Jan. 5, 1954 T. O. ADAMS, JR 2,665,055

ADJUSTABLE BLADE FAN

Filed Nov. 4, 1947 3 Sheets-Sheet 1

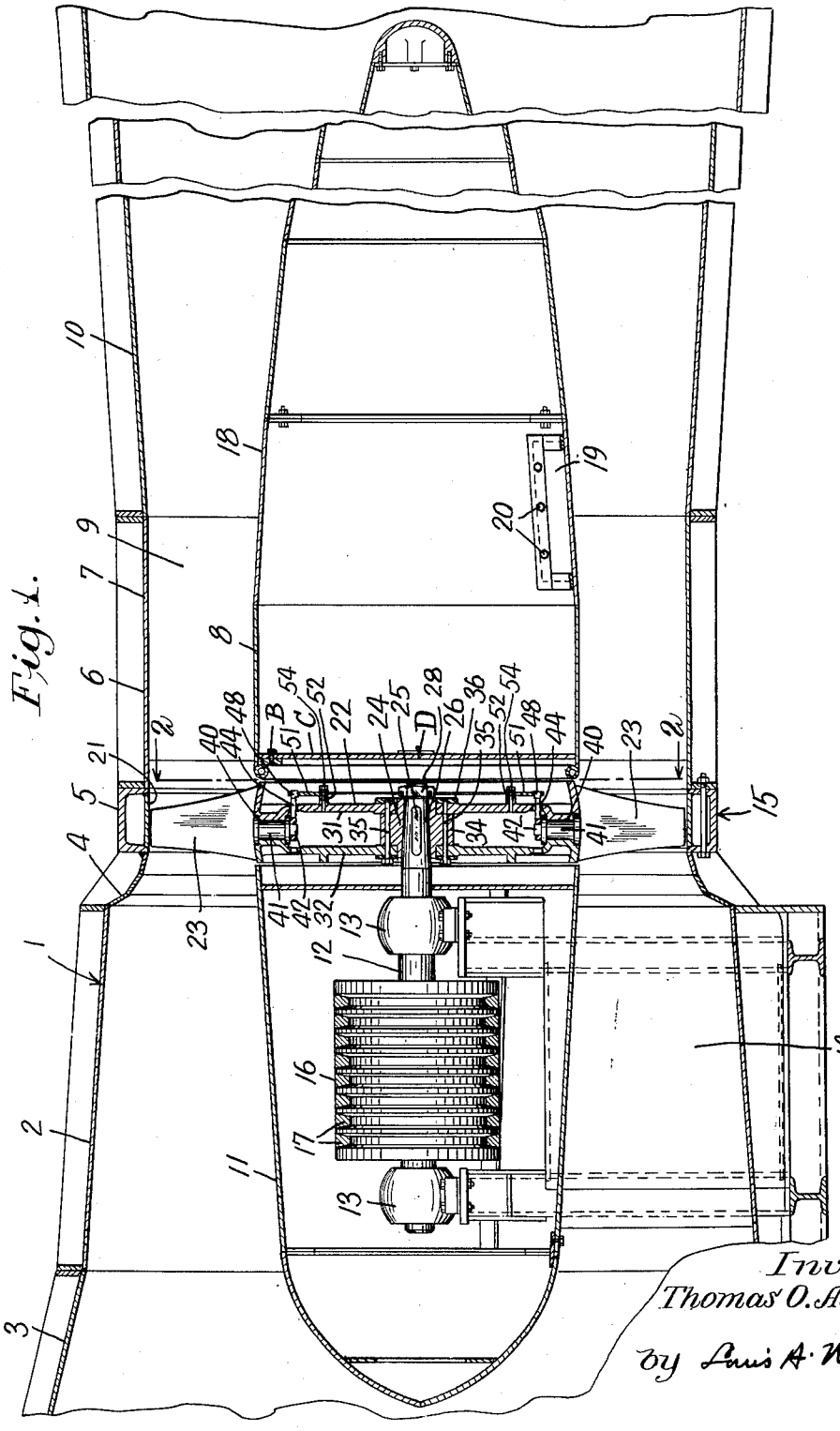


Fig. 1.

