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(54) **Suction cleaner.**

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DE-A- 2 124 761
DE-A- 2 910 832
US-A- 4 021 879
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Description

The present invention relates to suction cleaners, and particularly though not exclusively to a "clean air" cleaner having means for measuring the pressure and/or air flow within the cleaner and means for indicating to the user when the hose (or nozzle) is blocked. A "dust bag full" indication may also be provided, and/or an indication of how full the bag is.

A "clean air" cleaner is a cleaner in which the fan is positioned after the dust bag, in the direction of air flow, so that dust entrained in the incoming air is trapped within the bag and does not pass through the fan. Typically, a secondary filter, positioned between the bag and the fan, is provided to catch particles of dust which are too small to be caught by the bag. In addition, there is generally an exhaust microfilter, positioned after the fan, whose purpose is to prevent extremely small particles (for example pollen) from being expelled in the cleaner exhaust.

It is known, for example from United States Patent 4294595, to provide a "clean air" cleaner having a first pressure switch adjacent the nozzle intake, and a second pressure switch adjacent the inlet to the fan (in the "clean air" part of the flow path). Measurement of the differential pressure between the two switches is used to give an indication of a blockage between these two points, for example due to clogging of the secondary filter, due to the dust bag filling up, or due to a blockage at the inlet to the cleaner. If any of these conditions are met, a cut-out operates, preventing operation of the cleaner motor.

One difficulty with this arrangement is that, when the motor cuts out, the user is not given any indication as to the reason. In particular, he does not know whether the dust bag needs to be emptied, or the inlet to the cleaner needs to be unblocked.

Many modern suction cleaners have the capability of being operated at a number of different power levels, so that the user can select an optimal suction level for the particular job in hand. A difficulty with the cut out arrangement described above, when incorporated into a cleaner of this type, is that the point at which the cut out will operate for a given blockage depends critically on the power level that is being used. Thus, the point at which the cleaner cuts out is likely to appear rather arbitrary to the user.

A further difficulty has become evident in cleaners which make use of an exhaust microfilter. When the exhaust microfilter becomes clogged, static pressure in the cleaner increases, and airflow through the cleaner decreases. This tends to result in clogging at the inlet being detected at flow values and/or pressures which are different from when the microfilter is clean. Also, inaccurate bag full detection results, and the danger of motor overheating increases.

It is the first object of the present invention at least to alleviate the problems of the prior art.

It is another object to provide a suction cleaner (for example a "clean air" cleaner) with means for detecting a blockage within the cleaner by the measurement of air flow and/or pressure with allowance being made for the fact that the measured values of air flow and/or pressure will depend upon the power level at which the cleaner is operating.

It is a further object to provide a convenient, reliable and accurate means of determining the air flow and/or pressure within the "clean air" part of the flow path.

It is a further object to determine blockages and/or bag full conditions with improved consistency regardless of the back-pressure resulting from a partially blocked exhaust microfilter.

In US-A-4021879, the chamber of a vacuum cleaner where the electric motor is housed includes a detector tube downstream of the motor fan. The detector tube is used in providing motor speed feedback. A signal lamp lights and the motor stops when the filter bag is clogged.

In DE-A-2124761 a vacuum cleaner includes a flapper plate which acts against a spring for actuating an indicator in dependence upon detected pressure.

According to the present invention there is provided a suction cleaner with the features of Claim 1.

Conveniently, the detecting means may comprise a pressure sensor connected to a tube which opens at a pressure tap aperture on the upstream side of the diffuser. The pressure sensor can be a multi-contact pressure switch.

The fan diffuser typically consists of an annular surface, which may be in the form of a truncated cone, outstanding from which are the plurality of angled, preferably curved vanes which convert the generally circular airflow, as it leaves the fan, into the substantially radial airflow. The pressure tap aperture may be in this surface, preferably between two adjacent vanes, the inward ends of which are joined to form a cul-de-sac. It has been found, by experimentation, that with such an arrangement the pressure, measured at the aperture, depends both upon the static pressure and the velocity pressure; accordingly, the output of the pressure detector gives an indication of the airflow through the cleaner.

It is believed that, previously, air-flow detection arrangements of this kind have not been favoured, primarily because it has proved difficult to obtain sufficient pressure differences between the various motor power settings. Positioning the opening, as in the present invention, at the upstream side of the diffuser means that maximum pressure differences are obtained, since flow velocities are high.

