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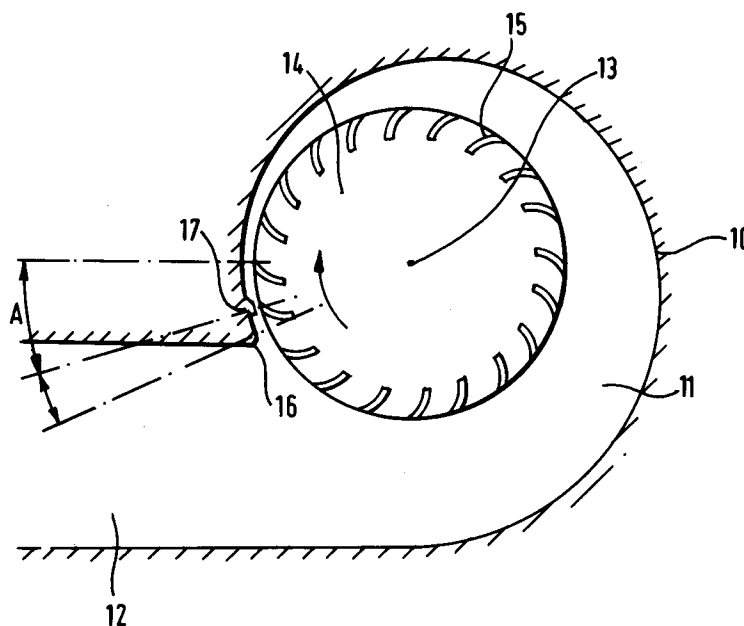
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(54) **Noise suppression.**

(57) A fan (14) is rotatably mounted in a housing (10) and has a plurality of blades (15). Fan (14) and housing (10) are arranged to co-operate, for example by providing two spaced apart formations (16) and

(17), such that rotation of the fan (14) generates two sound waves which tends to cancel out. The fan is particularly suitable for use with a tumble dryer.

**Fig.1.****EP 0 466 983 A1**

This invention relates to noise suppression. The invention has been specifically developed to suppress noise in the fans of tumble dryers, but the principle of the invention is of wider application.

Tumble dryers are of course generally operated in the home, and it is highly undesirable for the machines to be noisy.

The rotating drum of a tumble dryer runs at low speed and can be mounted in bearings which reduce noise and furthermore the drum operates within an outer casing which provides sound insulation.

However, it is well-known that problems arise from noise generated by the fan which draws moist air out of the drum and delivers it to the machine outlet. Since the fan must have blades and the fan must rotate at high speed, the passage of successive blades across the outlet produces a beat having a precise frequency and this can produce an irritating whine.

One known solution to the problem consists of providing a resonance chamber between the fan and the outlet of the machine. If the dimensions of the chamber are correctly chosen, the chamber produces a sound wave which is 180° out of phase with the fan noise and this suppresses the noise.

The use of a resonance chamber has two additional problems associated with it. Firstly, the resonance chamber takes up a significant amount of space, and secondly, any chamber of given dimensions will only operate successfully with the fan moving at a particular speed.

We have now developed an alternative solution to the problem which takes up much less space than when using a resonance chamber and which is independent of fan speed.

According to the invention, a fan rotatably mounted in a housing and having a plurality of blades is characterised in that the fan and housing are arranged to co-operate such that rotation of the fan generates two sound waves which are out of phase and hence tend to cancel out.

Preferably the housing has two formations which are spaced apart, passage of the fan blades past the two formations causing the generation of the two sound waves.

One formation conveniently comprises an edge of an outlet of the housing.

The other formation preferably comprises a rib or other projection.

The formations are preferably spaced apart by a distance which is equal to $P \times n + \frac{1}{2}P$, where P is the pitch of the fan blades and n is a whole number.

It is however preferred that the formations are spaced apart by a distance which is equal to half the pitch of the fan blades or $1\frac{1}{2}$ times the pitch of the fan blades, i.e. n is equal to zero or one.

The invention includes a rotary machine fitted with a fan according to the invention.

The invention particularly includes a tumble dryer fitted with a fan according to the invention.

By way of example, a specific embodiment of the invention will now be described, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic cross section through an embodiment of fan according to the invention;

Figure 2 is a front elevation of an embodiment of tumble dryer fitted with a fan according to the invention; and

Figure 3 is a partly sectioned side view of the tumble dryer of Figure 1.

The fan shown in Figure 1 has been specifically developed for use with a gas heated tumble dryer. Because of the larger heat input possible in a gas heated dryer, a greater air-flow is required than with an electrically heated dryer and so it is necessary to use a two pole motor rather than a four pole motor.

The higher speed and larger air-flow produced with the 2-pole motor makes the high frequency noise suppression more difficult to achieve by means of a resonance chamber. To overcome this problem we devised the alternative solution shown in Figure 1 which is much neater, takes up virtually no additional space, and is independent of fan speed. The solution can be used with four pole motors as well as with two pole motors.

