Jan. 24, 1950 T. H. TROLLER 2,495,434

VARIABLE PITCH PROPELLER

Filed May 17, 1946 4 Sheets-Sheet 1

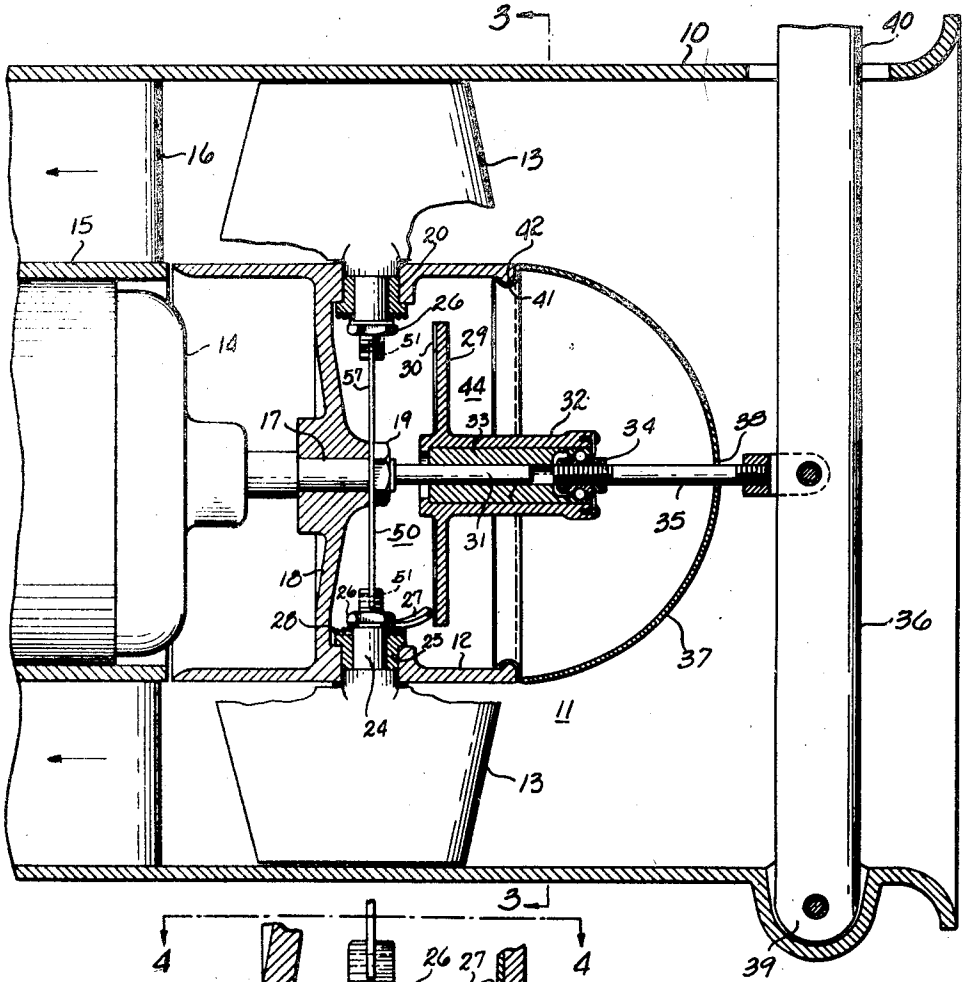


Fig. 1

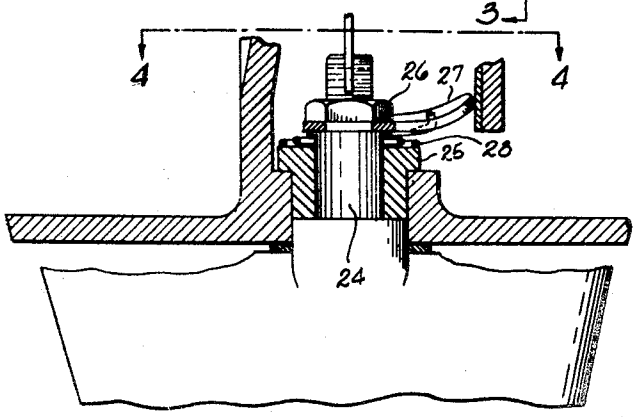


Fig. 2

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VARIABLE PITCH PROPELLER

