July 26, 1932. A. D. GARDNER 1,868,528

FAN

Filed July 8, 1930 3 Sheets-Sheet 1

FIG. 3

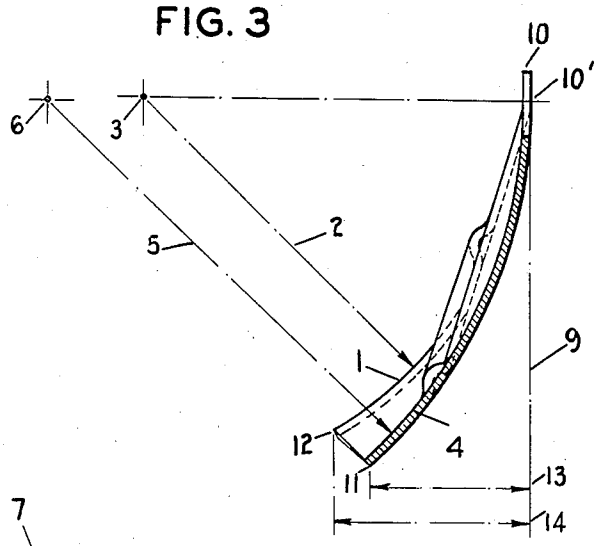


FIG. 1

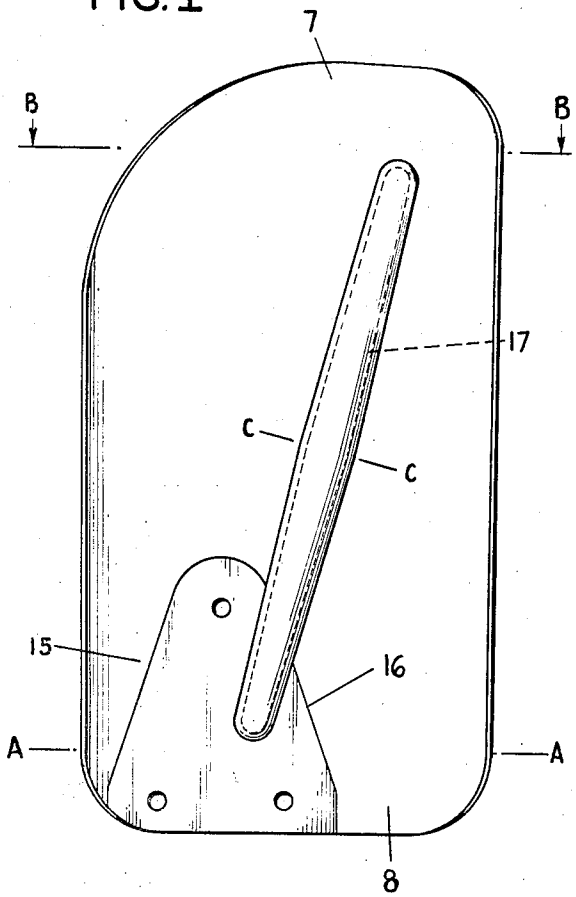


FIG. 2

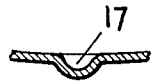


FIG. 5



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July 26, 1932. A. D. GARDNER 1,868,528

