COMBINED CASING AND NOISE MUFFLER FOR A VORTEX FAN

Filed Feb. 1, 1966 2 Sheets-Sheet 1

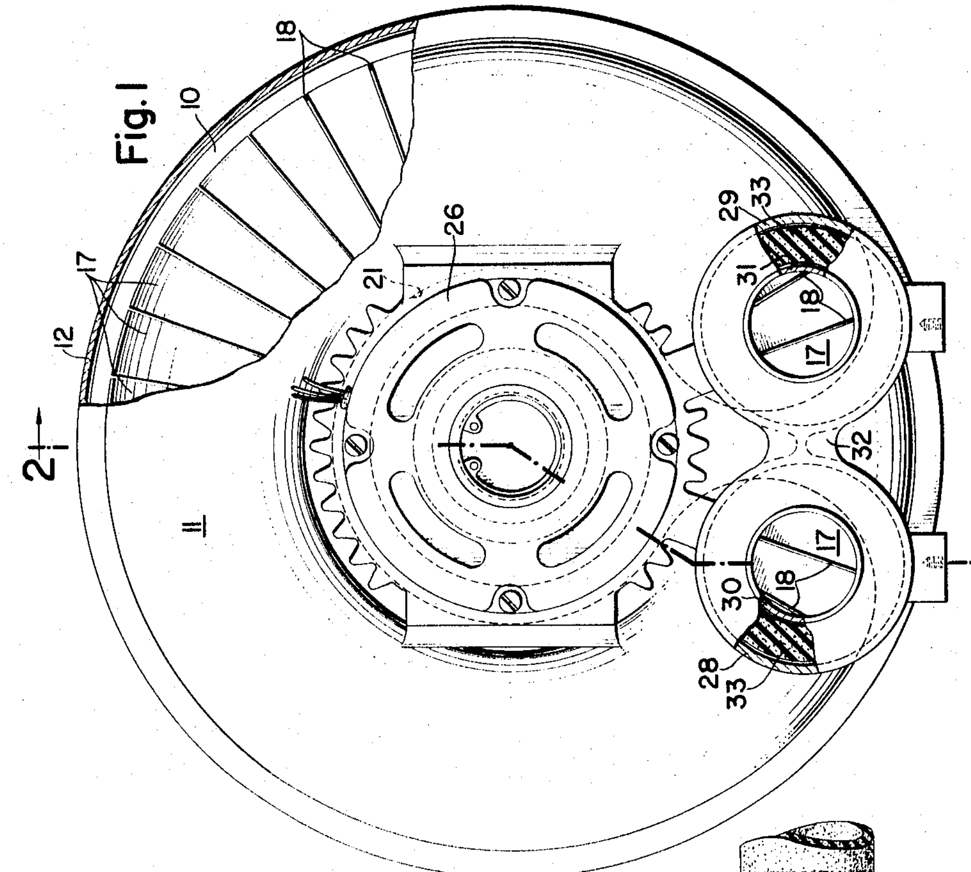

Fig. 1

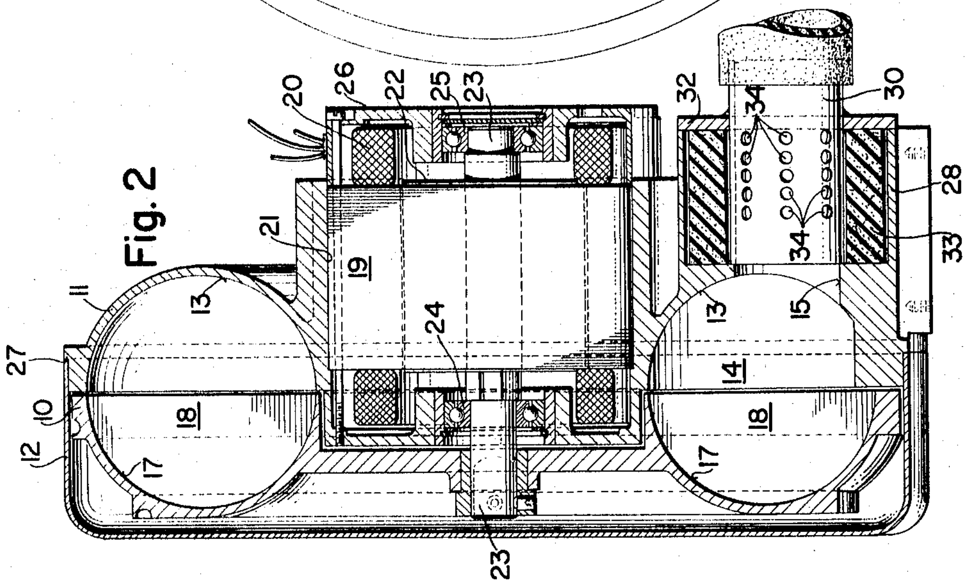

Fig. 2

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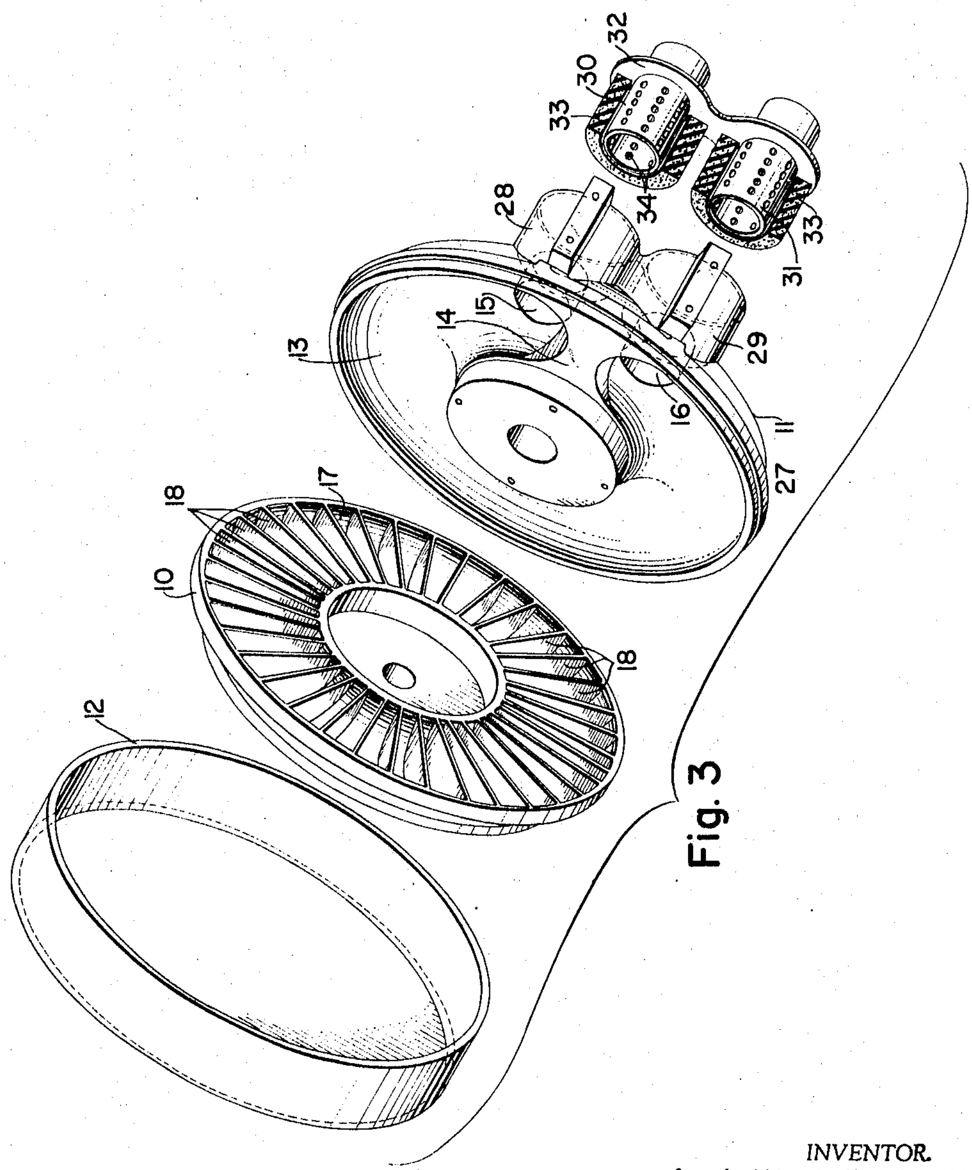

Fig. 3

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3,355,095
Patented Nov. 28, 1967

3,355,095

COMBINED CASING AND NOISE MUFFLER FOR A VORTEX FAN

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Filed Feb. 1, 1966, Ser. No. 524,132
1 Claim. (Cl. 230—125)

ABSTRACT OF THE DISCLOSURE

A vortex fan has a single unitary casing in which are provided an open side channel, a housing for a driving electric motor and enlarged cavities communicating respectively with inlet and outlet openings in the side channel. Straight self-supporting ducts carried within the cavities and connected for fluid flow to the inlet and outlet openings form with the cavities acoustically resonant chambers. The ducts have a series of distributed wall perforations providing acoustical coupling between the interior of the ducts and the respective separate chambers. The ducts are flanged to provide a closure for the respective chambers and have an imperforate portion extending exteriorly beyond the flanged portion to provide means for direct connection to external fluid flow systems. Preferably each chamber is filled with a preformed body of material having frequency-selective sound energy dissipative characteristics.

