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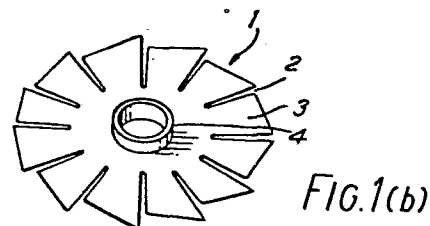
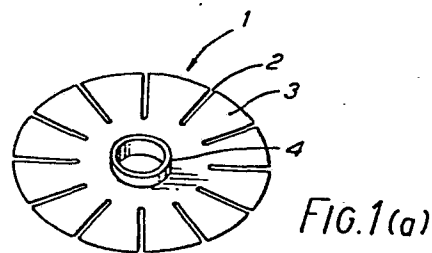
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54 **Construction of fan blades.**

57 A cooling fan for an engine or motor is constructed so that the blades, at least, are formed of shape memory material. The construction procedure is such as to cause the material to assume one condition, in which the angle of attack for the blades is relatively low, for temperatures below a threshold value and to assume another condition, in which the angle of attack of the blades is relatively high, for temperatures above the threshold value.



TITLE MODIFIED
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FANS

The present invention relates to fans, and in particular to fans suitable for cooling engines or motors.

It is very often advantageous for an engine, such as an internal combustion engine or for an electric motor to have a fan to cool it during operation. Nearly all electric motors are provided with such fans. One of the problems of electric motors provided with fans is that they generate a rather high noise level.

According to the invention from one aspect there is provided a rotary fan having blades constructed of shape memory material and capable of assuming a first angle of attack at temperatures below a threshold value and a second angle of attack, greater than the first, at a temperature above said threshold value.

According to the present invention, from another aspect a fan is provided, which may be used for cooling an engine or motor, in which the blades have a small angle of attack at ambient temperatures, and due to being made of a shape memory material, for example shape memory brass or a copper-zinc-aluminium alloy known as "Bet alloy N-1040" and manufactured by Raychem Inc. of California, U.S.A., will deform to give a normal fan angle of attack at a temperature above a particular threshold value. An example of such a threshold value, suitable for use with an electric motor, is 50 to 70°C.

The fan is advantageously punched out from sheet metal shape memory material so as to have a disc form at ambient temperature. When it is raised to an elevated temperature, for

example 50 to 70°C, then provided that the fan has an appropriate construction history, the punched out blades of the disc will incline to the desired fan angle, so that air is projected over the windings of the motor.

5 This is particularly advantageous with an electric motor, because the heating of the motor takes place mainly when under load at low speeds. The noise of the motor, however, is highest when the motor is operating at a high speed.

Thus with the construction according to the present
10 invention, when the motor starts off, the "fan" will be essentially disc-shaped, and will make substantially no noise. As the current builds up, the motor itself will increase in temperature, and the fan will also increase in temperature, because it will be connected thereto directly. The fan blades
15 will then begin to alter or form due to the shape memory characteristics of the metal, and this will project air over the armature, thus cooling it down. When the motor operates at full speed, the actual rotation of the motor will itself induce a cooling, and the current demand will be greatly reduced, in
20 any event, so that the requirement for a fan will drop. Thus, when the motor operates at full speed, the temperature of the armature will drop, and the "fan" will reassume its disc-like configuration, thus reducing significantly the noise.

If the fan is of disc form at ambient temperature, the
25 angle of attack will, of course, then be zero. It is possible, however, for the blades to have a smaller than normal angle of attack at ambient temperature.

A typical construction procedure for a fan in accordance with one example of the invention will now be described with
30 reference to the accompanying drawings which show a fan in various stages of construction.

The fan is initially formed (Fig. 1(a)) as a flat disc 1 with radial slots such as 2 defining the blades, such as 3, of the fan. A central boss 4 is provided, and this member may or
35 may not be formed of shape memory material. It can be advantageous for the boss 4 to be formed of material of high

thermal conductivity so as to assist heat flow to the vicinity of the blades.

As shown in Figure 1(b), the blades are twisted, by cold or hot shaping, to form blades with a normal angle of attack for such fans (e.g. 25° - 35°).

The so formed fan is then heated to give austenitic crystal structure (beta or parent phase) then rapidly cooled, or subjected to stress whose magnitude is related to temperature, to give crystal form of martensite.

