

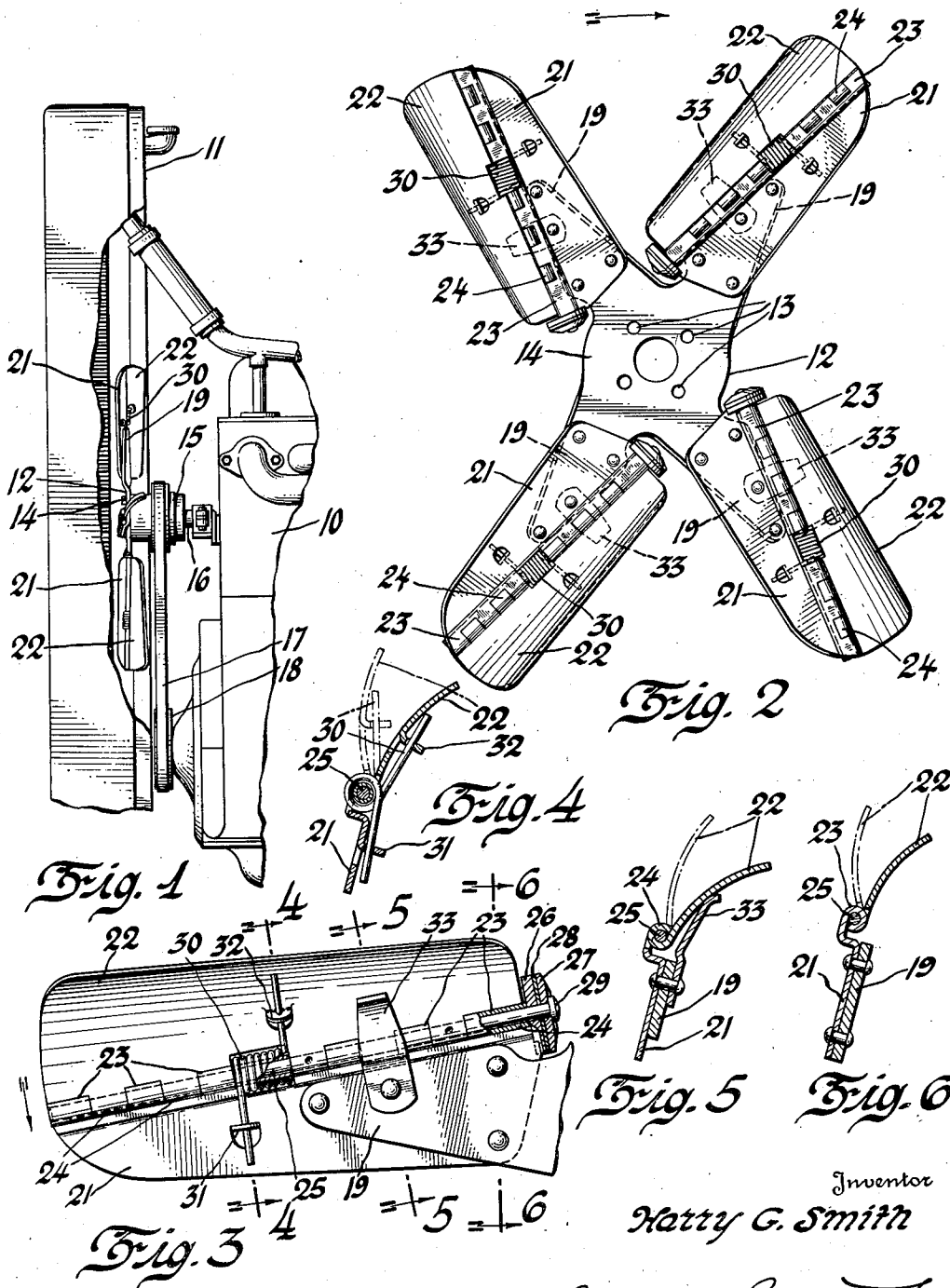
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This invention relates to screw propellers and, particularly, to automotive vehicle propelling engine cooling fans whose blades decrease in pitch as their speed increases.

