(54) Title: IMPROVEMENTS RELATING TO FLOOR CLEANING DEVICES

(57) Abstract: The invention provides a vacuum cleaning device having a suction fan, an electric motor (9) coupled thereto to drive the suction fan, a warning indicator (L) and processor circuitry (33) for controlling the motor and the indicator (L) and responsive to changes in either the motor speed or the current drawn by the motor. When either the motor speed exceeds a preset value or the current drawn falls below a preset value for a preset period of time, the warning indicator (L) is operated. The motor (9) and suction fan may also be switched off.
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Improvements Relating to Floor Cleaning Devices

This invention relates to a floor cleaning device, particularly but not exclusively to a robotic vacuum cleaner, and to a suction fan unit therefor.

Vacuum cleaners operate by having a fan unit which draws dirt-laden air through a dirty air inlet and then through a separating arrangement which separates the dirt from the air. Often the dirty air inlet will have a beater bar or brush roller which is rotated so as to agitate the floor covering which is intended to be cleaned and so loosen the dirt. The separating arrangement can comprise a filter bag or a cyclonic separation arrangement. In either case the cleaner must be manually emptied when it is full, either by disconnecting and removing a disposable bag and replacing it with a new one, or, in the case of a cyclonic separator, removing the cyclonic collector bin, emptying it and refitting it. It is usually left to the user to judge when emptying is necessary although it is known in the case of filter bags to have an automatic indicator to assist the user in making this judgement.

Blockage of the device is unusual but not impossible. For example, continued failure to empty a full vacuum cleaner can cause the bag to rupture or the cyclonic separator to become ineffective. Extremely heavy or voluminous amounts of dirt and dust on the floor being cleaned may also cause a blockage between the dirty air inlet and the separator, especially if there are restrictions or sharp corners in the airflow passage upstream of the separator.

It is an object of the present invention to provide a floor cleaning device which is capable of determining automatically whether the device has become blocked during usage. It is a further object of the present invention to provide a floor cleaning device which is capable of providing a warning to a user when a blockage has, or is likely to have, occurred.
According to the present invention there is provided a vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a sensor for sensing the speed of the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the sensor, wherein the processing circuitry is responsive to changes in the motor speed such that, when the motor speed exceeds a preset value for a preset period of time, the warning indicator is operated.

The invention also provides a vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a current sensor for sensing the current drawn by the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the current sensor, wherein the processor circuitry is responsive to changes in the drawn current such that, when a preset reduction in drawn current is sensed by the current sensor for at least a preset period of time, the warning indicator is operated.

The invention further provides a method of operating a vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a sensor for sensing the speed of the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the sensor, the method comprising the steps of continuously or periodically sensing the speed of the motor and operating the warning indicator if the speed of the motor exceeds a preset value for a preset period of time.

The invention still further provides a method of operating a vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a current sensor for sensing the current drawn by the motor, a warning indicator and processor
circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the current sensor, the method comprising the steps of continuously or periodically sensing the current drawn by the motor and operating the warning indicator when a preset reduction in drawn current is sensed by the current sensor for at least a preset period of time.

In order that the invention may be more clearly understood, reference will now be made to the accompanying drawings, wherein:

Figure 1 is a perspective view of a robotic vacuum cleaner embodying the invention;

Figure 2 is a block circuit diagram of the power management system and navigation system of the cleaner of Figure 1;

Figure 3 is a more detailed block circuit diagram of the power management system shown in Figure 2;

Figure 4 is a block circuit diagram of the control circuit of the fan and motor unit of the cleaner, and

Figure 5 shows how the speed of motor varies in use.

Referring firstly to Figure 1 of the drawings, there is shown therein a robotic floor cleaning device in the form of a robotic vacuum cleaner comprising a main body 10, two drive wheels 11, a brushbar housing 12, two rechargeable batteries 13, 14, a cyclonic separator 15 of the type described in EP-A-0 042 723, a user interface 16, a light detector 17 (or a plurality thereof) and various sensors 19, 27 - 31 which will be more particularly described hereinafter. The light detector 17 detects light received
from a plurality of compass points around the vacuum cleaner and is more particularly described in our copending International Patent Application No PCT/GB99/04092.