FAN

Filed July 8, 1930 3 Sheets-Sheet 2

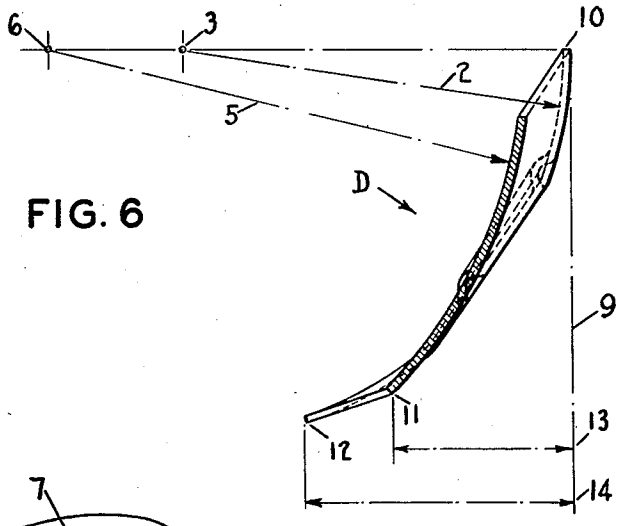


FIG. 6

FIG 4

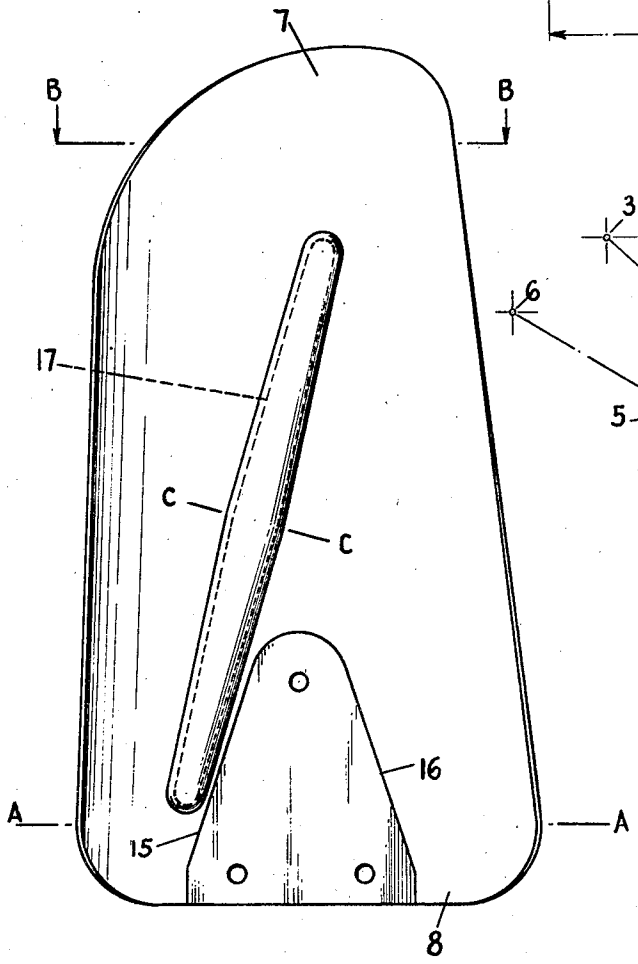
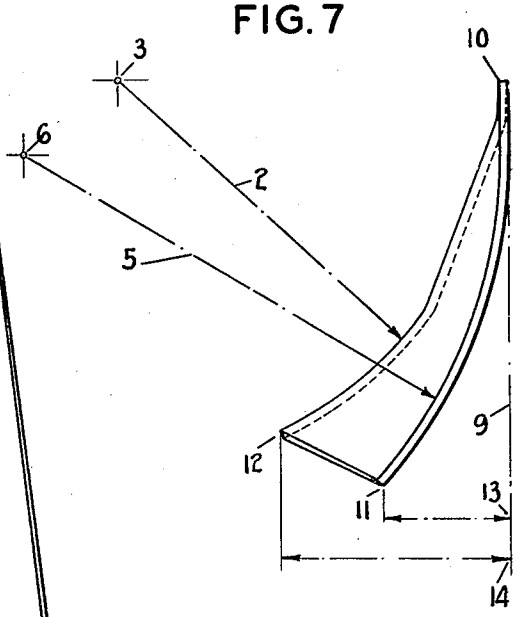


FIG. 7



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July 26, 1932. A. D. GARDNER 1,868,528

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Filed July 8, 1930 3 Sheets-Sheet 3