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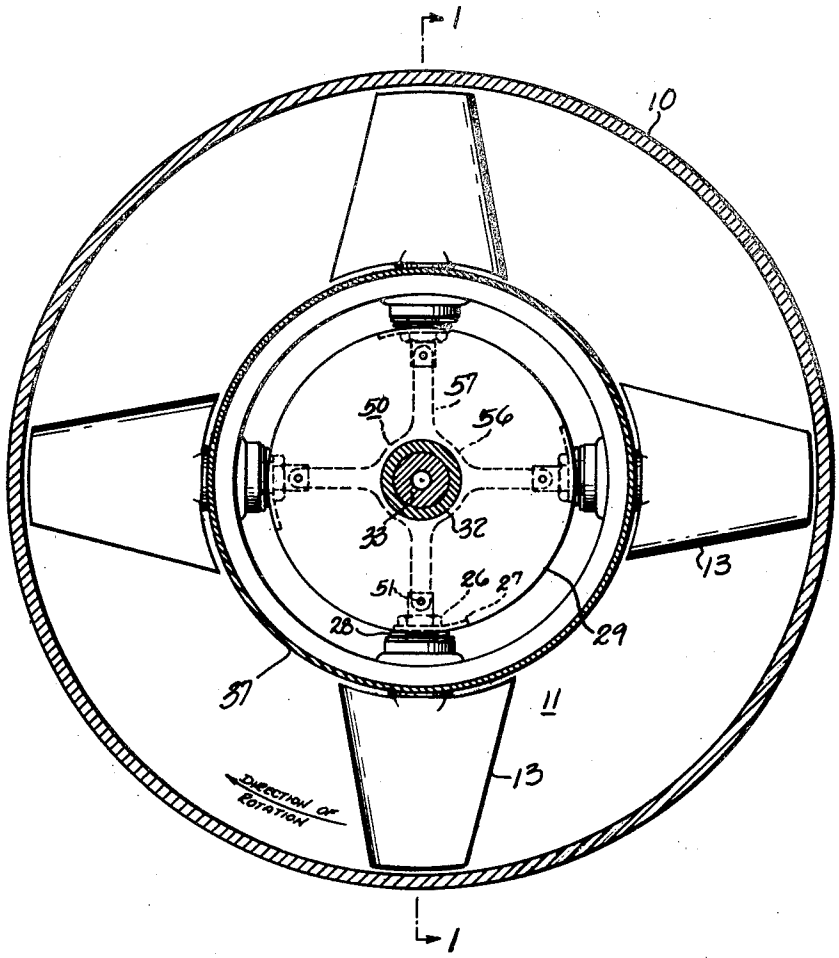


Fig. 3

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VARIABLE PITCH PROPELLER

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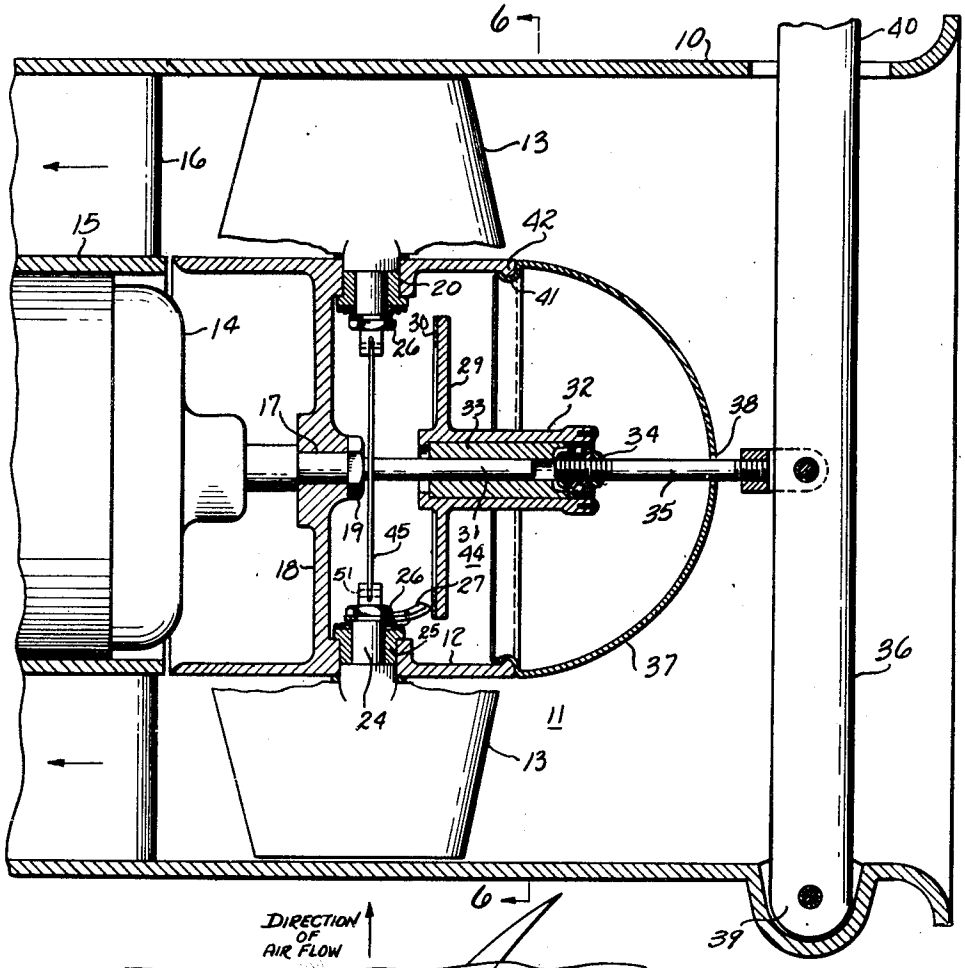