The circuit shown in Figure 2 comprises the two rechargeable batteries 13, 14, a battery and motor management system 18, a motor and suction fan unit 9, motors 20 and 21 for driving the left and right hand wheels 11 of the vacuum cleaner, a motor 22 for driving a brush bar of the vacuum cleaner, processing circuitry 23 (which includes a microprocessor and field programmable gate arrays, or equivalent circuitry) for a navigation system 34 (see Figure 3), left and right hand sensor interfaces 24 and 25, respectively, a user interface board 26, the light detector 17, and a blockage warning indicator L. The blockage warning indicator L takes the form of a light or lamp which can be illuminated.

The navigation system 34 of the robotic vacuum cleaner also includes a plurality of infrared transmitters 27a and infrared receivers 27b, a plurality of ultrasonic transmitters 19a and ultrasonic receivers 19b, threshold detectors 30 for detecting the presence of a portable threshold locator (not shown) beyond which the vacuum cleaner may not pass, and one or more pyroelectric detectors 31 for detecting animals and fires. There are four main ultrasonic receivers 19b which face forwards, rearwards and to opposite sides of the robotic vacuum cleaner. The signals received from these receivers 19b not only provide information representative of the distance of the vacuum cleaner from a feature of the room or from an object in the room, but the amplitude and width of the received signals may vary according to the type of material sensed.

As shown in Figure 3, the battery and motor management system 18 comprises a central processor 33 which receives data from battery monitors (not shown) in the rechargeable batteries 13, 14. The processor 33 calculates the charge remaining in the batteries 13, 14 and passes this information on to the processing circuitry 23 of the navigation system 34.
The central processor 33, typically a Hitachi H8/3334 F microprocessor, is connected to the user interface board 26 and supplies power to the navigation system 34 which includes the processing circuitry 23 and sensors 19, 22 - 31. It also supplies power to the motors 20, 21 and 22 and to the motor and suction fan unit 9.

A global ON/OFF switch 35 is located on the user interface 16. The switch 35 interacts directly with the processor 33. Setting the switch 35 to OFF initiates a power down sequence which ultimately sets the processor 33 into an inactive state. Setting the switch 35 to ON activates the processor 33 which then executes a power-up sequence.

Communication lines 36 between the processor 33 and the navigation system 34 carry data relating to the batteries 13, 14 and power supplies for motors 20, 21, 22 and the fan unit 9 in one direction, and a drive command for the motor and suction fan unit 9 and power switching in the other direction.

The battery and motor management system 18 includes a power supply unit 37 for providing a regulated supply to the navigation system 34. The power supply unit 37 and the power supplies to motors 20, 21 and 22 and the motor and suction fan unit 9 have current sensors (not shown). These allow the processor 33 to monitor the current taken by the power supply unit 37, the motors 20, 21 and 22 and motor and suction fan unit 9 and to shut down the vacuum cleaner if a predefined limit is exceeded. Information relating to the current taken by the motors 20 and 21 also provides an indication of the gradient and type of surface over which the vacuum cleaner is moving. The outputs from the current sensors are analogue signals. These are conditioned and then converted to digital values for subsequent processing by analogue-to-digital converters integrated into the processor 33.

The traction and brush bar motors 20, 21 and 22 require pulse width modulation (PWM) speed control. The system therefore requires 3 PWM generators capable of providing 0-
100% PWM at >50 kHz with a resolution of 1/128. The PWM control of the motors 20, 21 and 22 is carried out in the navigation system 34.

The provision of two separate processing systems 23 and 33 allows each system to carry out an integrity check on the other respective system and to shut down the vacuum cleaner if a fault is detected.