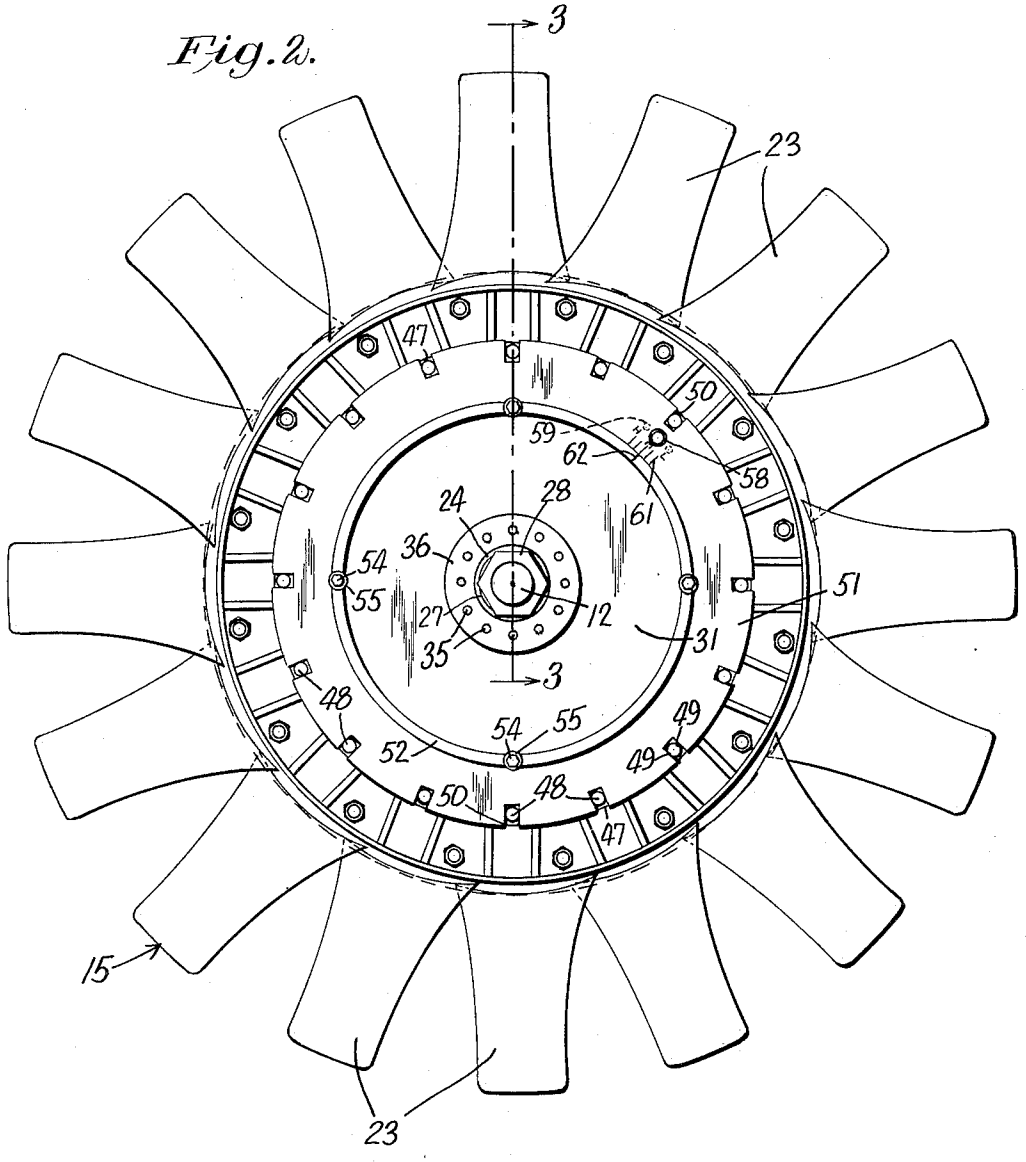
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Fig. 2.



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Fig. 3.

