K. BAUMANN.

TURBINE.

APPLICATION FILED MAY 3, 1919.

1,362,074.

Patented Dec. 14, 1920.

2 SHEETS—SHEET 1.

Fig.1

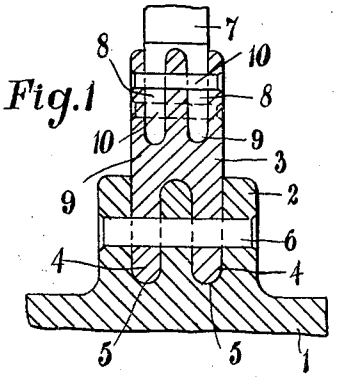


Fig.2

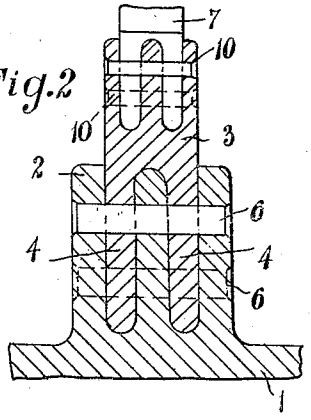


Fig.3

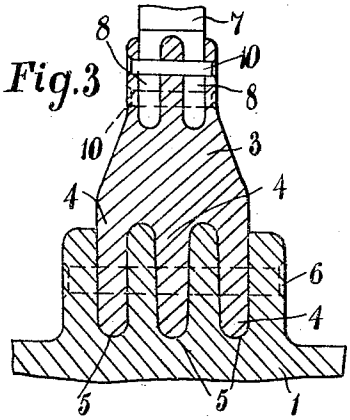


Fig.4

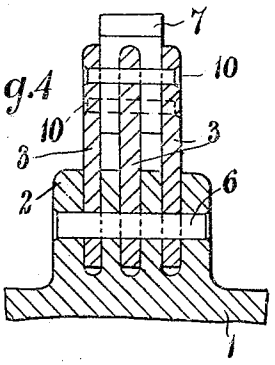


Fig.7

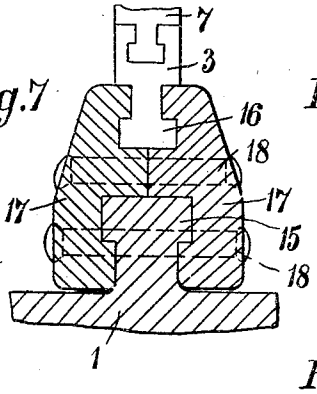


Fig.8

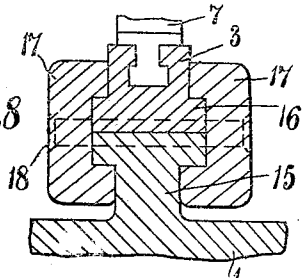
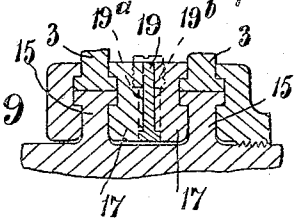


Fig.9



INVENTOR

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by E. M. McCallister

his attorney

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2 SHEETS—SHEET 2.

