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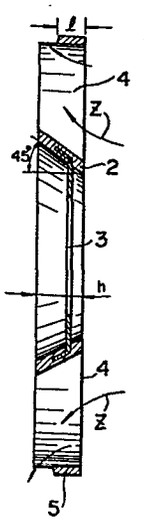
(54) A cooling fan for an automotive vehicle engine cooling unit.

(57) The fan comprises a truncated-cone-shaped boss (2), a plurality of blades (4) and an annular ring (5) rigidly connecting the tips of the blades (4), the axial width (1) of the ring (5) being in the range of from one fourth to three fourths of the axial height (h) of the boss (2).

FIG.9



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DESCRIPTION

The present invention relates generally to a cooling fan of an engine cooling unit used with an automotive vehicle, and more particularly to an annular ring rigidly connecting the tips of the blades of the cooling fan.

The background of the present invention will be explained with respect to its application to the cooling fan of an engine cooling unit used with an automotive vehicle.

Generally, an automotive vehicle engine cooling fan is disposed between a radiator and an engine in order to introduce outside air into the engine compartment to cool the radiator. Further, the cooling fan is usually fitted to the axle of a water pump and driven by a crank shaft.

Two types of prior-art automotive vehicle engine cooling fans exist: an oblique-flow type engine cooling fan and an axial-flow type engine cooling fan. The oblique-flow type cooling fan comprises a conical boss and a plurality of blades, and some of the axial-flow type cooling fan comprise additionally a ring connecting the tips of the blades.

In the oblique-flow type, since the blades are inclined at a large angle to the direction of flow, they can produce quite a large amount of air flow, but a relatively great reaction force due to resistance to air flow is applied to the blades. As a result, in the case where ambient temperature is high, there exists a problem in that the strength and the durability may not be sufficient.

In the axial-flow type with the ring connecting the tips of the blades, on the other hand, the above-mentioned problem can be solved by constraining the blade tips with the ring, which also has the same effect of reducing the tip clearance and can increase the amount of air flow significantly, but still less than that of the oblique-flow type.

The structure of the prior-art cooling fans for an automotive vehicle engine cooling unit will be described in more detail hereinafter with reference to the attached drawings

With these problems in mind, therefore, it is the primary object of the present invention to provide a cooling fan for an automotive vehicle engine cooling unit of sufficient strength and durability, and of increased air flow efficiency.

To achieve the above-mentioned object, the cooling fan for an automotive vehicle engine cooling unit

according to the present invention comprises a truncated-cone-shaped boss portion, a plurality of blades fixed to the boss portion at a predetermined twist angle, and an annular ring rigidly connecting the ends of the blades in such a way that the width of the ring is in the range of from one-fourth to three-fourths of the height of the boss-portion.

The cooling fan according to the present invention ensures sufficient mechanical strength while preventing reduction of the air-flow rate, thereby combining the advantages of the oblique-flow type (large air-flow rate) and the axial-flow type (large mechanical strength).

The features and advantages of the cooling fan of an automotive vehicle engine cooling unit according to the present invention over the prior-art cooling fan will be more clearly appreciated from the following description of the preferred embodiment of the invention taken in conjunction with the accompanying drawings in which like reference numerals designate the same or similar elements or sections throughout the figures thereof and in which;

Fig. 1 is a front view of a prior-art cooling fan of oblique-flow type used for an automotive vehicle engine cooling unit;

Fig. 2 is a side view (showing only one blade) of the prior-art cooling fan of oblique-flow type shown in

Fig. 1;

Fig. 3 is a cross-sectional view taken along the lines III-III of Fig. 1;

Fig. 4 is a front view of a prior-art cooling fan of axial-flow type used for an automotive vehicle engine cooling unit;

Fig. 5 is a side view (showing only one blade) of the prior-art cooling fan of axial-flow type shown in Fig. 5;

Fig. 6 is a cross-sectional view taken along the lines VI-VI of Fig. 4;

Fig. 7 is a front view of the cooling fan for an automotive vehicle engine cooling unit according to the present invention;

Fig. 8 is a side view (showing only one blade) of the cooling fan according to the present invention of Fig. 7;

Fig. 9 is a cross-sectional view taken along the lines IX-IX of Fig. 7; and

Fig. 10 is a graphical representation for assistance in explaining the effect of the cooling fan for an automotive vehicle engine cooling unit according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

To facilitate understanding of the present invention, a brief reference will be made to prior-art cooling fans for an automotive vehicle engine cooling unit,

with reference to the attached drawings.

