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(12) # EUROPEAN PATENT APPLICATION

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(54) **Fan construction.**

(57) A fan comprising a rotatable fan shaft (10), a hub (14, 15) mounted on the shaft, a plurality of blades (16), the axes of which extend generally radially outwardly with respect to the axis of rotation of the fan shaft, the inner ends of the blades (16) being connected to the shaft by a torsion bar spring (24) secured, at one end (22), directly to the inner end of each blade (16) and, at the other end (26), directly to the shaft (10), the torsion bars each serving to act as a strut to transmit the blade axial loads.

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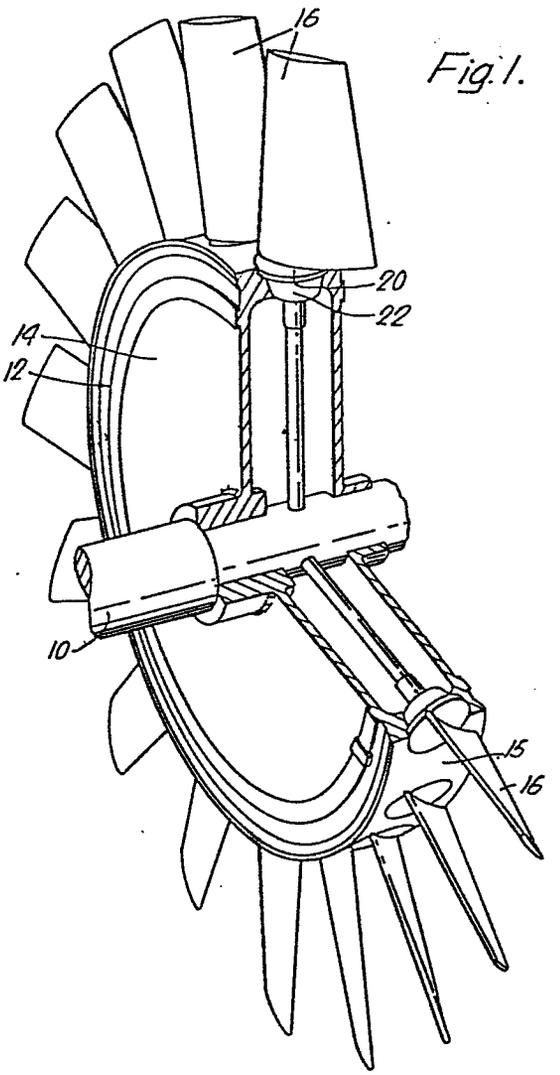

Fig. 1.

FAN CONSTRUCTION

The present invention relates to fans.

Fans usually comprise a rotatable shaft having secured thereto a hub and a plurality of blades, the axes of which extend generally radially outwardly with respect to the axis of rotation of the fan shaft. The blades may either be fixed blades in which case they are secured to the hub by bolted blade root flanges or, they can be variable pitch blades which involve complex blade bearing suspension systems allowing all of the blades to be pivoted about their respective axes simultaneously.

During operation of the fans, whether they be of the fixed or the variable pitch type, there will be substantial load caused by the blades which is borne by the hub. The hub usually includes a radial support plate connected to the fan shaft and a hub ring at the outer edge of the support plate, on which the blades are mounted. The load is accommodated by the hub which requires, normally, a complex, high strength structural rim and support plate.

It is now proposed, according to the present invention, to provide a fan comprising a rotatable fan shaft, a hub mounted on the shaft, a plurality of blades, the axes of which extend generally radially outwardly with respect to the axis of rotation of the fan shaft, means to mount the inner ends of the blades on the hub, said means including a torsion bar spring secured, at one end, directly to the inner end of each blade, and, at the other end, directly to the shaft, and each serving to act as a strut to transmit the blade axial loads.

It will be appreciated that the provision of a torsion bar spring as the mounting means for the inner end of each

blade is a very simple method of mounting the blade and yet eliminates the requirement for any further blade axial thrust bearing. It also is capable of absorbing blade vibration thus removing the requirement for large blade flanges, large bolts, large hubs and complex blade bearing suspension systems. In fact, because of the absorption of the vibration and the removal of the requirement for carrying the loads on the hub rim, the whole blade mounting structure in the form of the hub and the shaft can be of a less robust nature than has hitherto been necessary, which significantly reduces the cost as well as the weight of the fan.

Each blade may be provided with a blade root boss engagable in a recess in the hub and said one end of the torsion bar can be connected to the blade root boss.

