(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 389 059 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
**20.01.2010 Bulletin 2010/03**

(21) Application number: **01937127.7**

(22) Date of filing: **15.05.2001**

(51) Int Cl.:
***A47L 9/28*** *(2006.01)*

(86) International application number:
**PCT/TR2001/000021**

(87) International publication number:
**WO 2002/091899 (21.11.2002 Gazette 2002/47)**

(54) **A CONTROL METHOD FOR A VACUUM CLEANER**

REGELVERFAHREN FÜR EINEN STAUBSAUGER

PROCEDE DE COMMANDE D'UN ASPIRATEUR

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR**
Designated Extension States:
**AL LT LV MK RO SI**

(43) Date of publication of application:
**18.02.2004 Bulletin 2004/08**

(73) Proprietor: **Arçelik A.S.**
**81719 Istanbul (TR)**

(72) Inventors:
- **TÜZÜNGÜ, Mustafa**
**81719 Istanbul (TR)**
- **SULAMACI, Banu**
**81719 Istanbul (TR)**
- **EFECIK, Bülent**
**81719 Istanbul (TR)**

(56) References cited:
**EP-A- 0 467 347** **EP-A- 0 636 341**
**EP-A- 0 933 058**

- **PATENT ABSTRACTS OF JAPAN vol. 17, no. 708 (C-1147), 24 December 1993 (1993-12-24) & JP 05 245080 A (MATSUSHITA ELECTRIC IND CO LTD), 24 September 1993 (1993-09-24)**



EP 1 389 059 B1

Printed by Jouve, 75001 PARIS (FR)

## Description

**[0001]** The present invention relates to a method used in vacuum cleaners for controlling the motor power by using pressure variations.

**[0002]** One of the user behaviors is that users are likely to leave the cleaner in running condition when not in actual use. This will cause high energy consumption and high noise level. Another user behavior is that the user tends to rub the surface of the rug, bare floor, etc., unconsciously faster when dirt or stain is observed. In these conditions, if the motor power stays at a predetermined level there will be an unsatisfactory cleaning performance.

**[0003]** In prior art, suction force of the vacuum cleaner is adjusted manually or automatically. In manual adjustment of suction force, the user varies the speed of the motor by means of a potentiometer. The adjusted power level may not be the optimum level for the vacuum cleaner. It is observed that the user tends to use maximum power under any circumstances since it is impossible for the user to truly determine the need for maximum power. Since using maximum power under all conditions is not usually necessary, selecting unnecessarily high power level causes high noise level and high energy consumption.

**[0004]** There are some vacuum cleaners in prior art that realize the adjustment of the motor power automatically. In these vacuum cleaners the motor power is adjusted according to the dust quantity sensed by dust sensors or according to the change in suction level sensed by pressure sensors.

**[0005]** An example to the vacuum cleaners where a pressure sensor is used is explained in the European Patent Application EP 0933058. In this application, it is explained that the suction pressure is measured by means of a pressure sensor that feeds back its measurement to the controller which detects the pressure variations and changes the speed level of the motor.

**[0006]** In these techniques it is not intended to detect user behavior for the adjustments of motor power.

**[0007]** The object of the present invention is to develop a method to control the motor power according to user behavior.

**[0008]** The present invention is illustrated in the drawings, wherein:

Figure 1 - is the shematic view of a vacuum cleaner.
Figure 2 - is the flow chart of the control method.
Figure 3 - is a sample graph showing pressure values, mean pressure and crossings

**[0009]** The components shown in the drawings have the following numbers:

1- Vacuum cleaner
2- Pressure sensor
3- Motor
4- Control means
5- Nozzle

**[0010]** In the preferred embodiment of this invention, vacuum cleaner (1) comprises a motor (3) that provides the suction, a nozzle (5) that contacts the surface in order to clean it, a pressure sensor (2) placed on the dust passageway to detect the pressure variations and a control means (4) that controls the motor (3).

**[0011]** The type of the surface that is being cleaned effects the pressure values measured by the pressure sensor (2). When the nozzle (5) of the vacuum cleaner (1) meets a resistance such as a carpet, floor etc. air to be sucked lowers in amount. If the type of the surface to be cleaned is such that it covers the nozzle (5) totally, not allowing any air to pass through, the pressure level reaches vacuum.