Fig. 5

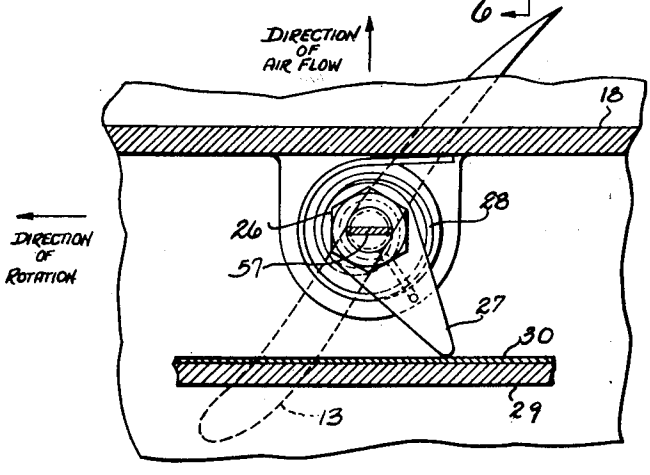


Fig. 4

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VARIABLE PITCH PROPELLER

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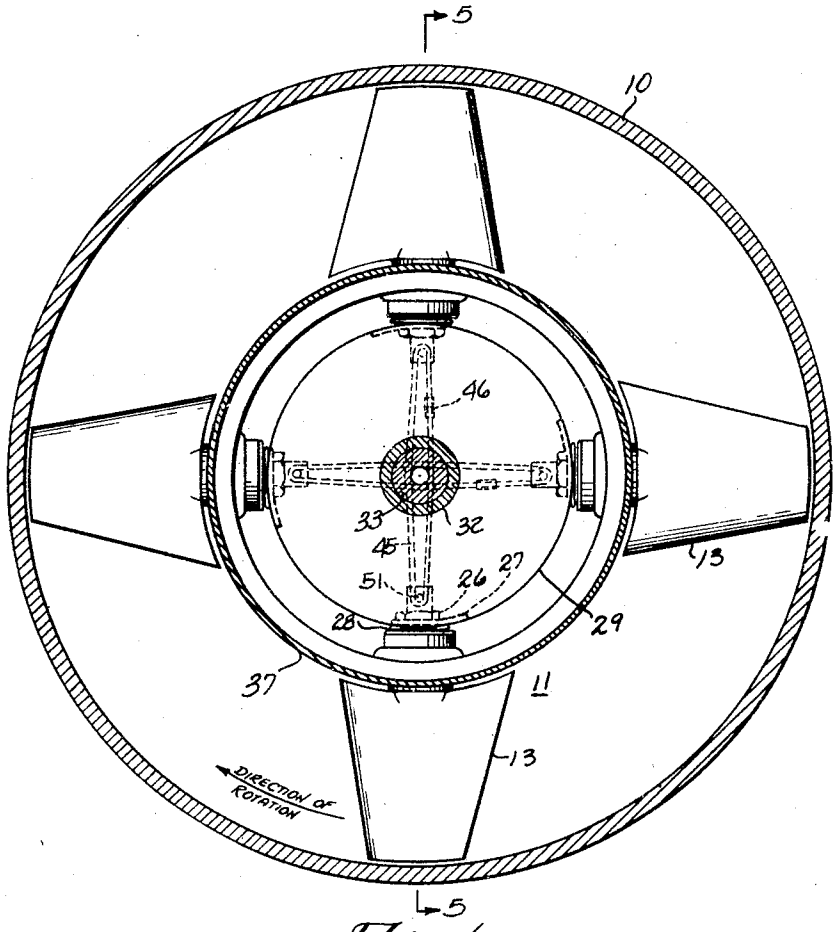