Automotive vehicle engine cooling fans such as that shown in Figs. 1-3 are well known in the prior art. In Figs. 1-3, the reference numeral 1 denotes a cooling fan which includes a hollow truncated-cone-shaped boss portion 2, a mounting plate 3 fixed to the boss portion 2 so as to project radially inward from the boss portion 2, and four blades 4 fixed at a predetermined angle to the outer surface of the boss portion 2. As depicted in more detail in Fig. 2, each blade 4 is conformed in such a way that the base of the blade is fixed to the boss 2 at an inclination of about 45 degrees with respect to a surface perpendicular to the axis of rotation (referred to as vertical surface hereinafter) and the tip of the blade is inclined at about 65 degrees with respect to the vertical surface.

Therefore, when driven, the cooling fan 1 produces air flow in the direction of arrow X shown in Fig. 3 with the aid of the blades 4 and the boss portion 2. This cooling fan 1 is called an oblique flow type fan.

In such a cooling fan 1, however, since the blades 4 are inclined at a large angle, a relatively great reaction force due to resistance to air flow is applied to the blades 4. As a result, particularly in the case where the ambient temperature is high, there exists a problem in that the blades 4 may not be strong enough, and the blades 4 may have a short working lifetime and the amount

of air flow may decrease.

Therefore, in order to overcome these problems, another type of cooling fan 1 has been previously developed in which the boss portion 2 is cylindrical and the tips of the blades 4 are rigidly connected by an annular ring 5, as depicted in Figs. 4, 5 and 6.

In such a cooling fan, however, although the above-mentioned problem of lack of strength can be solved, there arises another problem in that air flow and thus the cooling effect from this type of fan is substantially less than the other.

In view of the above description, reference is now made to an embodiment of the cooling fan of an automotive vehicle engine cooling unit according to the present invention, with reference to Figs. 7, 8 and 9. In the figures, the reference numeral 1 denotes a cooling fan for an automotive vehicle. The cooling fan according to the present invention comprises a hollow truncated-cone-shaped boss portion 2, a mounting plate 3 fixed to the boss portion 2 so as to project radially inward from the inside surface of the boss portion 2, a plurality of blades 4 (four blades in this embodiment) fixed to the outside surface of the boss portion 2 at a predetermined angle, and an annular ring 5 rigidly connecting the tips of the blades 4 together. The blades 4 are disposed radially symmetrically around the boss portion, and are inclined at an angle of about 45 degrees at the bases thereof and at an

angle of about 65 degrees at the tips thereof with respect to the vertical surface, as depicted in Fig. 8. Furthermore, as depicted in Fig. 9, the surface of the boss portion 2 is inclined at about 45 degrees with respect to the axis of rotation.

The ring 5 is fixed to the upstream side of the tip of each blade 4. In this embodiment, the width ℓ of the ring 5 (the axial dimension thereof) is formed so as to be between one-fourth and three-fourths of the height h of the boss portion 2 (the axial dimension thereof) or the width of the blades 4. That is, the relationship between the ring width ℓ and the boss height h is as follows:

$$1/4\ h \leq \ell \leq 3/4\ h$$

The operation of the cooling fan according to the present invention will now be described.

When the cooling fan 1 is driven clockwise, as shown by the arrow in Fig. 7, by a crank shaft via a belt and pulley, air flows in the direction indicated by the arrow Z in Fig. 9. The air flow is produced due to the inclinations of the boss portion 2 and the blades 4; that is, the cooling fan serves as an oblique-flow type fan. In this case, since the above-mentioned annular ring 5 is fixed to the tips of the blades 4 (on the upstream side with respect to the air flow) and the width ℓ of the ring 5 is smaller than the width of the blades 4 or the height h of the boss portion 2, there exists an unobstructed flow path of predetermined width on the downstream side of the

blades 4. As a result, the ring 5 does not create aerodynamic resistance as the air flows obliquely, that is, in the radial direction to the fan 1. As a result, the air flow rate from the cooling fan in Fig. 7, compares with that from the fan of Fig. 1.

This effect can be clarified by experiments, as depicted by a solid line P in Fig. 10.