As the next step in the procedure, the fan is re-formed, at room temperature, into a disc-shaped plate (i.e. martensite under stress). The structure is "trained" by repeating several times the foregoing sequence of "betatizing". quenching, deforming and then betatizing again.

When the construction procedure is complete, the fan assumes its disc-like shape at relatively low temperatures but reverts to this fan-like form, with angle of attack 25° - 35° , when its temperature is raised to, say, 50°C to 70°C .

It can be shown that, for shape memory materials, the relationship

$$t_{\max} = \frac{2Z \epsilon_{\max}}{\sin \alpha}$$

where t represents the material's thickness,

Z represents the blade root width

ϵ represents the strain, and

α represents the blade angle

On the basis of the foregoing relationship, and assuming a certain maximum value for the strain factor (typically 3%) curves can be drawn of material thickness plotted against blade angle and it can be shown that different curves are produced by different blade root widths.

For example, a blade angle of 30° corresponds to:

- 5
- (a) a material thickness of approximately 0.70mm for a blade root width of 6mm, or
 - (b) a material thickness of approximately 1.50mm for a blade root width of 12mm, or
 - (c) a material thickness of approximately 2.20mm for a blade root width of 18mm.

What we claim is:

1. A rotary fan having blades constructed of shape memory material and capable of assuming a first angle of attack at temperatures below a threshold value and a second angle of attack, greater than the first, at temperatures above said threshold value.
2. A fan according to Claim 1 wherein the shape memory material comprises shape memory brass.
3. A fan according to Claim 1 wherein the shape memory material comprises an alloy of copper, zinc and aluminum, known as Betalloy N-1040.
4. A fan according to any preceding claim formed with a boss of high thermal conductivity.
5. A fan according to any preceding claim wherein said first angle of attack is substantially zero and said second angle of attack is in the range from 25° to 35° .
6. A fan according to any preceding claim wherein the threshold value of temperature is in the range from 50°C to 70°C .
7. A fan, for cooling an engine or motor, in which the blades have a small angle of attack at ambient temperatures and deform to give a greater angle of attack at temperatures above a threshold value, wherein the blades are formed of a shape memory material.
8. A fan substantially as herein described.

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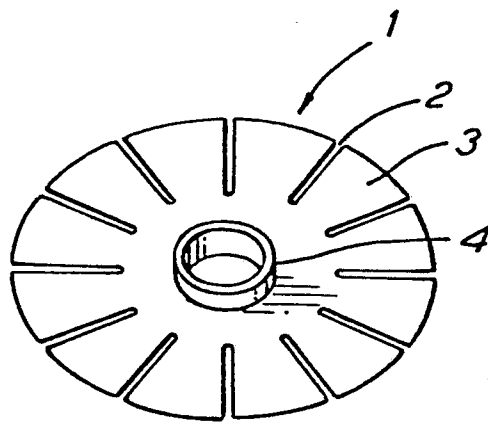


FIG. 1(a)

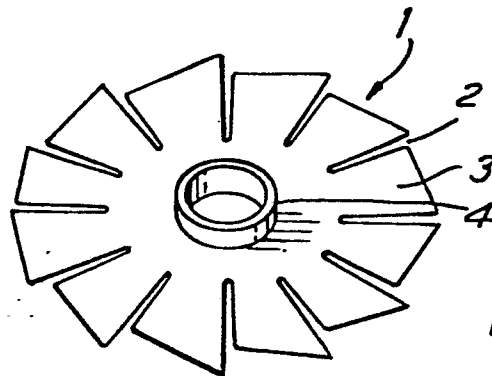


FIG. 1(b)



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	US - A - 3 764 227 (ALBERTZART) * The whole document *	1,5,7,8	F 04 D 29/36
X	FR - A - 2 351 446 (DELTA MATERIALS RESEARCH LIMITED) * Page 1, line 9 - page 2, line 16; page 7, line 33 - page 8, line 15; figure 11 * & GB - A - 1 573 204	1,4,7	
	DE - A - 2 112 261 (WINTER) * The whole document *	1,5-7	TECHNICAL FIELDS SEARCHED (Int. Cl.)
	MACHINE DESIGN, vol. 51, October 1979, nr. 24 Cleveland, US D.T. CURRY: "New uses for metals that remember", pages 113-117 * Pages 114,115 *	2,3,6	F 04 D F 01 D F 01 P C 22 F
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 28-08-1981	Examiner WENZEL