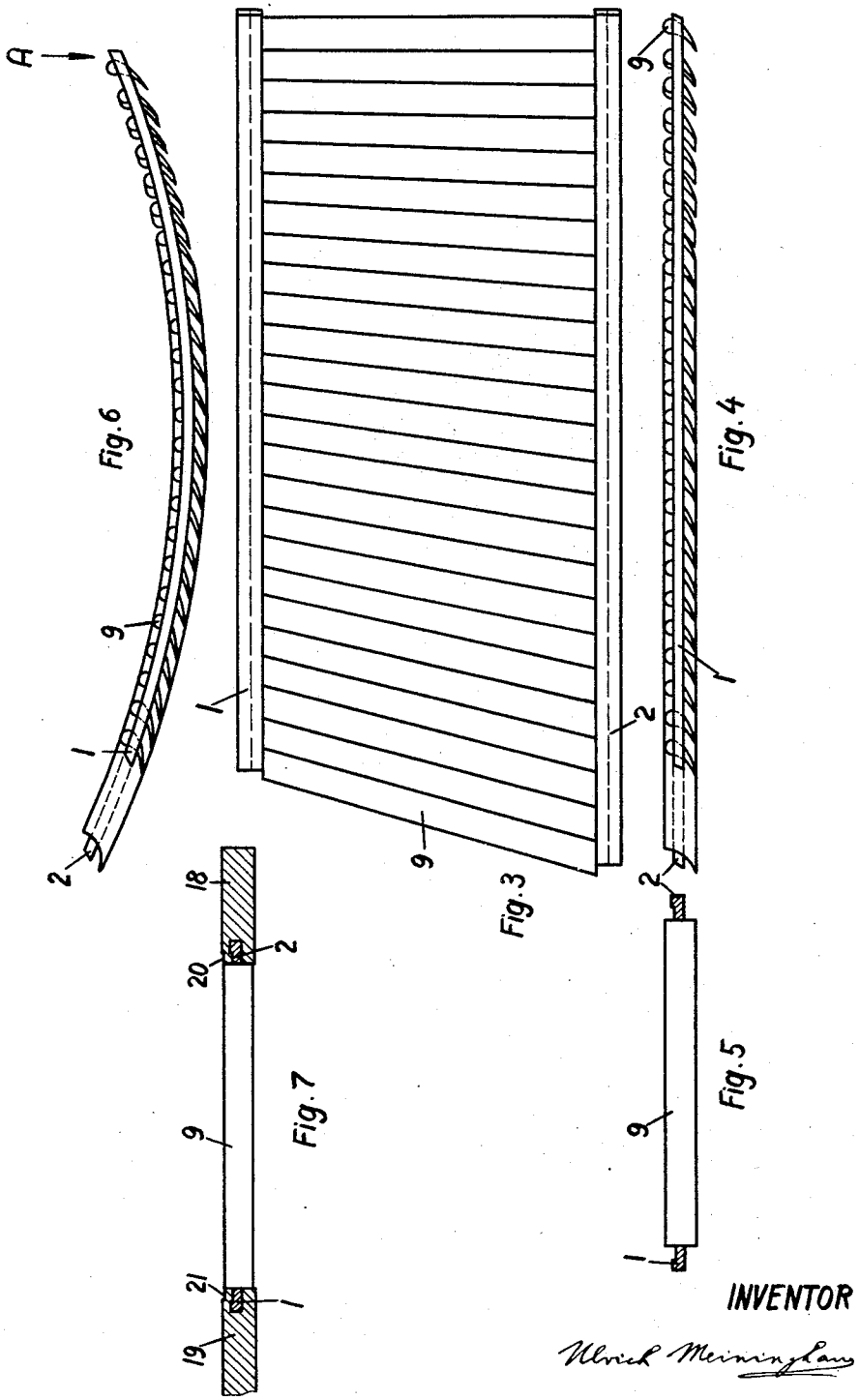
INVENTOR

Ulrich Meininghaus

July 2, 1935. U. MEININGHAUS 2,006,684

BLADE RING FOR RADIAL FLOW MACHINES

Filed July 26, 1933 2 Sheets-Sheet 2



INVENTOR

Ulrich Meininghaus

Patented July 2, 1935 2,006,684

UNITED STATES PATENT OFFICE

2,006,684

BLADE RING FOR RADIAL FLOW MACHINES

Ulrich Meininghaus, Mulheim-Ruhr, Germany

Application July 26, 1933, Serial No. 682,179
In Germany September 10, 1932

8 Claims. (Cl. 253—16.5)

My invention relates to the fastening of blades in radially impinged machines, like steam or gas turbines, and has for its object to increase the resistance against the bending forces exerted by the driving torque of the machine.

In the construction of radially traversed blading it has been found particularly advantageous to hold the blades at both ends in closed rings. Of these rings the one—known as the foot ring—transfers the torque exerted from the blades to the driving shaft, and also holds the blades rigidly in central position. The other ring—known as the head ring—also holds the blades together in consequence of its closed form against the centrifugal forces, but must be carried by the blades themselves. By such an arrangement the great advantage arises that each ring needs only to take up half the centrifugal forces, that moreover the blade ends which are fixed in the rings and are hereby weakened, are stressed by these centrifugal forces practically only by shearing and not by bending, and that finally the bending moment produced by the peripheral forces of the blades at their ends distributes itself between the two blade ends and is only therefore half as large per blade end. It is consequently possible to arrive at a very cheap blade attachment effected by welding and rolling in.

As soon however as larger performances must be transferred from a blade, the bending stress exerted on the blade ends by the bending moment caused by the peripheral forces becomes greater, even when distributed on the two blade ends, than can be permitted to the blade ends which are weakened by the cheap method of attachment. Milled blade profiles and blade ends must then be employed, the cost of manufacture of which amounts to many times that of the simple construction from rolled profiles which are welded and rolled in and are permissible for lesser loads.