Fig. 6

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Patented Jan. 24, 1950 2,495,434

UNITED STATES PATENT OFFICE

2,495,434

VARIABLE PITCH PROPELLER

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Application May 17, 1946, Serial No. 670,494

13 Claims. (Cl. 170—160.4)

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The invention relates in general to variable pitch propellers and more particularly to centrifugal anchoring means for anchoring the propeller blades or other elements to the rotating devices to give ease in turning or adjusting the pitch of the propeller blades and to a mechanism for adjusting the pitch of the easily turnable propeller blades of the fan.

In the operation of rotating devices having propeller blades or other elements secured thereto, a considerable amount of centrifugal force is set up due to the speed of rotation. Heretofore the practice has been to anchor the shanks of the propeller blades in suitable sockets or bearings provided in the rim of the rotating device. The sockets or bearings were subjected to a large radial thrust which made the shanks of the blades hard to rotate within their bearings or sockets. The friction set up incident to the large radial thrust rendered it difficult to turn or vary the pitch of the propeller blades by a pitch adjusting mechanism when the fan blades were rotating at high speed.

An object of my invention is the provision of rendering the propeller blades easily turnable in their sockets whereby a pitch adjusting mechanism may readily vary the pitch of the propeller blades when the fan is rotating at high speed.

Another object of my invention is the provision of anchoring the propeller blades in a rotating rim so that the bearings or sockets do not have to withstand a large radial thrust incident to large centrifugal forces resulting from the rotation of the propeller blades taken in combination with a pitch adjusting mechanism which functions to vary the pitch of the propeller blades during rotation of the propeller blades.

Another object of my invention is the provision of anchoring or interconnecting opposite propeller blades together whereby the radial thrust incident to the centrifugal force is opposed and whereby the pitch of the propeller blades may be varied by a pitch adjusting mechanism during rotation of the propeller blades.

Another object of my invention is the provision of a rotatable mounted disc member having an annular face adapted to press against arms which are connected to the blades and which when the arms are moved, provides for rotating the blades taken in combination with the provision of rendering the blades easily turnable in their sockets or bearings when the propeller blades have been rotated at high speed.

Another object of the invention is the provision of a variable pitch propeller mounted upon a

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drive shaft with the blades actuated at variable pitch angles by an axially movable disc member which is carried by the shaft and which presses against arms connected to the blades for rotating the blades to vary their pitch angle, together with the provision of means to render the propeller blades easily turnable in their sockets or bearings.

Another object of the invention is the provision of individually adjusting the pitch angle of the blades for a fixed axial position of the actuating disc member which controls the joint operation of all of the blades, together with the provision of means to render the propeller blades easily turnable in their sockets or bearings.

Another object of the invention is the provision of an axially movable disc member which controls the pitch of the blades and which does not interfere with the assembling or dismantling of the blades or associated parts, together with the provision of means to render the propeller blades easily turnable in their sockets or bearings.

Another object of the invention is the provision of spring means connected to each of the arms of the blades for exerting a force to oppose the movement of the arms by the actuating disc member.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view of an embodiment of the invention taken along the line 1—1 of Figure 3, and with portions of the blades broken away;

Figure 2 is an enlarged and fragmentary cross-sectional view of a fan blade and the bearings which rotatively support the fan blade, portions of the blades being broken away;

Figure 3 is a cross sectional view taken along the line 3—3 of Figure 1, with the nose-like cover removed to show the centrifugal anchoring means and the actuating disc member which presses against and operates the arms connected to the shanks of the propeller blades for rotating the propeller blades for varying the pitch thereof;

Figure 4 is a view taken along the line 4—4 of Figure 2;

Figure 5 is a view similar to Figure 1, with portions of the blades broken away, but shows a modified form of centrifugal anchoring means; and

Figure 6 is a cross-sectional view taken along the line 6—6 of Figure 5, with the nose-like

cover removed to show the centrifugal anchoring means and the actuating disc member which presses against and operates the arms connected to the shanks of the propeller blades for rotating the propeller blades for varying the pitch thereof.

