(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 November 2002 (21.11.2002)

PCT

(10) International Publication Number
WO 02/091899 A1

(51) International Patent Classification[7]: A47L 9/28

(21) International Application Number: PCT/TR01/00021

(22) International Filing Date: 15 May 2001 (15.05.2001)

(25) Filing Language: English

(26) Publication Language: English

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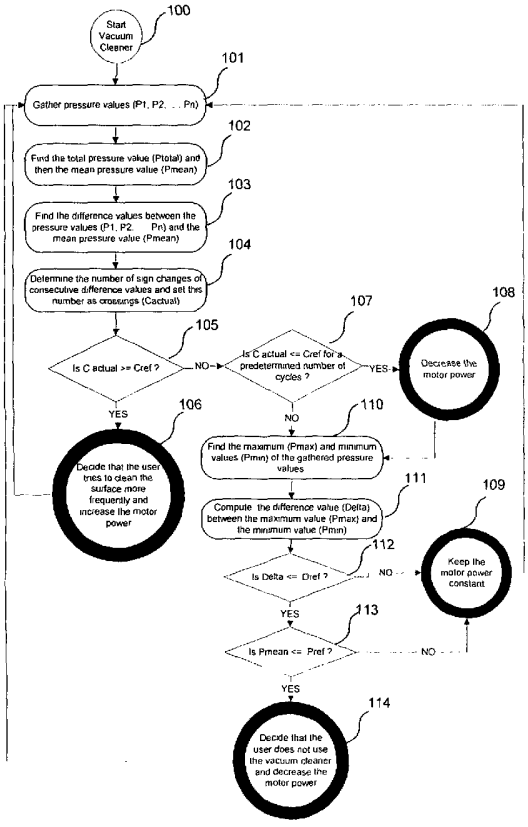
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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: A CONTROL METHOD FOR A VACUUM CLEANER



(57) Abstract: A control method for a vacuum cleaer (1) including a pressure sensor (2) to detect pressure variations, a control means (4) to perform control algorithms, a motor (3) that provides suction and a nozzle (5). The cleaning frequency of the user is measures in order to control the motor (3) accordingly.

WO 02/091899 A1

Published:
— *with international search report*

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A CONTROL METHOD FOR A VACUUM CLEANER

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

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.

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.

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.

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.

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

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

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

The components shown in the drawings have the following numbers:

1- Vacuum cleaner

2- Pressure sensor

3- Motor

4- Control means

5- Nozzle

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).

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.

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.

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}).

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

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

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

After finding the mean pressure (P_{mean}), the difference values (Δ_1, Δ_2, ... Δ_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 reference 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 (Δ) between the maximum (P_{max}) and minimum (P_{min}) values is computed (111).

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

The difference value (Δ) 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 (Δ) is greater than this reference value (D_{ref}), motor power is kept constant (109). If the difference value (Δ) 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).

In another alternative method of this invention mean pressure (P_{mean}) of the previous measurement cycle is used and the difference values (Δ_1, Δ_2, ... Δ_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.

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 (Δ_1, Δ_2, ... Δ_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 (Δ_1, Δ_2, ... Δ_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 1 to 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 (Δ) between the maximum (P_{max}) and minimum (P_{min}) values (111), comparing the difference value (Δ) between these maximum (P_{max}) and minimum (P_{min}) values with a predetermined reference difference value (D_{ref}) (112), if the difference value (Δ) 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).