In Fig. 10, the abscissa indicates the ratio of ring width $\underline{\ell}$ to boss height $\underline{h}$, and the axis of ordinate indicates the rate of air flow produced just downstream of the fan 1.

The reason the ring width $\underline{\ell}$ is restricted to more than one-fourth of the boss height $\underline{h}$ as expressed by the above expression is to ensure the mechanical strength of the cooling fan (1). Although dependent upon the material of the fan, if the width $\underline{\ell}$ of the ring 5 is at least one-fourth of the boss height $\underline{h}$, it is possible to ensure adequate strength and durability.

As described above, in the cooling fan according to the present invention, since the cooling fan comprises a truncated-cone-shaped boss portion, a plurality of blades fixed to the boss portion at a predetermined inclination, and a ring rigidly connecting the tip of the blades, in such a way that the width of the above-mentioned ring is in the range of from one-fourth to three-fourths of the height of the above-mentioned boss portion, it is possible to ensure adequate mechanical strength, improve durability,

maintain high air flow efficiency, and thus ensure efficient cooling.

It will be understood by those skilled in the art that the foregoing description is in terms of preferred embodiments of the present invention wherein various changes and modifications may be made without departing from the spirit and scope of the invention, as set forth in the appended claims.

C L A I M S

1. A cooling fan for an automotive vehicle engine cooling unit, which comprises:

a) a central boss adapted to rotate about its center of mass,

b) a plurality of blades fixed to said boss at a predetermined angle with respect to a surface perpendicular to the axis of rotation of said boss and

c) a ring connecting the tips of said blades,

c h a r a c t e r i z e d in that the axial width of the ring (5) is smaller than that of said boss (2), said ring (5) being fixed to said blades (4) on the upstream side with respect to the flow of air produced when said boss (2) is rotated.

2. A cooling fan as set forth in claim 1, c h a r a c t e r i z e d in that the axial width of said ring (5) is in the range from one fourth to three fourths of the axial height of said boss (2).