My invention is being illustrated and described in connection with a variable pitch fan but it is to be understood that it applies to variable pitch blades of all kinds.

As illustrated in the drawing, the variable pitch fan is designated generally by the reference character 11 and is arranged to be rotatably mounted within an outer annular duct 10 which may be connected in any suitable duct system for distributing the fan driven air. The variable pitch fan 11 may be driven by any suitable means and as shown in the drawings, the fan is driven by an electric motor 14 which may be mounted within an inner annular housing 15 which is supported substantially concentric within the outer annular duct 10 by means of stationary guide vanes 16.

The rim 12 and the plurality of blades 13 have shank portions 24 rotatably mounted in sockets 20 each having a sleeve bushing 25 spaced at annular distances about the rim 12, whereby the blades may be turned by the pitch adjusting mechanism 44. The rim 12 is provided with a web 18 which is arranged to be mounted upon the motor shaft 17 by means of a nut 19. The web 18 is secured to the rim 12 at a place to one side of the sockets 20, whereby the rim 12 and the web 18 form an angularly related structure for carrying the blades. As is manifest, the motor shaft 17 supports and drives the complete fan assembly which greatly facilitates the mounting of the variable pitch fan within the outer annular duct 10.

In operation, the centrifugal force tends to throw the blades and their shanks radially outwardly from the sockets in which they are mounted, and thereby subjects the rim 12 and the web 18 to mechanical strain. In my invention, I provide for opposing the centrifugal force and for holding the blades in their sockets in the rim by means of an interconnecting or anchoring means which in Figures 1 and 2 is shown as straps 50 in the form of a spider. The opposite ends of the respective straps 50 are connected to the shanks of oppositely mounted blades by means of a suitable connection means which may be in the form of a cross-pin 51 suitably fastened in the shanks of the blades. The straps 50 and the cross-pins 51 oppose the centrifugal force and hold the propeller blades in the rim. Inasmuch as the straps 50 and the cross-pins 51 oppose the centrifugal force, the annular rim 12 may be made of lightweight or low strength construction material and may be of relatively thin section. In my invention, the only duty opposed upon the rim is that of rotating the blades.

The spider 50 has a centrally disposed portion 56 and outwardly extending anchoring arms 57 connected respectively to the shanks 24 by the cross-pins 51. The anchoring arms 57 are twistable whereby the fan blades may be adjusted to any desired pitch by a pitch adjusting mechanism identified generally by the reference character 44.

Adjustably mounted upon the inner end of each of the shank portions 24 of the fan blades is an actuating arm 27. As shown best in Figure 4, the actuating arms 27 extend outwardly from the shank portions 24 and are arranged to be actuated by an actuating disc member 29 which is rotatably mounted upon a shaft extension 31 of the motor shaft 17. As shown in Figure 1, the left-hand side of the actuating disc member 29 may be provided with a wear face plate 30 which presses against the ends of the actuating arms 27 for varying the pitch of the fan blades 13. The actuating arms 27 are adjustably mounted upon the shank portion 24 by means of nuts 26. The propeller blades 13 may be each individually adjusted with respect to a fixed axial position of the actuating disc member 29 by loosening the nuts 26 and turning the blades to their correct position, after which the nuts 26 may again be tightened. Consequently, as the actuating disc member 29 is axially moved upon the shaft extension 31, the blades turn simultaneously to vary their pitch angles. A spring 28 is associated with each of the actuating arms 27 to exert a force in opposition to the movement of the arms by the actuating disc member 29. As shown best in Figures 2 and 4, one end of the spring 28 is connected to the actuating arm 27 and the other end of the spring is arranged to fit against the web 18 which supports the rim of the variable pitch fan. Accordingly, the springs 28 hold the actuating arm against the wear face plate 30 of the actuating disc member 29. Under running conditions, the action of the centrifugal forces and/or the air forces upon the blades is such as to constrain the ends of the actuating arms 27 against the wear face plate 30, in addition to the spring pressure.