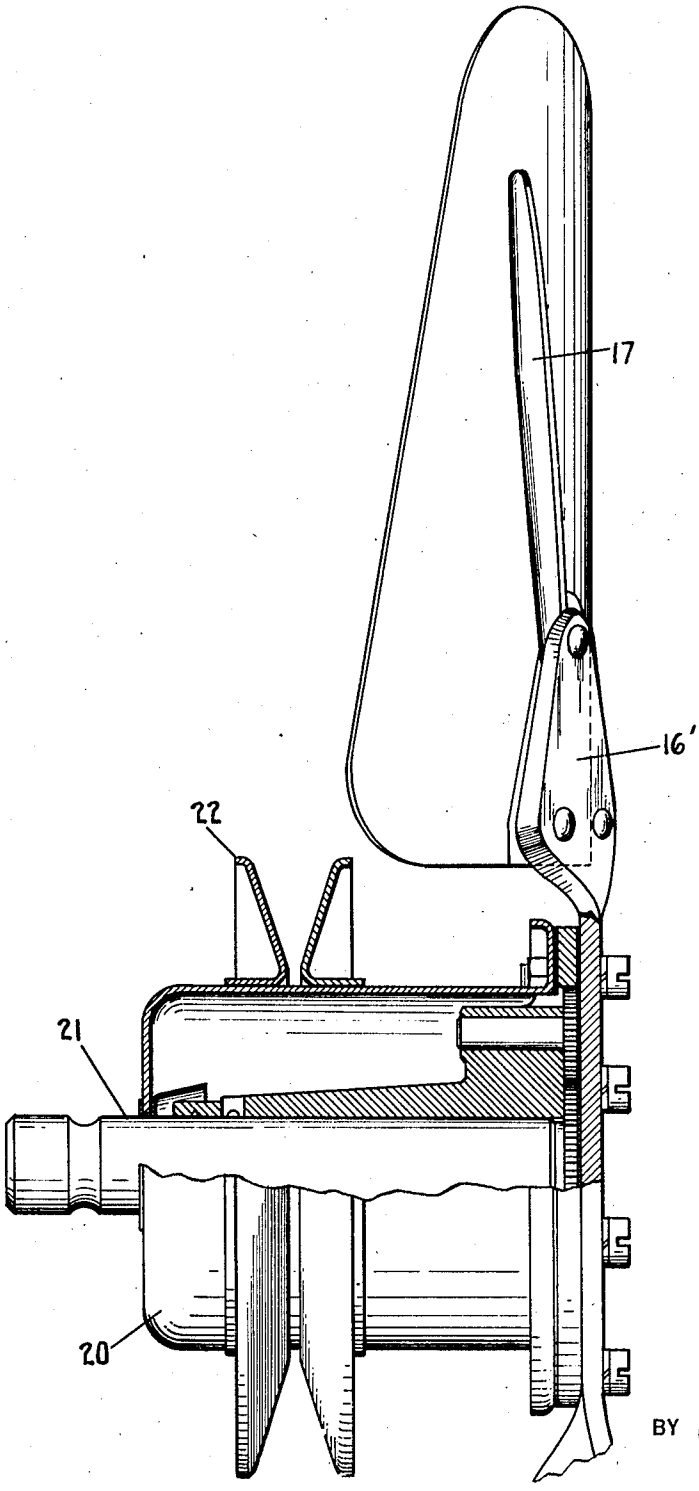


FIG. 8

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Patented July 26, 1932 1,868,528

UNITED STATES PATENT OFFICE

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FAN

Application filed July 8, 1930. Serial No. 466,485.

This invention relates to apparatus for producing a flow of air by rotating blade members made from sheet material of substantially uniform thickness. The invention finds particular use as fans for producing a flow of air through automobile engine radiators but it is applicable to various other uses where a steady flow of air or other fluid is to be produced.

In fans such as are used on automobiles prior to my invention the blades have been so constructed as to produce the major amount of thrust against the air at the periphery of the fan. These prior types of fans not only produce an uneven flow of air through the fan blades but they also are quite noisy in operation.

It is one of the objects of my invention to construct fan blades and so attach them to a rotatable member as to more evenly distribute the flow of air throughout the area of the fan.

Another object of the invention is to produce a fan that is quiet in operation at practically all speeds.

A further object of the invention is to construct blades with a strengthening member stamped integrally with the blades.