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FIG.1
PRIOR ART

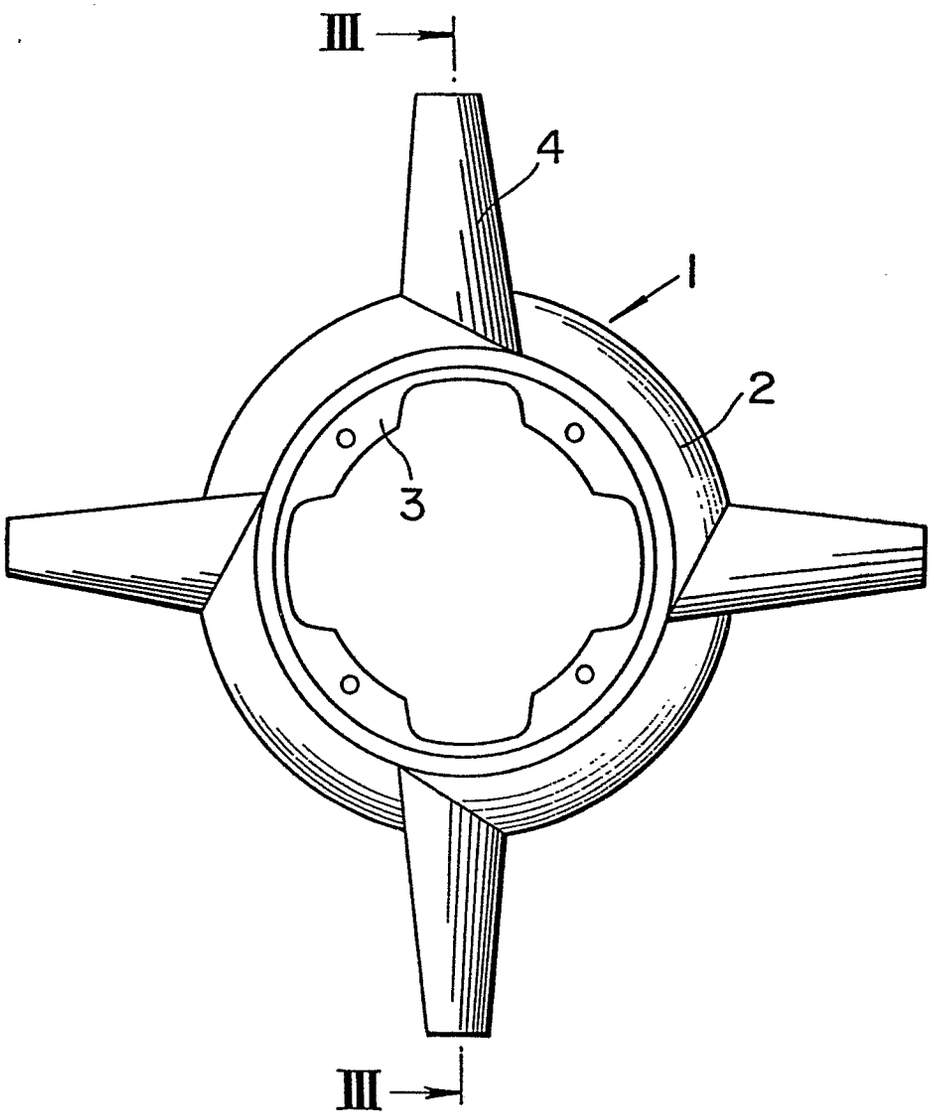

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FIG.2
PRIOR ART

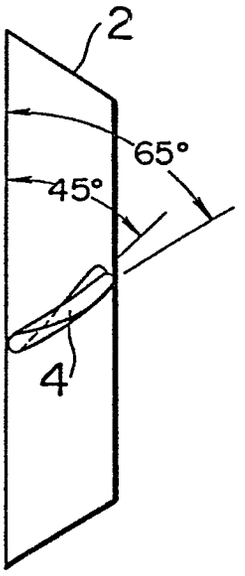

FIG.3
PRIOR ART

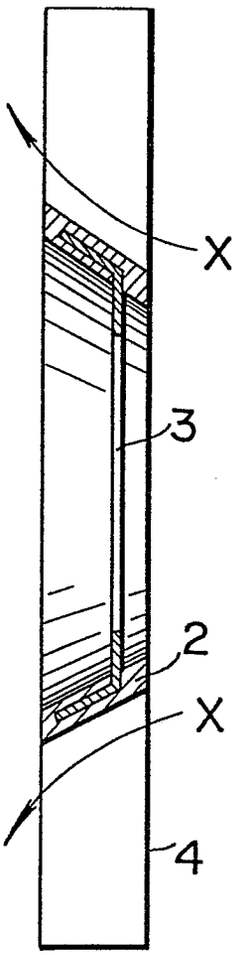

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FIG.4
PRIOR ART

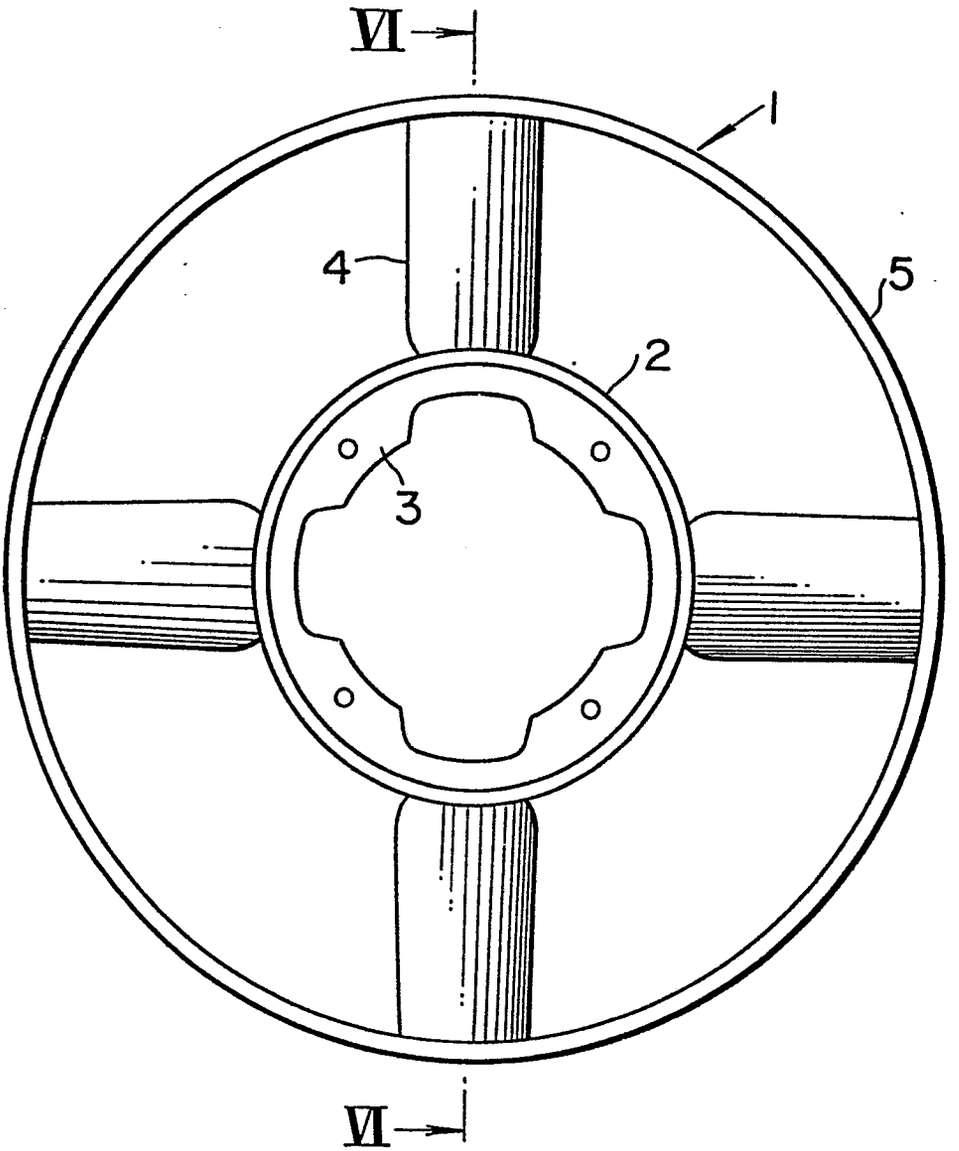

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FIG.6
