Oct. 30, 1945. B. S. FOSS 2,388,208

CONTROL VANES FOR FANS

Filed May 27, 1943 4 Sheets-Sheet 1

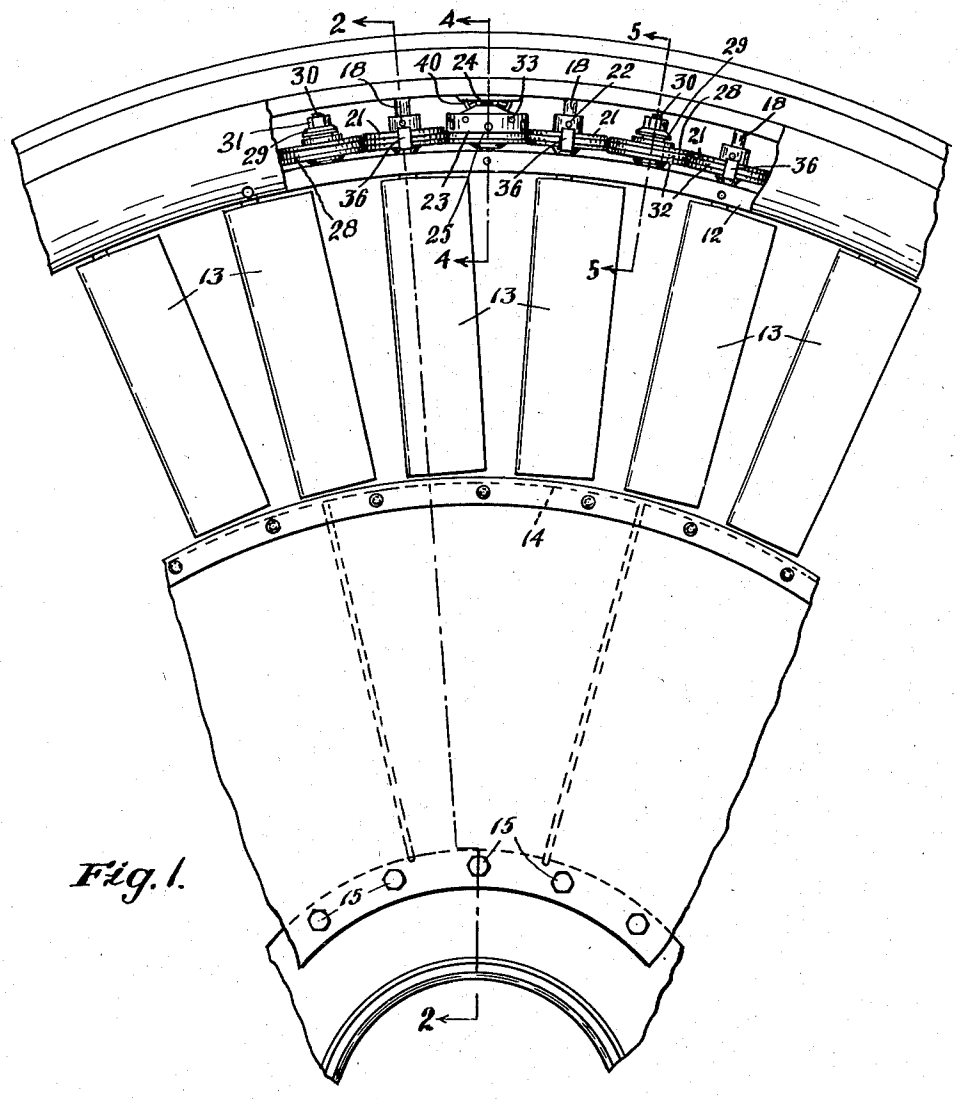


Fig. 1.