The particular method of operating and navigating the robotic vacuum cleaner is not a part of the present invention. Suffice it to say that the control and navigation system will drive the cleaner around an area to be cleaned and the various sensors 19, 27 - 31 will detect any portable threshold locators, obstacles in the room and other room features, such as corners of the room and fireplaces, and the processing circuitry 23 will navigate the robotic vacuum cleaner in order to avoid collision with any such obstacles and to change direction when a corner of a room is reached. One particular operating method is described in more detail in our copending International Patent Application No PCT/GB99/04072.

Referring to Figure 4, the motor and suction fan unit 9 shown within the broken line includes a motor stator 40 and a rotor 39 which is mounted on a motor shaft 58 which drives a fan. The motor is a 4/2 two-phase switched reluctance motor. A shaft encoder (not shown) is located on the motor shaft 58. The optical pickup from the encoder generates a square-wave output whose edges occur every 90 degrees as the rotor aligns with the stator poles, i.e. two pulses per rev. The frequency of this signal tracks the motor speed. The motor and suction fan unit 9 also includes a processor 70 which receives the shaft encoder signal from shaft encoder. The processor 70 processes the signal from the shaft encoder and generates FET control signals which are passed to the FET array 72 to drive the stator windings. The timing of these signals is based on a control map for the motor; the on and off angles vary with speed and define the amount of power input to the motor.
The motor and suction fan unit 9 has two connections to the power-management control processor 33. These are on/off switch input and speed output (which is actually one of the FET drive signals). Additionally, the processor 33 monitors the input current and volts to the motor and suction fan unit 9. The current drawn by the motor and suction fan unit 9 is sensed by the control processor 33.

In a first iteration of the present embodiment, the speed of rotation of the rotor 39 is limited by the processor 70 to a particular speed, in this specific embodiment 20,000 rpm. The processor 70 incorporates a closed loop which maintains constant the rotor speed and this optimises dirt pickup efficiency. The input current to the FET array 72 is a function of the airflow within the vacuum cleaner. If a blockage occurs anywhere in the airflow path of the cleaner, the load on the fan will substantially decrease and so the current drawn by the motor and suction fan unit 9 will substantially decrease. For example, the current drawn in normal operation by the motor and suction fan unit 9, providing around 200 watts, would be around 5 amps. If the airflow path becomes blocked, the current drawn would fall to around 2 amps and this will be detectable by the processor 33. The processor 33 is programmed to sense this decrease in current and, if the situation exists for more than a preset period of time, eg. five seconds, will initiate shutdown of the motor and suction fan unit 9. In this event, the control processor 33 will send a signal to the user interface 26 via the navigation processing system 23 instructing the user interface 26 to illuminate the blockage warning indicator L. Illumination of the warning indicator L comprises continuous or flashing illumination of the light or lamp at a maximum intensity.

In an alternative iteration, the motor and suction fan unit 9 is designed to run at maximum speed until it becomes self-limiting under normal operation. In this embodiment, the maximum loaded speed would be about 23,000 rpm. Under these circumstances if a blockage occurs anywhere in the airflow path of the cleaner, the motor and suction fan unit 9 will speed up to around 30,000 rpm because the load on the motor will decrease. The motor limits itself by cutting back the FET drive. As it speeds
up, the input power (i.e. the current) actually drops from around 6A to 2A. The values for current and motor speed are continuously monitored and transmitted to the main navigation processor 23. The processor 23 is responsible for turning the motor and suction fan unit 9 on and off by sending commands to the processor 23. If the blockage persists for more than a preset period of time, e.g. five seconds, the processor 23 will, via the communications link 36, instruct the user interface board 26 to illuminate the blockage warning indicator L and shut down the motor and fan unit 9. The speed of the motor at which the processor 23 will illuminate the warning indicator L and shut off the motor and fan unit 9 can be varied to any value above that at which the motor normally runs, i.e. above 23,000 rpm.