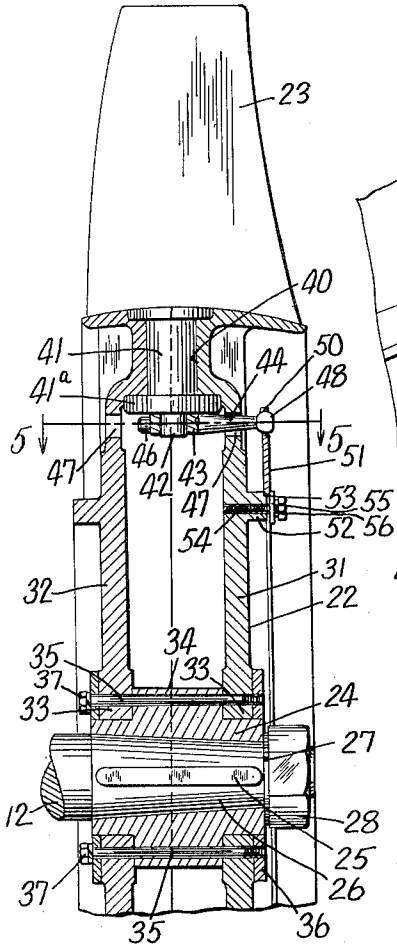


Fig. 4.

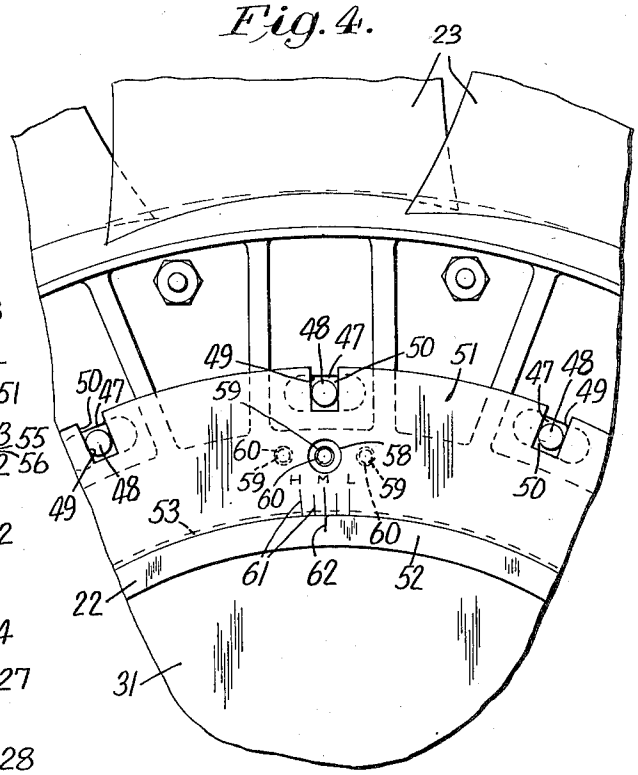


Fig. 5.

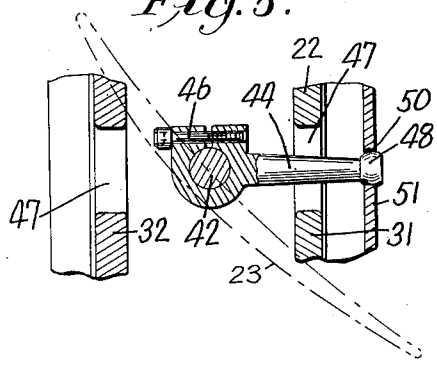
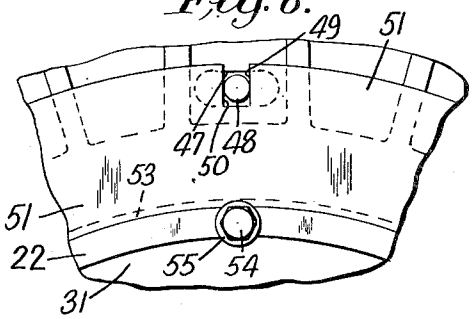


Fig. 6.



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UNITED STATES PATENT OFFICE

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ADJUSTABLE BLADE FAN

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9 Claims. (Cl. 230—114)

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My invention relates generally to fans for moving air or fluids under pressure through ducts, and more particularly to simple mechanism for adjusting the pitch of the fan blades within predetermined limits to vary the volume and pressure of the fluid flow.