Automatic allowance for the increased back pressure due to clogging of the exhaust filter (where one is provided) may be compensated for by measuring not the absolute pressure at the upstream side of the diffuser, but rather the differential pressure between there and a point inside the body of the cleaner upstream of the exhaust filter. Thus, variations of static pressure within the cleaner will not distort the flow reading.

In a preferred embodiment, the suction cleaner is of variable power and as preferable features includes means for selecting a motor power level, means for producing a signal representative of the detected pressure or air flow, control means arranged to compare the said signal with a stored value representative of a limit value and dependent upon the selected power level, and arranged either to activate an indicating means if the detected value exceeds the limit value or if the detected value is less than the limit value.

Conveniently, the means for selecting the motor power level may be switchable between selected discrete power levels, and in this case the stored values may also be discrete, for example in the form of a table stored within a microprocessor. The means for detecting pressure of air flow may then comprise a multi-contact pressure switch, with the closing of the various contacts being assigned to specific stored values within the microprocessor dependent upon the motor power level.

In one embodiment the said signal is a digital representation (produced via an a/d converter) of the detected pressure or air flow value.

Additional discrimination between various conditions can be obtained by the use of two separate detecting means, with one arranged to detect the pressure at an input of the cleaner, for example adjacent the entrance to a dust bag, in addition to the one at the diffuser. The use of two separate detectors enables one to distinguish between "bag full" and "hose blocked" conditions. For optimal discrimination, the stored values for the respective detecting means may be dependent, in each case, upon the selected power level; alternatively, only one of the stored limit values may be so dependent, and the other simply fixed.

The indicating means is conveniently a digital LED display, although it would also be possible to use simply lights and/or an audible warning. Alternatively, a synthesised voice message could be used. In addition to the "hose blocked" and "bag full" indications, the indicating means may also be arranged to provide an indication of approximately how full the bag is and/or how blocked the filter is. Means may also be provided to cut power to the motor in the event that a "bag full" or "hose blocked" condition is determined.

Making use of a microprocessor as the control means, means that a number of additional features can be added. In one embodiment, the cleaner has an automatic mode, in which the power level is automatically adjusted to hold the suction level substantially constant regardless of the nature of the surface being cleaned. This may be done in dependence upon the pressure (or suction) measured by a pressure switch at the input side of the cleaner, for example adjacent the nozzle or the opening to the bag. If desired, the microprocessor may include timing means arranged to delay actuation of the indicating means for a fixed period after a "hose blocked" condition has been determined. In this way, a distinction can be made between the nozzle simply sticking on a smooth floor (the response to which, in the automatic mode, is for the power level to be reduced), and a truly blocked nozzle (for which the response is to actuate the indicating means and, possibly, to switch off the motor entirely).

Alternatively, means could be provided for inhibiting the indicating means when the automatic mode is selected, or for automatically and periodically inhibiting the automatic mode so that "bag full" and "hose blocked" conditions can be spotted.

Instead of storing a plurality of values for determining the fullness of the bag, in dependence upon the various power levels, the cleaner can be arranged to determine the bag fullness at only a single, predetermined, power level. In such a case, a "bag check" button is provided, the actuation of which causes the cleaner to operate at a predetermined power level. The measure of bag fullness can then be determined from the rate of air flow through the cleaner (eg at the diffuser), with the appropriate value being displayed on the indicating means. When the button is released, the cleaner may revert to normal operation.

The cleaner of the present invention is preferably a "clean air" cleaner, in which the air being sucked in is passed through the dust bag and a secondary filter before it reaches the fan.

The invention may be carried into practice in a number of ways and one specific suction cleaner will now be described, by way of example, with reference to the drawings, in which:

Figure 1 is a diagrammatic section through a "clean air" cleaner embodying the invention;

Figure 2 is an end elevation of a fan diffuser for use in the cleaner of Figure 1;

Figure 3 is a graph showing, schematically, how the pressure at the diffuser pressure tap varies with air flow; and

Figure 4 is a schematic graph, similar to Figure 3, showing how the bag full indication depends upon the power setting of the fan motor.

A typical suction cleaner embodying the present invention is shown schematically in Figure 1. It will be appreciated, of course, that the principle of this invention can be applied equally well to upright suction cleaners. The cleaner of Figure 1 comprises an external housing 10 which is divided by an intermediate wall 12 into a front bag chamber 14 and a rear, "clean air" chamber 16. Mounted in an aperture in the intermediate wall 12 there is a secondary filter 18. Immediately behind this, in the rear chamber, there is a two stage centrifugal fan 20 followed by a diffuser 22 and a motor 24. The fan, diffuser and motor are all contained within a generally cylindrical housing 26 which opens, at its end, into the "clean air" chamber 16. The "clean air" chamber 16 has an exhaust opening 28, air passing through this opening being filtered by an exhaust microfilter 30.