It is an important feature that there is a time delay before shutting down the motor and fan unit 9 in response to the detection of a situation which indicates the presence of a blockage. It is possible to simulate a blockage, intentionally or unintentionally, by pressing the dirty air inlet of the cleaner flat on the floor or other surface being cleaned so that little or no air flows through the cleaner. It is assumed here that the user will not do this for any significant length of time, e.g. not more than five seconds. The timed response of the processor 23 is arranged to ensure that premature shut down of the cleaner does not take place through the manual user situation described above. The preset period of time is preferred to be at least 2 seconds but can be varied from the period of 5 seconds mentioned above to suit requirements.

It is not essential that the motor and suction fan unit 9 is switched off simultaneously with the operation of the warning indicator L. In a further embodiment of the invention, the processor 23 is programmed to operate exactly as described above except that the motor and suction fan unit 9 continues to operate after the warning indicator L has been operated. This can be advantageous in some circumstances. It is also possible to arrange for the warning indicator L to take the form of an audible signal which is particularly useful when the invention is embodied in a robotic vacuum cleaner designed to operate autonomously as described above. If the motor and suction fan unit 9 is not
switched off when the warning indicator L is operated, the warning indicator L is advantageously audible and is arranged to produce a sound which is likely to be heard from a distance and above the noise of the motor and suction fan unit 9.

The processor 23 can also be programmed to provide some advance warning to the user of the vacuum cleaning device of the fact that a blockage may be present or building up. In a still further embodiment of the invention, the warning indicator L is a light or lamp which is illuminated to a maximum intensity to warn the user of a blockage being present. The signal provided by the indicator L can be either continuous or flashing. This signal will only be given by the indicator L when either the speed of the motor has remained above the preset value (30,000 rpm) or the preset reduction in current (3A) has persisted for the preset period of time (5 seconds). However, whenever the motor speed exceeds the preset value (30,000 rpm), the indicator L can be illuminated in a different manner to warn the user of the possibility of a blockage being present or imminent but that the conditions under which a blockage is assumed to have occurred have not yet occurred. For example, the light L can be illuminated to an intensity lower than the maximum intensity so that the light glows rather than shines. Alternatively, the light L can be made to flash. If the light L is arranged to flash when there is a blockage, the flashing sequence under the conditions just described can be made to be less frequent or of shorter duration than that implemented when there is a blockage. Figure 5 shows how the speed of the motor varies with time. At point 60 the motor speed exceeds the maximum preset speed (30,000 rpm) for a short time, which may be caused by the inlet nozzle of the cleaner becoming momentarily blocked. The time that the speed exceeds preset speed is less than the time required for the warning indicator to be illuminated. However, in region 65, the motor speed exceeds the maximum preset speed (30,000 rpm) for a much longer time, which may be caused by the airflow path becoming blocked. The motor speed exceeds the preset speed for a time which is longer than the preset period (e.g. 2 or 5 seconds) and thus the warning indicator will be illuminated.
This versatility of the control of the warning indicator L by the processor 23 can also be used to provide further information to the user concerning the likelihood of a blockage occurring in the vacuum cleaner. In a further embodiment in which the speed of the motor is sensed, the normal speed of the motor is recognised to be approximately 23,000 rpm. The processor 23 is programmed to illuminate the lamp L continuously and at maximum intensity if the speed of the motor exceeds 30,000 rpm for at least 5 seconds. However, since the speed of the motor is monitored continuously, a signal can be generated whenever the speed of the motor rises above 23,000 rpm. The processor 23 can be programmed to calculate the ratio of the current motor speed above 23,000 rpm to the maximum permitted motor speed above 23,000 rpm (7,000 rpm) and then to illuminate the lamp L to an intensity which is equivalent to that proportion of the maximum intensity. Hence the lamp L glows faintly when the motor speed exceeds the normal speed by only a relatively small amount with the intensity of the light increasing as the motor speed approaches 30,000 rpm. Equally, the excess speed of the motor can be indicated by the lamp L being made to flash in a sequence representative of the excess speed. For example, if the motor speed is only slightly above 23,000 rpm, the flashing sequence can consist of very short flashes interspersed with long periods and the flashes can become longer with respect to the intervening periods as the motor speed approaches 30,000 rpm. Alternatively, the flashes and intervening periods can be of fixed ratio with the frequency of the flashes increasing with the speed of the motor. The same effect can be achieved when the drawn current is sensed, with the drop in current being identified as a proportion of the maximum permitted drop and the lamp L being either illuminated to a proportional intensity or caused to flash in a sequence indicative of the drop in current.