The provision of a torsion bar can apply to constant pitch fans, in which case there is no need for heavy bolting flanges, as mentioned above. Alternatively, the torsion bar can be provided in a fan having pitch control means to vary the pitch of all the blades simultaneously. The torsion bar can be so designed that the resulting rotation of the blades about their individual axes is accommodated by suitable twisting of the associated torsion bar springs. While this will provide a certain torsional, resilient restoring moment, if the torsion bar is in its relaxed condition at the normal operating pitch of the blades, then this resilient restoring moment need not produce any problem.

While the pitch control means can be provided at any position along the length of the torsion bars, it is preferably provided adjacent the one end of the torsion bar which is attached to the blade root.

In order that the present invention may more readily be understood, the following description is given, merely by way of example, reference being made to the accompanying drawings in which:-

Figure 1 is a schematic perspective view, partly in

section, of one embodiment of a fan according to the invention; and

Figure 2 is a similar view of a second embodiment.

Referring now to Figure 1 of the drawings, the fan illustrated therein includes an impeller or fan shaft 10 carrying an impeller hub 12 including a support plate 14 and a hub rim 15.

Mounted at circumferentially spaced locations around the rim 14 are a plurality of blades 16 each having, at their radially inner end, a blade root boss 20 which is secured to one end 22 of a torsion bar spring 24. The other end 26 of the torsion bar spring is secured directly to impeller shaft 10. The torsion bar springs may be secured in any way to the shaft and to the blade root bosses, e.g. by welding. In order to facilitate their removal and the removal of the individual blades, however, they are preferably threaded at their ends and screwed into threaded bores 25,27 in the shaft and blade root bosses respectively. Suitable locking means, such as lock nuts (not shown) are advantageously provided.

The blade root bosses 20 are of frusto-conical form and are engaged in corresponding recesses 28 in the hub rim 15.

By providing the torsion bar spring 24 for each blade, which acts as a strut directly connecting the blade root boss 20 to the impeller shaft 10, there is no need to make the support plate 14 or the hub rim 15 as heavy structural elements, as the torsion bar springs bear nearly all the load. Any vibration which occurs in the blades is accommodated by flexing of the torsion bar springs and the spring effect tends to damp out the vibration. For both of these reasons, even with larger fans, it is not necessary to utilize even larger and larger bearings, support plates and hub rims as well as larger shafts.

Referring now to Figure 2 like parts have been indicated by like reference numerals. However, it will be

seen that adjacent the outer end of the torsion bar springs 24 are mounted a regulated and balance lever assembly 30 having arms 31, one of which is provided with a thrust block 32 engaged in a channel 36. It will be seen that the hub support plate 14 has mounted therewithin an actuator support bearing 34 within which is mounted an hydraulic actuator 35, the actual movement of which is controlled by a spool valve 37 mounted on a rotating union 31. An actuator piston retaining rod 33 is shown within a regulating disc 39 which is provided with the external channel 36 in which the block 32 is mounted.

The signal from the spool valve 37 causes the actuator 34 to cause axial movement of the regulating disc 35 and its associated channel 36 which causes axial movement with respect to the shaft of the fan, of the thrust block 32, which in turn causes pivoting of each torsion bar 24 and its associated blade 16 about the axis of that torsion bar thereby to adjust the angle of each blade. It will be appreciated that all of the blades 16 are adjusted in the same way simultaneously. This adjustment movement is accommodated within the twisting capability of each respective torsion bar spring 24, while still allowing the latter to absorb blade vibrations.

CLAIMS

1. A fan comprising a rotatable fan shaft (10), a hub (14,15) mounted on the fan shaft, a plurality of blades (16), the axes of which extend generally radially outwardly with respect to the axis of rotation of the fan shaft and means (24) to mount the inner ends of the blades on the hub, characterised in that said means to mount the blades include a torsion bar spring (24) secured, at one end (22), directly to the inner end of the blade (16) and, and at the other end (26), directly to the shaft (10), and each serving to act as a strut to transmit the blade axial load.

2. A fan according to claim 1, characterised in that the inner end of each blade (16) is provided with a blade root boss (20) engageable in a recess (28) in the hub (14,15) and in that said one end (22) of the torsion bar spring (24) is connected to said blade root boss (20).

3. A fan according to claim 2, characterised in that said one end of the torsion bar springs are threaded (at 27) and are screwed into threaded bores in the associated blade root boss (20).

4. A fan according to claim 1, 2 or 3, characterised in that pitch control means are provided to vary the pitch of all of the blades simultaneously, the resulting rotation of the blades about their individual axes being accommodated by suitable twisting of the associated torsion bar spring.