5 The principal object of the invention is to provide a propeller of the type referred to whose blades will not flutter when the propeller is operating or become fatigued by the changes in pitch which occur when the speed of the propeller changes.

For a better understanding of the nature and objects of this invention, reference is made to the following specification wherein there is described the preferred embodiment of the invention which is illustrated in the accompanying drawing.

In the accompanying drawing:

Figure 1 shows a fan in which my invention is embodied installed on the propelling engine of an automotive vehicle of conventional design.

20 Figure 2 is a front elevation of the fan.

Figure 3 is an enlarged view of the rear side of a blade of the fan.

Figures 4, 5 and 6 are sections taken, respectively, on the lines 4-4, 5-5 and 6-6 of Figure 3.

In the drawing, the reference character 10 indicates the water-cooled propelling engine of an automotive vehicle of conventional design and the reference character 11 the radiator by which the engine cooling water is cooled. The engine 30 10 is located in advance of the body of the vehicle and the radiator 11 in advance of the engine so that movement of the vehicle causes air to circulate through the radiator and over the engine. 35 To supplement the volume of air which is circulated through the radiator and over the engine due to movement of the vehicle, particularly when the vehicle is moving slowly, there is provided between the radiator and the engine a screw fan 40 12. The fan 12 is secured by screws (not shown) which extend through openings 13 in its hub to a pulley 15 which is mounted so that it may rotate on a shaft 16 which is carried by the engine. The fan is driven at a rate proportional to the 45 speed of the engine in a direction to draw air through the radiator and propel it over the engine by a belt 17 which passes around the pulley 15 and a pulley 18 which is secured to the crankshaft of the engine.

50 On the hub 14 of the fan there are formed prongs 19 which are twisted slightly at their junctions with the body of the hub so that their leading edges are located somewhat forward of their trailing edges. To each of the prongs 19 55 there is secured a blade which consists of rigid

and inflexible leading and trailing vanes 21 and 22. Each of the leading vanes 21 is riveted to a prong 19 of the hub 14 and is, consequently, disposed parallel thereto. Each prong and its attached vane 21 constitutes an arm. The leading 5 edge of each of the trailing vanes 22 is connected to the trailing edge of one of the leading vanes 21 by a hinge whose axis is inclined in the direction of rotation of the fan at an angle of about eleven degrees (11°) to the line radial to the axis of ro- 10 tation of the fan which intersects it at its outer extremity.

The eyes 23 and 24 of the hinge are integral with the vanes 21 and 22, respectively, and their axis is disposed forward of the bodies of the 15 vanes. The pintle 25 of the hinge is spot-welded or pinned to one or more of the eyes 24 of the hinge so that it cannot shift axially with respect to the trailing vane 22. The inner end of the pintle 25 is encircled by thrust washers 26 and 20 27 and a washer 28 of lubricant impregnated anti-friction material which is interposed between the thrust washers. The thrust washers 26 and 27 are seated, respectively, on the inner end of the leading vane 21 and on a head 29 formed on the 25 inner extremity of the pintle 25.

The trailing vanes 22 are curved transversely rearwardly and are biased in the direction to increase the pitch of the blades by a coil spring 30 which encircles a portion of the pintle 25 and 30 whose extremities extend through ears 31 and 32 struck out from the leading and trailing vanes, respectively. Movement of the trailing vane in the direction in which it is biased by the spring 30 is limited by a stop 33 secured to the stub arm 35 19 and the leading vane 21. When the trailing vane is in engagement with the stop, as it is when the fan is at rest, its trailing edge is located to the rear of the plane of rotation of the leading vane and its center of gravity is located 40 to the rear of the axis of the hinge which connects it to the leading vane.

