(12) UK Patent Application (19) GB (11) 2 357 028 (13) A

(43) Date of A Publication 13.06.2001

(21) Application No 9928652.8

(22) Date of Filing 06.12.1999

(51) INT CL[7]
A47L 9/00 11/40

(52) UK CL (Edition S)
A4F FCCX FD14 FEF12 FFC FHC13

(56) Documents Cited
WO 99/59042 A1

(58) Field of Search
UK CL (Edition R) A4F FC FCCB FCCX FFC FSCX FSSX
INT CL[7] A47L 9/00 11/40
Online: WPI, EPODOC, PAJ

(71) Applicant(s)
Notetry Limited
(Incorporated in the United Kingdom)
Kingsmead Mill, LITTLE SOMERFORD, Wiltshire, SN15 5JN, United Kingdom

(72) Inventor(s)
David Lindsey Bisset
Stuart Bruce Riches

(74) Agent and/or Address for Service
Dyson Limited
Intellectual Property Department, Tetbury Hill, MALMESBURY, Wiltshire, SN16 0RP, United Kingdom

(54) Abstract Title
Barrier for robotic floor cleaning device

(57) Barriers (405, 406, 407) are provided for marking a threshold which an autonomous cleaning device should not cross. The threshold can be a descending stairway (402) or a plant (403) which sensors on the cleaning device (100) may not be able to properly detect. The barrier (405, 406, 407) comprises a self-supporting structure having a surface which can reflect the interrogatory radiation, such as infra-red or ultrasonic radiation, from the distance sensors on the cleaning device back to the device. Preferably the barrier has a substantially continuous surface which is vertically extending with respect to the floor. The barrier can comprise a plurality of hinged parts or parts which telescope together to allow easy storage of the barrier.

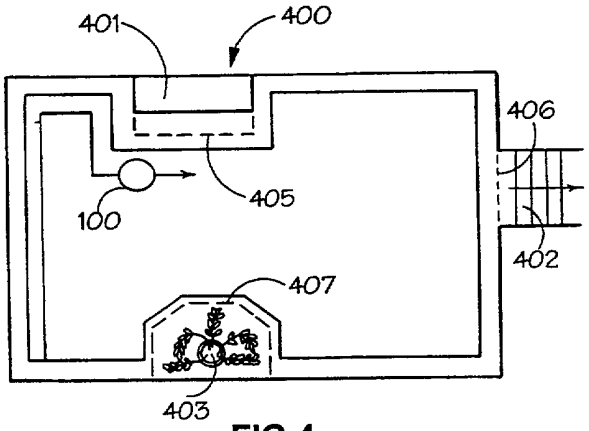

FIG.4.

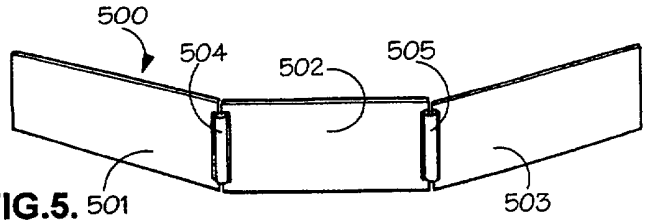

FIG.5.