Fans of the character herein involved are used as ventilating fans for mines, buildings, and ships, and it is often desirable to vary the volume and pressure of the fluid flow to meet altered conditions. It is also desirable that the pitch adjusting mechanism shall be such as to permit the simultaneous adjustment of the pitch angle of all of the blades of a fan, that it be possible to effect such adjustment by the change in position of a single element, that it be possible to release for adjustment and tighten after adjustment the part which requires such adjustment, with a minimum of difficulty, and that nothing more than wrench and lever means shall be required for the making of the necessary adjustments and the fixing of the parts in the modified positions thereof.

It is an object of the present invention to provide improved and simple mechanism for adjusting the blade pitch of propeller type fans and for maintaining the blades of such fans in the various positions to which they may be adjusted. It is another object of the present invention to provide improved adjusting and holding means for the blades of adjustable blade fans permitting the simultaneous and like adjustment of all of the blades, the effecting of such adjustments, and the holding of the blades after such adjustments have been effected, with the use of but a single primary adjusting member, and the making of such adjustments and the holding of the parts in adjusted positions by means of relatively light weight, so that excessive centrifugal forces will not be developed, and with the formation of the adjusting mechanism so that no unbalanced centrifugal force affecting the operation of the fan rotor will be produced. Other objects and advantages of the invention will hereinafter more fully appear.

While the invention may be incorporated in other types of fans, I have shown the same embodied in a mine ventilating fan in the accompanying drawings, in which for purposes of illustration one form which the invention may assume in practice has been shown, and in these drawings

Fig. 1 is a longitudinal vertical section through a mine fan in which the invention is incorporated.

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Fig. 2 is an enlarged end elevational view of the fan rotor of Fig. 1, with casing parts omitted, the view being, subject to the understanding mentioned, taken approximately on the plane of the line 2—2 of Fig. 1.

Fig. 3 is a section on the plane of the line 3—3 of Fig. 2, on an enlarged scale.

Fig. 4 is an enlarged fragmentary view of a portion of the structure shown in Fig. 2, showing indexing and adjusting means.

Fig. 5 is an enlarged section on the line 5—5 of Fig. 3, showing a detail of the adjusting mechanism.

Fig. 6 is an enlarged fragmentary view showing releasable locking means.

Referring to the drawings, and first to Fig. 1, it will be noted that there is shown in this figure a mine fan generally designated 1. This mine fan structure includes a frusto-conical intake section 2 adapted to be connected by suitable conduit means 3 with a mine shaft or the like and with its other end connected by a flared intake 4 with a propeller ring 5 to whose other side a vane ring assembly 6 is connected, this last including an outer fairing 7 and an inner fairing 8 connected together by vanes 9. To the rear of the vane ring assembly there is arranged an exhaust stack 10 of gradually increasing cross section.

A streamlined nose portion 11 providing a housing for a fan supporting and driving shaft 12 rotatably supported in bearings 13 carried by a streamlined bearing pedestal 14 lies within the frusto-conical intake 2 and the forward portion of the flared intake 4, which parts, together with the ring 5, make up a casing assembly generally designated 15. The shaft 12 is shown as carrying a large multiple V-belt drive pulley 16 which is driven by V-belts 17 whose opposite runs pass through streamlined fairings, not shown because they are on the near side of the section on which Fig. 1 is taken. A streamlined tail section 18, which lies rearwardly of the inner fairing 8 and is connected to the latter has an access door 19 which may be opened by releasing the holding bolts 20. Within the propeller ring is a clearance ring 21, in close proximity to which the tips of the fan blades, later mentioned, move.

Upon the shaft 12 there is supported for rotation with such shaft a split cast rotor 22 carrying a series of fan blades 23. This rotor includes a hub portion 24 keyed as at 25 to a tapered portion 26 of the shaft 12 and held in position by a suitable washer 27 and a nut 28 threadedly engaged with the end of the shaft 12. The rotor