In the arrangements described above, the user interface lamp L will be fully illuminated (either continuously or periodically) when the cleaner senses that it is likely that a blockage is present in the airflow path. The blockage could take the form of an accumulation of debris collected within the airflow path between the dirty air inlet and the separating apparatus or, if the separating apparatus is not emptied sufficiently
frequently, the blockage could occur within the separating apparatus itself. A further possible cause of the motor speed increasing or the drawn current reducing is that one or more of the pre-motor and post-motor filters is overdue for replacement or cleaning. The possibility of the cause of the sensed blockage being a filter requiring replacement or cleaning can be eliminated by the provision of alternative sensing and indicating means which will allow the user to be informed of this specific situation. Therefore, the blockage indicator L will be illuminated only in a reduced range of circumstances. For example, pressure sensors can be located on either side of the pre-motor and post-motor filters so that, if one of these filter requires replacement, a different warning indicator located within the user interface 26 is illuminated in preference to the blockage warning indicator L. Thus, the processing circuitry only illuminates the blockage indicator L if the motor speed or current meets the conditions required for the indicator L to be illuminated and the filter condition sensing means determines that the filter condition is satisfactory. This has the advantage that a user receives accurate information about where a problem lies and can more quickly address the problem, such as by looking for a blockage in the airflow path only when the blockage indicator is illuminated and only replacing or washing the clogged filter when this is indicated as needing attention.

The invention is not intended to be limited to the precise features of the embodiment described above. Various modifications and variations will be apparent to a skilled reader. It will be apparent that this invention is not limited to autonomous vacuum cleaners but can be used on manually operated machines for domestic or commercial use.
Claims:

1. A vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a sensor for sensing the speed of the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the sensor, wherein the processing circuitry is responsive to changes in the motor speed such that, when the motor speed exceeds a preset value for a preset period of time, the warning indicator is operated.

2. A vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a current sensor for sensing the current drawn by the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the current sensor, wherein the processor circuitry is responsive to changes in the drawn current such that, when a preset reduction in drawn current is sensed by the current sensor for at least a preset period of time, the warning indicator is operated.

3. A vacuum cleaning device as claimed in claim 1 or 2, wherein the processing circuitry is capable of switching off the motor when the warning indicator is operated.

4. A vacuum cleaning device as claimed in any one of the preceding claims, wherein the preset period of time is more than two seconds.

5. A vacuum cleaning device as claimed in claim 4, wherein the preset period of time is substantially five seconds.
6. A vacuum cleaning device as claimed in any one of the preceding claims, wherein the warning indicator comprises a light which is illuminated when the warning indicator is operated.

7. A vacuum cleaning device as claimed in claim 6, wherein the processor circuitry is capable of illuminating the light to different levels of intensity and/or in a flashing sequence.

8. A vacuum cleaning device as claimed in any one of the preceding claims, wherein the warning indicator comprises an audible signal.

9. A vacuum cleaning device as claimed in any one of the preceding claims further comprising sensing means for sensing the condition of a filter in the airflow path of the cleaning device and wherein the processing circuitry operates the warning indicator only if the motor speed or current reaches a level where the warning should be operated and the filter condition sensing means indicates that the filter condition is satisfactory.

10. A vacuum cleaning device as claimed in any one of the preceding claims, wherein the motor is a switched reluctance motor.