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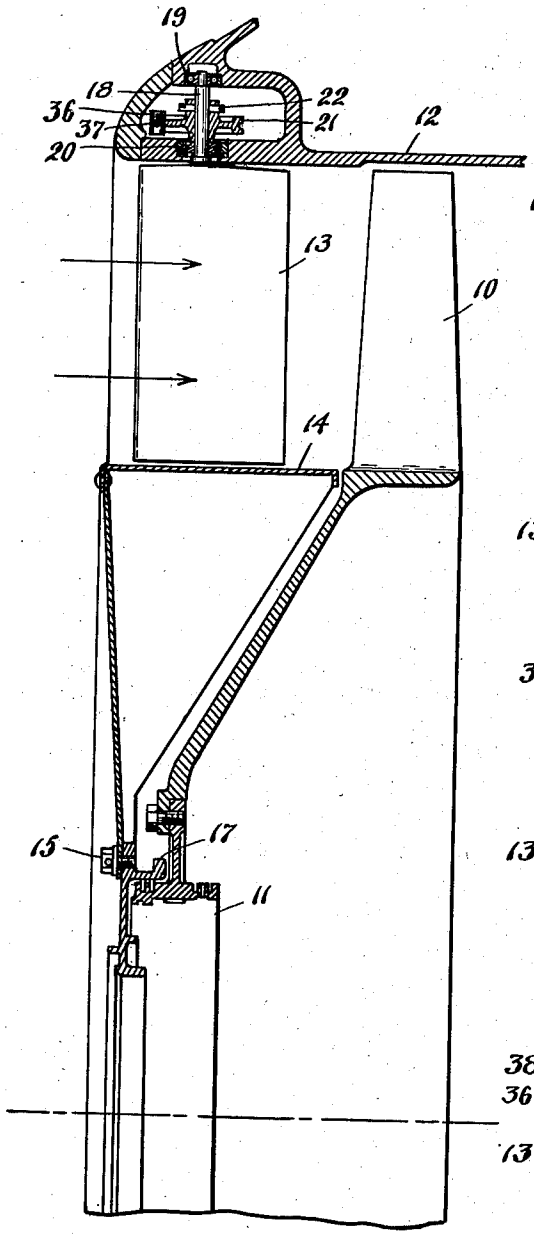


Fig. 2.

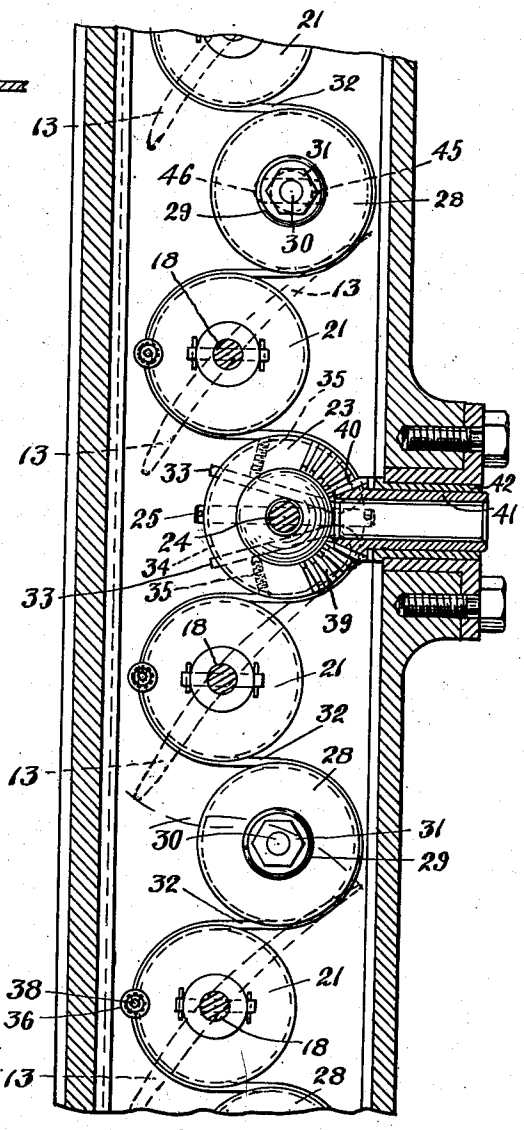


Fig. 3.

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CONTROL VANES FOR FANS

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Fig. 4.