The majority of what is shown in Figure 1 is conventional. There is a fan housing 10 which defines a volute 11 having an outlet 12. Mounted for rotation within the housing 10, about an axis 13, is the fan 14. The fan has a plurality of blades 15 spaced apart around its periphery.

Each time one of the blades 15 passes the edge 16 of the outlet 12, a beat is produced. This succession of beats combine together to produce a sound wave which is irritating to the ear.

We solved this problem by providing a second formation in the form of a projection 17. The projection has a face directed towards the blades which extends substantially radially with respect to the fan. This is supported by a ramp-like or wedge-like rear face.

It will be seen that the angular distance B between the formations is equal to half the angular pitch of the blades. The movement of the blades past the second formation 17 produces a second sound wave which is out of phase by half a pitch and hence the two sound waves tend to cancel out.

Other arrangements are possible, and the angular pitch B could, for example be $1\frac{1}{2}$ times the angular pitch A .

If the speed of the fan increases or decreases, the solution is still effective because the two sound

waves change in frequency by the same amount, but remain exactly half a pitch out of phase.

Figures 2 and 3 show a tumble dryer according to the invention, fitted with a fan of the kind shown in Figure 1.

The tumble dryer has a generally rectangular outer casing 18 containing a rotatable drum 19, access to which is gained through a circular front door 20. The drum is rotatable about a bearing 21 by means of a motor 22. The motor 22 also drives the fan 14 by means of a shaft 23.

The fan draws air in from outside the dryer through an inlet 24 and expels the air through an outlet 25. There is a heater 26 at the rear of the drum 19 and so heated air is drawn into the drum 19, through the wet clothes in the drum, and then into the fan housing 10 through a filter 27.

In this embodiment the fan has an outside diameter of 150 mm, the smallest radius of the volute 11 is 82 mm and the height of the projection 17 is 3 mm. There are twenty blades. Other dimensions and configurations are of course possible.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A fan rotatably mounted in a housing and having a plurality of blades, characterised in that the fan 14 and the housing 10 are arranged to co-operate such that rotation of the

fan generates two sound waves which are out of phase and hence tend to cancel out.

2. A fan as claimed in Claim 1, in which the housing 10 has two formations 16 and 17 which are spaced apart, passage of the fan blades 15 past the two formations causing the generation of the two sound waves.

3. A fan as claimed in Claim 2, in which one formation 16 comprises an edge of an outlet 12 of the housing.

4. A fan as claimed in Claim 2 or Claim 3, in which one formation comprises a rib or other projection 17.

5. A fan as claimed in any one of Claims 2 to 4, in which the formations are spaced apart by a distance which is equal to $P \times n + \frac{1}{2}P$, where P is the pitch between the blades and n is a whole number.

6. A fan as claimed in Claim 5, in which the formations are spaced apart by a distance which is equal to half the pitch of the blades.

7. A fan as claimed in Claim 5 in which the formations are spaced apart by a distance which is equal to $1\frac{1}{2}$ times the pitch of the blades.