Figure 1

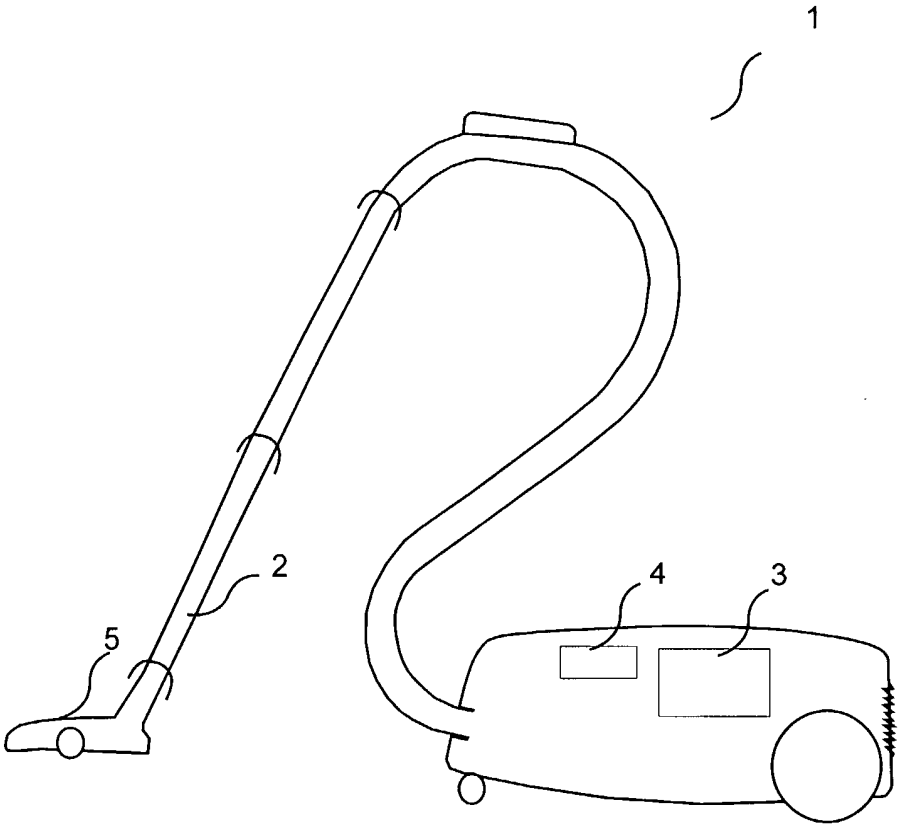


Figure 2

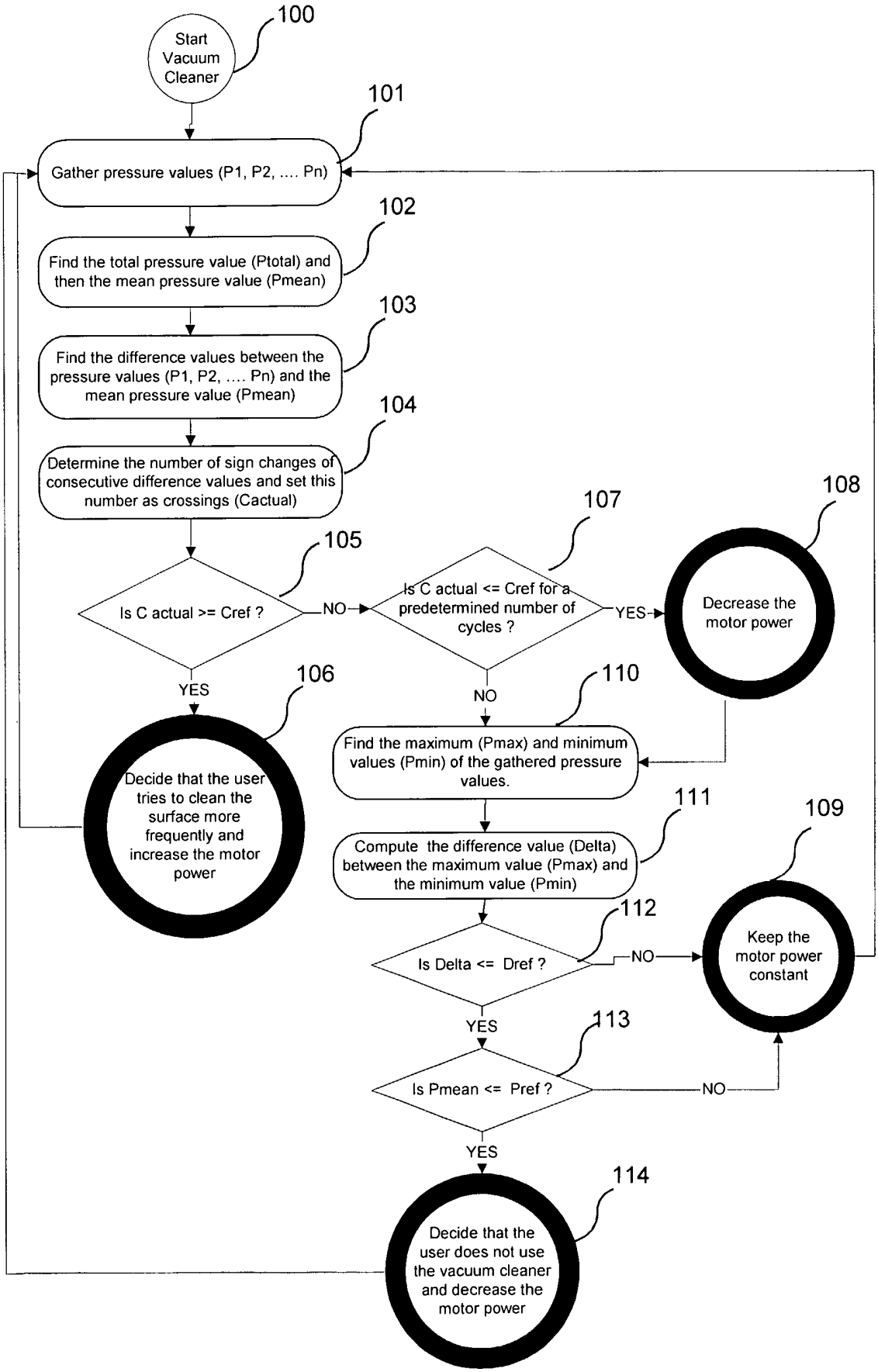
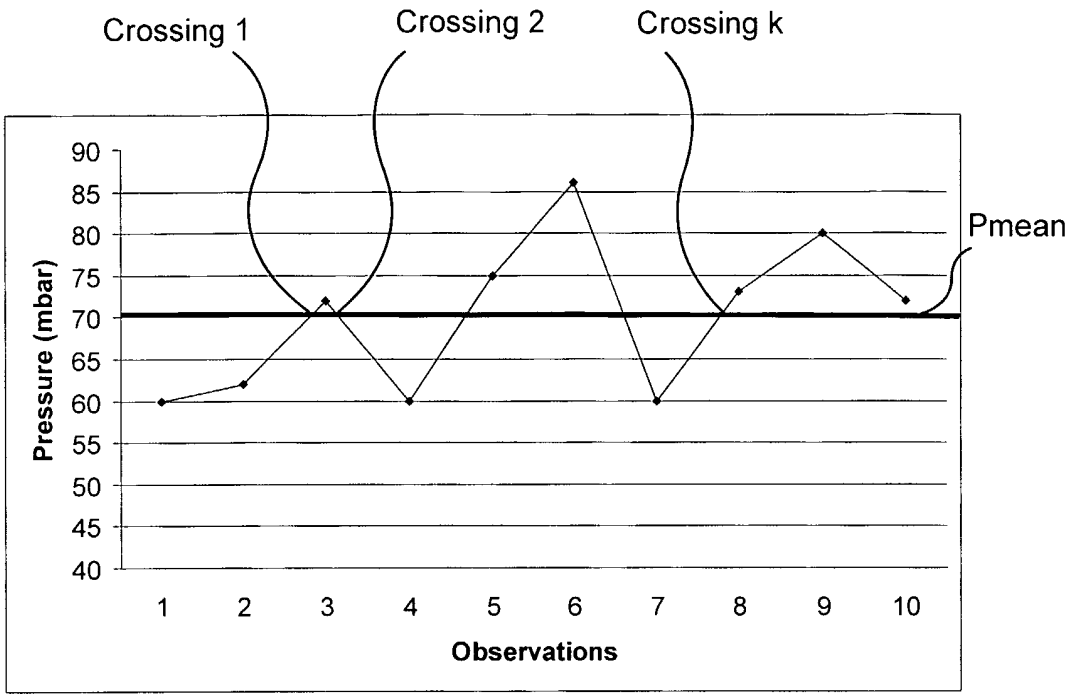

100
Start Vacuum Cleaner
101
Gather pressure values (P1, P2, ... Pn)
102
Find the total pressure value (Ptotal) and then the mean pressure value (Pmean)
103
Find the difference values between the pressure values (P1, P2, ... Pn) and the mean pressure value (Pmean)
104
Determine the number of sign changes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

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

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/IR 01/00021

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A47L9/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A47L G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	---	4
Y	EP 0 467 347 A (SANYO ELECTRIC CO.,LTD.) 22 January 1992 (1992-01-22) column 4, line 43 -column 10, line 21 column 11, line 47 -column 17, line 16; figures 1,6,7A-7D,8,10,13-15	1
A	---	3
A	EP 0 933 058 A (STMICROELECTRONICS S.R.L.) 4 August 1999 (1999-08-04) cited in the application the whole document	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 January 2002	04/02/2002

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INTERNATIONAL SEARCH REPORT

In nal Application No
PCT/IR 01/00021

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

Ir ›nal Application No
IC1/FR 01/00021

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