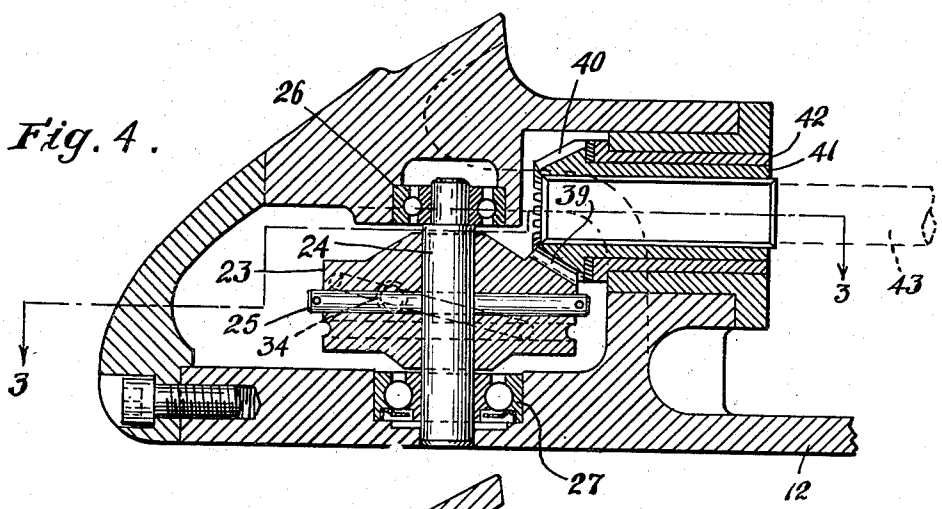
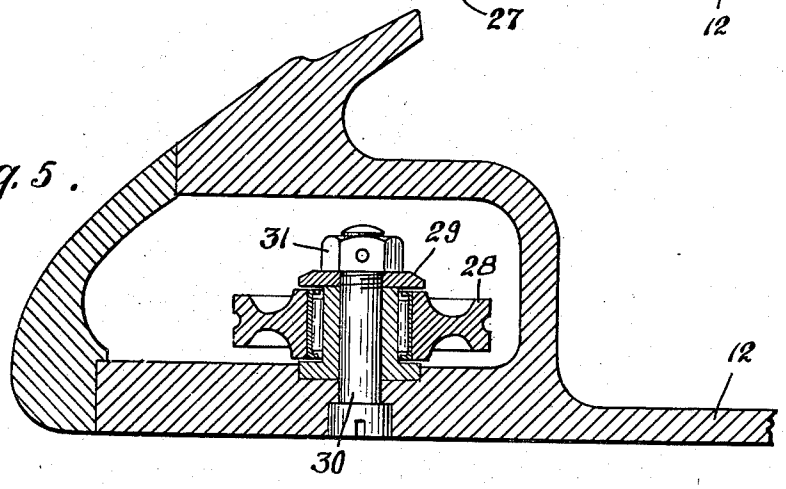


Fig. 5.



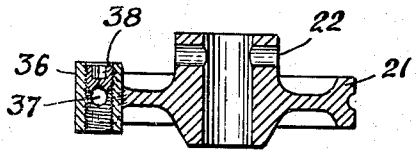


Fig. 6.

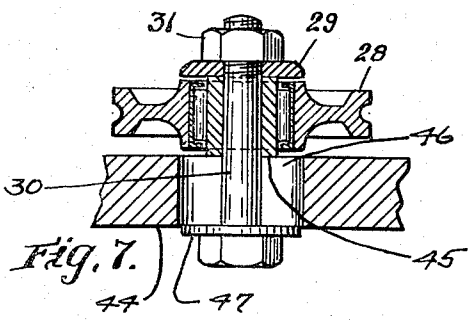


Fig. 7.