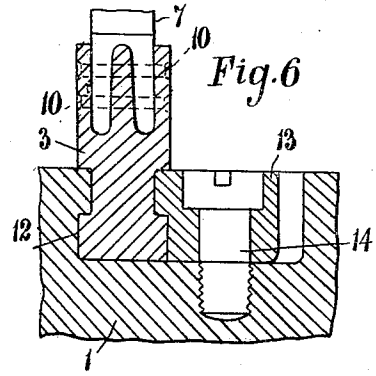

Fig.6

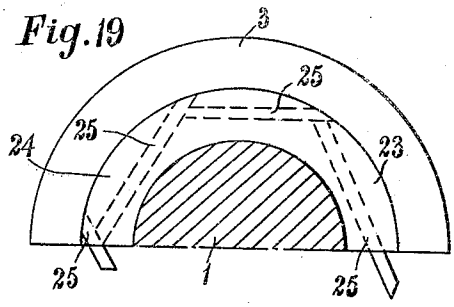

Fig.19

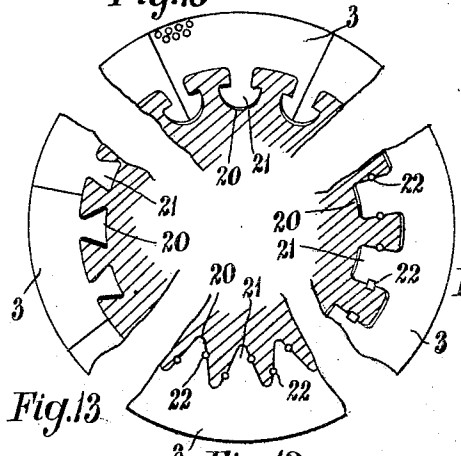

Fig.10

Fig.13

Fig.12

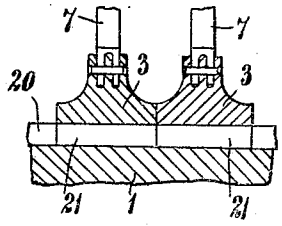

Fig.14

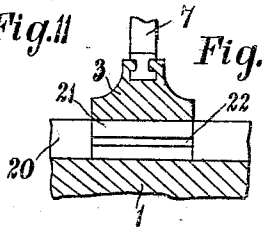

Fig.11

Fig.15

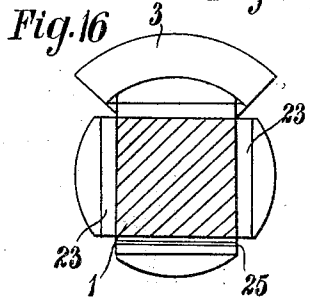

Fig.16

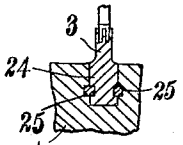

Fig.17

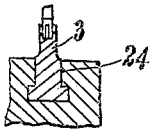

Fig.18

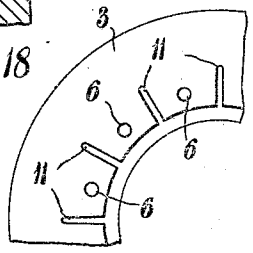

Fig.5

INVENTOR

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UNITED STATES PATENT OFFICE.

KARL BAUMANN, OF URMSTON, ENGLAND, ASSIGNOR TO THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY LIMITED, A CORPORATION OF GREAT BRITAIN.

TURBINE.

1,362,074. Specification of Letters Patent. Patented Dec. 14, 1920.

Application filed May 3, 1919. Serial No. 294,542.

To all whom it may concern:

Be it known that I, KARL BAUMANN, a citizen of the Confederation of Switzerland, and a resident of Urmston, in the county of Lancaster, England, have invented a new and useful Improvement in or Relating to Turbines, of which the following is a specification.

This invention relates to turbines and more particularly to the rotors or movable blade carrying elements of turbines in which the moving blades are attached to disks, wheels or the like, mounted on the rotor shaft. As at present constructed such disks, wheels or the like, are usually shrunk and keyed on the shaft with the result that the torque is transmitted from the disk or wheel to the shaft but not the centrifugal forces of the blades and the disk or wheel. With this construction the disk, wheel or the like must be of sufficient strength to take all the stresses due to centrifugal force.

In those cases in which the diameter of the disk is comparatively small and the bore relatively large, it is difficult to construct a disk of sufficient strength to take the centrifugal forces. A further difficulty resides in the fact that in order to prevent such a disk from becoming loose on the shaft when running at a high speed it is necessary to employ a considerable shrinkage fit between the disk and the shaft, which increases the difficulty of assembling and disassembling the disks from the shaft.

The present invention has for its object to provide an improved turbine rotor or movable blade carrying element in which the above mentioned disadvantages are overcome and the weight of the rotor can be considerably reduced, and according thereto the blades are attached to the disk or wheel, or to a plurality of ring segments forming together the equivalent of a disk or wheel in any suitable or well known way and the disk or wheel, or segments as the case may be, are connected to the shaft of the rotor in such a manner that the whole or the greater part of the centrifugal forces of the blades and of the disk or segments will be directly transmitted to the shaft.

In carrying out the invention the method of attachment of the blades to the disk or segments and of the disk or segments to the shaft may be of any suitable type, the two attachments being, however, essentially separate and independent of one another, and such that the centrifugal forces and forces due to the torque are transmitted from the blade attachment to the disk attachment through the disk or segments (hereinafter referred to as the blade holder) as directly as possible, preferably though not necessarily in a substantially radial direction. The attachment between the blade holder and the shaft must be of sufficient strength to take, in addition to the centrifugal forces of the blades and of the blade packers, if any, those of the blade holder itself.