Within the front bag chamber 14 there is a dust filter bag 32, fed by a flexible hose or suction tube 34 which passes through an inlet opening in the housing 10. At the far end of the hose 34 is a suction nozzle (not shown).

In use, dirty air is sucked along the hose 34, and into the dust bag 32, where most of the dust is caught. The air then passes through the secondary filter 18, which traps almost all of the rest of the dust, and via the fan 20, diffuser 22, and motor 24 into the clean air chamber 16. From here it passes via the exhaust microfilter 30 (which traps small particles of pollen and like material) before passing out of the housing 10 through the exhaust opening 28.

Mounted to the interior of the housing 10 is a first pressure switch PS1, which is arranged to measure the suction pressure at point A, adjacent to the entrance to the dust bag. Alternatively, the switch could be positioned to measure the suction (i.e. negative pressure) within the hose 34 at the end adjacent the bag. The switch has three settings, at 3000, 5000, 6000 Pa (300, 500 and 600 mm wg), and provides an output, indicative of the measured suction exceeding one or more of these values, which is passed to a microprocessor 36 located in a control section towards the rear of the cleaner.

A second pressure switch, PS2, is provided in the clean air chamber 16 to provide an indication of the air flow at point C on the diffuser, as will now be described with reference to Figure 2.

Figure 2 is an end view of a plastics-material diffuser, the purpose of which is to channel air flowing from the fan blades towards a central aperture 38. The diffuser has a generally cylindrical external surface 40 which is angled in conical fashion towards the aperture 38. On the surface 40 are provided a plurality of upstanding vanes 42 between which the rotating air flow passes. As the flow passes towards the centre of the diffuser its rotational speed is gradually decreased by virtue of the angled vanes.

Between two adjacent vanes near the periphery of the surface 40 there is a dam 48; thus, there is formed between the vanes 44, 46 and the dam 48 a cul-de-sac in the air flow. Passing through the surface 40 into this cul-de-sac there is a small circular aperture 50, via which the pressure in the cul-de-sac can be measured by the pressure switch PS2 (see Figure 1).

It has been found by experiment that the pressure within the aperture 50, as measured by the switch PS2, depends partly upon the static pressure at that point, but more importantly upon the airflow which is passing through the cleaner. A typical curve, showing how the pressure at PS2 varies with the airflow, is shown in Figure 3. As will be appreciated, the aperture 50, and the accompanying tube which transmits the pressure at that point to the pressure switch PS2 act in a manner roughly analogous to a Pitot tube.

The pressure switch PS2 supplies a signal, depending upon the air flow, to the microprocessor 36. Conveniently, this signal indicates which, if any, of the following pressures are exceeded; 1100, 1600, 1900 Pa (110, 160, 190 mm wg). The pressure measured at the switch PS2 is not absolute, but differential. The signal supplied to the microprocessor indicates the amount by which the pressure at C (which is, as has already been stated, representative of the air flow) exceeds the pressure at D, within the clean air chamber 16. Using a differential rather than an actual pressure measurement means that any back pressure, created by virtue of the exhaust microfilter 30 being partially clogged, will be automatically compensated for.

The cleaner motor 24 is controlled by a motor control unit 52, receiving power along external power lines 54. Located on the top of the external housing 10 there is a control/indicator panel 56 which, amongst other things, includes a foot-operated switch (not shown) by which the user can select the power level at which the cleaner is to operate, for example 100%, 70%, 60% and 50% of maximum. The chosen power level is communicated to the microprocessor 36 which then issues an appropriate command to the motor control unit 52.

The signals supplied to the microprocessor from the pressure switches PS1 and PS2 are used to determine certain error conditions as will now be described.

As will be evident from Figure 4, the relationship between the pressure registered by the switch

PS2 and the air flow through the cleaner will depend upon the motor setting chosen by the user, mainly due to air compressibility. Thus, instead of the single curve of Figure 3, we in fact have a series of curves, for different power settings. A "bag full" condition is characterised by low to medium air flow through the cleaner, resulting in low to medium pressure at the diffuser pressure tap tube, accompanied by low suction within the dust bag as measured by the pressure switch PS1. What is meant by "low to medium" and "low" will of course depend upon the power setting in use, and appropriate definitions of these values are selected by the microprocessor in dependence upon the power setting selected by the user on control panel 56.