In order to relieve the blade ends from the bending moment in the peripheral direction, which arises from the giving up of energy of the working medium, and so to make the cheap blading construction applicable also for highly loaded blades, it has already been proposed to unite the head and foot rings by the provision of supplementary inclined supports running aslant the central axis of the machine in the peripheral direction. This gives rise in the known manner to triangles of forces by means of which the bending stresses are transformed into tensile and compression forces. This solution however has not attained any importance because it is hardly possible to carry it out in practice. The supplementary supports must have a greater length than the blades as they are arranged aslant the blades. They are therefore stressed more highly than the blades themselves by the centrifugal force which produces the highest bending stress in the middle of the blades, i. e. their radial thickness must be at least as large as that of the blades. As the blade rings must be arranged quite closely around one another, if a sufficient number of blades is to be accommodated, there is naturally no space available between the several blade rings for the accommodation of supports of the same height as the blades themselves.

It would be theoretically possible to dispose them only in the last, i. e. the outermost blade row. Here, however, the blades themselves are in most cases already stressed at their middle cross sections by centrifugal force to the extreme permissible amount. It is therefore impossible to provide supports longer than the blades which would be disposed at a greater diameter and therefore subjected to greater centrifugal force than the blades themselves, because the supports could no longer be constructed sufficiently resistant to the centrifugal force.