**[0012]** During cleaning operation the user pushes the nozzle (5) forth or pull it back in order to clean the surface. Since the opening of the nozzle (5) becomes partially or wholly covered by the surface during these back and forth movements, pressure variations occur. This feature is used to determine the frequency of cleaning.

**[0013]** When the vacuum cleaner (1) is started (100), for a predetermined period of time (t) pressure values ($P_1$, $P_2$, .... $P_n$) measured by the pressure sensor (2) are gathered (101). Then the pressure values ($P_1$, $P_2$, .... $P_n$) are added-up to find the total pressure ($P_{total}$).

$$P_{total} = P_1, P_2, \ldots . P_n$$

**[0014]** Then the number of measurements "n" divides the total pressure (Ptotal) in order to find the mean pressure ($P_{mean}$) (102).

$$P_{mean} = P_{total} / n$$

**[0015]** After finding the mean pressure ($P_{mean}$), the difference values ($\Delta_1$, $\Delta_2$, .... $\Delta_n$) between the pressure values ($P_1$, $P_2$, .... $P_n$) and the mean pressure ($P_{mean}$) are found (103). Then the changes of sign of consecutive difference values are determined and the number of sign changes is set as the number of crossings ($C_{actual}$) that defines the actual cleaning frequency that is the number of back and forth movement of the nozzle (5) per unit time (104). Then the actual number of crossings ($C_{actual}$) is compared with a reference number of crossings ($C_{ref}$) that defines the reference cleaning frequency (105). If the actual number of crossings ($C_{actual}$) is greater than the reference number of crossings ($C_{ref}$), it is decided that the frequency of cleaning is big enough that it is needed to increase motor (3) power (106). Then the new pressure values are gathered again (101). If the actual number of crossings ($C_{actual}$) is smaller than the refer-

ence number of crossings ($C_{ref}$), and if the actual number of crossings ($C_{actual}$) is found smaller than the reference number of crossings ($C_{ref}$) for a predetermined number of cycles (107), motor power is decreased (108). Then it is checked whether the vacuum cleaner is being used or not by the following way; the maximum ($P_{max}$) and the minimum values ($P_{min}$) of the gathered pressure values ($P_1$, $P_2$, .... $P_n$) are found (110). Then a difference value ($\Delta$) between the maximum ($P_{max}$) and minimum ($P_{min}$) values is computed (111).

$$\Delta = P_{max} - P_{min}$$

**[0016]** The difference value ($\Delta$) between these maximum ($P_{max}$) and minimum ($P_{min}$) values is then compared with a predetermined reference difference value ($D_{ref}$) (112). If the difference value ($\Delta$) is greater than this reference value ($D_{ref}$), motor power is kept constant (109). If the difference value ($\Delta$) is smaller than this reference value ($D_{ref}$), then mean pressure ($P_{mean}$) is compared with a predetermined reference pressure value ($P_{ref}$) (113). If mean pressure value ($P_{mean}$) is smaller than the predetermined reference pressure value ($P_{ref}$), it is decided that the user does not use the vacuum cleaner so the vacuum cleaner can go into a power saving mode and the motor (3) power is decreased to a predetermined stand-by power (114) and the new pressure values are gathered (101). The vacuum cleaner is started again to operate with its regular motor power only by the user. If mean pressure value ($P_{mean}$) is greater than the predetermined reference pressure value ($P_{ref}$), it is decided that the user uses the vacuum cleaner so the motor power is kept at the same level (109). And it is started again to gather new pressure values for a new predetermined period of time (101).

**[0017]** In another alternative method of this invention mean pressure ($P_{mean}$) of the previous measurement cycle is used and the difference values ($\Delta_1$, $\Delta_2$, .... $\Delta_n$) between the pressure values ($P_1$, $P_2$, .... $P_n$) and the mean pressure ($P_{mean}$) of the previous measurement cycle are found.

## Claims

1. A control method for a vacuum cleaner (1) including a motor (3) that provides the suction, a nozzle (5) that contacts the surface in order to clean it, a pressure sensor (2) preferably placed on the dust passageway, a control means (4) that controls the motor (3), the method comprising the steps of: detecting the pressure and pressure differences by the pressure sensor, increasing the motor power when the user tends to clean the surface with a frequency higher than a predetermined frequency that defines the number of back and forth movements of the nozzle (5) per unit time, wherein the pressure variations, detected by said pressure sensor (2), are used to determine the frequency with which the user tends to clean the suface.