As an example, it will be seen from Figure 4 that a "bag full" condition is identified by the microprocessor if the diffuser pressure tap tube pressure falls below 1600 Pa (160 mm water), when the power setting is 100% or 70%, and if the pressure falls below 1100 Pa (110 mm water) when the power setting is 60% or 50%. In either case, this identification is made only if the suction determined by the pressure switch PS1 is also low; for example if it is below 5000 Pa (500 mm water) at 100% or 70%, and below 3000 Pa (300 mm water) at 60% or 50%.

A "hose blocked" condition can be identified if the suction in the bag is high, and at the same time the air flow through the cleaner is low. Again, the expressions "high" and "low" depend upon the power setting in use. For example, the microprocessor may be programmed to identify a "hose blocked" condition at 100% or 70% power when the suction measured by PS1 exceeds 6000 Pa (600 mm water), while the pressure at PS2 is less than 1600 Pa (160 mm water). On the other hand, when the power setting is 60% or 50% the microprocessor may be programmed to use the values 5000 Pa and 1100 Pa (500 mm and 110 mm water) respectively.

The figures given above are, of course, exemplary. It will be evident that with suitable programming, the microprocessor can be arranged to determine the "hose blocked" and "bag full" conditions according to different criteria for each power setting with the limit values being determined by experimentation. Also, if sufficiently accurate information is provided from the two pressure switches, the microprocessor can in a similar way give an indication of approximately how full the bag is. Alternatively, a slightly simpler arrangement is to provide a "bag check" button on the control/indicator panel 56; when the user presses this button, the microprocessor instructs the motor control unit 52 to operate the motor at a given power level, say 50%, and the fullness of the bag can then be determined directly by the airflow measured by the switch PS2. When the button is released, the microprocessor returns the cleaner to normal operation.

The various conditions mentioned above, as determined by the microprocessor, are displayed on the control/indicator panel 56 by means of an LED display. Also, the microprocessor may be arranged to send a cut out signal to the motor control unit 52 in the event of the hose blocking, or the bag becoming full.

In one particular embodiment, the control/indicator panel 56 includes an "auto" switch, the pressing of which causes the microprocessor to instruct the motor control unit 52 to operate the cleaner in such a way that the suction, as measured by the switch PS1, is substantially constant. In this way, the power setting will automatically change as the user moves the suction nozzle for example from a deep pile carpet to a smooth floor. When in the automatic mode, the microprocessor instructs the motor control unit to increase the power if the suction at PS1 is less than 5000 Pa (500 mm wg), to maintain it if the suction lies between 5000 and 6000 Pa (500 and 600 mm), and to reduce it if the suction exceeds 6000 Pa (600 mm).

Some means must of course be provided to prevent the diagnostic routines from interfering with the automatic operation when the cleaner is in the auto-mode. Several possibilities are envisaged. Firstly, the diagnostic routines could be disabled entirely when the cleaner is in the auto-mode. Secondly, the microprocessor could be arranged automatically to switch the cleaner between the auto-mode and the normal mode, from time to time, thus enabling the normal diagnostic routines to operate. Thirdly, the microprocessor could be arranged to switch in the diagnostic routines only if an abnormal condition persists for an extended period.

In the latter case, for example when the cleaner is in the auto-mode, moving the nozzle from a carpet to a smooth floor will tend to result in the nozzle sticking slightly and the suction level increasing. The microprocessor will, accordingly, reduce the suction level to a more suitable value. On the other hand, if the nozzle or the hose becomes clogged, the increased suction would persist for an extended period and in this case the microprocessor would, after a given period, switch on the "hose blocked" indicator, and cut out the motor.

Claims

1. A suction cleaner including means for detecting a pressure or air flow at an upstream surface (40) of a diffuser (22) of a suction fan

(20), the diffuser including a plurality of angled vanes (42) which are positioned to convert a generally circular air flow, as it leaves the fan, into a substantially radial air flow, and means for actuating an indicator in dependence upon the detected pressure or air flow.

2. A suction cleaner as claimed in Claim 1 in which the detecting means comprises a pressure sensor connected to a tube which opens at a pressure tap aperture (50) on the upstream surface of the diffuser.

3. A suction cleaner as claimed in Claim 2 in which the pressure-tap aperture (50) is located between two adjacent vanes (44,46) in the upstream surface of the diffuser, the said surface being transverse to an axis of the fan.

4. A suction cleaner as claimed in Claim 3 in which the angled vanes (42) are upstanding from the said surface, and are generally perpendicular thereto.