This invention relates to a vortex fan and more particularly to a casing for such a fan which combines in one structure means providing a side channel, inlet and outlet ducts, and a muffler for reducing the noise level without compromising the fan performance.

Vortex pumps for handling liquids are well known in the art and have been used successfully for obtaining high cut-off pressures with relatively low peripheral speeds of the impeller. These pumps are characterized by having an open side channel which cooperates with a multi-bladed impeller to produce a helical-toroidal path for fluid flow through the pump. When this type of pump is used for handling air or gases, a serious noise problem arises which is not present when liquids are being used. Previous attempts to correct the noise problem have resulted in severely degrading the performance as a fan to the point where such performance is no longer attractive unless the noise can be tolerated. As a result, the vortex fan has not found general favor as a practical means for obtaining high pressures in air or gas flow systems.

It is, therefore, an object of this invention to provide simple and effective means for reducing the noise level of a vortex fan without adversely affecting the fan performance and without adding substantially to the size and weight of the fan or to the complexity of its assembly.

In one aspect thereof, this invention provides a unitary casing containing an open side channel for the impeller, inlet and outlet ducts for said channel and tuned resonant chambers having dissipative characteristics and formed as part of the casing and surrounding and acoustically coupled to said ducts for reducing the noise in a frequency band related to the number of impeller blades and the angular velocity of the impeller.

The features of the invention which are believed to be novel are set forth with particularity in the appended claim. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings.

In the drawings:

FIG. 1 is an end elevational view of a vortex fan embodying the invention with parts of the casing cut away to show the impeller and also the muffler construction.

FIG. 2 is a longitudinal sectional view of the device of FIG. 1 taken substantially on the line 2—2 of FIG. 1.

FIG. 3 is a disassembled perspective view of the device of FIG. 1.

Referring now to the drawings, there is shown a vortex fan comprising essentially a rotary impeller **10**, a stationary casing **11** and a cover **12**.

The casing **11** is formed with a semi-toroidal cavity **13** which forms the side channel for the fan. A radial dividing wall **14** in the cavity **13** interrupts the peripheral continuity of the semi-toroidal channel and apertures **15** and **16** formed in the casing and located adjacent to and on opposite sides of the dividing wall **14** provide inlet and outlet openings for fluid flow in the channel.

The rotary impeller **10** is also formed with a semi-toroidal cavity **17** substantially identical with the cavity **13** in the casing **11** except that a series of radially extending peripherally-spaced blades **18** are contained in cavity **17** and form a series of cells facing and opening into the casing cavity **13** when the parts are in assembled position as in FIG. 2.

It will be seen that the impeller **10** forms with the cavity **13** a helical-toroidal path for fluid flow with the pitch of the helix being determined by the peripheral spacing of the blades **18**.

An electric motor stator core **19** with winding **20** is pressed into a bore **21** formed in the casing **11**. A rotor core **22** is secured to a shaft **23** journaled at one end in bearing **24** supported in the casing **11**, and at the other end in bearing **25** supported in a removable end cover **26**.

The impeller **10** is secured to shaft **23** for rotation therewith and has a close running fit with all adjacent surfaces of the casing **11** to minimize air leakage. The cover **12** is fitted to the casing **11** on a rabbeted shoulder **27** and the joint is sealed to form a sealed enclosure for the impeller **10**.

The structure involving the impeller blades **18** recurrently sweeping past the air stream entering and exiting through the apertures **15** and **16** produces a siren effect which generates a disagreeable whining noise in the audible frequency range. The maximum noise level centers about a frequency related to the number of blades and the angular velocity of the impeller and shows up on the noise spectrum as a rather distinct peak. Efforts to reduce the peak noise level by the use of a conventional plenum chamber lined with sound absorbing material were unsuccessful because the loss in pressure head due to redirected flow in the plenum chamber could not be tolerated. That is to say, this method of noise reduction resulted in a fan having a poor pressure-flow characteristic.

However, in accordance with the present invention, structure was discovered which reduced the noise level to a satisfactory value and at the same time had little or no adverse effect on the pressure-flow performance of the vortex fan and this structure will now be described in detail.