GB 2 357 028 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

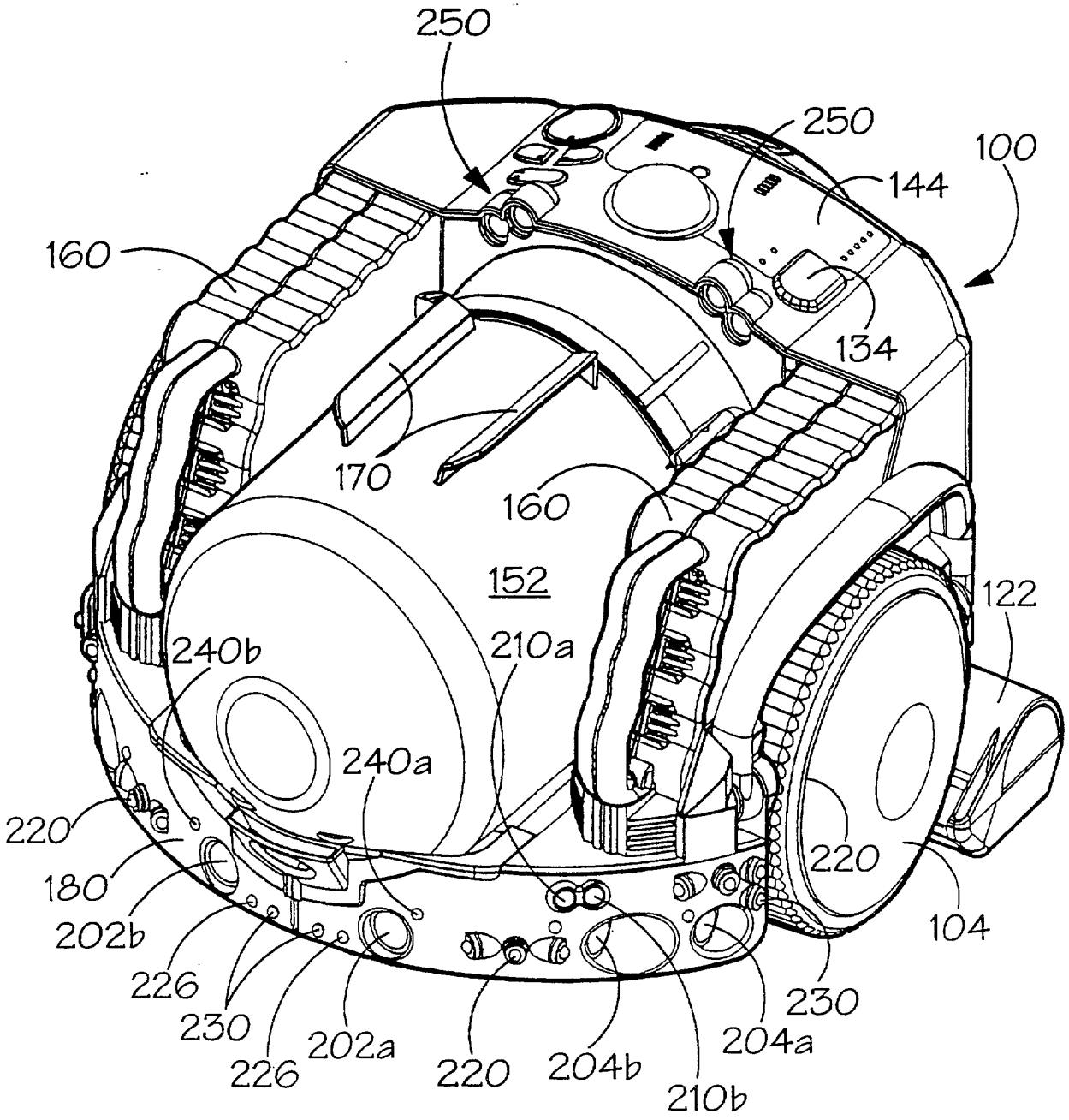
250
250
100
144
160
134
170
160
152
122
240b
210a
240a
220
180
202b
226
230
226
230
202a
220
204b
210b
204a
230
220
104

FIG.1.

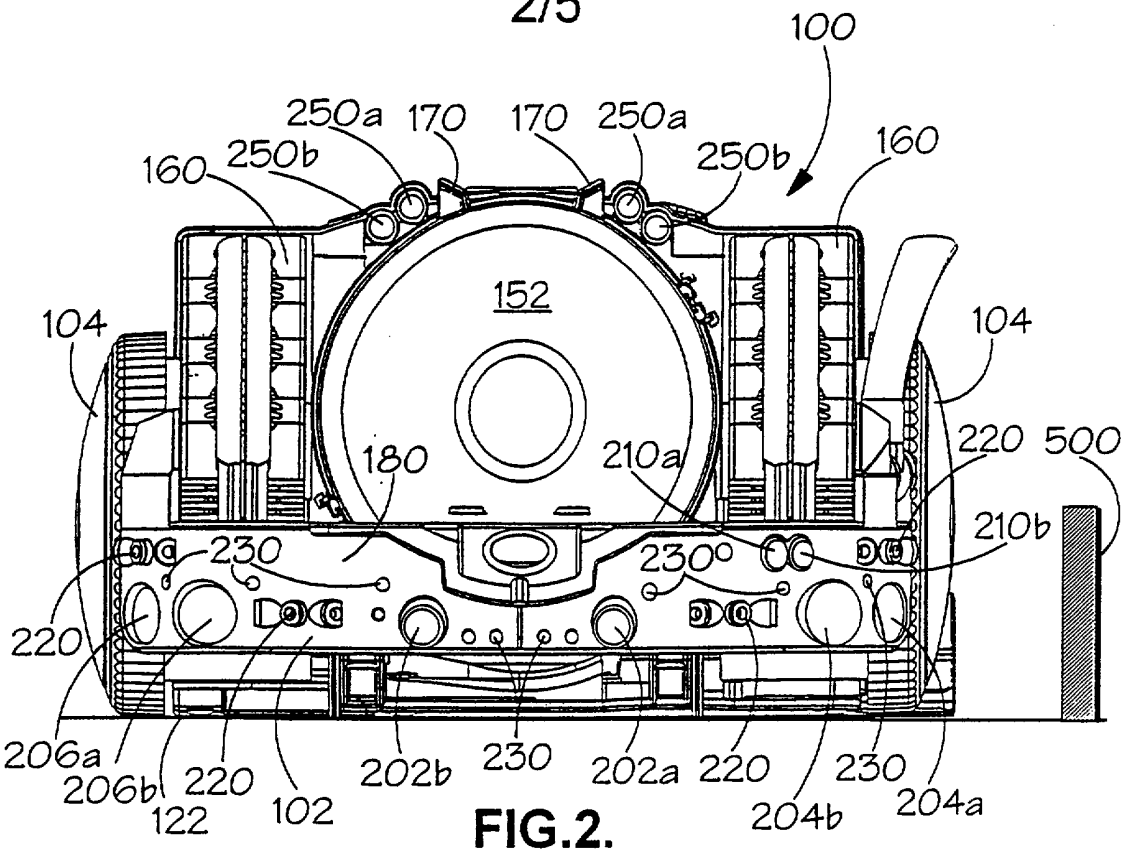
100
250a
170
170
250a
250b
250b
160
160
152
104
104
180
210a
220
500
210b
230
230
220
206a
206b
220
122
102
202b
230
202a
220
204b
230
204a