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CONTROL VANES FOR FANS

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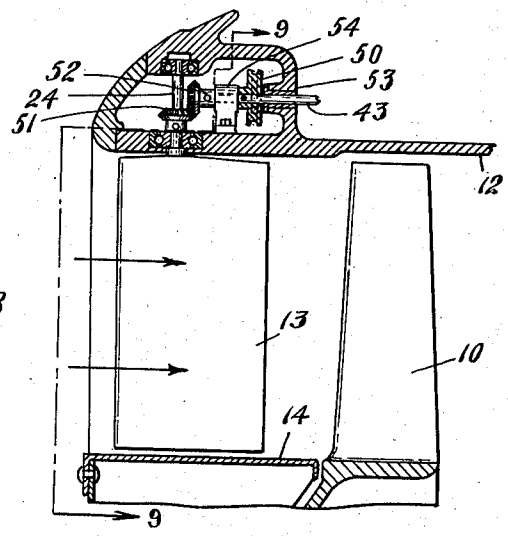


Fig. 8

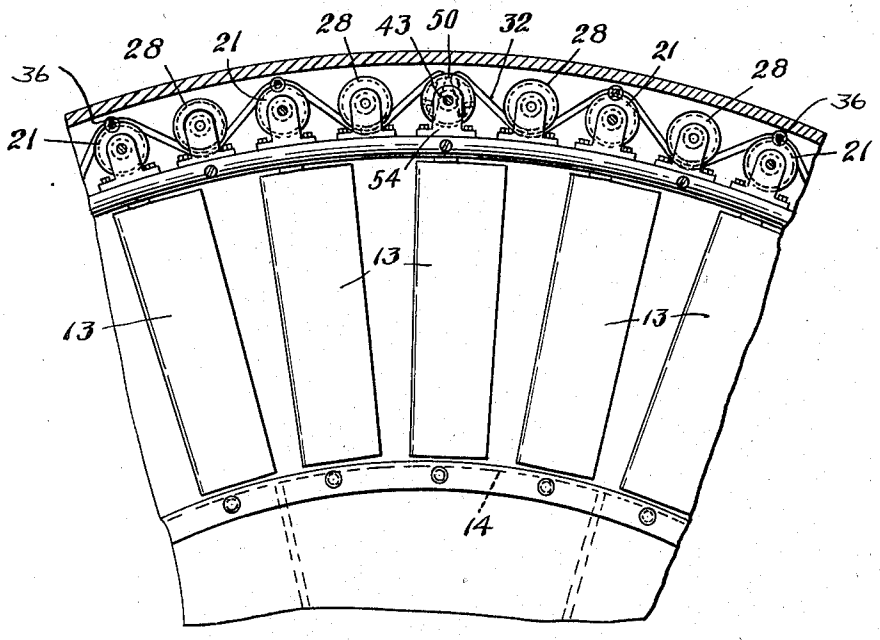


Fig. 9.

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Patented Oct. 30, 1945

2,388,208

UNITED STATES PATENT OFFICE

2,388,208

CONTROL VANES FOR FANS

Benjamin S. Foss, Brookline, Mass., assignor to B. F. Sturtevant Company, Hyde Park, Boston, Mass.

Application May 27, 1943, Serial No. 488,699

3 Claims. (Cl. 230—114)

This invention relates to control vanes for fans, of the type which may be adjusted to add spin to the air handled by a fan for reducing its pressure, or which may be adjusted to provide counter spin to the air handled by a fan for increasing its pressure.

Control vanes of this type are shown generally by the H. F. Hagen U. S. Patents Nos. 1,846,863 and 1,892,303, and the theory of their operation is explained fully therein.

It is usual to support control vanes of this type, which will in the following be referred to as "spin vanes," by pivoting them at their bases and tips, the pivots of their bases being journaled in inner housings around the shafts of fans and the pivots of their tips being journaled in the outer casings guiding the air into the fans. Such constructions are shown by the H. F. Hagen U. S. Patent No. 1,989,413 and the Bartlett and Leonard U. S. Patent No. 2,113,391.