The casing **11** is formed on the side opposite to the cavity **13** with two separate extended cylindrical chambers **28** and **29** which communicate with the respective apertures **15** and **16** as shown. These chambers are of larger internal diameter than the associated apertures and have their axial directions preferably parallel with the motor shaft axis. Ducts **30** and **31** having internal diameters that match those of the apertures **15** and **16** are inserted axially within said chambers and in aligned connection with said apertures to form straight fluid-guiding inlet and outlet means. A flange **32** secured to the ducts **30** and 31 forms a cover for the chambers 28 and 29. Securement of the flange 32 to the ducts and to the chambers may be readily effected by the use of well-known epoxy cements. Although a single flange is shown in the illustrative embodiment, separate flanges for each duct may be used if desired and it is possible to form the flange integrally with the chamber wall.

The annular spaces formed between the ducts 30 and 31 and the walls of the chambers 28 and 29 are substantially filled with low-density sound absorbing material preferably in the form of a preformed annular body 33 of deformable foam plastic material.

The ducts 30 and 31 in the portions within the chambers have a peripherally and longitudinally distributed series of perforations 34 made in the walls thereof which form acoustic coupling means between the annular chambers 28 and 29 and the respective duct interiors. Imperforate portions of the ducts extend exteriorly of the chambers to provide means for direct connection to external fluid-flow systems. as shown.

The foam plastic material 33, while apparently filling the annular space between the ducts and the chamber walls, is composed of interconnected air cells which occupy about 97% of the total preformed volume so that each of the annular chambers functions as an acoustically resonant chamber having dissipative characteristics for selectively absorbing sound in a predetermined frequency band. This effective volume of the annular chamber is chosen in relation to the effective total aperture formed by the wall perforations 34 to provide a resonant chamber for trapping and attenuating sound waves in the frequency band where the maximum noise peak associated with the impeller blade frequency normally would occur as explained above. Thus, the objectionable air-bourne whining noise inherent in the normal vortex fan structure when used for gas flow is effectively trapped out and absorbed by the structure of this invention at a point close to its origin and so cannot be transmitted to the external fluid flow system. Of extreme importance is the fact that the noise-eliminating structure of this invention does not impose any material restrictions on the air flow and so does not adversely effect the fan performance. Air flow through the perforated ducts 30 and 31 is hardly distinguishable aerodynamically from flow through similar ducts without the perforations. Furthermore, the structure is simple, has few parts, is easily assembled and can with facility and advantage be formed integrally as part of the existing casing structure.

The chambers form a low impedance path for sound waves of a desirably selected frequency band to which they are tuned. The material in the chambers is selected to be especially dissipative of sound energy in this frequency region so that undesirable sound waves are selectively trapped and dissipated in the chambers and do not enter the air stream either at the inlet or the outlet openings. Thus, the whining sound is severely attenuated and cannot be transmitted out of the fan casing with any intensity and so is no longer a human disturbing factor in the operation of the fan.

A suitable material for the preformed element 33 is polyurethane foam obtainable commercially from the Scott Paper Company and known in the trade as Scott Industrial Foam and Scottfelt. The advantages of the preformed elements as compared with loose filling material for item 33, in addition to convenience and ease of manufacture, includes the ability to closely control the amount of material and its porosity and allows bonding the element 33 to the chamber or tube walls if desired to dampen vibration thereof.

The simplicity of the structure facilitates its assembly and the fact that there are few parameters subject to assembly variation because of the integral-casting feature, promotes uniformity of performance.

While the invention has been explained by describing a particular embodiment thereof, it will be apparent that improvements and modifications may be made without departing from the scope of the invention as defined in the appended claim.

Having thus set forth the nature of this invention, what I claim herein is:

A casing for a vortex fan comprising a unitary casting, a semi-toroidal channel formed in one face thereof, a cylindrical motor-supporting housing formed in the opposite face thereof, a radial dividing wall in said channel, apertures formed in said casing in the region close to and on opposite sides of said dividing wall, said apertures communicating with said channel to provide openings for fluid flow into and out of said channel, separate straight self-supporting fluid guiding ducts connected to said openings and extending normally away from said casing on the same side thereof as the motor-supporting housing, cavity means formed integrally with said casing and surrounding each of said ducts, flange means carried by each duct and forming with said duct and cavity means a single closed resonant chamber for each duct, said ducts having a series of distributed wall perforations providing acoustial coupling between the interior of each duct and the respective chamber, and a preformed annular body of material having a frequency-selective sound energy dissipative characteristic substantially filling each of said chambers, said ducts each having an imperforate portion extending exteriorly of its respective chamber beyond said flange means to provide means for direct connection to external fluid flow systems.

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