includes cooperating annular plates 31 and 32 having portions 33 engaging the opposite end surfaces of an enlarged flange 34 of the hub 24, the plate portions 33 being secured to the hub by bolts 35 threadedly engaging a ring 36, said bolts extending through both plates and through the collar portion 34 of the hub 24. The plates 31 and 32 cooperate to form bearings 40 in which shanks 41, shown as cast integrally with the fan blades 23, are rotatably received. When there are no centrifugal forces acting on the fan blades, the blades may be rotated except as they are held, as hereinafter more fully described, on axes in the bearings 40. At the inner end of each shank 41 there is an enlarged collar portion 41a from which there extends radially inwardly a boss or pilot 42, and upon each of these bosses there is mounted a clamp 43 which has integral with it an arm 44, and these arms may be secured at any desired angle with respect to the fan blades 23 with which they are associated by means of bolts 46. The plates 31 and 32 each have an arcuate series of openings 47 through them, and the arms 44 project through the openings in one plate or the other depending upon the manner of assembly, it being understood that if the arms are to be projected through the openings in the plate 32, this plate will be machined and tapped in the manner shortly to be described with respect to the plate 31. Herein they are shown as extending through the openings 47 in the plate 31, the plate which is nearer to the streamlined tail of the fan casing. Each arm has a rounded head 48 for reception in and cooperation with the side walls 49 of notches 50 in a ring 51 which will shortly be more fully described.

The ring 51 is provided about its periphery, as will be noted, with a series of notches 50 which are uniformly spaced, each of these notches having its side walls 49 mutually parallel and receiving between said side walls snugly one of the ball-shaped extremities 48 of the arms 44, so that movements of the ring 51 may effect adjustment of the fan blades. The ring 51 is mounted upon an annular flange 52 which is grooved as at 53 so as to provide a recess in which the inner edge of the ring may be rotatably received. The ring may be fixed in position relative to the flange 52 by means of bolts 54, washers 55, and lock washers 56, the bolts upon tightening thereof pressing the washers against the outer surface of the ring 51 and thus clamping the edge of this ring between the wall of the groove 53 and the washers. The fit of the ring is loose enough to permit it to have a rotary sliding motion in the groove when the bolts 54 are slightly unscrewed. The ring 51 has a hole or opening 58 formed through it and on the same arc with this hole but in the rotor plate 31 there are a number of smaller holes or openings 59, these latter holes being provided with steel bushings 60 as liners. Radially inwardly of the hole 58 there are marks 61 representing different angle adjustments of the blades. These come directly above an index line 62 on the flange 52. This combination of lines may be used for locating the steel ring 51 in any one of a number of selected positions. The fan blades will be in their median position of angular adjustment when the central line marked M is opposite the line 62 on the flange, in their position of maximum air displacement when the line marked H is opposite the line 62 on the flange, and in their position of minimum air displacement when the line L comes opposite the mark on the flange 52.

The mode of use of the blade adjusting mechanism will be readily understood. The bolts 54 are unscrewed in the plate 31, thereby permitting the ring 51 to be rotated. A rod or other suitable lever device is then inserted through the hole 58 in the ring 51 and has its end extended into one of the holes 59 in the rotor plate 31. By using the rod as a lever, fulcruming in a hole 59 and engaging an abutment surface provided by the wall of the hole 58, and moving the outer end of said lever in a plane generally tangential to a cylinder struck from the axis of the rotor shaft and of a radius equal to the radial distance to the center of the holes 59, the ring 51 may be actuated circumferentially and cause the various arms 44 to turn the shanks of the several fan blades angularly in proportion to the arcuate adjustment of the ring 51. When the desired angle is attained, the bolts 54 may be tightened and cause the washers 55 to clamp the ring 51 firmly with respect to the rotor, and thus the angle of the blades may be maintained until it is again desired to adjust it. In effecting adjustment it will be noted that the wall of a hole 59 (or of a bushing 60) provides a fulcrum and the wall of the hole or opening 58 an abutment, and that the lever engages oppositely facing surfaces in these holes which are spaced axially of the fan with respect to each other. The surfaces engaged by the lever during adjusting face oppositely circumferentially of the rotor.

Should a new range, either higher or lower than the initial setting be desired, it may be obtained by locating the ring 51 in one of its extreme positions. The several bolts 46 would then be loosened by inserting an Allen wrench through the openings 47 in the plate 32. The blades could then be rotated to any desired angle and the clamps again tightened. By following this procedure with each of the blades of the rotor, a new range of adjustment can be secured.