The fan 12 is secured to the pulley 15 with the trailing edges of the trailing vanes 22 extending away from the radiator 11 and toward the 45 engine 10. When the fan is installed in this manner and the engine is operating, the fan is rotated at a speed proportional to the speed of the engine in the direction indicated by the arrows in Figures 2 and 3 and, consequently, 50 draws air through the radiator and propels it over the engine. As the speed of the engine increases, the trailing vanes swing from the positions in which they are shown in solid lines toward the positions in which they are shown in 55

dash-and-dot lines in Figures 4, 5 and 6 and the pitch of the blades of the fan is, consequently, reduced. The result of this is that the rate at which the fan 12 delivers air does not increase in proportion to its rate of rotation and, consequently, if the fan is designed so that it will deliver air at the same rate as a fan of conventional design at relatively low speeds, it will deliver less air and, consequently, consume less power and create less noise than the latter at higher speeds. This characteristic of my fan renders it peculiarly suited for use as an engine cooling fan in automotive vehicles of conventional design in which the circulation of air due to the movement of the vehicle does not satisfy the engine cooling air requirements while the vehicle is moving relatively slowly, but more and more nearly satisfies it as the speed of the vehicle increases.

Two forces, viz., centrifugal force and the resistance of the atmosphere to the passage of the blades through it, tend at all times while the fan is operating to reduce the pitch of the blades. The modus operandi of the air resistance requires no explanation. Centrifugal force is effective at all times because the axes of the hinges are not inclined oppositely to the direction of rotation of the fan and, therefore, all movements of the trailing vanes from the solid toward the dash-and-dot line positions in which they are shown in Figures 4, 5 and 6 are accompanied by movements of the centers of gravity of the trailing vanes away from the axis of rotation of the fan and vice versa. However, the angle at which the hinges are inclined in the direction of rotation of the fan is so large that centrifugal force together with the springs 30 and the friction in the hinges are the dominant factors in effecting movement of the trailing vanes and determining the pitch of the blades at different speeds of rotation of the fan.

Sufficient endwise clearance is provided between the eyes 23 and 24 of the hinges which connect the leading and trailing vanes of the blades, and the elements of the thrust bearings 26—27—28 are so adjusted that the centrifugal force which tends to displace the trailing vanes radially with respect to the leading vanes during operation of the fan is taken entirely by the thrust bearings. Since the provision of the lubricant impregnated anti-friction washers 28 render the thrust bearings self-lubricating, this arrangement makes it possible not only to provide without difficulty sufficient bearing area to prevent destruction by overloading of the bearing surfaces which take the centrifugal force and to maintain the friction in the bearings uniform but also to give the friction any desired value, within limits, by selecting anti-friction washers of the proper characteristics. The friction in the hinges should, of course, be sufficient to prevent the trailing vanes fluttering at any speed of operation of the fan. It will, of course, be noted that since the changes in pitch of the blades of the fan are effected without flexure of the vanes, the blades will not become fatigued by the changes in pitch which occur when the speed of the fan changes. It will also be noted that since the leading edges of the leading vanes 21 are disposed somewhat forward of the trailing edges thereof, the leading as well as the trailing vanes serve to propel air.

I claim:

1. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation

of the hub, a vane whose leading edge is connected to the arm by a hinge which extends lengthwise of the arm and whose trailing edge is free to rotate about the axis of the hinge in response to forces applied to the vane as a result of rotation of the hub, means which yieldingly biases the vane to a position in which it is disposed at an angle to the path in which the arm travels, and bearing elements by which centrifugal force which is applied to the vane as a result of rotation of the hub is transferred to the arm.

2. In a screw propeller, a rotatable hub, a vane which is connected to and extends away from the hub at an angle to the axis of rotation of the hub and is inclined to the path in which it travels, a vane, a hinge which connects the leading edge of the second-specified vane to the first-specified vane so that the trailing edge of the second-specified vane is free to rotate about an axis which extends lengthwise of the first-specified vane and is inclined in the direction of rotation of the propeller in response to the centrifugal force applied to the second-specified vane as a result of rotation of the hub including aligned eyes on the vanes and a pintle which extends through the eyes and is secured to an eye on the second-specified vane, means which yieldingly biases the second-specified vane to a position in which it is inclined in the same direction to the path in which it travels as the first-specified vane and to a greater degree with the center of gravity of the second-specified vane located without the path in which the axis of the hinge rotates including a spring which is coiled around the pintle between eyes of the hinge with one of the ends of the spring connected to each of the vanes, and means by which centrifugal force which is applied to the second-specified vane as a result of rotation of the hub is transferred to the first-specified vane including a bearing element carried by the inner end of the pintle and a bearing element seated against the inner end of the first-specified vane.