In the accompanying drawings, the several figures of which are hereinafter described in detail, various constructional forms which the invention may assume are indicated diagrammatically, the same reference numerals being used to indicate like parts throughout the various figures.

In Figure 1 the turbine shaft is shown at 1 with a grooved collar 2 formed thereon. The blade holder 3, consisting of two or more segments, is provided on its inner circumference with tongues 4, 4, adapted to fit in the grooves 5, 5 in the collar 2. The blade holder is attached to the shaft collar by bolts or rivets 6 passing through both the collar 2 of the shaft and the tongues 4, 4 of the blade holder 3. The turbine blades are indicated at 7 and may be attached to the blade holder 3 in any suitable and well known manner, the attachment for the blades shown in this figure comprising tongues 8, 8 formed on the foot of the blade which are received into circumferential grooves or recesses 9, 9 in the blade holder, and a double row of rivets 10, 10.

In Fig. 2 the construction is very similar to that illustrated in Fig. 1 except that the collar 2 on the shaft and the tongues 4, 4 on the blade holder 3 are of greater depth to permit of a double row of bolts or rivets 6, 6 being employed, thus providing an attachment of greater strength between the blade holder and the shaft.

In Fig. 3 a construction of greater strength than that illustrated in Figs. 1 and 2 is secured by increasing the thickness of the blade holder 3 as illustrated where it is attached to the shaft.

The segments comprising the blade holder 3 may either be made in one piece, as illustrated in Figs. 1 to 3, or may consist of a plurality of plates arranged side by side as

shown in Fig. 4. Where, as will usually be the case, a plurality of blade holders are mounted side by side on the shaft it may sometimes be found convenient to use one set only of rivets or bolts 6 passing through all of said blade holders and the collars on the shaft.

In the forms of the invention shown in the preceding figures the blade holder 3 must be made in not less than two parts to allow of its insertion in the grooves on the collar, but may be made in a greater number of parts if desired. Alternatively, the blade holder may have but a single groove on its inner circumference into which the collar or flange on the shaft fits, the blade holder thus straddling the collar on the shaft. However, for most conditions occurring in practice this construction would not usually be sufficiently strong, and one or other of the constructions illustrated in Figs. 1 to 4 will generally be found preferable.

In these constructions, in addition to the radial pull on the attachment between the blade holder and the shaft there will also be a pull in a tangential direction which will be most evident on the rivets or bolts nearest to the joints between the segments of the blade holder, and in order to keep this pull as small as possible radial slots 11, as shown in Fig. 5, may be formed in the blade holder 3. Another convenient procedure is to assemble the blade holder segments with initial tension by heating the shaft while the blade holders are being assembled thereon.

Fig. 6 illustrates another construction in which the blade holder 3, formed of a number of segments as before, is assembled on the shaft 1 in an undercut groove 12, a portion of the shaft 1 adjacent to said groove being cut away to permit of the last segment of the blade holder 3 being placed in position, such cut away portion being then filled up by a stop or filling piece 13 secured to the shaft by screws 14 in a well known manner.

Fig. 7 illustrates another form of attachment between the blade holder and the shaft. In this form of the invention a collar 15 of dove-tail or T shape is formed on the shaft 1 of the rotor of the turbine, and the blade holder 3 is provided on its inner edge with a corresponding dove-tail or T shaped collar 16. The blade holder is attached to the shaft by claws or plates 17, 17 furnished with grooves adapted to engage the collars 15 and 16 on the shaft and on the blade holder respectively, the claws or plates 17, 17 being secured together by rivets or bolts 18, 18 some or all of which latter may, if desired, also pass through the collars 15 and 16 on the shaft and blade holder.

Fig. 8 illustrates a modification of the attachment shown in Fig. 7, the inner surface of the collar 16 on the blade holder 3 resting on the outer surface of the collar 15 on the shaft 1, the claws or plates 17, 17 then having but a single groove embracing the outstanding flanges of both the collars 15 and 16. With this construction a single row of rivets 18 connecting the two plates 17, 17 and lying, as shown, partly in the collar 15 and partly in the collar 16 will generally be found sufficient.

In some cases, as illustrated in Fig. 9, the claws 17, 17 between adjacent blade holders 3, 3 may be held in position by means of distance pieces 19 inserted between adjacent claws 17. With this construction a filling piece is used to hold the last segment of the distance or packing piece in position in a manner well known.