5. A fan according to claim 4, characterised in that said pitch control means (30-40) are provided adjacent the said one ends (22) of the torsion bar springs (24).

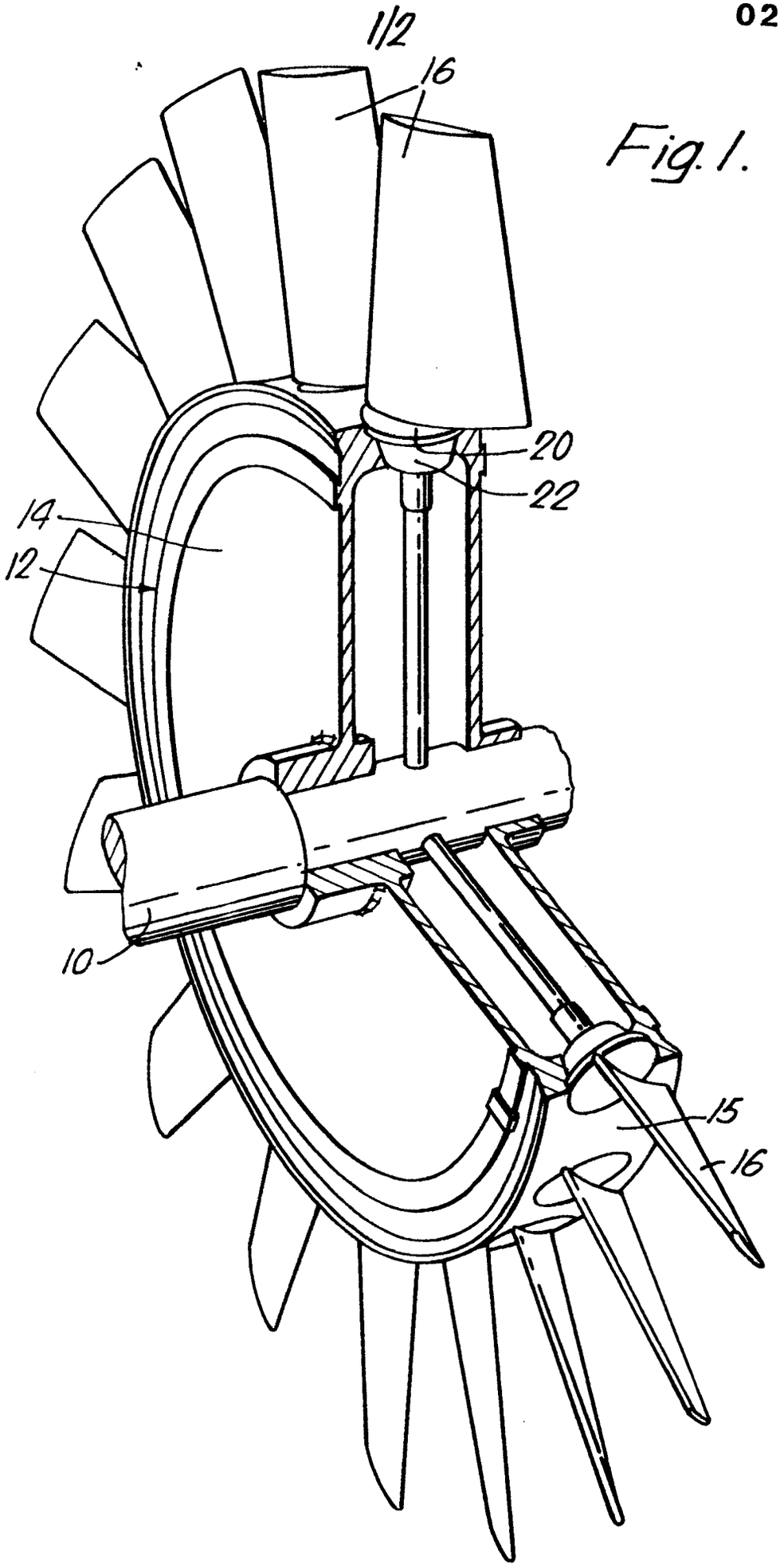

Fig. 1.