Such constructions are not desired for some types of service, particularly in the case where the spin vanes are to be used with a fan in the cowl of an airplane engine, for the reasons that the inner supporting housings would obstruct the air stream and cause turbulence therein and the cowls would be attached through the vanes to the inner housings with the result that the relative movement between the cowl and the engine would set up vibrations in the vanes and would tend to bind them against adjustment. Another difficulty is that of providing access in the case of an airplane to the inner supports for the servicing thereof.

A feature of this invention resides in supporting the spin vanes only at their tips or outer ends where they also are adjusted.

Another feature of this invention resides in providing simultaneous adjustment of several spin vanes by the use of simple grooved pulleys and wire control cable, thus eliminating the usual gears and cams and their weight, friction and backlash.

Objects of this invention are to simplify the support of and the adjustment of spin vanes used with fans.

The invention will now be described with reference to the drawings, of which:

Fig. 1 is a partial front elevation view with a portion broken away, illustrating one embodiment of this invention applied to an airplane engine;

Fig. 2 is a sectional view along the lines 2—2 of Fig. 1 and illustrates one of the pulleys attached to the vanes;

Fig. 3 is a developed section along the lines 3—3 of Fig. 4 and shows additionally a control cable in the grooves of the various grooved pulleys.

Fig. 4 is a sectional view along the lines 4—4 of Fig. 1 and illustrates the master control pulley;

Fig. 5 is a sectional view along the lines 5—5 of Fig. 1 and illustrates one of the idler pulleys;

Fig. 6 is an enlarged view of one of the grooved pulleys shown by Fig. 2;

Fig. 7 is a sectional view of an adjustable idler pulley which may be used instead of the one shown by Fig. 5;

Fig. 8 is a side section of another embodiment of this invention particularly suitable for use in small cowls, and

Fig. 9 is a sectional view along the lines 9—9 of Fig. 8.

In modern, high powered airplanes, the air pressures provided by the impact of the cylinders of air cooled engines against the air, and the radiators of liquid cooled engines against the air, even when aided by the induction action of flaps, are insufficient for providing adequate air volumes at all times for cooling the engines. This is especially so in the case of airplanes which are designed for high altitude flying where the density of the air is low. Accordingly it has become necessary to provide fans driven by the engines for providing adequate cooling. However since the fan must be designed to provide the air pressures required at high altitudes, at low levels it provides much higher pressures than are needed and consumes too much power from the engine.

Adjustable spin vanes provide a satisfactory method of adjusting the pressure provided by such a fan and for varying the power required by the fan from the engine.

At low altitudes and for take-offs where less cooling is required, the spin vanes may be adjusted towards maximum spin in the direction of rotation of the fan blades whereby the fan will provide low air pressures and consume reduced power from the engine.

For high altitude flying the spin vanes may be adjusted to positions providing no spin or to positions providing contra spin for providing high air pressures.

With reference to Fig. 2 of the drawings, a propeller fan comprising a plurality of blades 10 mounted on a hub 11, is provided for cooling an airplane engine and is adapted to be driven from the engine by mechanism not shown.

The cowl 12 extends around the fan and the spin vanes 13 are supported in the front end of the cowl, the assembly illustrated being for a tractor type engine.

The vanes have substantially the same inner and outer diameters as the blades 10. The cylindrical baffle 14 extends under the vanes 13 and serves to guide all the air entering the cowl, through the vanes.

The baffle 14 is bolted at 15 to the member 16 which in turn is adapted to be bolted to the engine to which the assembly is applied. The member 16 has the inner extension 17 forming an oil seal around the hub 11.

The vanes 13 are attached to the pivot rods 18 which are journaled for rotation in the cowl in the upper ball bearings 19 and the lower ball bearings 20. The grooved, vane adjusting pulleys 21 are keyed at 22 to the rods 18 and serve to rotate same as will be described.

The grooved, master control pulley 23 is located between adjacent pulleys of one pair of the pulleys 21 and with its center to one side of the centers of the pulleys 21. It has a shaft 24 to which it is keyed at 25 and which is journaled for rotation in the cowl in the upper ball bearing 26 and the lower ball bearing 27.