FIG.2.

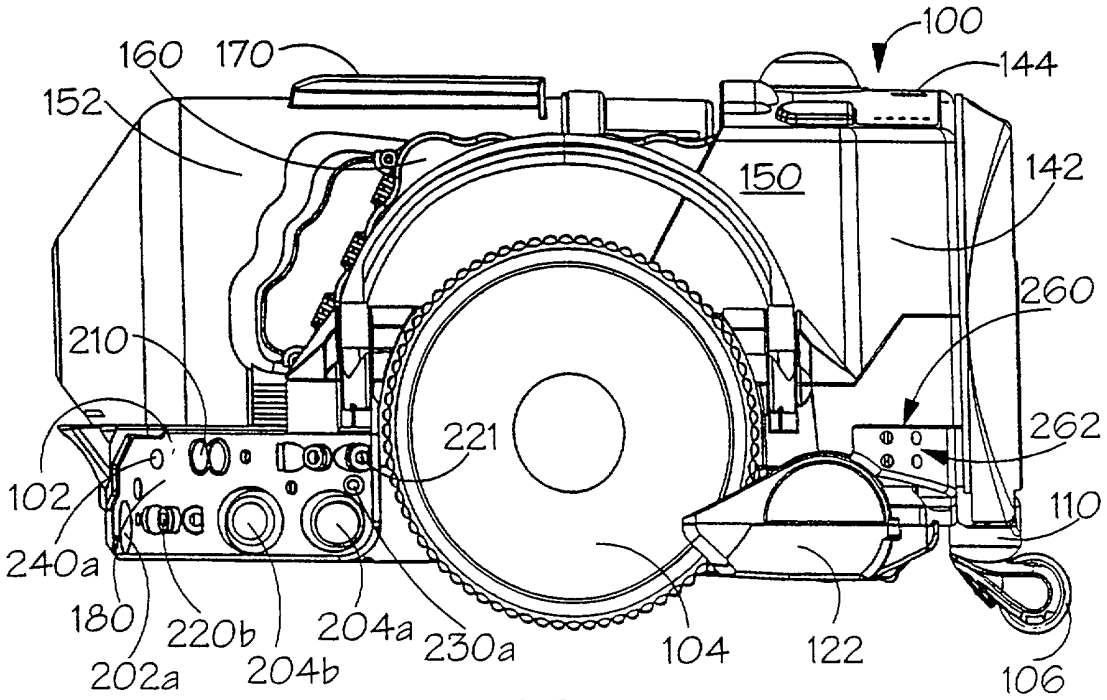
100
160
170
144
152
150
142
260
210
221
262
102
110
240a
180
220b
204a
230a
104
122
106
202a
204b

FIG.3.