11. A vacuum cleaning device as claimed in any one of the preceding claims, wherein the motor has a shaft on which a shaft encoder is located.

12. A vacuum cleaning device as claimed in any one of the preceding claims, wherein the vacuum cleaning device is a robotic vacuum cleaner.

13. A vacuum cleaning device as claimed in claim 12, further including power operated means for moving the cleaner along the floor, at least one rechargeable battery, a navigation system for navigating the cleaner around a room to be cleaned, and a power
management system for distributing power from the or each battery to the power operated means, to the suction fan and to the navigation system.

14. A robotic vacuum cleaner substantially as hereinbefore described with reference to the accompanying drawings.

15. A method of operating a vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a sensor for sensing the speed of the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the sensor, the method comprising the steps of continuously or periodically sensing the speed of the motor and operating the warning indicator if the speed of the motor exceeds a preset value for a preset period of time.

16. A method as claimed in claim 15, wherein the preset value of the motor speed is greater than 23k rpm.

17. A method as claimed in claim 16, wherein the preset value of the motor speed is 30k rpm.

18. A method of operating a vacuum cleaning device having a suction fan, an electric motor coupled thereto to drive the suction fan, a current sensor for sensing the current drawn by the motor, a warning indicator and processor circuitry which controls the motor so as to maintain the motor running at or close to a predetermined speed during normal usage, and which is connected to the indicator and the current sensor, the method comprising the steps of continuously or periodically sensing the current drawn by the motor and operating the warning indicator when a preset reduction in drawn current is sensed by the current sensor for at least a preset period of time.
19.  A method as claimed in claim 18, wherein the preset reduction in drawn current is a reduction of at least 2 amps.

20.  A method as claimed in claim 19, wherein the preset reduction in drawn current is a reduction of substantially 3 amps.

21.  A method as claimed in any one of claims 15 to 20, wherein the warning indicator is a light and operation of the warning indicator causes illumination of the light.

22.  A method as claimed in claim 21, wherein the step of operating the warning indicator comprises illuminating the light to a maximum intensity.

23.  A method as claimed in claim 22, wherein the light is illuminated to an intensity less than the maximum intensity before the preset period has expired if either the motor speed exceeds the preset value or the drawn current reduces by the preset reduction.

24.  A method as claimed in claim 22 or 23, wherein the light is illuminated to an intensity less than the maximum intensity if either the motor speed approaches the preset value or the drawn current reduces by an amount approaching the preset reduction.

25.  A method as claimed in claim 24, wherein the intensity of the light is increased in proportion to the proximity of either the motor speed to the preset value or the drawn current reduction to the preset reduction.

26.  A method as claimed in claim 22, wherein the light is caused to flash at a preset rate before the preset period has expired if either the motor speed exceeds the preset value or the drawn current reduces by the preset reduction.
27. A method as claimed in claim 22 or 26, wherein the light caused to flash at a preset rate if either the motor speed approaches the preset value or the drawn current reduces by an amount approaching the preset reduction.

28. A method as claimed in claim 27, wherein the rate of flashing is increased in proportion to the proximity of either the motor speed to the preset value or the drawn current reduction to the preset reduction.

29. A method as claimed in any one of claims 15 to 28, wherein the step of operating the warning indicator is accompanied by a simultaneous step of switching off the motor.

30. A method of operating a vacuum cleaning device substantially as hereinbefore described with reference to the accompanying drawings.
FIG. 1.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

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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)

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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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<td>EP 0 370 610 A (HOOVER PLC) 30 May 1990 (1990-05-30) column 3, line 7 -column 5, line 23;</td>
<td>1-3, 6, 9, 14, 21, 29, 30</td>
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<td>EP 0 373 353 A (INTERLAVA AG) 20 June 1990 (1990-06-20) column 7, line 3 -column 9, line 44;</td>
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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

**Date of the actual completion of the international search**

26 January 2001

**Date of mailing of the international search report**

02/02/2001

Name and mailing address of the ISA

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