The grooved, idler pulleys 28 are located between the adjacent pulleys of the other pairs of pulleys 21 and with their centers to one side of the centers of the pulleys 21. They are rotatably mounted on the bearings 29 which are bolted to the inner wall of the cowl by the bolts 30 and nuts 31.

With reference to Fig. 3, the control cable 32 is interlaced as illustrated in the grooves of the pulleys 21, the groove of the pulley 23 and the grooves of the pulleys 28. Its two ends 33 are doubled back at the pulley 23 and pulled through the holes 34 (Fig. 4) in the pulley and when pulled tight so that all the slack is taken out, the screws 35 are screwed in threads tapped in openings in the pulley, against the ends 33 of the cable to secure them to the pulley 23 so that upon rotation of the pulley the cable will move with it.

The cable 32 may be a twisted wire type cable such as is used with pulleys of the type illustrated for adjusting airplane control surfaces. The cable serves as a belt. Other forms of pulleys and belts could be used.

The pulleys 21 have the portions 36 at one side of each of the pulleys, these portions being drilled at 37 in alignment with the grooves in the pulleys for receiving the cable 30 which passes through the portions 36. The portions 36 are also drilled and tapped to receive the machine screws 38 which are screwed down against the cable securing it positively to the pulleys 21 so that upon movement of the cable the pulleys 21 are rotated without any lost motion.

The pulley 23 has the gear teeth 39 cut in one-third of its upper surface and forms a bevel gear in that portion of its surface. This meshes with the bevel gear 40 which is formed on an enlargement of the inner end of the cylinder 41. The cylinder 41 is rotatably supported by the bearing 42 in the cowl. The cylinder 41 is drilled to receive the shaft 43 which is adapted to be keyed thereto.

The shaft 43 may be rotated manually by a control in the pilot's cockpit or in the engineer's compartment or by a motor which may be under thermostatic control.

The grooved pulleys 28 serve as idler pulleys for maintaining the cable 32 in contact with large arcs of the grooved pulleys 21 to which the vanes are attached.

The idler pulleys 28 may be made adjustable as illustrated by Fig. 7 and in dotted outline by Fig. 3, for varying the tension of the cable between one or more of the pulleys 22. The slot 46 is provided in the inner wall 44 of the casing 12. The supporting bolt 30 has a diameter much smaller than the width of the slot. The washer 47 and the bearing member 45 contact the walls of the slot, and when the nut 31 is tightened down, the member 45 and the washer 47 hold the pulley 28 in the chosen position.

Upon rotation of the shaft 43, the bevel gear rotates through the gear 39, the master control pulley 23. Rotation of the pulley 23 causes the cable 32 to rotate the pulleys 21 and the vanes 13 to which they are attached.

The embodiment of the invention illustrated by Figs. 1–7 is preferred for the larger cowls. For smaller cowls, the diameter of the circle defining the path of the cable 32 is decreased, resulting in increased tendency of the cable to slip out of the grooves in the pulleys 21, 23, and 28. The embodiment of Figs. 8 and 9 was designed for the small cowls and is similar to that of Figs. 1–7 except that the pulleys are turned through angles of 90° and instead of being mounted on the radially extending pivot rods, are attached to the pivot rods through simple bevel gears.

The pulley 50 of Figs. 8 and 9 which corresponds to the pulley 23 of Figs. 1–4 is mounted on the shaft 43. The inner end of the shaft 43 has the bevel gear 52 attached thereto. The bevel gear 51 is mounted on the pivot rod 24 and meshes with the gear 52 whereby upon rotation of the shaft 43, the pivot rod 24 is rotated.

The pulleys 21 are mounted and are attached by bevel gears to their pivot rods 18, as illustrated by Fig. 8 with the exception that the shafts on which they are mounted while similar to the shaft 43 of Fig. 8, does not extend through the end wall 53 as does the shaft 43 of Fig. 8.

The idler pulleys 28 of Figs. 7 and 8 are mounted as the pulleys 21 of Figs. 8 and 9 are, except that the shafts on which they are mounted terminate at the bearing supports 54 and do not have gears thereon.