5. A suction cleaner as claimed in Claim 3 or Claim 4 in which the adjacent vanes are joined together at their axially inward ends, adjacent the pressure tap aperture (50).

6. A suction cleaner as claimed in any one of the preceding claims in which the pressure sensor is a multi-contact pressure switch (PS2).

7. A suction cleaner as claimed in any one of Claims 1 to 6 in which the means for detecting a pressure or air flow comprise a differential pressure sensor (PS2) arranged to detect the differential pressure between a point (C) on the upstream side of the diffuser and a further point (D) inside a main body of the cleaner upstream from an exhaust filter (30).

Patentansprüche

1. Staubsauger, umfassend eine Einrichtung zum Nachweis eines Drucks oder Luftstroms an einer stromaufwärts gelegenen Fläche (40) eines Diffusors (22) eines Sauggebläses (20), wobei der Diffusor eine Mehrzahl von angewinkelten Radschaufeln (42) aufweist, die angeordnet sind, um einen im allgemeinen kreisförmigen Luftstrom, der das Gebläse verläßt, in einen im wesentlichen radialen Luftstrom umzuwandeln, und eine Einrichtung, um eine Anzeigevorrichtung in Abhängigkeit vom nachgewiesenen Druck oder Luftstrom zu betätigen.

2. Staubsauger nach Anspruch 1, wobei die Nachweiseinrichtung einen Drucksensor aufweist, der mit einem Rohr, das sich an einer Druckabgriffößnung (50) an der stromaufwärts gelegenen Fläche des Diffusors öffnet, verbunden ist.

3. Staubsauger nach Anspruch 2, wobei die Druckabgriffööffnung (50) sich zwischen zwei benachbarten Radschaufeln (44, 46) in der stromaufwärts gelegenen Fläche des Diffusors befindet, wobei die Fläche quer zu einer Gebläseachse angeordnet ist.

4. Staubsauger nach Anspruch 3, wobei die angewinkelten Radschaufeln (42) von der genannten Fläche abstehen und im allgemeinen senkrecht zu dieser angeordnet sind.

5. Staubsauger nach Anspruch 3 oder 4, wobei die benachbarten Radschaufeln miteinander an ihren axial nach innen gerichteten Enden neben der Druckabgriffööffnung verbunden sind.

6. Staubsauger nach einem der vorstehenden Ansprüche, wobei es sich beim Drucksensor um einen Mehrfachkontakt-Druckwächter (PS2) handelt.

7. Staubsauger nach einem der Ansprüche 1 bis 6, wobei die Einrichtung zum Nachweis eines Drucks oder Luftstroms einen Differential-Drucksensor (PS2) umfaßt, der zum Nachweis des Druckunterschieds zwischen einem Punkt (C) auf der stromaufwärts gelegenen Seite des Diffusors und einem weiteren Punkt (D) innerhalb eines Hauptkörpers des Staubsaugers stromaufwärts zu einem Auslaßfilter (30) angeordnet ist.

Revendications

1. Aspirateur comportant un dispositif pour détecter une pression ou un flux d'air sur une surface en amont (40) d'un diffuseur (22) d'un ventilateur d'aspirateur (20), le diffuseur comportant une pluralité de pales incurvées (42) qui sont positionnées pour convertir un flux d'air généralement circulaire, lorsqu'il quitte le ventilateur, en un flux d'air essentiellement radial, et un dispositif pour mettre en action un indicateur en fonction de la pression détectée ou du flux d'air.

2. Aspirateur selon la revendication 1 dans lequel le dispositif de détection comprend un capteur de pression relié à un tube qui ouvre une ouverture du robinet de pression (50) sur la

surface en amont du diffuseur.

3. Aspirateur selon la revendication 2 dans lequel l'ouverture du robinet de pression (50) est située entre deux pales voisines (44, 46) sur la surface en amont du diffuseur, ladite surface étant transverse par rapport à un axe du ventilateur.

4. Aspirateur selon la revendication 3 dans lequel les pales incurvées (42) sont érigées à partir de ladite surface, et sont généralement perpendiculaires à celle-ci.

5. Aspirateur selon la revendication 3 ou la revendication 4 dans lequel les pales voisines au voisinage de l'ouverture du robinet de pression (50) sont reliées ensemble à leurs extrémités internes de façon axiale

6. Aspirateur selon l'une quelconque des revendications précédentes dans lequel le capteur de pression est un commutateur de pression à contacts multiples (PS2).