A constructional form of the invention which differs from those described in the preceding figures is illustrated in Figs. 10 to 15 inclusive. In this form of the invention the shaft 1 is provided with axially alined grooves 20, the segments 3 forming the blade holder being provided on their inner edges with projections 21, adapted to slide in the grooves 20. The shape of the grooves 20 may vary, the projections on the segments 3 being formed to correspond. In Fig. 10 the grooves 20 are of mushroom shape, the projections 21 being formed correspondingly, while in Fig. 13 the grooves and projections are of dove-tail shape. In Fig. 11 rectangular grooves are illustrated and in Fig. 12 grooves of V shape. In the latter cases the segments 3 are maintained in position in the grooves by means of suitable pins, wedges or the like indicated at 22.

In Figs. 10 to 13 the blading is not shown but this may be attached to the segments forming the blade holder 3 as shown either in Figs. 14 or 15, or in any other well known and suitable manner.

Still another manner in which the invention may be carried into effect is illustrated diagrammatically in Figs. 16, 17 and 18. As here illustrated the shaft 1 has formed around its circumference a plurality of transverse rectilinear grooves 23, the inner edges of the segments 3 forming the blade holder are furnished with corresponding rectilinear projections 24 and are slid into position in the grooves 23 on the shaft. The grooves 23 on the shaft may be, as shown in Fig. 18, of undercut or dove-tail shape, the inner edge of the segments 24 of the blade holder being correspondingly formed, or the segments 3 may be held in position in the grooves 23 on the shaft by means of suitable pins or wedges 25 as illustrated in Fig. 17. If, as illustrated, the blade holder 3 consists of four segments three of them

may be assembled on the shaft in the manner described above by being slid into position on the grooves 23, the fourth segment being inserted radially in a plain groove, *i. e.*, not undercut, and held in position therein by wedges, screws or the like. The construction illustrated in Fig. 16 is not limited to the employment of a blade holder consisting of four segments as six, eight or any other number may be used, a corresponding number of rectilinear grooves being formed around the shaft.

If desired, all of the blade segments 3 may be secured in their grooves on the shaft by means of keys or wedges 25, in which case the blade holder may conveniently consist of only two segments, two sets of keys or wedges being employed in connection with each segment, the keys of each set being arranged in an approximately tangential direction and at an angle of 90° relatively to one another, though it may sometimes be found desirable to employ a greater number of keys for each segment of the blade holder.

Where the segments of the blade holder are secured to the shaft by tangentially disposed keys or wedges, as described above, the groove on the shaft may be circumferential, the inner boundary of the segments being formed to correspond as indicated in Fig. 19. In this figure the blade holder consists of two segments, only one of which is, however, illustrated, and is held in position in a circumferential groove 23 on the shaft 1 by keys 25 driven in tangentially.

Although in the several forms of the invention illustrated in the drawings the blade holders are shown as carrying only a single row of blades it is to be understood that the invention is not limited in this respect as in some cases it may be found convenient to mount two or more rows of blades on a single blade holder.

I claim as my invention.

1. In a turbine, the combination of a rotor shaft and blade holding means secured thereon, the securing portions of the shaft and blade holding means being capable of transmitting centrifugal forces wholly radially to the shaft.

2. In a turbine, the combination of a rotor shaft, blade holding means secured thereon, and blades secured to the holding means, the connections between the blade holding means and shaft and between the blades and blade holding means being capable of transmitting forces wholly radially from the blades to the blade holding means and from the latter to the shaft.

3. In a turbine, a rotor element, a blade holding element, connecting means for the elements having interfitting portions and including means to transmit radial forces from one element to the other, the portions of one element being symmetrically disposed with reference to the portion or portions of the other element whereby centrifugal forces are transmitted radially from one element to the other without the development of unbalanced lateral forces.

4. In a high speed mechanism, the combination of a rotor shaft, an element carried by the shaft, connecting means between the shaft and element to transmit radial forces from the element to the shaft, said connecting means including interfitting portions with balanced radial transmission means whereby the resultant of all radial forces are in a plane normal to the rotor axis.

5. In a high speed mechanism, the combination of a rotor shaft, a means adapted to be secured to the rotor shaft including segments, means to secure the first-named means to the shaft including interfitting portions carried by the shaft and each segment with means to transmit radial forces from each segment to the shaft.

6. In a turbine, the combination of a rotor element, blade carrying means on the rotor comprising segmental elements, and interfitting portions carried by the rotor and segmental elements, one element having an odd number of portions and the other element an even number of portions, together with means to transmit centrifugal forces from the segmental elements to the rotor elements.

In testimony whereof I have hereunto subscribed my name this 31st day of March 1919.

KARL BAUMANN.