The vanes 13 may be adjusted from wide open position where they are at 0° with respect to air flow and have no effect upon the air, through an angle of substantially 90° to substantially closed position where they exert maximum spin for maximum reduction of air pressure and fan power. They may be adjusted to provide counter spin. Thus, they may be adjusted, for example, from counter spin angles of say 35° to spin inducing angles of 55°.

The teeth 39 on the master control pulleys 23 may be increased in number to give an angle of adjustment greater than 90°. For example, it is contemplated to provide a range of adjustment extending from angles of 35° counter spin to spin inducing angles of 80°.

With the vanes in counter spin positions, the pressure provided by the fan is greater than where no spin vanes are used, thus enabling a fan to provide greater pressures than it could provide alone.

While the invention has been described in connection with spin vanes located upstream with respect to air flow of a propeller fan, they could be located downstream of a propeller fan for increasing or counteracting the spin natural to such fans. Likewise, they may be used with centrifugal fans.

While one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not

limited to the exact apparatus and arrangement of apparatus illustrated as modifications thereof may be suggested by those skilled in the art without departure from the essence of the invention.

What is claimed is:

1. A propeller fan assembly comprising a plurality of propeller blades, an inner cylindrical wall around said blades and extending upstream thereof and forming an inlet passage thereinto, an outer wall spaced from said inner wall, a plurality of spin vanes arranged in said passage, inner bearings journalled in said inner wall, substantially radially extending rotary shafts having their inner ends attached to the outer ends of said vanes, said shafts extending through said bearings into the space between said walls, outer bearings around the outer ends of said shafts, means supporting said outer bearings in the space between said walls, vane adjusting pulleys attached to said shafts between said inner and outer bearings, shafts attached to and extending radially outwardly from said inner wall into said space, idler pulleys rotatably mounted on said last mentioned shafts between adjacent pairs of said first mentioned pulleys, a belt in said space in contact with all of said pulleys, and means for rotating said belt, said idler pulleys being positioned to lead said belt substantially normally over said vane adjusting pulleys.

2. A propeller fan assembly comprising a plurality of propeller blades, an inner cylindrical wall around said blades and extending upstream thereof and forming an inlet passage thereinto, an outer wall spaced from said inner wall, a plurality of spin vanes arranged in said passage, inner bearings journalled in said inner wall, substantailly radially extending rotary shafts having their inner ends attached to the outer ends of said vanes, said shafts extending through said bearings into the space between said walls, outer bearings around the outer ends of said shafts, means supporting said outer bearings in the space between said walls, vane adjusting pulleys attached to said shafts between said inner and outer bearings, one of said pulleys being a control pulley, shafts attached to and extending radially outwardly from said inner wall into said space, idler pulleys rotatably mounted on said last mentioned shafts between adjacent pairs of said first mentioned pulleys, a belt in said space in contact with all of said pulleys, and means supported from said inner wall for rotating said belt, said idler pulleys being positioned to lead said belt substantially normally over said vane adjusting pulleys.

3. A propeller fan assembly comprising a plurality of propeller blades, an inner cylindrical wall around said blades and extending upstream thereof and forming an inlet passage thereinto, an outer wall spaced from said inner wall, a plurality of spin vanes arranged in said passage, inner bearings journalled in said inner wall, substantially radially extending rotary shafts having their inner ends attached to the outer ends of said vanes, said shafts extending through said bearings into the space between said walls, outer bearings around the outer ends of said shafts, means supporting said outer bearings in the space between said walls, vane adjusting pulleys attached to said shafts between said inner and outer bearings, one of said pulleys being a control pulley, shafts attached to and extending radially outwardly from said inner wall into said space, idler pulleys rotatably mounted on said last mentioned shafts between adjacent pairs of said first mentioned pulleys, a belt in said space in contact with all of said pulleys, means attaching said belt to said control pulley and to said idler pulleys, and means supported from said inner wall for rotating said belt, said idler pulleys being positioned to lead said belt substantially normally over said vane adjusting pulleys.

BENJAMIN S. FOSS.