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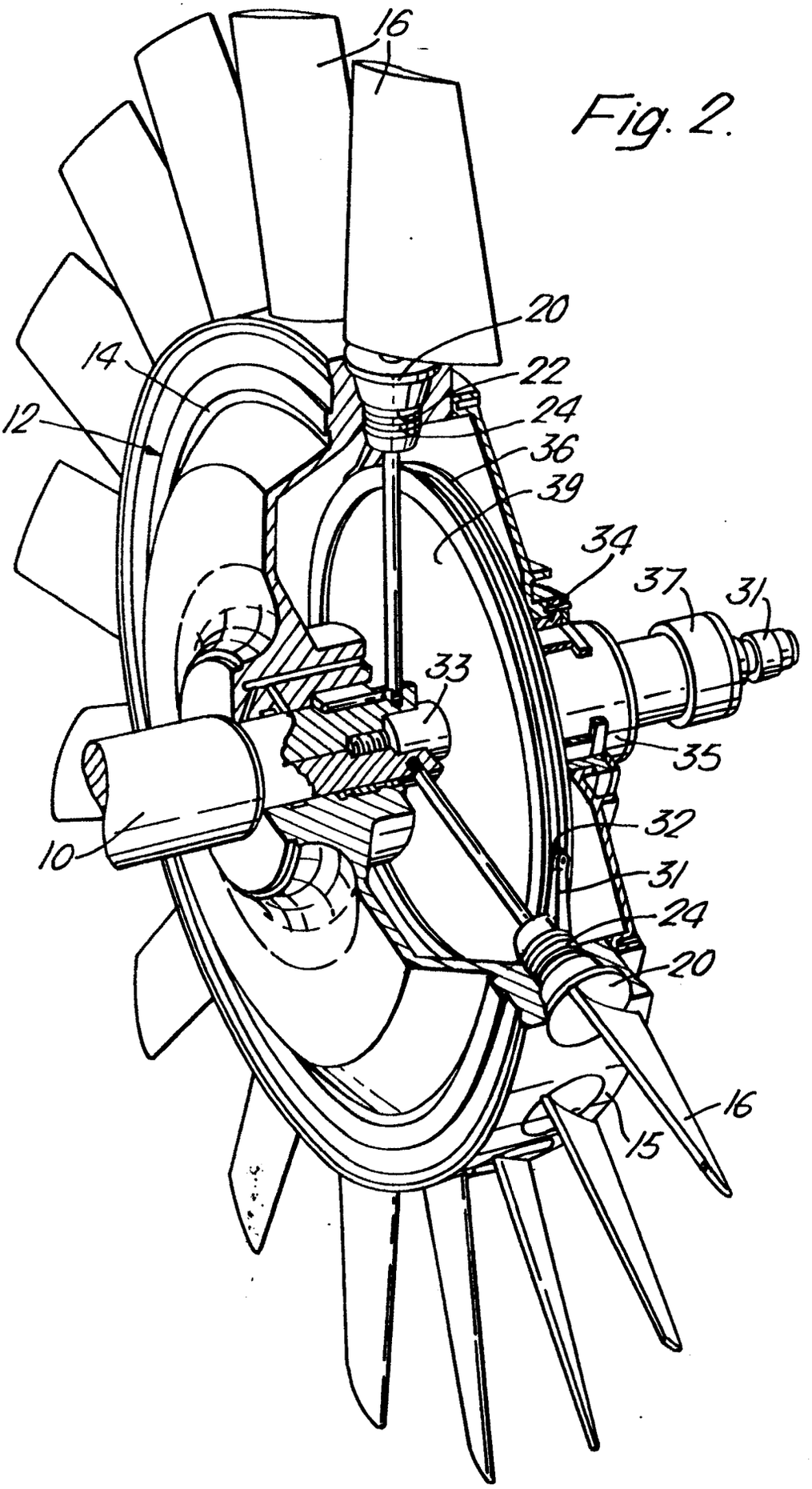
Fig. 2.



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EUROPEAN SEARCH REPORT

0208031
Application number

EP 85 30 4883

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
X	US-A-2 495 434 (TROLLER) * Column 3, lines 40-75; figures 1-4; column 5, lines 31-44; figures 5,6 *	1,2,4, 5	F 04 D 29/36
X	GB-A- 59 014 (POWER JETS LTD.) * Page 3, lines 66-120; figure *	1,2,4, 5	
X	DE-A-1 503 480 (KÜHNLE, KOPP & KAUSCH AG) * Page 2, last paragraph; page 3, first paragraph; figure 1; page 5, last paragraph; page 6, figure 3 *	1,2,4, 5	
A	FR-A-1 263 168 (SULZER) * Page1, last paragraph; page 2, left-hand column, two first and last paragraphs; figures 1,2 *	3	TECHNICAL FIELDS SEARCHED (Int. Cl 4) F 04 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-03-1986	KAPOULAS T.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
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