7. Aspirateur selon l'une quelconque des revendications 1 à 6 dans lequel le dispositif pour détecter une pression ou un flux d'air comprend un capteur de pression différentielle (PS2) adapté pour détecter la pression différentielle entre un point (C) en amont du diffuseur et un autre point (D) à l'intérieur du corps principal de l'aspirateur en amont du filtre d'échappement (30).

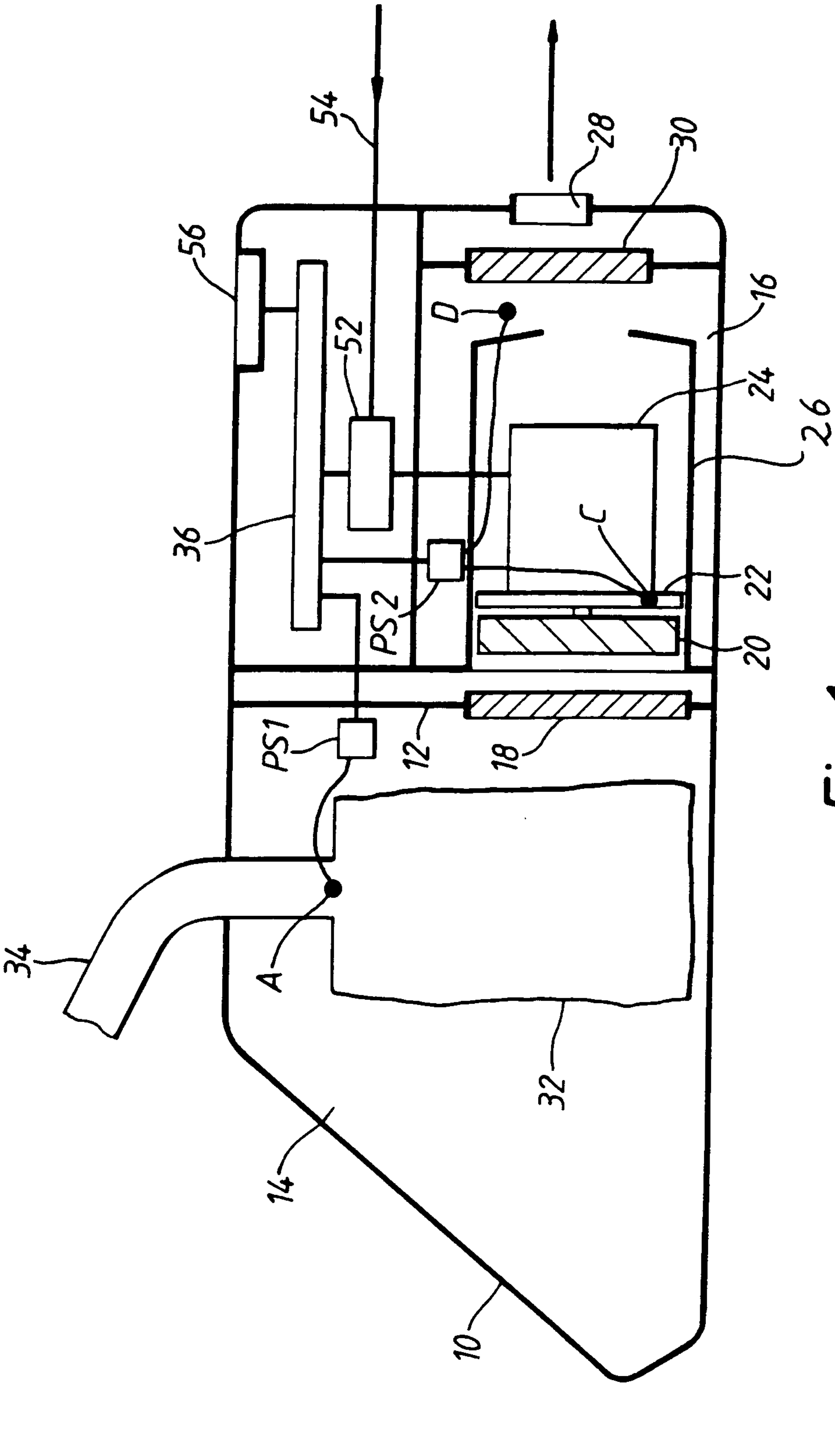

Fig. 1.