2. A control method according to claim 1 comprising the steps of starting the vacuum cleaner (1) (100), gathering the pressure values ($P_1$, $P_2$, .... $P_n$) measured by the pressure sensor (2) (101), adding up the pressure values ($P_1$, $P_2$, .... $P_n$) to find the total pressure ($P_{total}$) dividing the total pressure ($P_{total}$) by the number of measurements (n) in order to find the mean pressure ($P_{mean}$) (102), comparing the pressure values ($P_1$, $P_2$, .... $P_n$) with the mean pressure ($P_{mean}$) and computing the actual number of crossings ($C_{actual}$) which defines the actual cleaning frequency by finding the difference values ($\Delta_1$, $\Delta_2$, .... $\Delta_n$) between the pressure values ($P_1$, $P_2$, .... $P_n$) and the mean pressure ($P_{mean}$) (103), determining the changes of sign of consecutive difference values ($\Delta_1$, $\Delta_2$, .... $\Delta_n$), assigning the number of sign change as the number of crossings ($C_{actual}$) (104), comparing the actual number of crossings ($C_{actual}$) with a reference number of crossings ($C_{ref}$) which defines a reference cleaning frequency (105), if the actual number of crossings ($C_{actual}$) is greater than the reference number of crossings ($C_{ref}$) deciding that the frequency of cleaning is big enough that it is needed to increase motor (3) power (106), if the actual number of crossings ($C_{actual}$) is smaller than the reference number of crossings ($C_{ref}$).

3. A control method according to Claim 2 further comprising the steps of decreasing the motor power (108), if the actual number of crossing ($C_{actual}$) is found smaller than the reference crossing numbers ($C_{ref}$) for a predetermined number of cycles (107).

4. A control method according to Claim 1 to 3 further comprising the steps of computing the maximum ($P_{max}$) and the minimum values ($P_{min}$) of the gathered pressure values ($P_1$, $P_2$, .... $P_n$) (110), finding a difference value (Delta) between the maximum ($P_{max}$) and minimum ($P_{min}$) values (111), comparing the difference value (Delta) between these maximum ($P_{max}$) and minimum ($P_{min}$) values with a predetermined reference difference value ($D_{ref}$) (112), if the difference value (Delta) is smaller than this reference value ($D_{ref}$), comparing the mean pressure ($P_{mean}$) with a predetermined reference pressure value ($P_{ref}$) (113), if mean pressure value ($P_{mean}$) is smaller than the predetermined reference pressure value ($P_{ref}$), deciding that the user does not use the vacuum cleaner and decreasing the motor (3) power to a predetermined stand-by power (114).

**Patentansprüche**

1. Verfahren zum Steuern eines Staubsaugers (1), aufweisend einen Motor (3), der das Ansaugen vorsieht, eine Düse (5), die in Kontakt mit der zu reinigenden Fläche tritt, einen Drucksensor (2), der vorzugsweise am Staubkanal angeordnet ist, und ein Steuerungsmittel (4), das den Motor (3) steuert, wobei das Verfahren folgende Schritte umfasst: Detektieren des Drucks und der Druckdifferenzen durch den Drucksensor (2), Erhöhen die Leistung des Motors (3), wenn der Benutzer dazu neigt, die Fläche mit einer Frequenz zu reinigen, die höher ist als eine vorbestimmte Frequenz, welche die Anzahl der Vorwärts- und Rückwärtsbewegungen der Düse (5) pro Zeiteinheit definiert, wobei die Druckvariationen, die von dem genannten Drucksensor (2) detektiert werden, dazu benutzt werden, die Frequenz zu bestimmen, mit der der Benutzer dazu neigt, die Fläche zu reinigen.