The axially reciprocal movements of the actuating disc member 29 is governed by a control rod 35 which is actuated by a control lever 36 having one end 39 pivotally connected to one side of the outer annular duct 10 and having its other end 40 extending externally of the outer annular duct 10 for external actuation. The control rod 35 extends through an opening 38 in a nose-like cover 37 which may be suitably connected to the forward edge of the rim 12, such for example, as by a crimped edge 41 which resiliently engages a bead 42 provided on the internal surface of the rim of the fan. As illustrated, the control rod 35 is connected to the hollow hub 32 of the actuating disc member 29 by means of a ball bearing unit 34, whereby the actuating disc member 29 may rotate upon the shaft extension 31 as the variable pitch fan is operated. A bushing 33 is mounted inside of the hollow hub 32 and is arranged to provide a bearing surface with the extension shaft 31.

In operation, the pitch of the fan blades is adjustably varied by moving the control lever 36 which in turn axially positions the actuating disc member 29 for holding the blades at a predetermined pitch angle as determined by the setting of the control lever 36. The pitch of the blades may be varied while the fan is rotating and any suitable means may be employed to hold the outer end 40 of the control lever in a fixed position after the pitch of the blades has once been set or adjusted. During rotation of the fan, the centrifugal forces and/or the pressure of the air upon the blades 13 is such as to cause the actuating arms 27 to be pressed against the wear face plate 30 of the actuating disc member 29. When the fan is idle, the springs 28 continue to bias the ends of the actuating arms 27 against the wear face plate 30 of the actuating disc member 29. The springs 28 may be dispensed with because just as soon as the fan has started to rotate the centrifugal forces, cause, and/or the air forces the blades to rotate in such direction as to cause the actuating arms 27 to press against the wear face plate 30

of the actuating disc member 29. In other words, should the actuating arms 27 be not contacting the wear face plate 30 when the fan is idle, they will be immediately turned by the centrifugal forces and/or the pressure of the air acting against the fan blades 13 to immediately press them against the wear face plate 30.

It is noted that the actuating disc member 29 constitutes a very simple construction for varying the pitch of the fan blades and affords an easy method of assembling the units inasmuch as there is no necessity for the radial alignment of the actuating arms 27 with respect to the wear face plate 30.

The interconnecting or anchoring means 50 opposes the centrifugal forces and/or the pressure of the air upon the blades 13 and holds the shank portions of the blades within the sleeve bushings 25. As will be noted there are no thrust bearings required in this construction so that the shanks move freely within the sleeve bushings 25 with the result that the blades may be easily turned by the pitch adjusting mechanism 44 when the fan blades are rotated. The interconnecting anchoring means 50 contribute to the successful turning of the fan blades when actuated by the pitch adjusting mechanism, and the pitch adjusting mechanism need not be of a complicated nature inasmuch as the fan blades are easily turnable within their sockets or bearings.

In Figures 5 and 6, I show a modified form of the interconnecting or anchoring means and in the modified form the interconnecting or anchoring means comprises a cable means 45 of a twistable nature which is looped around the cross-pins 51 which pass through the shank portions of the blades. The cable may be fastened together by any suitable means such as by a cable connecting device 46. The loops of the cable pass on opposite sides of the extension shaft 31. The words "cable means" include wires, cables, wire rope, or any other elongated twistable element whether of a single strand or of a plurality of strands.

The combined operation of the interconnecting means between opposite fan blades which renders the blades easily turnable in their sockets and the disc member 29 which operates the actuating arms for turning the fan blades, produces an overall mechanism which enables the operator to vary the pitch of the blades while the fan is rotating at high speed. The pitch adjusting mechanism may be of a simple construction since the fan blades are easily turnable in their sockets.