Another object of the invention is to locate the strengthening rib or member on the pressure side of the surface blade.

Another object is to construct fan blades having warped surfaces.

Another object is to construct a fan blade with variable radius of curvature from the inner to the outer end.

A further object is to construct a fan blade with variable projected pitch, later defined, from the inner to the outer end of the blade.

Other objects will appear in the appended description, reference being had to the drawings in which:

Fig. 1 is an elevation of a fan blade embodying the features of the invention.

Fig. 2 is a cross section of the strengthening rib on the blade of Fig. 1 taken along the lines C—C.

Fig. 3 is a sectional plan view of the blade of Fig. 1 showing the relation of the curvature of the outer and inner end of the blade and their position in respect to the plane of rotation, the section and curvature being taken along the lines B—B and A—A respectively.

Fig. 4 is an elevation of the blade of Fig. 6 taken in the direction of the arrow D and showing a differently proportioned blade for accomplishing the results of the invention.

Fig. 5 is a cross section of the strengthening rib of Fig. 4 taken along the line C—C.

Fig. 6 is a sectional end view of the blade of Fig. 4 illustrating the relation between the curvature of the inner and outer ends of the fan blades, the section and curvature being taken along the lines B—B and A—A of that figure respectively.

Fig. 7 is a plan view of a somewhat modified form of blade giving the plane of rotation and the relation between the curvatures of the two ends of the blade, the strengthening rib not being illustrated.

Fig. 8 is an elevation, partly in section, of an automobile fan illustrating one application of the invention.

Referring to Figs. 1, 2 and 3 of the drawings, the fan blade is so stamped of thin sheet metal as to have a surface equivalent to a section of a frustum of an oblique cone. As shown in Fig. 3, the inner end 1 of the fan blade, that is the end that is attached to the rotatable member 20 (Fig. 8) such as a hub or axle, has a radius 2 of curvature with a center at 3. The outer end of the fan blade 4 has a greater radius of curvature 5 having a center at 6. In this particular design the fan blade is a section of a surface of a frustum of a cone, which section has side boundaries that are not in any plane of the axis. The outer end of the blade 7 is located at the base of the cone and the inner end 8 at the other end. The frustum of a cone may have different dimensions depending upon the particular design desired and the invention is not to be limited to any particular dimensions, but by way of example, it may be said that the blade of Fig. 1 has a total length of $6\frac{11}{16}$ inches and the radii 2 and 5 are 3 inches and $3\frac{3}{4}$ inches respectively with the plane of rotation 9 of the fan passing tangent to the outer end of the leading edge 10 of the fan blade, the distance between the outer end of

the trailing edge 11 is 1¼ inches and the distance between the inner end 12 of this edge is 1 17/32.

The shaping of the blade in Fig. 3 is such that the projection of the trailing edge of the outer end of the blade onto a plane perpendicular to the plane of rotation 9, namely the distance 11, 13, is less than a similar projection of the curve of the inner end, namely the distance 12, 14. These latter distances are defined as the projected pitch. The blade decreases in projected pitch and increases in radius of curvature from the inner to the outer end.

Instead of making the lower end of the blade with a complete circular arc I flatten a certain part thereof, as defined by the lines 15, 16 (Fig. 1) so as to receive the end of the fan spider 16′ (Fig. 8) to which the blade is riveted or otherwise secured.

To strengthen the fan blades a strengthening rib is formed therein preferably by corrugating it to produce a ridge on one side and a groove or furrow on the other. This groove is indicated by reference character 17 (Fig. 2). I have made numerous experiments and find that when this groove is located on the radiator or suction side of the fan it decreases the amount of air delivered by the fan, but when the rib is located on the pressure or engine side of the fan there is substantially no lessening of the amount of air delivered. I therefore place the strenthening rib on the pressure side. I also have found that better driving action of the air is produced when this corrugation or strengthening rib extends across the blade at an angle to the longitudinal axis of the blade and slanting back from the direction of rotation though good results are obtained by locating the groove at other positions on the pressure side of the fan.

