July 28, 1953 E. M. BUTCHER 2,646,920

ROTARY BLADED OR THE LIKE ASSEMBLY

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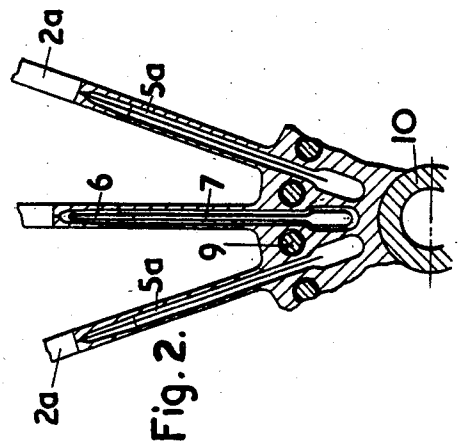


Fig. 2.

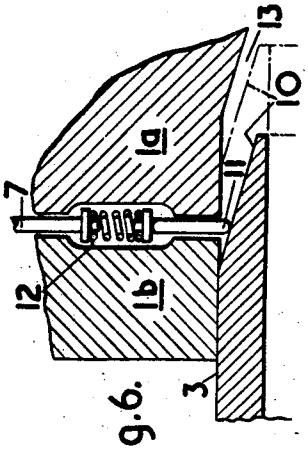


Fig. 6.

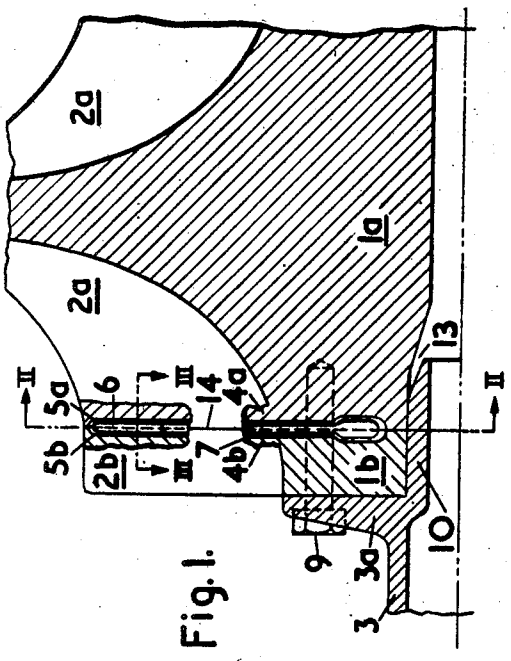


Fig. 1.

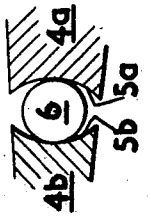


Fig. 5.

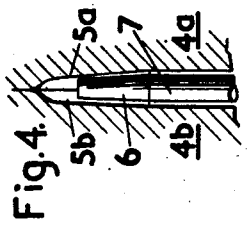


Fig. 4.

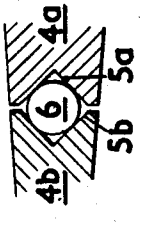


Fig. 3.

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ROTARY BLADED OR LIKE ASSEMBLY

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4 Claims. (Cl. 230—134)

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This invention relates to rotary bladed or like structures comprising a plurality of blades or vanes, each extending in a radial or substantially radial direction and lying wholly or partly in a plane or planes other than a plane of rotation, one or more of said blades or vanes being divided in a plane of rotation into two sections having their adjacent edges in axial abutment or in close proximity so as to form in effect a single blade or vane. A structure of this kind is sometimes found to be a constructional convenience in that it simplifies the manufacture of a rotor having blades or vanes of complex form by enabling the complete rotor to be made in two parts, each carrying sections of blades or vanes, the two parts being subsequently assembled by bolting together with the respective blade or vane sections in axial alignment and either abutting or in close proximity. A case to which the invention is particularly applicable is that of a centrifugal impeller in which the radial vanes have curved entry edges and in which, in order to simplify manufacture, the rotor is made in two parts separated in a plane of rotation, one of which parts carries the curved entry edge section and the other the main section of each vane, the two rotor parts being secured together so that the curved entry vane sections are in close proximity to or abut against and are in axial alignment with the main vane sections.