The interconnecting means which extends across the fan structure and interconnects the ends of the shanks of the fan blades to opposite centrifugal force is related to my application Serial No. 536,074, filed May 18, 1944, for Centrifugal anchoring means for rotating elements and, as in that application, the interconnecting or anchoring means which oppose centrifugal forces and hold the shank portions of the blades within the sleeve bushings 25 are relatively free of torsional stress in the minimum pitch angle position of the fan blades. The mechanism for varying the pitch of the propeller blades is related to my application Serial No. 537,567, filed May 27, 1944, for Pitch adjusting mechanism. In other words, this case is a continuation-in-part of said other applications.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only

by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. In a rotary device adapted to be mounted on the end of a shaft, said device comprising a rotating annular rim and radially extending securing means securing said annular rim to said shaft, said rim provided with sockets spaced circumferentially thereabout, and blades each having a shank portion rotatively mounted in one of said sockets and each having holding means thereon inward of its respective socket, an improved mechanism for varying the pitch of said blades while the rate of rotation of said rotary device continues uniform and for maintaining said blades in their different adjusted positions, which mechanism includes connection means on each of said shanks, interconnecting means disposed internally of the annular rim and extending inwardly from and interconnecting said connection means, said interconnecting means being twistable to allow rotation of said shanks in said sockets, blade pitch-adjusting elements one secured to each of said shank portions, unitary means cooperating with said several elements and movable in one direction, longitudinal of the axis of rotation of said device, to move said elements to change the blade pitch and concurrently to increase the twisting of said interconnecting means, and means for moving said unitary means longitudinally of the axis of rotation of said device in said direction.

2. Mechanism according to claim 1 in which the blades of which the pitch is to be varied and which are to be maintained in their different adjusted positions are so proportioned and balanced that the action of the air and of centrifugal force thereon normally causes the blades to be biased in such angular directions that their respective blade pitch-adjusting elements resist movement of said unitary means in said one direction.

3. In a fan, a hub, a rim, and a web structure connecting said hub and rim and supporting the latter on the former, said rim having spaced circumferentially about its inner periphery inwardly projecting bosses each carrying at its radially inner end a bushing for rotatably receiving a portion of a fan blade shank, fan blades each having shank portions including a portion rotatably received in one of said bushings and a portion engageable with the outer end of one of said bushings to limit radially inward blade movement, means for relieving said rim and web structure of the centrifugal forces produced by said blades upon rotation of the fan including tension elements connected to the shank portions of said blades and connected together and relatively free of torsional stress in the minimum pitch angle position of said fan blades, and means for holding said blades in various selected angular positions irrespective of the rate of fan rotation.

4. A rotary device comprising a revolving annular structure, blades rotatively mounted in said structure, supporting means for said blades whereby said blades may be rotated to vary the pitch thereof while maintaining uniformity of radial projection from said structure, interconnecting means to relieve said annular structure of centrifugal forces produced by the rotation of said blades with said structure and to hold said blades radially in said structure, said intercon-

necting means comprising tie connections extending across the annular structure chordally of the latter and being connected to said blades, said blades each having an actuating arm extending outwardly therefrom and disposed for actuation, a disc having an annular face adapted to press against the arms and thereby rotate the blades, means for rotatively mounting the disc for turning about an axis which substantially coincides with the axis of the rotary device, and means for moving the disc in an axial direction to press against the arms.

5. A rotary device comprising a driven shaft, a revolving annular structure mounted on said shaft, blades rotatively mounted in said structure, supporting means for said blades whereby said blades may be rotated to vary the pitch thereof while maintaining uniformity of radial projection from said structure, interconnecting means to oppose centrifugal force and hold said blades radially in said structure, said interconnecting means comprising connections distinct from said annular structure extending across the structure and being connected to said blades and including radially extending portions in line with the axes of rotation of said blades relative to said structure, said blades each having an actuating arm extending outwardly therefrom and disposed for actuation, means for actuating the arms and thereby moving the blades, said means comprising an actuating member having an annular face adapted to press against the said arms and thereby rotate the blades, means for rotatively mounting the actuating member on the shaft about an axis which substantially coincides with the axis of rotation of the revolving annular structure, and means for moving the actuating member in an axial direction along the shaft to press against the arms.

6. A rotary device comprising a revolving structure comprising a hub, a peripheral rim portion and web means connecting said hub and rim, blades rotatively supported in said rim portion for turning to vary the pitch thereof, supporting means for said blades maintaining uniformity of radial projection thereof from said rim portion while providing for rotation thereof, a shaft supporting said hub, driving means for said shaft at one side of said web means, said rim portion projecting at the other side of said web means to provide a recess, interconnecting means to oppose centrifugal forces to each other and hold said blades radially fixed in said structure, said interconnecting means extending across said structure within said recess and being connected to said blades, each of said blades having an actuating arm extending outwardly therefrom within said recess, a disc having an annular face adapted to press against said arms to effect blade pitch adjustment, means for mounting said disc within said recess for turning on an axis in the same line with the axis of rotation of said structure, and means for moving the disc in an axial direction to cause the same to press against said arms.