2. Steuerungsverfahren nach Anspruch 1, folgende Schritte umfassend: Starten des Staubsaugers (1) (100), Erfassen der Druckwerte ($P_1$, $P_2$, .... $P_n$), die vom Drucksensor (2) gemessen werden (101), Addieren der Druckwerte ($P_1$, $P_2$, .... $P_n$), um den Gesamtdruck ($P_{total}$) zu ermitteln, Teilen des Gesamtdrucks ($P_{total}$) durch die Anzahl der Messungen (n), um den mittleren Druck ($P_{mean}$) zu ermitteln (102), Vergleichen der Druckwerte ($P_1$, $P_2$, .... $P_n$) mit dem mittleren Druck ($P_{mean}$) und Berechnen der tatsächlichen Anzahl der Überquerungen ($C_{actual}$), was die tatsächliche Reinigungsfrequenz definiert, indem die Differenzwerte ($\Delta_1$, $\Delta_2$, .... $\Delta_n$) zwischen den Druckwerten ($P_1$, $P_2$, .... $P_n$) und dem mittleren Druck ($P_{mean}$) ermittelt werden (103), Bestimmen der Vorzeichenänderungen aufeinanderfolgender Differenzwerte ($\Delta_1$, $\Delta_2$, .... $\Delta_n$), Zuweisen der Anzahl von Vorzeichenänderungen als Anzahl der Überquerungen ($C_{actual}$) (104), Vergleichen der tatsächlichen Anzahl der Überquerungen ($C_{actual}$) mit einer Bezugsanzahl von Überquerungen ($C_{ref}$), welche eine Bezugsreinigungsfrequenz definiert (105), wenn die tatsächliche Anzahl der Überquerungen ($C_{actual}$) größer ist als die Bezugsanzahl von Überquerungen ($C_{ref}$), Entscheiden, dass die Reinigungsfrequenz so hoch ist, dass es notwendig ist, die Leistung des Motors (3) zu erhöhen (106), wenn die tatsächliche Anzahl der Überquerungen ($C_{actual}$) kleiner ist als die Bezugsanzahl von Überquerungen ($C_{ref}$).

3. Steuerungsverfahren nach Anspruch 2, ferner folgende Schritte umfassend: Senken die Leistung des Motors (3) (108), wenn die tatsächliche Anzahl der Überquerungen ($C_{actual}$) für eine vorbestimmte Anzahl von Zyklen kleiner befunden wird als die Bezugsanzahl von Überquerungen ($C_{ref}$) (107).

4. Steuerungsverfahren nach Ansprüche 1 bis 3, ferner folgenden Schritte umfassend: Berechnen des maximalen ($P_{max}$) und des minimalen Werts ($P_{min}$) der erfassten Druckwerte ($P_1$, $P_2$, .... $P_n$) (110), Ermitteln eines Differenzwerts (Delta) zwischen dem maximalen ($P_{max}$) und dem minimalen Wert ($P_{min}$) (111), Vergleichen des Differenzwerts (Delta) zwischen dem maximalen ($P_{max}$) und dem minimalen Wert ($P_{min}$) mit einem vorbestimmten Bezugsdifferenzwert ($D_{ref}$) (112), wenn der Differenzwert (Delta) kleiner ist als dieser Bezugswert ($D_{ref}$), Vergleichen des mittleren Drucks ($P_{mean}$) mit einem vorbestimmten Referenzdruckwert ($P_{ref}$) (113), wenn der mittlere Druckwert ($P_{mean}$) kleiner ist als der vorbestimmte Referenzdruckwert ($P_{ref}$), Entscheiden, dass der Benutzer den Staubsauger nicht benutzt, und Absenken der Leistung des Motors (3) auf eine vorbestimmte Bereitschaftsleistung (114).

**Revendications**

1. Une méthode de contrôle pour un aspirateur (1) comprenant un moteur (3) qui permet l'aspiration, un suceur (5) qui touche la surface afin de la nettoyer, un capteur de pression (2) préférablement situé dans le passage de poussière, un moyen de contrôle (4) qui contrôle le moteur (3), la méthode comprenant les étapes de : détection de la pression et les différences de pression par le capteur de pression (2), augmentation de la puissance de moteur (3) lorsque l'utilisateur a tendance à nettoyer la surface avec une fréquence supérieure à une fréquence préréglé qui définit le nombre de mouvements d'avant en arrière du suceur (5) par unité de temps, où les variations de pression, détectées par ledit capteur de pression (2), sont utilisées pour déterminer la fréquence avec laquelle l'utilisateur a tendance de nettoyer la surface.