The invention proposes a new way of solving the problem described above. It resides in arranging that the individual blades possess, in the peripheral direction, a progressively changing inclination to the central axis of the machine. In order to avoid one-sided narrowing or broadening of the blade channels to too large an extent by the inclination of the blades to one another, and consequently impeded guiding of the driving medium or impermissibly high wall friction, the progressive change in inclination in the blades is, according to a further feature of the invention, attained by making the blade pitches between the two blade ends different, the difference being progressively subdivided over a plurality of blades. This difference can be so small that it is practically imperceptible for the individual channels between the blades, but amounts by progressive addition to the desired inclination. To attain the object of the invention it is therefore only necessary that at similar points of the periphery the blade pitch (i. e. the distance between the ends of adjacent blades) at opposite ends of the blades should differ from one another and that different blade pitches over the periphery should be employed at opposite ends of the blades. The most favourable conditions as regards cost of manufacture and shape of blade channel arise

when a number of regular but different blade pitches are employed (preferably two). Conveniently, the different blade pitches at opposite ends of the blades may alternate in sections. As, for structural reasons, the blades are generally united in groups of from ten to thirty blades in the form of segments ready for assembly, the manufacture is particularly simple if, within each segment, the inclination of the blades in the peripheral direction to the central axis of the machine rises from nothing to a desired maximum, by making the blade pitch on one side greater than on the other side. The change in inclination can either always take place in the same direction, or even better, alternately in one direction and the other. In every case the desired form of force triangles is obtained without the flow conditions in the blades being disadvantageously influenced. The bending forces are taken up by tensile and compression forces in the blades themselves without the blade ends needing to be resistant to bending. As the blade ring is held at its distance from the foot ring by the blades themselves only, the arrangement must be such that the head ring cannot incline itself with regard to the foot ring by change in the inclination of the blades. As the head ring is a closed ring, the absolute parallel position with regard to the foot ring can be ensured by arranging that the inclination of the blades is always symmetrical at opposite points of a diameter of the ring. All the forces seeking to alter the position of the head ring are then equal at two diametrically opposite points, which prevents a tipping effect. It is desirable therefore that the blades at the periphery should return to the position parallel to the central axis of the machine at least twice with a one-sided inclination and at least four times with a two-sided inclination.

Figures 1 and 2 are diagrammatic developed plan views of the peripheries of examples of blade rings constructed in accordance with the invention.

Figure 3 is a plan view of a single blade segment.

Figure 4 is a side view, of the blade segment illustrated in Figure 3, showing the blade segment in the unbent condition.

Figure 5 is a side view of the ends of the blade segments shown in Figure 4.

Figure 6 shows the same side view as Figure 4 with the blade segment bent to correspond with the mean blade diameter.

Figure 7 shows the rolling in of the blade segments, in two carrier rings which are cut along the mean axis.

In Figure 1, lines 1—8 represent the side supports of the blade segments to which the blades 9, also shown by lines, are welded or otherwise connected. The supports 1—8 are rolled in known manner into the head and foot rings in order to produce the finished blade ring. According to Figure 1 the whole periphery consists of four blade segments 1—2, 3—4, 5—6 and 7—8. Naturally any desired further number of segments can be provided. The blade pitch at the supports 1, 4, 5 and 8 is the equal and less than that of the blade ends at the supports 2, 3, 6 and 7, where again it is equal for all four supports. Therefore only two different blade pitches and kinds of support are employed so that the manufacture is simple and cheap. In the blade segment 1—2 the first blade is at its upper end perpendicular to the supports. As the blade pitch of the support 2 is larger than that of the support 1 the blades incline more and more up to a maximum inclination at the lower end of the segment 1—2. As the difference in blade pitch is only small, the form of the blade channels is in practice not unfavourably influenced. The segment 3—4 begins with the maximum oblique position of the blades. As here however the blade pitch at the support 3 is larger than that at the support 4, the blades again approximate more and more to a position at right angles to the supports, which is reached at the lower end. The segment 5—6 is constructed symmetrically with regard to the segment 1—2, and the segment 7—8 symmetrically with regard to the segment 5—6. If the whole periphery consists of these four segments, the symmetrical arrangement ensures that the head ring maintains its parallel position even under displacing forces. If, for example, the supports 1, 3, 5 and 7 are fixed in the head ring and the supports 2, 4, 6 and 8 in the foot ring so that they cannot be displaced relatively to one another, all forces which seek to increase the distance between the rings or to bring them nearer together always occur at points exactly diametrically opposite to one another. The head ring cannot therefore tip out of the parallel position to the foot ring. It is naturally possible to depart from this exact symmetry within certain limits without objection. The more segments are employed, i. e. the more often the blades alternate from the maximum inclination to the perpendicular, the less importance need be attached to symmetry.