8. A rotary machine fitted with a fan as claimed in any one of the preceding claims.

9. A rotary machine as claimed in Claim 7, in which the rotary machine is a tumble dryer.

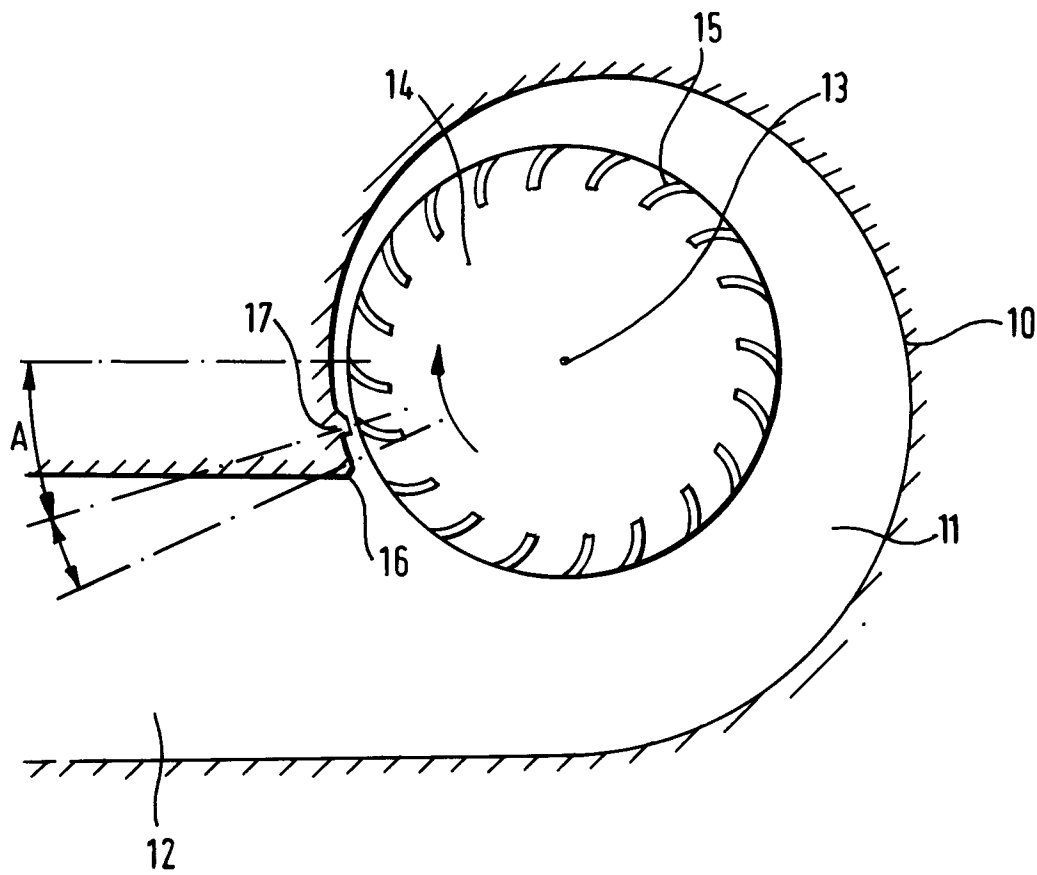
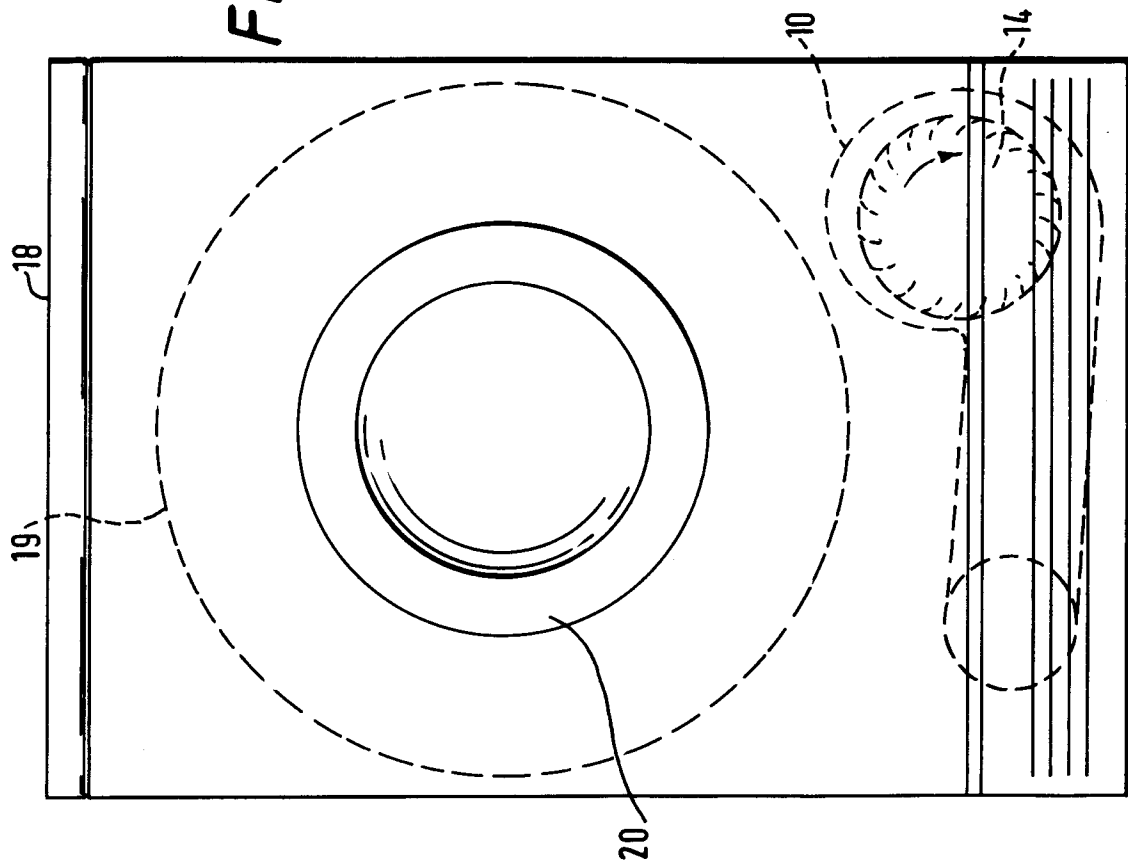
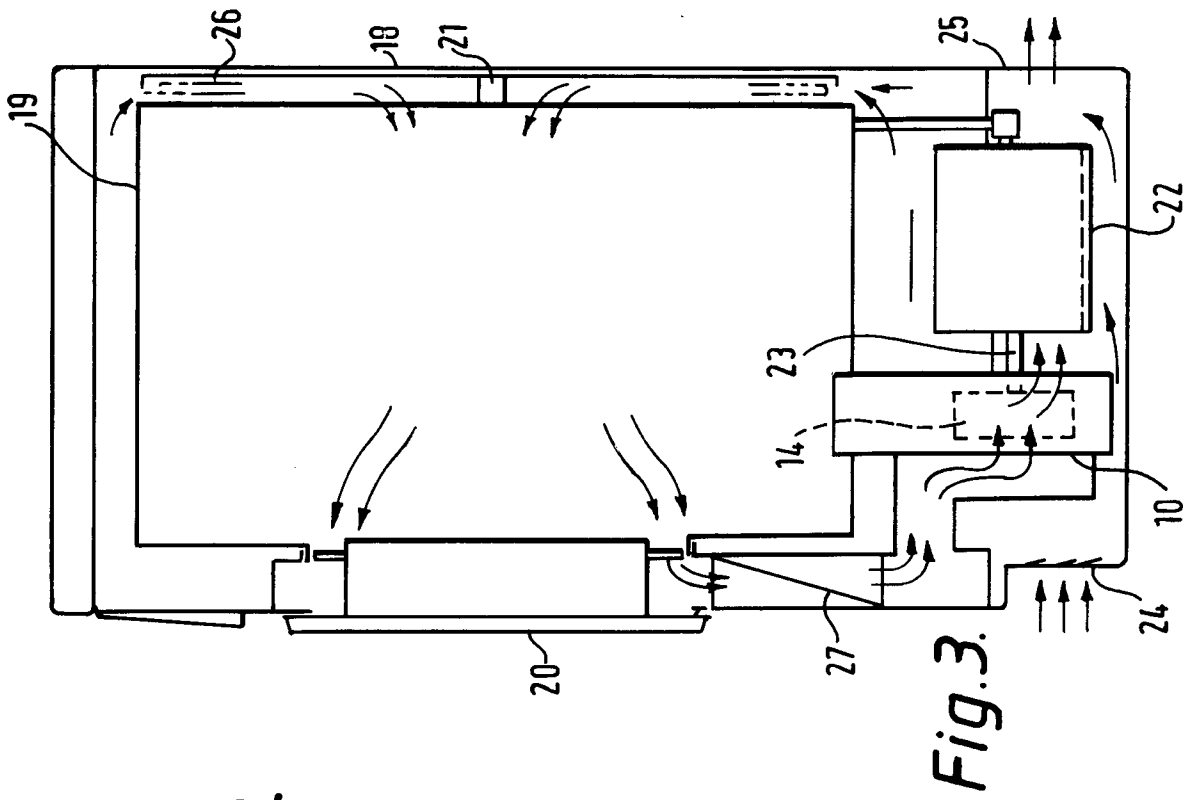