PRIOR ART

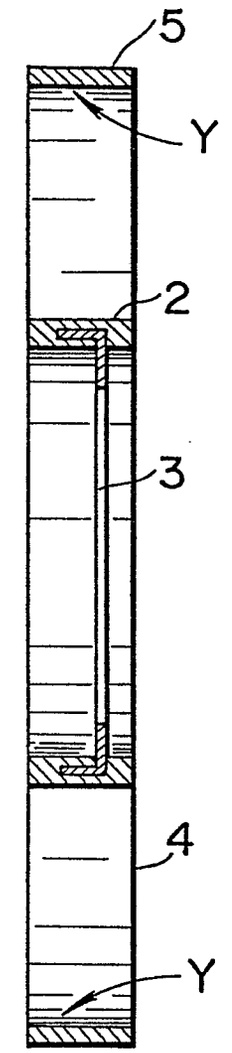

FIG.5
PRIOR ART

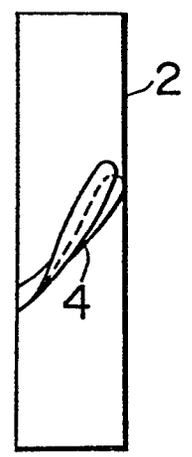

FIG.7

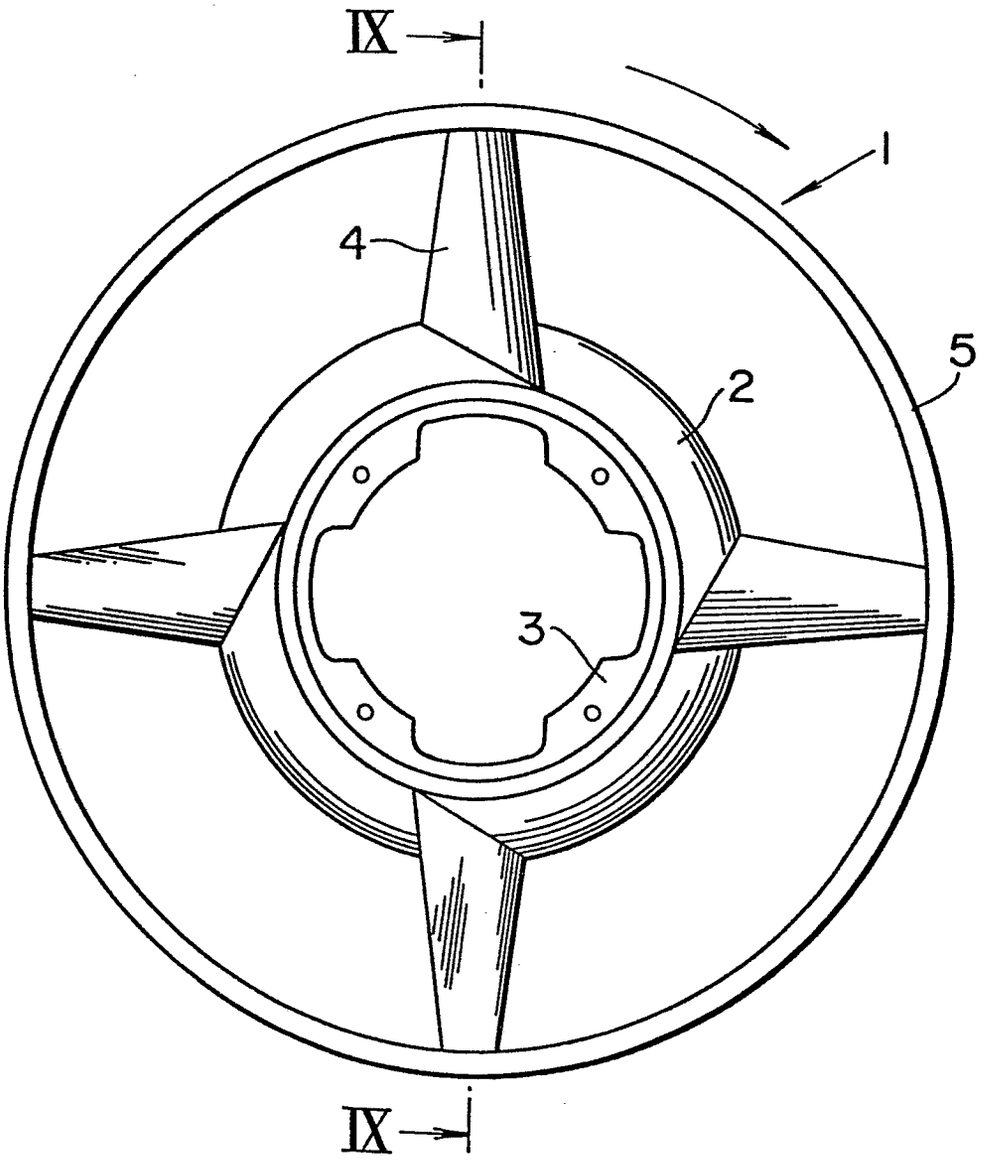

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FIG.8

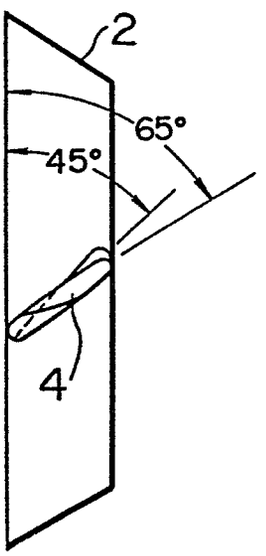

FIG.9

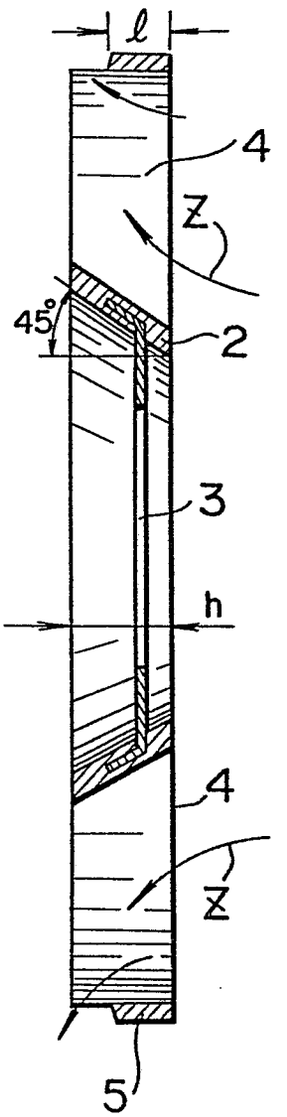

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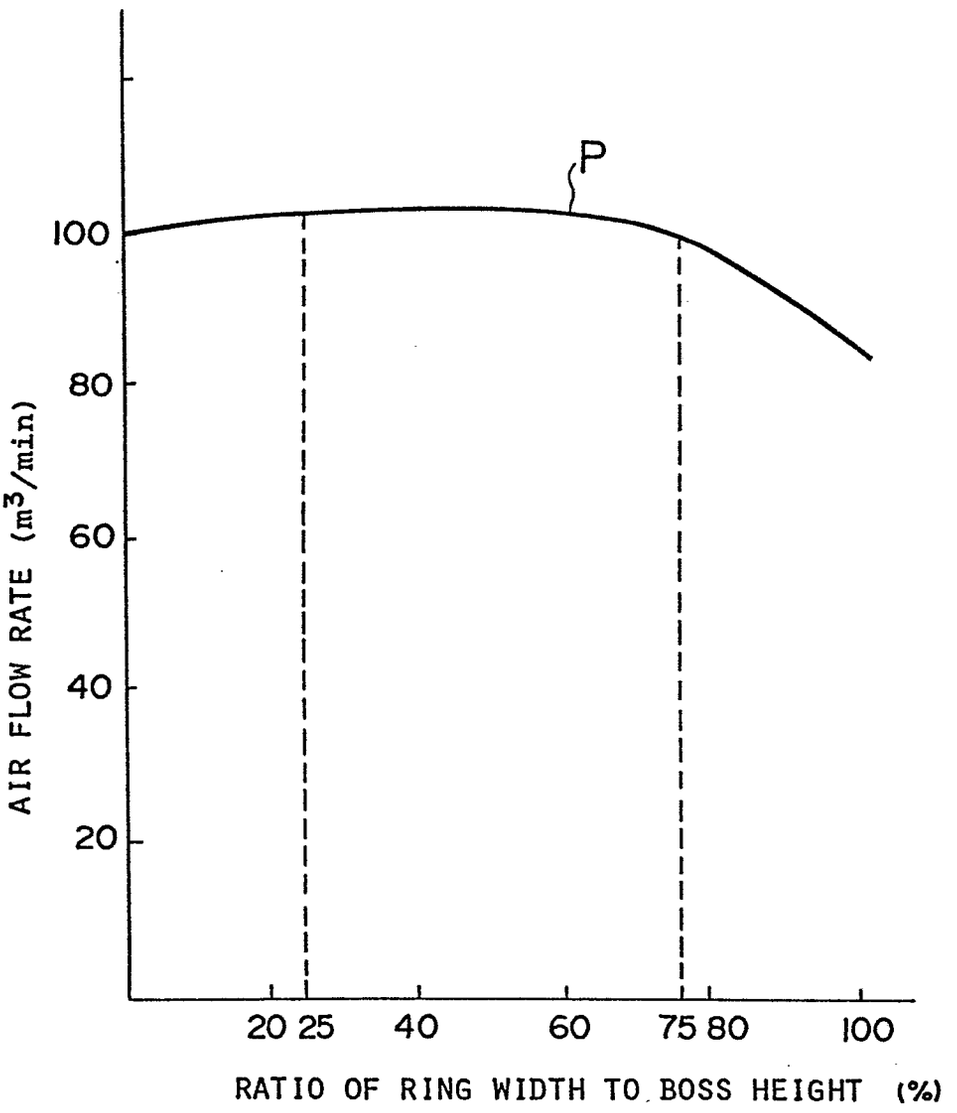
FIG.10



European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 82 10 4254

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	US-A-3 028 072 (ATALLA) * Whole document *	1,2	F 04 D 29/32
X	US-A-2 779 424 (LYON) * Whole document *	1	
X	GB-A-1 586 763 (NU-AIRE) * Figures 1,2 *	1	
P,X	EP-A-0 044 243 (CANADIAN FRAM) * Page 2, lines 10-24; page 4, lines 20-31; figures 1,2 *	1	
A	GB-A-2 014 658 (PAPST-MOTOREN KG) * Page 1, line 52 - page 2, line 60; page 4, lines 22-38; figure 8 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) F 04 D F 01 P
A	FR-A-2 445 457 (NISSAN MOTOR COMPANY) * Pages 1-4; figure 4 * & GB - A - 2 041 103	1	
A	DE-A-2 756 880 (TOYOTA) * Pages 42-44; claims 1-3; figures 8,12 * & US - A - 4 189 281	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-08-1982	WENZEL A.R.

CATEGORY OF CITED DOCUMENTS

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