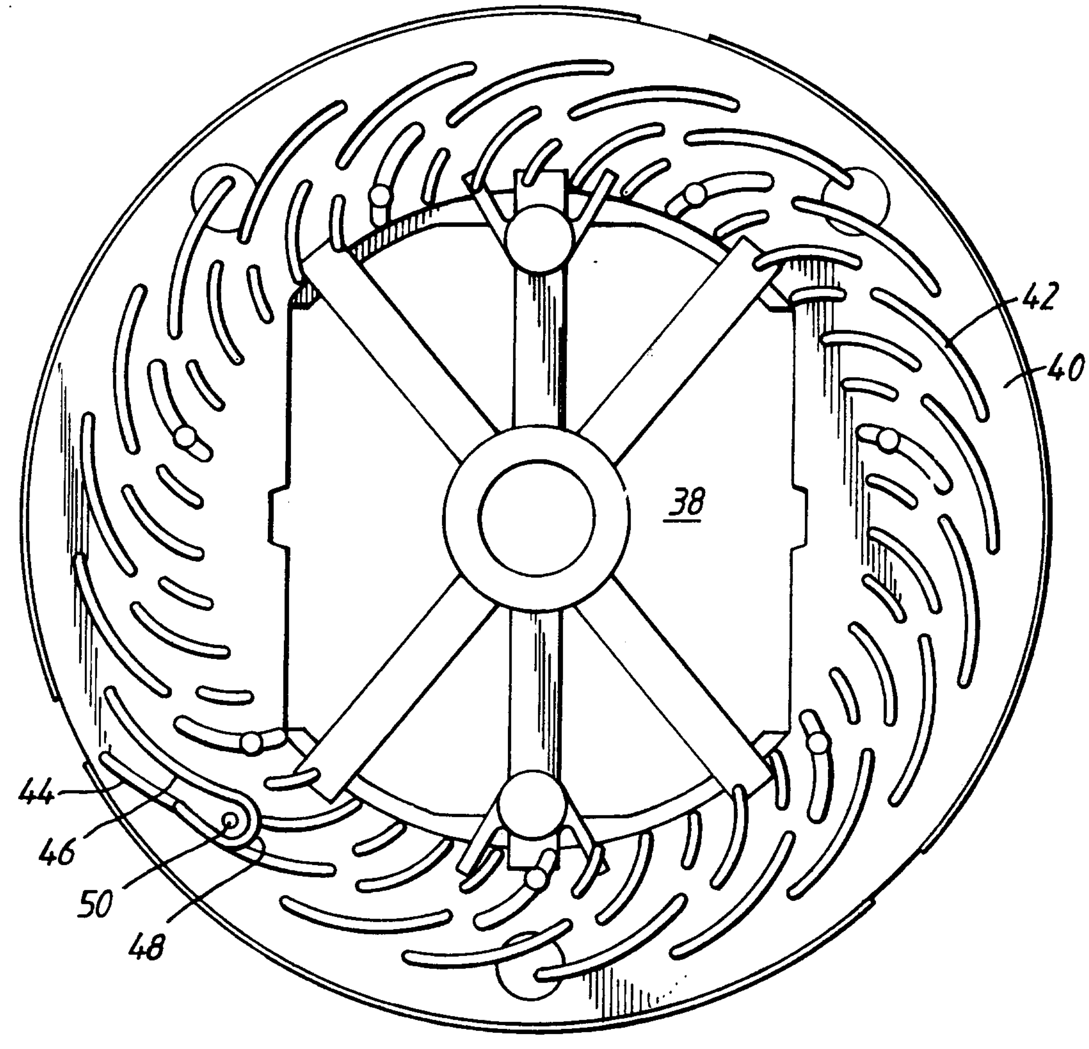

Fig. 2.