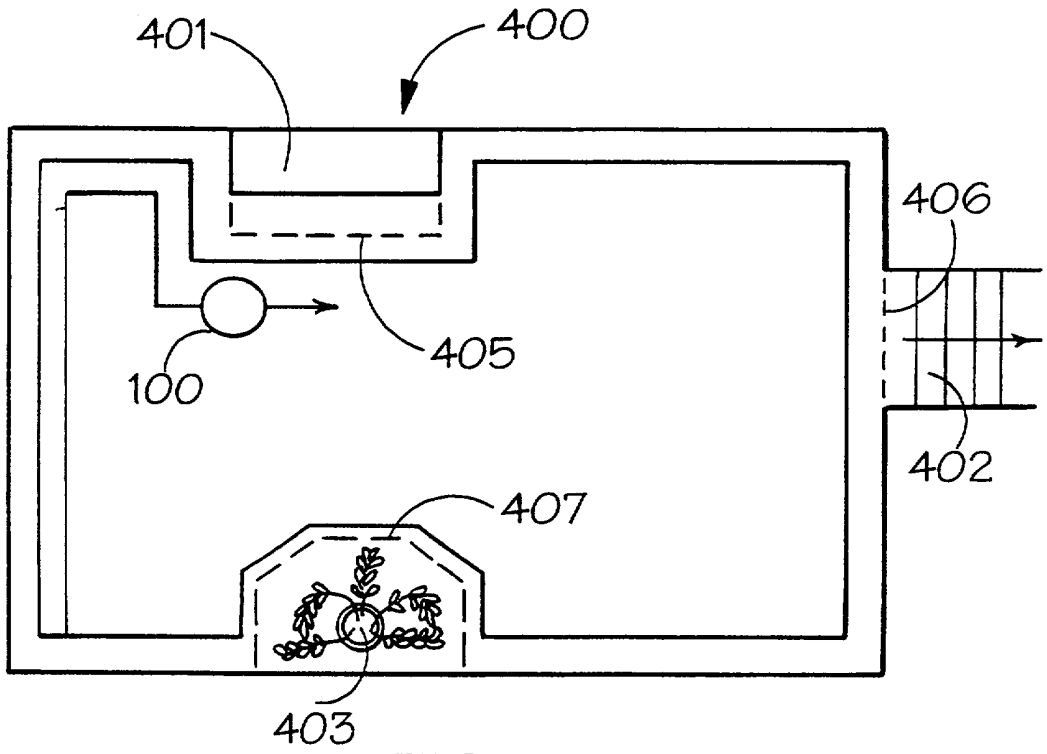

FIG.4.

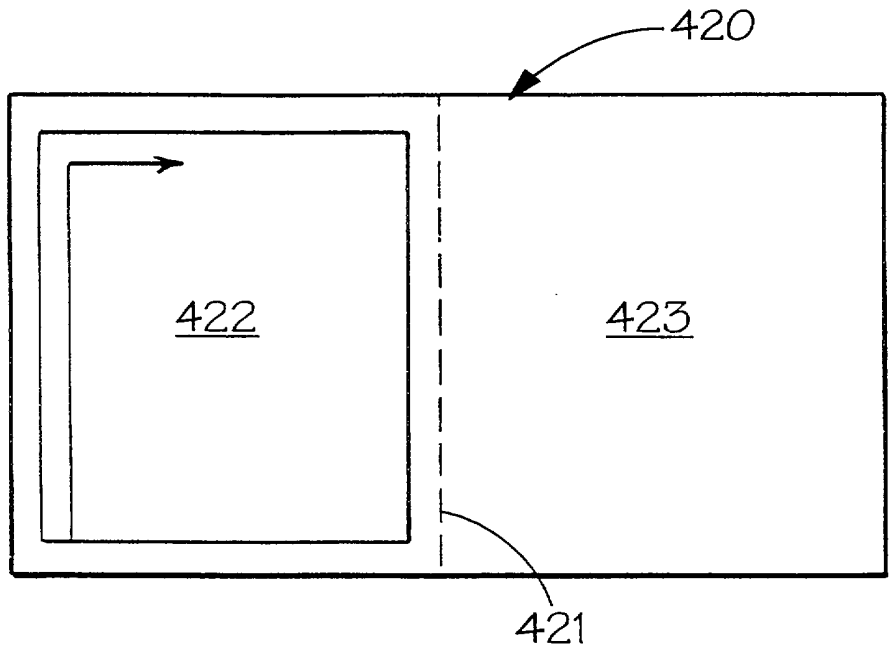

FIG.13.