Figure 2 shows a corresponding construction when the inclination of the blades increases in both directions. Here the supports 10, 13, 15 and 16 have the same blade pitch, which is smaller than the likewise equal blade pitch at the supports 11, 12, 14 and 17. The effect is the same as that shown in Figure 1. The minimum number of segments or alterations in inclination which is necessary to attain blade symmetry is in this case eight, as shown in Figure 2. Owing to the greater number of segments in this case less attention need be made to complete symmetry.

Figures 3 and 7 show the invention as applied to a single blade segment in which blade pieces 9 cut from a rolled steel profile are welded between supports 1 and 2. The reference numerals in Figures 1 and 2 apply to these figures with the addition of the carrier rings 18 and 19 in Fig. 7 into which the blade segments are rolled. The rolling is effected by pressing the material at the points 20 and 21. Before the introduction of the supports 1 and 2 of the blade segments, (and the remaining supports 3 to 17), the blade segments are bent by hand or by a suitable apparatus to the diameter of the carrier rings 18 and 19 as is shown by a comparison of Figure 6 with the straight form shown in Figure 4.

It follows from the drawings that in the arrangement according to the invention, triangles of forces are formed which prevent mutual displacement of the head and foot rings without the blade ends having to withstand bending moments. The result is that only tensile and compression forces have to be dealt with. The triangles of forces are such that no non-permissible widenings or narrowings of the blade channels arise although no supporting means other than the blades themselves are employed. With this arrangement therefore large peripheral forces can be transferred while using the cheapest method of attachment for the blades without corresponding disadvantages of any practical importance.

The figures show diagrammatic examples only, to which the invention is not bound.

I claim:

1. A blade ring suitable for use in a radial flow machine comprising a plurality of blades and carrier rings adapted to support both ends of said blades, the inclination of said blades changing progressively along the circumference of said carrier rings in relation to the centre line of said carrier rings by means of providing a difference in the distance between the blades at one carrier ring and the opposite ring.

2. Apparatus according to claim 1, wherein the pitches on both blade ends differ by an amount which is progressively distributed over a plurality of blades.

3. Apparatus according to claim 1, wherein the pitches on both blade ends differ from each other at the same points of the circumference.

4. Apparatus according to claim 1, wherein along the circumference different pitches are applied.

5. Apparatus according to claim 1, wherein along the circumference two different pitches are applied.

6. A blade ring suitable for use in a radial flow machine comprising a plurality of blades, strips capable of holding together a number of said blades at both ends and thus forming single sections of said blade ring, and carrier rings adapted to support said strips and blade ends, the inclination of said blades changing progressively along the circumference of said carrier rings in relation to the centre line of said carrier rings, by means of providing said strips with constant, but different pitches.

7. A blade ring suitable for use in a radial flow machine comprising a plurality of blades and carrier rings adapted to support both ends of said blades, the inclination of said blades changing progressively along the circumference of said carrier rings in relation to the centre line of said carrier rings to both sides of the parallel position by means of providing a difference in the distance between the blades at one carrier ring and the opposite ring, whereby the blades pass at least four times along the circumference the position parallel to the centre line of the machine.

8. A blade ring suitable for use in a radial flow machine comprising a plurality of blades and carrier rings adapted to support both ends of said blades the inclination of said blades changing progressively along the circumference of said carrier rings in relation to the centre line of said carrier rings to one side of the parallel position only by means of providing a difference in the distance between the blades at one carrier ring and the opposite ring, whereby the blades pass at least twice along the circumference the position parallel to the centre line of the machine.

ULRICH MEININGHAUS.