7. A rotary device comprising a revolving structure comprising a hub, a peripheral rim portion and web means connecting said hub and rim, blades rotatively supported in said rim portion for turning to vary the pitch thereof, supporting means for said blades maintaining uniformity of radial projection thereof from said rim portion while providing for rotation thereof, a shaft supporting said hub, driving means for said shaft at one side of said web means, said rim portion projecting at the other side of said web means to provide a recess, interconnecting means to oppose centrifugal forces exerted by said blades and hold said blades radially fixed in said structure, said interconnecting means extending across said structure within said recess and being connected to said blades, each of said blades having an actuating arm extending outwardly therefrom within said recess, a disc having an annular face adapted to press against said arms to effect blade pitch adjustment, means for mounting said disc within said recess for turning on an axis in the same line with the axis of rotation of said structure, said disc mounting means including an extension of said shaft projecting into said recess, and means for moving the disc in an axial direction to cause the same to press against said arms.

8. A rotary device comprising a revolving annular structure, blades rotatively mounted on said structure, means for supporting said blades on said structure for rotation to vary the pitch thereof while maintaining uniformity of radial projection from said structure, the axes of rotation of said blades all lying in a common plane, means to oppose centrifugal force and hold said blades radially fixed in said structure, said last mentioned means including blade-interconnecting means extending across the structure and connected to said blades and having radially extending portions each cut by the plane in which the axes of blade rotation lie, said blades each having an actuating arm extending laterally therefrom and disposed for actuation, a disc having an annular face adapted to press against the arms and thereby rotate the blades, means for rotatively mounting the disc for turning about an axis which substantially coincides with the axis of the rotary device, and means for moving the disc in an axial direction to press against the arms.

9. A rotary device comprising a revolving structure comprising a hub, a peripheral rim portion and web means connecting said hub and rim, said rim having peripheral recesses and bearing bores extending inwardly from said recesses with annular shoulders at the inner ends of said recesses surrounding the outer ends of said bearing bores, blades rotatively supported in said rim portion for turning to vary the pitch thereof while maintaining uniformity of radial projection, said blades having shank portions journaled in said bearing bores and larger portions received in said recesses and providing shoulders seating on said annular shoulders, means for interconnecting said blades to oppose centrifugal force and to hold said shanks in said sockets and said shoulders in engagement with each other and to relieve the revolving structure of the mechanical strains produced by centrifugal forces acting on said blades, said interconnecting means including portions connecting the shank of each blade with the shank of an opposite blade and being twistable to allow rotation of said shanks in said sockets and acting to hold said shoulders in mutual contact, and pitch adjusting mechanism for rotating said shank portions to vary the pitch of the blades at will including a common element movable transversely to said blades to change the pitch adjustment of each of the same.

10. In an axial flow fan, a fan casing providing a fan chamber, a fan structure rotatable within said fan chamber, said fan structure including a hub, a peripheral rim portion, web means connecting said hub and rim portion, said rim portion having peripheral recesses and carrying bushings providing bearing bores extending in-

wardly from said recesses with annular shoulders at the inner ends of said recesses surrounding the outer ends of said bearing bores, blades rotatively supported in said bushings for turning on the axes of said bores, said blades having shank portions journaled in said bearing bores and larger portions received in said recesses and providing shoulders seating on said annular shoulders, means for maintaining said shoulders in contact with each other and for off-setting with each other the centrifugal forces acting on said blades upon rotation of said fan structure including means for interconnecting said blades, said blade interconnecting means including twistable tension portions connected with the shank of each blade, and pitch adjusting mechanism for rotating said blades on the axes of said bores including a common element shiftable axially of said fan structure and operatively connected through unidirectional thrust transmitting means with all of said blades.

11. The combination recited in claim 10 including, in addition to blade interconnecting means including twistable tension portions connected with the shank of each blade, securing means for each blade cooperating with the shank

thereof and with the inner ends of the bushings.

12. The combination recited in claim 11 in which the securing means for each blade includes a plurality of elements one of which has a generally radially extending arm with which the common element is engageable.

13. The combination recited in claim 12 in which there is provided resilient means acting on the arms and reacting on the fan structure for turning said blades in a direction to maintain said arms in contact with said common element.

THEODOR H. TROLLER.

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