2. Une méthode de contrôle selon la Revendication 1 comprenant les étapes consistant à démarrer l'aspirateur (1) (100), collecter les valeurs de pression ($P_1$, $P_2$, .... $P_n$) mésurées par le capteur de pression (2) (101), additionner les valeurs de pression ($P_1$, $P_2$, .... $P_n$) afin de trouver la pression totale ($P_{total}$) division la pression totale ($P_{total}$) par le nombre de mesures (n) afin de trouver la pression moyenne ($P_{mean}$) (102), comparer les valeurs de pression ($P_1$, $P_2$, .... $P_n$) avec la pression moyenne ($P_{mean}$) et calculer le nombre réel de passages ($C_{actual}$) qui definit la fréquence réel de nettoyage en trouvant les valeurs de différence ($\Delta_1$, $\Delta_2$, .... $\Delta_n$) entre les valeurs de pression ($P_1$, $P_2$, .... $P_n$) et la pression moyenne ($P_{mean}$) (103), determiner les changements de signal des valeurs de différence consécutives ($\Delta_1$, $A_2$, .... $\Delta_n$), assigner le nomber de changement de signal comme le nombre de passages ($C_{actual}$) (104), com-

parer le nombre réel de passages ($C_{actual}$) avec un nombre de passages de référence ($C_{ref}$) qui définit une fréquence de nettoyage de référence (105), si le nombre réel de passages ($C_{actual}$) est supérieur au nombre de passages de référence ($C_{ref}$) décider que la fréquence de nettoyage est assez grande qu'il est nécessaire d'augmenter la puissance de moteur (3) (106), si le nombre réel de passages ($C_{actual}$) est plus petit que le nombre de passages de référence ($C_{ref}$).

**3.** Une méthode de contrôle selon la Revendication 2 comprenant au surplus les étapes consistant à diminuer la puissance de moteur (3) (108), si le nombre réel de passages ($C_{actual}$) est trouvé plus petit que le nombre de passages de référence ($C_{ref}$) pour un nombre de cycles préréglé (107).

**4.** Une méthodé de contrôle selon l'une quelconque des revendications de 1 à 3 comprenant au surplus les étapes consistant à calculer les valeurs maximales ($P_{max}$) et minimales ($P_{min}$) des valeurs collectées de pression ($P_1$, $P_2$, .... $P_n$) (110), trouver une valeur de différence (Delta) entre les valeurs maximales ($P_{max}$) et minimales ($P_{min}$) (111), comparer la valeur de différence (Delta) entre les valeurs maximales ($P_{max}$) et minimales ($P_{min}$) avec une valeur de différence de référence préréglé ($D_{ref}$) (112), si la valeur de différence (Delta) est plus petit que cette valeur de référence ($D_{ref}$), comparer la pression moyenne ($P_{mean}$) avec une valeur de pression de référence préréglé ($P_{ref}$) (113), si la valeur moyenne de pression ($P_{mean}$) est plus petit que la valeur de pression de référence préréglé ($P_{ref}$), décider que l'utilisateur n'utilise pas l'aspirateur et diminuer la puissance de moteur (3) à une puissance de veille préréglé (114).