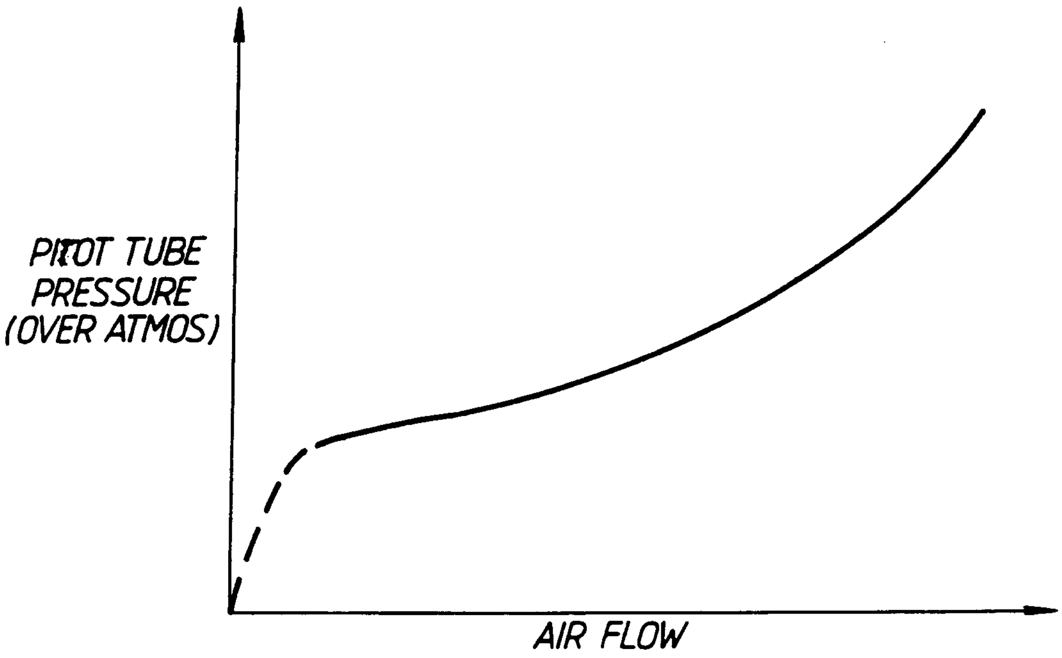
PITOT TUBE
PRESSURE
(OVER ATMOS)
AIR FLOW

Fig. 3.

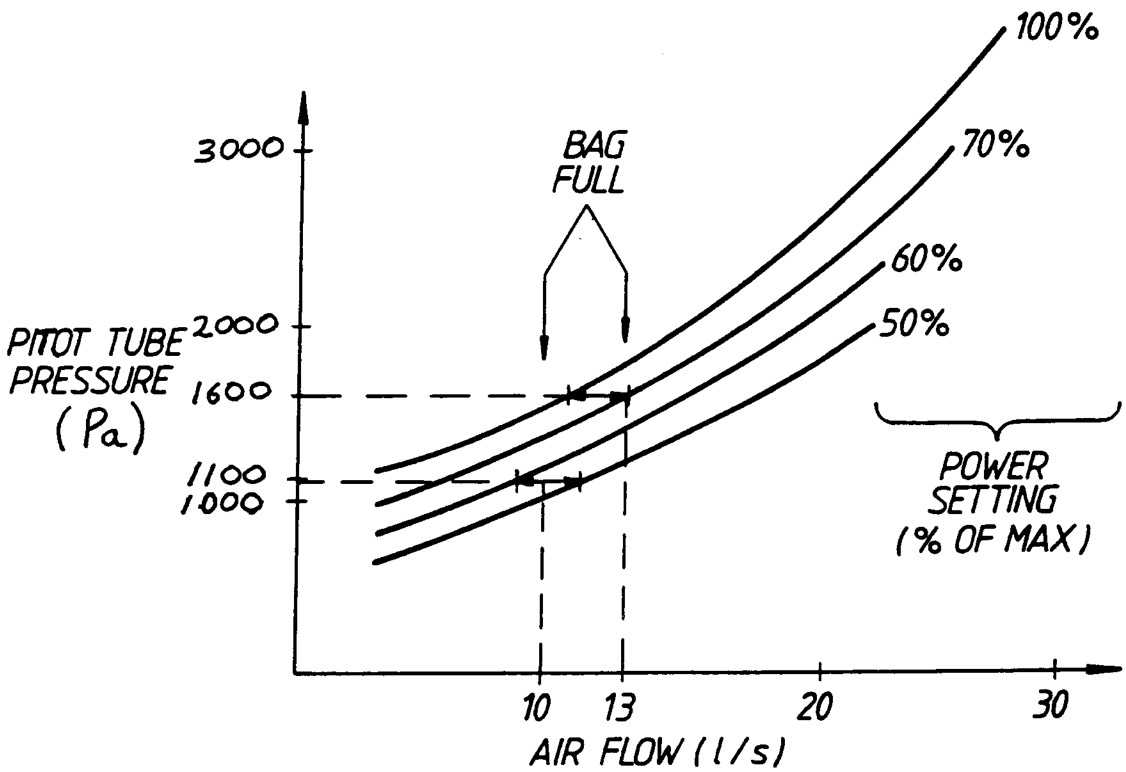
100%
70%
60%
50%
BAG
FULL
3000
2000
1600
1100
1000
PITOT TUBE
PRESSURE
(Pa)
POWER
SETTING
(% OF MAX)
10
13
20
30
AIR FLOW (l/s)

Fig. 4.