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3,058,528

NOISE SUPPRESSED FAN STRUCTURE

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FIG. 2.

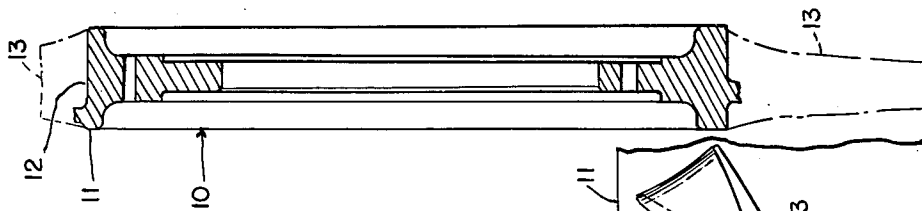


FIG. 3.

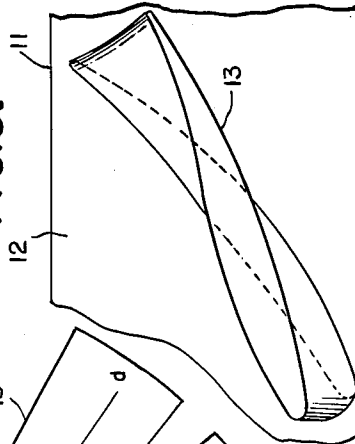
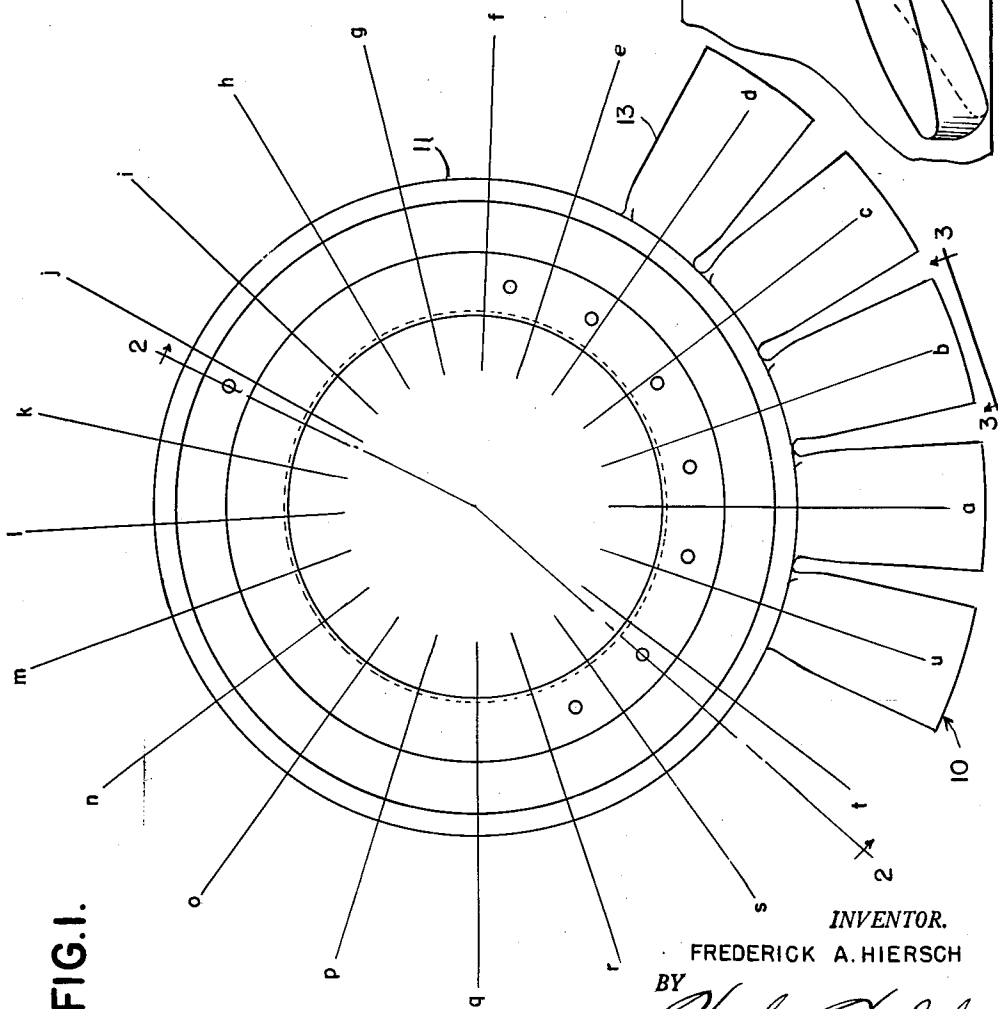


FIG. 1.

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NOISE SUPPRESSED FAN STRUCTURE
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My invention relates to fan structures, and more particularly to the construction of high speed fans such as are used in the air cooling systems of large internal combustion engines, the construction being directed toward the suppression of noise. It is well known that heretofore in the development of large air cooled engines requiring the use of high speed fans to supply adequate cooling air, considerable noise occurs due to an inherent siren effect of the fan.

The problem of noise in modern society is an ever-increasing one, and as engines for larger vehicles become more high powered and more complex, means must be provided to suppress the noise produced. One area which heretofore has been relatively ignored is in the noises of high speed fans.

An object of the present invention is to suppress cooling fan noise by providing a new arrangement of vanes on the rotor.

Another object of the invention is to suppress fan noises without sacrificing efficiency of operation by constructing a multi-vaned fan in which the vanes are spaced irregularly on the rotor.