**Figure 1**

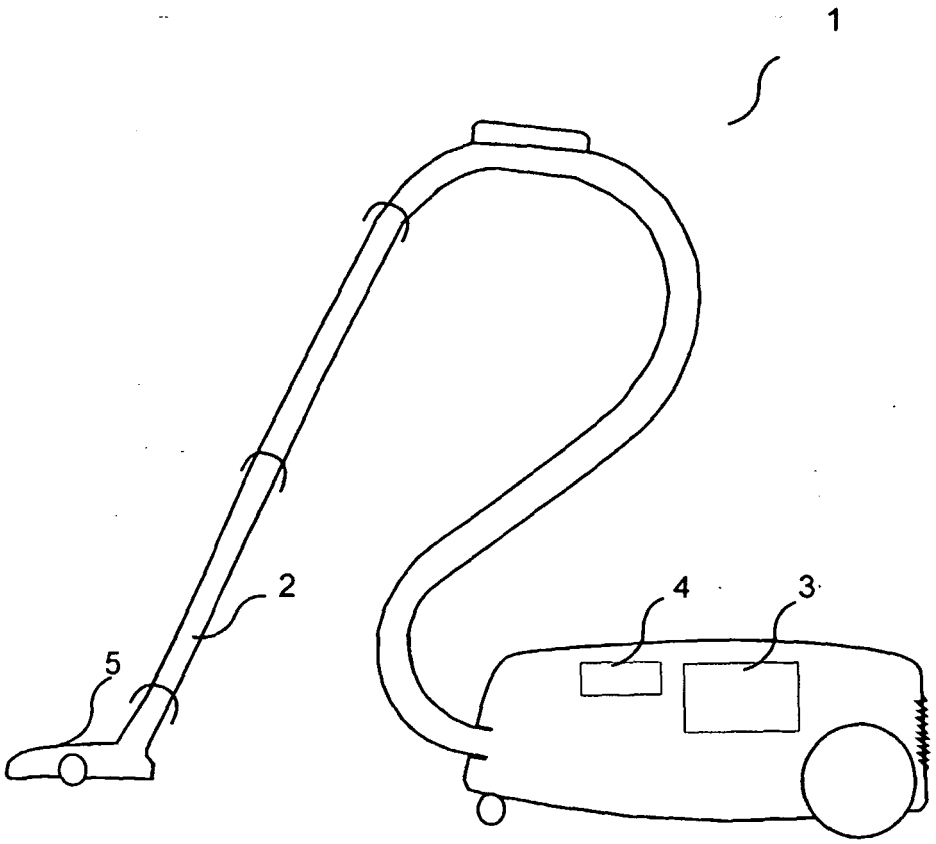


**Figure 2**

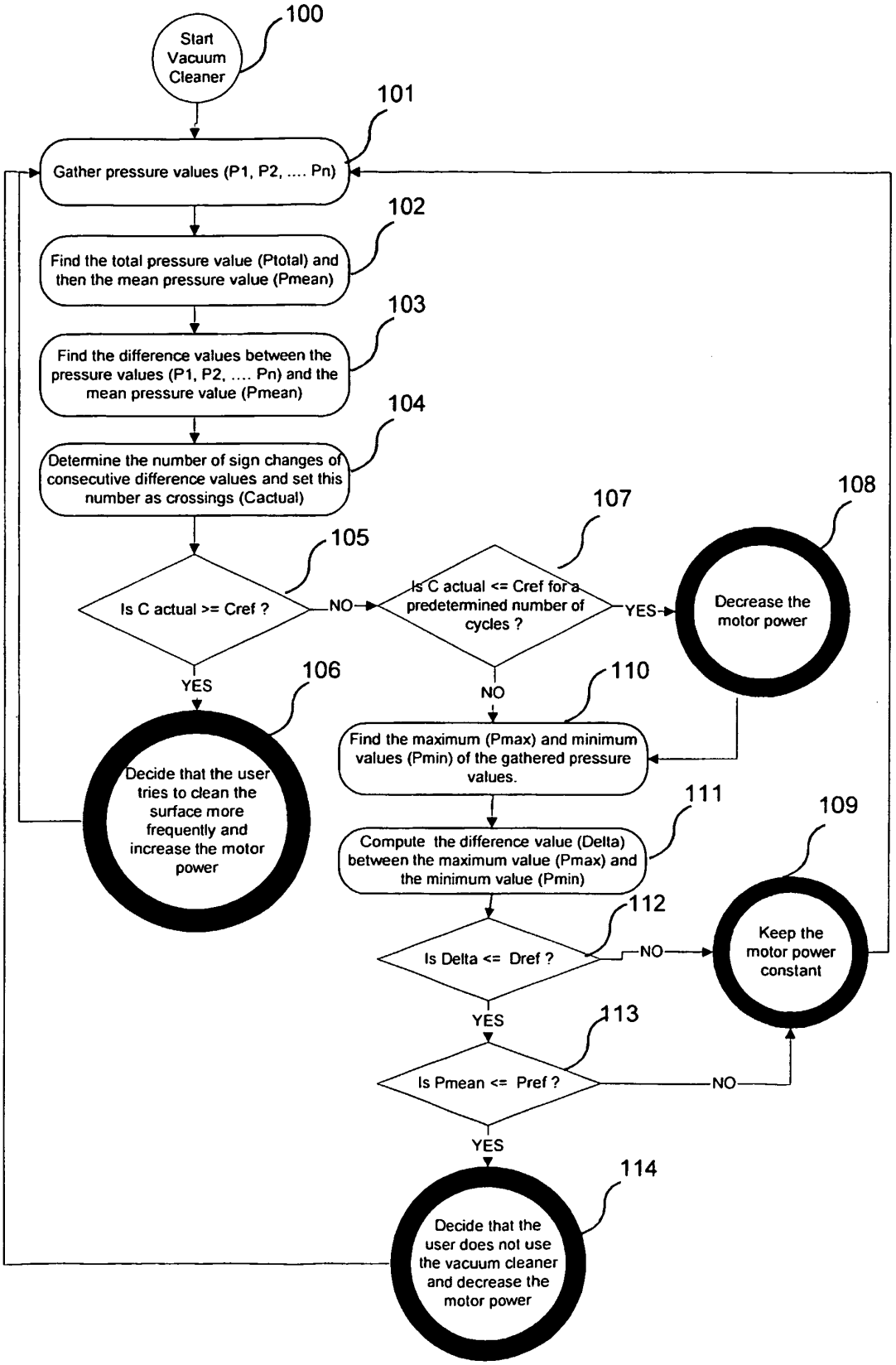
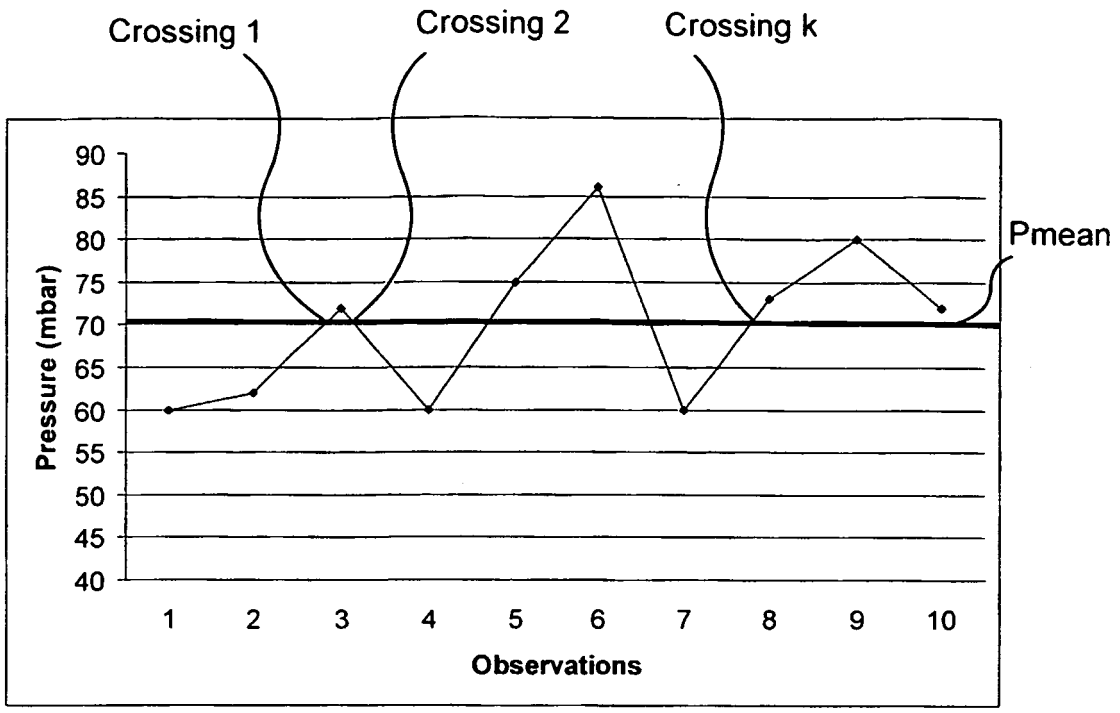