On the other hand the construction of a bladed or vaned rotor in two parts in this manner gives rise during operation to difficulties in maintaining alignment of the axially abutting edges, particularly in that trouble may be encountered due to aerodynamically or mechanically excited vibration of the individual section relative to one another. These difficulties render necessary very accurate manufacture and fitting in order to ensure suitable contact pressure between the two sections of each blade, and uniformity of such pressure from blade to blade, and it is an object of the present invention to provide a construction which will reduce the necessity for such high accuracy.

For the purpose according to the invention a rotary bladed or like structure of the kind specified is provided, between the axially aligned edges of the two sections of a blade, with an interconnecting element adapted to resist relative displacement between the blade sections in a plane of rotation containing said element, the latter being movable along guide means over a path corresponding to the required line of alignment between the two blade sections and exerting during said movement a wedging action with respect to said guide means, provision being made for the element to move so as to take up any slack in the connection whilst tending by said wedging action to maintain the blade sections in their proper axial alignment.

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Preferably the movement of the element is derived primarily from centrifugal loading of said element occurring when the structure is rotating, but it may also be derived to a major or minor degree from spring means provided for the purpose.

In one form of the invention each of a pair of axially abutting blade sections has a groove in its abutting edge, the two grooves together forming for an interconnecting element in the form of a plug which seats in and between the grooves, a guide path following the line of abutment and tapering in the radially outward direction, the plug being dimensioned to be a slightly slack fit in the grooves when at its radially inner position, so that under centrifugal loading it can move radially outwards until it reaches a position at which it wedges in the grooves. When this position is reached the two blade sections will be effectively interconnected so as to restrain relative movement thereof in the corresponding plane of rotation.

The rigidity of such connection is to some extent controllable by the shape of the grooves and material of the plug, and it is thus possible to have a substantially rigid interconnection, or to provide an interconnection whcih will deliberately permit a small relative movement between the blade sections whilst providing forces which will tend to reduce vibration.

The centrifugal loading of the plug may be augmented by the addition of a weighting part of the same or heavier material which need not participate in the wedging action, or by the use of springs. In the latter event means may be provided to ensure that the spring load is not applied to the plug until the two blade sections have been assembled together.

In its application to the rotor of a centrifugal impeller having more or less radial vanes made in two sections comprising a curved intake section and a relatively plane main section carried by separate rotor bodies which are secured together coaxially with the edges of the two sets of vane sections in axial alignment, the said edges of each set have guide channels formed therein and are interconnected by plugs operating in the guide channels in the manner above described.

By way of example various forms of the inven-

tion are hereinunder described with reference to the accompanying drawings in which:

Figure 1 is an axial section of part of a centrifugal impeller showing one form of the invention;

Figure 2 is a section on the line II—II of Figure 1,

Figure 3 is a section on the line III—III of Figure 1;

Figure 4 is an enlarged detail of Figure 1;

Figures 5 and 6 are detail views showing modified forms of the invention.

In Figure 1 a double sided centrifugal impeller comprises a hub *1a*, *1b*, having a number of radially extending vanes each made up of two sections *2a*, *2b*, the impeller being mounted for rotation on a hollow shaft **3**. The whole impeller structure is divided into two parts in a plane of rotation containing the line II—II, the main part of the impeller containing the hub *1a* and the vane sections *2a* while the smaller part of the impeller contains the hub portion *1b* and the vane sections *2b* the radially inner edges of which are suitably bent or curved over so as to form inlet guide vanes.

The shaft **3** and the two parts *1a*, *2a* and *1b*, *2b* of the impeller are held together by bolts **9** passing through a flange *3a* on shaft **3**, the edges *4a*, *4b* of the vane sections *2a*, *2b* respectively being thus held in close proximity or abutment along the line **14** and in axial alignment with one another.