3. In a screw propeller, a rotatable hub, a vane which is connected to and extends away from the hub at an angle to the axis of rotation of the hub and is inclined to the path in which it travels, a vane whose leading edge is connected to the first-specified vane by a hinge which extends lengthwise of the first-specified vane and is inclined in the direction of rotation of the propeller and whose trailing edge is free to rotate about the axis of the hinge in response to forces applied to the vane as a result of rotation of the hub, and means which yieldingly biases the second-specified vane to a position in which it is inclined in the same direction to the path in which it travels as the first-specified vane and to a greater degree with its center of gravity located without the path in which the axis of the hinge rotates.

4. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, a vane, a hinge which connects the vane to the arm so that it may swing about an axis which extends lengthwise of the arm including aligned eyes on the arm and the vane and a pintle which extends through the eyes and is secured to an eye on the vane, means by which centrifugal force which is applied to the vane as a result of rotation of the hub is transferred to the arm including a bearing element carried by the inner end of the pintle and a bearing element seated against the inner end of the arm, and means which yieldingly

biases the vane to a position in which it is disposed at an angle to the path in which the arm travels, including a spring which is coiled around the pintle between eyes of the hinge and connected to the arm and the vane.

5. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, a vane which is connected to the arm by a hinge which extends lengthwise of the arm and is inclined in the direction of rotation of the propeller and whose trailing edge is free to rotate about the axis of the hinge in response to the centrifugal force applied to the vane as a result of rotation of the hub, and means which yieldingly biases the vane to a position in which it is disposed at an angle to the path in which the arm travels with the center of gravity of the vane located without the plane of rotation of the axis of the hinge.

6. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, a vane, a hinge which connects the vane to the arm so that it may swing about an axis which extends lengthwise of the arm including aligned eyes on the arm and the vane and a pintle which extends through the eyes and is secured to one of them, and means by which centrifugal force which is applied to the vane as a result of rotation of the hub is transferred to the arm including a bearing element carried by the pintle and a bearing element seated against that one of the arm and the vane to whose eye the pintle is not secured.

7. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, a vane, a hinge which connects the vane to the arm so that it may swing about an axis which extends lengthwise of the arm including aligned eyes on the arm and the vane and a pintle which extends through the eyes and is secured to an eye on the vane, and means by which centrifugal force which is applied to the vane as a result of rotation of the hub is transferred to the arm including a bearing element carried by the inner end of the pintle and a bearing element seated against the inner end of the arm.

8. In a screw propeller, a rotatable hub, a vane which is connected to and extends away from the hub at an angle to the axis of rotation of the hub

and is inclined to the path in which it travels, a vane which is connected to the first-specified vane by a hinge which extends lengthwise of the first-specified vane and whose trailing edge is free to rotate about the axis of the hinge in response to forces applied to the vane as a result of rotation of the hub, and means which yieldingly biases the second-specified vane to a position in which it is inclined in the same direction to the path in which it travels as the first-specified vane and to a greater degree.

9. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, and a blade mounted on the arm with the leading edge of the blade connected thereto and the trailing edge of the blade free thereof—the arm and the blade being so constructed and arranged that the trailing edge of the blade may swing in response to forces applied to the blade as a result of rotation of the hub about an axis which extends lengthwise of the arm and is inclined in the direction of rotation of the propeller at such an angle that centrifugal force is the dominant factor in determining the pitch of the blade at different speeds of rotation of the propeller.

10. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, a vane, a hinge which connects the vane to the arm so that it may swing about an axis which extends lengthwise of the arm including aligned eyes on the arm and the vane, and means to relieve the juxtaposed ends of the eyes of the centrifugal force which is applied to the vane as a result of rotation of the hub.

11. In a screw propeller, a rotatable hub, an arm which is connected to and extends away from the hub at an angle to the axis of rotation of the hub, a vane, a hinge which connects the vane to the arm so that it may swing about an axis which extends lengthwise of the arm including aligned eyes on the arm and the vane, and means to relieve the juxtaposed ends of the eyes of the centrifugal force which is applied to the vane as a result of rotation of the hub including a pintle which extends through the eyes of the hinge and is secured to one of them.

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