Start Vacuum Cleaner
100
Gather pressure values (P1, P2, .... Pn)
101
Find the total pressure value (Ptotal) and then the mean pressure value (Pmean)
102
Find the difference values between the pressure values (P1, P2, .... Pn) and the mean pressure value (Pmean)
103
Determine the number of sign changes of consecutive difference values and set this number as crossings (Cactual)
104
Is C actual >= Cref ?
105
NO
YES
Is C actual <= Cref for a predetermined number of cycles ?
107
YES
Decrease the motor power
108
NO
Decide that the user tries to clean the surface more frequently and increase the motor power
106
Find the maximum (Pmax) and minimum values (Pmin) of the gathered pressure values.
110
Compute the difference value (Delta) between the maximum value (Pmax) and the minimum value (Pmin)
111
Keep the motor power constant
109
Is Delta <= Dref ?
112
NO
YES
Is Pmean <= Pref ?
113
NO
YES
Decide that the user does not use the vacuum cleaner and decrease the motor power
114

**Figure 3**


Crossing 1
Crossing 2
Crossing k
Pmean
Pressure (mbar)
90
85
80
75
70
65
60
55
50
45
40
1
2
3
4
5
6
7
8
9
10
Observations

## REFERENCES CITED IN THE DESCRIPTION

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

### Patent documents cited in the description


- EP 0933058 A **[0005]**