In each of these edges *4a*, *4b* is formed a V-shaped groove or channel *5a*, *5b* as shown in Figure 3, the edges being shown slightly separated for clarity. As seen in Figure 4 the radially outer positions of the grooves *5a*, *5b*, are gradually tapered within the space enclosed by the grooves *5a*, *5b* and slidable within them is a plug **6** of circular section and frusto-conical form, and having a lower portion **7** heavier than the portion **6** and of the same or different material. As the impeller rotates, the plug **6**, **7** is moved radially outwards by centrifugal force and the part **6** becomes wedged between the radially outer ends of the grooves *5a*, *5b*. With the plug in this position, the two vane sections *2a*, *2b* become firmly interconnected so as to prevent relative movement between them in the plane of rotation containing the plug.

The object of the heavier part **7** of the plug is to augment the centrifugal loading on the plug **6**, and the part **7** need not therefore participate in the wedging action. The plug **6** may of course itself be formed as a single element which itself occupies the greater length of the grooves.

The plug **6** may of course have a section other than circular, e. g. square, and may be of metal, but if vibration damping is the effect primarily required, the material of the plug may be one having good damping properties, for example, vulcanised fibre.

In Figure 5 the plug **6** is of circular section and is seated in grooves *5a*, *5b*, having an arcuate cross-section of greater radius than that of the plug **6** so as to permit some degree of lateral movement of the plug and thus a limited lateral movement between the blade sections *2a*, *2b* in the plane of rotation containing the plug.

In the construction of Figure 1 the centrifugal loading on the plug **6**, **7**, is augmented by the addition of a heavier part **7**. Alternatively the centrifugal loading may be augmented by the use of a spring, means being provided to ensure that the spring load is not applied to the plug until the blade sections are assembled. Such an arrangement is shown in Figure 6 in which the shaft **3** on which the centrifugal impeller is mounted is provided with a cam face **10** and a pin **11** can bear against a spring **12** adapted to act on the part **7**. The pin **11** can extend radially inwardly into a shaft socket **13** and when the shaft **3** is inserted into this socket the cam face **10** moves to the position shown in broken lines thus moving pin **11** radially outwards to compress spring **12** and thereby to urge part **7** radially outwards.

By means of the invention the need for a high degree of dimensional accuracy and individual adjustment of the aligned edges of the vane sections is thus avoided since each pair of vane sections is interconnected independently of any other pair and the accuracy of alignment of the sections of a pair is automatically maintained by the plug taking up differing radial positions under the influence of centrifugal force.

It is to be understood that although the invention has been described as primarily applicable to a centrifugal impeller, the principle of construction involved is equally applicable to an axial flow type of compressor or to any other bladed structure in which relatively thin rotor blades or vanes are required to be in edge contact, or in a condition closely approaching edge to edge contact, in a plane of rotation.

I claim:

1. A rotary bladed impeller structure comprising a hub, a series of blades radiating from said hub, individual blades being divided along a plane of rotation into at least two sections having their adjacent edges in close proximity, each of said adjacent edges having a groove extending there-along from the hub to the neighborhood of the blade tip, to form in each blade a radially extending tapered cavity which measured in the plane of rotation of the blade division is smallest near the tip and biggest near the hub, in combination with a wedge-shaped plug lying in said groove and proportioned to fit the said cavity when moved radially outwards under the action of centrifugal force, so that accordingly it wedges in the grooves and keys the adjacent blade sections together.

2. A rotary bladed structure as set forth in claim 1, wherein said groove in each of the pair of adjacent edges is of arcuate cross-section and the wedge-shaped plug is of circular cross-section.

3. A rotary bladed structure according to claim 1, wherein said cavity is formed with an enlarged space at its inner radial end and the wedge-shaped plug has an enlarged head housed in said enlarged space.

4. A rotary bladed structure as set forth in claim 1 including abutments radially movably mounted thereon below the radially inner ends of said wedge-shaped plugs, and springs compressed between said plugs and said abutments in a position to urge said plugs radially outwards.

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