It will be noted that in the form shown in Fig. 3 the center 3 is located in a plane perpendicular to the end surfaces of the frustum of the cone and spaced inward from the leading edge 10 of the blade, which is shown as a flat surface between the points 10 and 10′. It will also be noted that the center 6 is spaced slightly behind the plane passing through the leading edge.

There is no particular location of these center planes that must be adopted to secure the advantages of the improvement as far as positioning of the center planes may be used. For example, in Fig. 6 I have shown the centers 3 and 6 as being located in the vertical plane passing through the leading edge 10 of the blade and in Fig. 7 I have shown another design with which I obtain good results, the center 3 in a vertical plane passing through the leading edge 10 of the blade while the center 6 is located in a vertical plane spaced behind the leading edge. The obliqueness of the cone may thus be changed to suit various conditions by placing the centers 3 and 6 either toward or from each other in the vertical planes referred to and the invention is not to be limited to any particular arrangement of these centers or of other defining points of the shape of the blade.

In the form of blade shown in Fig. 4, the strengthening rib is located nearer the leading edge 10 than it is in Fig. 1. Also, in Fig. 4, the trailing edge of the blade instead of being substantially parallel to the leading edge 10, as in Fig. 1, makes an angle thereto tapering towards the leading edge from the inner end to the outer end. In Fig. 4 the strengthening rib is positioned somewhat differently as is shown in Fig. 5. The blade of this figure is likewise flattened at the inner end as defined by the lines 15, 16, to receive the end of the fan spider. It is preferable to round the corners of the blade as shown in the drawing. The two inner corners and the upper corner have about the same curvature, but the leading corner of the upper edge should preferably be rounded to a considerably greater extent, as is shown clearly in Figs. 1 and 4.

When a plurality of fan blades are secured to the arms of a spider fastened to a rotatable hub or axle and located with the strengthening rib on the pressure side of the fan superior results will be obtained due to the even flow of air throughout the fan area and the blades will rotate even at high speeds without making any substantial amount of noise nor absorb an excessive amount of power at high speeds.

I have illustrated in Fig. 8 how these blades may be secured to a rotatable member 20 journalled on a stub shaft 21 attached to an appropriate bracket on the engine (not shown). The pulley 22 receives the power from the engine to drive the fan.

I have shown by way of example a number of different designs of a blade but it will be evident that various other shapes may be employed while still retaining the basic features of the invention.

Having described my invention, what I claim is:

1. In fans, a rotatable center member and a plurality of blades secured thereto, each of said blades having a surface equivalent to a section of the surface of a frustum of a cone, with the base at the outer periphery of the fan and the radiating side boundary lines of which lie without any plane of the axis of the cone.

2. In fans, a rotatable center member and a plurality of curved blades secured thereto, each of said blades having a surface equivalent to a section of the surface of a frustum of an oblique cone, with the base at the outer periphery of the fan.

3. In fans, a rotatable member and a plurality of curved blades secured to said mem-

ber to force air axially thereof, each of said blades having a corrugation with the ridge of the corrugation on the pressure side and the furrow on the other side.

4. In fans, a rotatable member and a plurality of curved blades secured to said member to force air axially thereof, each of said blades having a corrugation extending outwardly and slanting toward the trailing edge of the blade.

5. In fans, a rotatable member and a plurality of curved blades secured to said member to force air axially thereof, each of said blades having a corrugation extending outwardly and slanting towards the trailing edge of the blades with the ridge of the corrugation on the pressure side and the furrow on the other side.

6. In fans, a rotatable member, and a plurality of fan blades secured to and radiating outwardly from said member at spaced circumferential points, said blades having a surface equivalent to a section of surface of a frustum of a cone with the base at the outer periphery of the fan.

7. In fans, a rotatable member and a plurality of fan blades secured to and radiating outwardly from said member at spaced circumferential points, said blades having a surface equivalent to a section of the surface of a frustum of an oblique cone with the base at the outer periphery of the fan.

In testimony whereof, I have signed my name to this specification this 3rd day of July, 1930.

ARCHIBALD D. GARDNER.