From the foregoing description, it will be apparent that I have provided a very simple and effective arrangement for varying the angular adjustment of all of the blades of a fan rotor and holding the blades in a desired common angular relation to the hub of the fan. Adjusting a single element will change the adjustment of all of the blades, and this element may be fixed, released, and re-fixed simply by tightening a relatively small number of holding elements, which clamp it against a surface relative to which it is moved during adjustment. Not only changes within the normal limits may be provided, but also entirely new sets of limits may be established in an easy and simple manner.

To effect the adjustments, the person to perform the job walks through the exhaust stack on the fan until he has reached the tail access door 19, and upon removal of the bolts 20 this door drops down about hinges not shown and access to the inner fairing 8 becomes possible. Having entered this fairing, the workman can remove a single bolt B and allow the upper half C of a split bulkhead to swing down about a hinge D, and this brings into easy access the bolts 54. The effecting of the adjustment and the complete reclosing of the fan ready for operation takes not over five minutes in actual practice. One of the greatest advantages of the invention inheres in the operator's ability to adjust the pitch of all of the blades simultaneously, and in

the extreme simplicity and cheapness of the structure for this purpose.

While I have in this application specifically described one form which my invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. Pitch adjusting mechanism for a propeller type fan having a rotor including a hub and a rim and a plurality of blades rotatably supported by said rotor for pitch angle adjustment and projecting radially from the rim thereof, said pitch adjusting mechanism including an adjusting member rotatably mounted on the rotor, means so operatively connecting the blades to said adjusting member that the adjustment of said member relative to said rotor varies the pitch of all of the blades, means for clamping said adjusting member to said rotor and supporting the same for rotation on an axis in the same line with the rotor axis, and means including a fulcrum on said rotor and an opening in said adjusting member for permitting a lever to have an end inserted through said opening into operative relation with said fulcrum and to be swung to effect an adjustment of said adjusting member to change the pitch angle of the fan blades with respect to said hub, said fulcrum and said opening being disposed at like radial distances from the rotor axis and closer to the latter than is said rim.

2. In a fan, a rotor having radially extending bearings in its periphery for the reception of the pivot portions of fan blades, fan blades having pivot portions received in said bearings, arms secured to said pivot portions, a ring coaxial with said rotor and having pairs of mutually opposite walls each pair receiving closely between them one of said arms, means for securing said ring to said rotor to effect holding of said arms against swinging relative to said rotor, and means for adjusting said ring relative to said rotor including, on one of them, a fulcrum, and, in the other of them an opening through which a lever may have an end passed into engagement with said fulcrum, said opening and fulcrum disposed nearer the axis of the rotor than the pivot portions of said fan blades.

3. In a fan, including a rotor and a vane ring having an inner fairing adjacent to said rotor and of a radius similar to the radius of the periphery of said rotor, said rotor having radially extending bearings in its periphery for the reception of the pivot portions of fan blades, fan blades having pivot portions received in said bearings, arms secured to said pivot portions, a ring coaxial with said rotor and having pairs of mutually opposite walls one pair cooperating with and closely receiving each of said arms, means for adjustably securing said ring to said rotor whereby the fixing of said ring relative to said rotor prevents swinging of said arms, and means inside said inner fairing for adjusting said ring relative to said rotor including, on one of them, a fulcrum for a ring adjusting lever and, on the other of them, and spaced axially of said fan from said fulcrum, abutment means also engageable by such a lever while the latter engages said fulcrum.

4. In a fan, a rotor comprising a hub and end plates mounted on the hub to rotate therewith, said end plates having rim portions cooperating in providing bearings for the pivot elements of fan blades, fan blades having pivot elements rotatably mounted in said bearings, means for holding said pivot elements against longitudinal movement in said bearings, one of said end plates having openings therein, arms secured to said pivot elements and projecting through said openings, a ring coaxial with said last mentioned plate and rotatably supported by the latter and having portions providing oppositely facing surfaces closely receiving said arms between them, means for releasably clamping said ring in non-rotatable relation to said last mentioned end plate, and surfaces facing in opposite directions circumferentially of said rotor, and one on said last mentioned end plate and another on said ring and both located radially inwardly of the pivot elements of said fan blades, and spaced from each other axially of said fan, and concurrently engageable by a lever for effecting their relative rotation.