Fig.1.





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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 7734

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.5)
X,A	FR-A-2 266 016 (INTERNATIONAL STANDARD ELECTRIC CORPORATION) * page 1, lines 1 - 5 ** page 6, line 36 - page 5, line 3; figures 5a, 5d, 5e * - - -	1-4,6	F 04 D 29/66 F 04 D 29/42
Y,A	EP-A-0 175 229 (HEIDOLPH-ELEKTRO) * page 1, lines 23 - 25 ** page 5, lines 19 - 30; claims 1, 2; figures 1, 3 * - - -	1-4,7	
Y	EP-A-0 039 459 (DEUTSCHE FORSCHUNGS-UND VERSUCHSANSTALT FÜR LUFT-UND RAUMFAHRT) * page 12, line 20 - page 13, line 14; figure 1 * - - -	1-4	
A	DE-A-1 428 130 (ERNST HEINKEL) * page 3, lines 25 - 29; figure 3 * - - -	1-4	
A	PATENT ABSTRACTS OF JAPAN vol. 11, no. 336 (M-638)(2783) 04 November 1987, & JP-A-62 118095 (MATSUSHITA ELECTRIC) 29 May 1987, * the whole document * - - -	1-4	
A	PATENT ABSTRACTS OF JAPAN vol. 11, no. 120 (M-580)(2567) 15 April 1987, & JP-A-61 261699 (NIPPON) 19 November 1986, * the whole document * - - -	1-4,6	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
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A	US-A-3 963 370 (YATES) * column 1, lines 5 - 9 ** column 2, line 21 - column 3, line 41; figures 1, 2 * - - - - -	8,9	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of search 11 December 90	Examiner TEERLING J.H.
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention		E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons ----- &: member of the same patent family, corresponding document	