For a more complete understanding of my invention, reference may be had to the accompanying drawing, illustrating a preferred embodiment of my invention in which like reference characters refer to like parts throughout the several views and in which

FIG. 1 is a plan view of a cooling fan constructed in accordance with the principles of the invention.

FIG. 2 is a cross-sectional view taken substantially on the line 2-2 of FIG. 1, and

FIG. 3 is an end view of one fan blade as seen substantially from the line 3-3 of FIG. 1.

A preferred fan structure 10 is illustrated as comprising a ring-like rotor 11 adapted for mounting on the fan drive of an internal combustion engine (not shown) and having a peripheral edge 12 on which are secured a plurality of spaced vanes 13, constructed on the center lines designated by the letters *a* through *u* in FIG. 1.

It should be noted that the fan structure 10 is what is commonly called a "high performance" fan. The primary criterion for a determination of whether a particular fan is a "high performance" or a "low performance" fan is found in the ratio of the diameter of the hub to the diameter to the tip of the blades. If this ratio is greater than one half, then the fan is considered to be a "high performance" fan.

Heretofore, it has been common practice in the manufacture of this type of structure, which is made by precision methods demanded for the high speeds encountered in operation, to space the vanes 13 equally. I have discovered however that the siren-like blast produced in operation can be effectively suppressed by spacing the vanes irregularly, as indicated by the center-line angular dimensions noted in the following chart:

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Vane center line	Engineered angle (±.5°), degrees	Spacing (±1°), degrees	Approximate deviation from equal spacing (17.14+), degrees
5 <i>a</i> -----	0-360	<i>a</i> to <i>b</i> -18.48	1.34
<i>b</i> -----	18.48	<i>b</i> to <i>c</i> -18.48	1.34
<i>c</i> -----	36.96	<i>c</i> to <i>d</i> -18.48	1.34
10 <i>d</i> -----	55.44	<i>d</i> to <i>e</i> -17.44	0.30
<i>e</i> -----	72.88	<i>e</i> to <i>f</i> -15.45	-1.69
<i>f</i> -----	88.33	<i>f</i> to <i>g</i> -15.52	-1.62
<i>g</i> -----	103.85	<i>g</i> to <i>h</i> -15.52	-1.62
<i>h</i> -----	119.37	<i>h</i> to <i>i</i> -15.52	-1.62
<i>i</i> -----	134.89	<i>i</i> to <i>j</i> -17.37	0.23
<i>j</i> -----	152.26	<i>j</i> to <i>k</i> -17.37	0.23
15 <i>k</i> -----	169.63	<i>k</i> to <i>l</i> -17.91	0.77
<i>l</i> -----	187.54	<i>l</i> to <i>m</i> -18.48	1.34
<i>m</i> -----	206.02	<i>m</i> to <i>n</i> -16.37	0.77
<i>n</i> -----	222.39	<i>n</i> to <i>o</i> -18.48	1.34
<i>o</i> -----	240.87	<i>o</i> to <i>p</i> -15.52	-1.62
<i>p</i> -----	256.39	<i>p</i> to <i>q</i> -16.37	-0.77
<i>q</i> -----	272.76	<i>q</i> to <i>r</i> -15.52	-1.62
<i>r</i> -----	288.28	<i>r</i> to <i>s</i> -18.48	1.34
20 <i>s</i> -----	306.76	<i>s</i> to <i>t</i> -18.48	1.34
<i>t</i> -----	325.24	<i>t</i> to <i>u</i> -17.37	0.23
<i>u</i> -----	342.61	<i>u</i> to <i>a</i> -17.39	0.25

The indicated spacing for the particular fan shown was arrived at empirically by using a rotor having adjustable vanes and measuring the sound pressure level of the noise produced in operation until a value of at least 15 db's less than the permissible noise level was achieved.

It is known that the noise level of a complex sound containing pure tones, when judged by the human ear, is about 15 db higher than the sound level recorded by instruments. The presence of pure tones appears to make a noise a nuisance as though the total sound pressure level were to be read 15 db higher than recorded by the instrument alone.

Although no specific calculable manufacturing standards have been determined which would be applicable to all fans, since fans vary so widely in numerous respects, I have found that for general purposes the irregular spacing solution to the noise problem is valid for fans having between 15 and 20 vanes, the fan being of an overall diameter of no less than 12 and no more than 30 inches, and having an output of between 20 to 100 horsepower. In addition, the maximum irregularity of spacing which will not interfere with the balance and efficient fan operation is about 2 to 5 degrees. Since a manufacturing tolerance of ±0.5° is involved, the engineered spacing tolerance is ±1°, which must also be taken into consideration.

The above chart illustrates only one type of irregularity, in a fan having 21 vanes, which effects the desired noise suppression. It will be apparent to one skilled in the art to which the invention pertains that various changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:
1. A high performance axial flow fan for internal combustion engines, comprising a rotor having a peripheral edge, and at least fifteen vane blades irregularly angularly spaced on said peripheral edge, the ratio of the diameter of said rotor to the diameter at the tip of said vane blades being more than half, the angular spacing between adjacent blades being a maximum of about five

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degrees from uniform spacing, the overall outer diameter of said fan being at least twelve inches, and the fan output being at least twenty horsepower.

2. A high performance axial flow fan for internal combustion engines, comprising a rotor having a peripheral edge, and at least fifteen but no more than twenty-five vane blades irregularly angularly spaced on said peripheral edge, the ratio of the diameter of said rotor to the diameter at the tip of said vane blades being more than half, the angular spacing between adjacent blades being a maximum of from about two to five degrees from uniform spacing, the overall outer diameter of said fan being

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at least twelve and no more than thirty inches, and the fan output being at least twenty horsepower and no more than one hundred horsepower.

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