5. In a fan, a rotor comprising a hub and end plates mounted on the hub to rotate therewith, said end plates having rim portions cooperating in providing bearings for the pivot elements of fan blades, fan blades having pivot elements rotatably mounted in said bearings, means for holding said pivot elements against longitudinal movement in said bearings, one of said end plates having openings therein, arms secured to said pivot elements and projecting through said openings, a ring coaxial with said last mentioned plate and rotatably supported by the latter and having notches closely receiving said arms, means for releasably clamping said ring in non-rotatable relation to said last mentioned end plate, and means on said plate and ring, on each closer to its axis than the distance between said arms and the axis of said rotor, and spaced from each other axially of said rotor and engageable simultaneously by a lever for effecting their relative rotation about the rotor axis, said other end plate having openings therein opposite the first mentioned openings and said arms having means for releasably securing them to said pivot elements accessible through said last mentioned openings.

6. In a fan, including a rotor and a vane ring having an inner fairing adjacent to said rotor and of a radius similar to the radius of the periphery of said rotor, said vane ring having an open end through which access to its interior may be had and said rotor comprising a hub and end plates mounted on the hub to rotate therewith, fan blades having pivot elements rotatably supported adjacent the outer peripheries of said plates for turning on their own axes, means for holding said pivot elements against radial movement with respect to said rotor, one of said end plates having openings therethrough, arms secured to said pivot elements and projecting through said openings, a ring member coaxial with said last mentioned plate and rotatably supported by said rotor and having wall portions closely receiving said arms, means for releasably clamping said member in nonrotatable relation to said rotor, and ring member adjusting means accessible from within said inner fairing and including in spaced relation to each other axially of said fan a fulcrum on said last mentioned plate and an abutment on said ring

member simultaneously engageable by a lever to effect their relative rotation.

7. In a fan, fan blades having pivot elements, a rotor comprising a hub and spaced end plates mounted on the hub to rotate therewith, said end plates having rim portions, and said fan blades having pivot elements rotatably supported by said rim portions and held thereby against radial movement in either direction relative to said rotor, one of said end plates having openings therein, arms secured to said pivot elements and projecting through said openings, a ring coaxial with said last mentioned plate and rotatable on the axis of said rotor and having portions closely engaging the opposite sides of said arms and cooperating with said arms in swinging of the latter and in holding them fixed, and means for fixing said ring in different relatively rotated positions with respect to said rotor, said other plate having openings therein opposite the first mentioned openings and said arms having means for releasably clamping them to the pivot elements accessible through the openings in said other plate.

8. Pitch adjusting mechanism for a propeller type fan having a rotor including a hub and a rim and a plurality of blades projecting radially from the rim thereof, including an annular adjusting member rotatably mounted on the rotor, means including arms fixed relative to said blades and recesses in said member in which said arms are closely received for operatively connecting the blades to said adjusting member so that the rotation of said member relative to said rotor varies the pitch of all of the blades, means for clamping said adjusting member to said rotor in different relatively rotated positions, and means including fulcra on said rotor, and an opening in said adjusting member extending parallel to the axis of adjustment thereof and through which a lever can be inserted, in a direction generally longitudinal of the axis of said rotor, into operative relation with said fulcra for effecting an adjustment of said adjusting member, when the latter is released for rotation, to change the angular relation of the fan blades with respect to the hub.

9. In a fan, a rotor having radially extending bearings in its periphery for the reception of the pivot portions of fan blades, fan blades having pivot portions received in said bearings and fixed against radial movement in either direction relative to the latter, arms secured to said pivot portions for selectively swinging the latter or holding them against turning on their axes, a ring coaxial with said rotor and having pairs of mutually opposite walls one pair cooperating with and closely receiving each of said arms, means for adjustably securing said ring to said rotor, and means for adjusting said ring relative to said rotor including, on one of them, a fulcrum with which a lever is engageable and can be caused to cooperate in effecting ring adjustment and, on the other of them, abutment means engageable by such a lever, said fan including also a vane ring providing a fairing close to the periphery of said rotor and having in communication with its interior an access door and so disposed that said means for adjusting said ring relative to said rotor is accessible from within it.

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