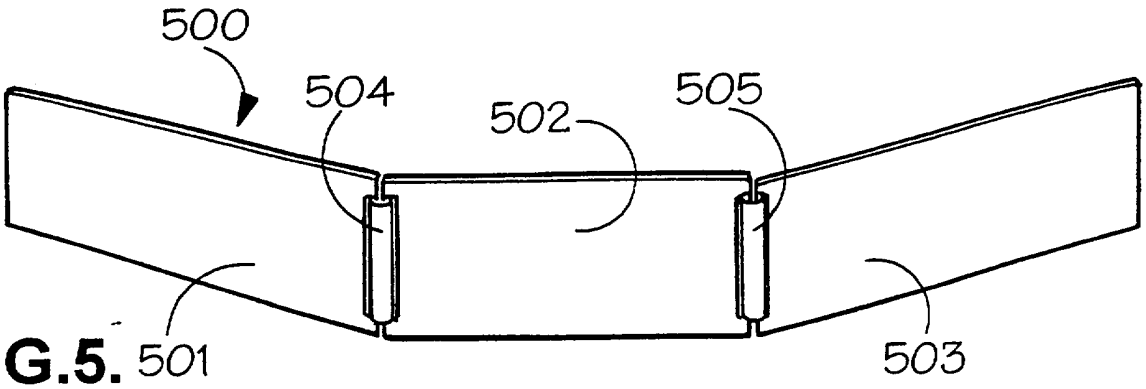

FIG.5.

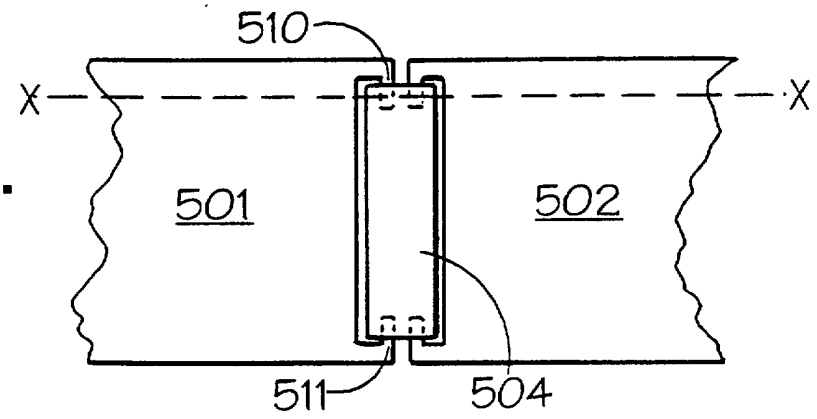

FIG.6.

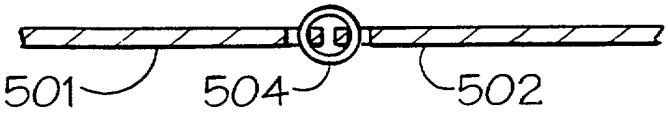

FIG.7.

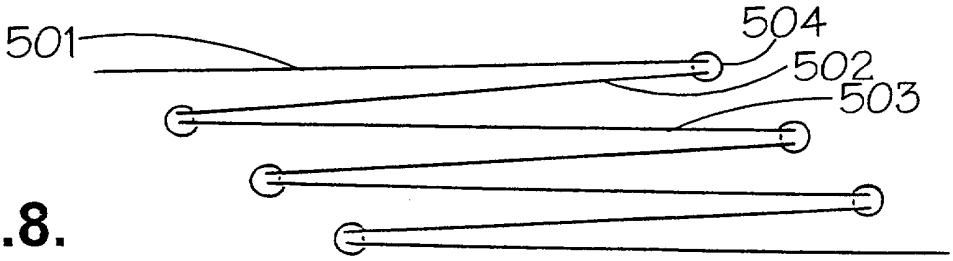

FIG.8.

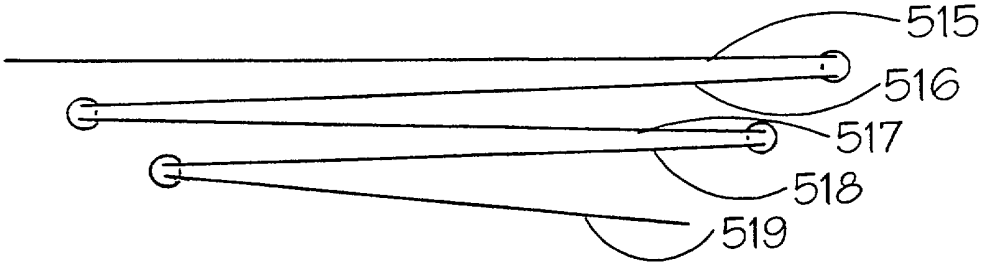

FIG.9.

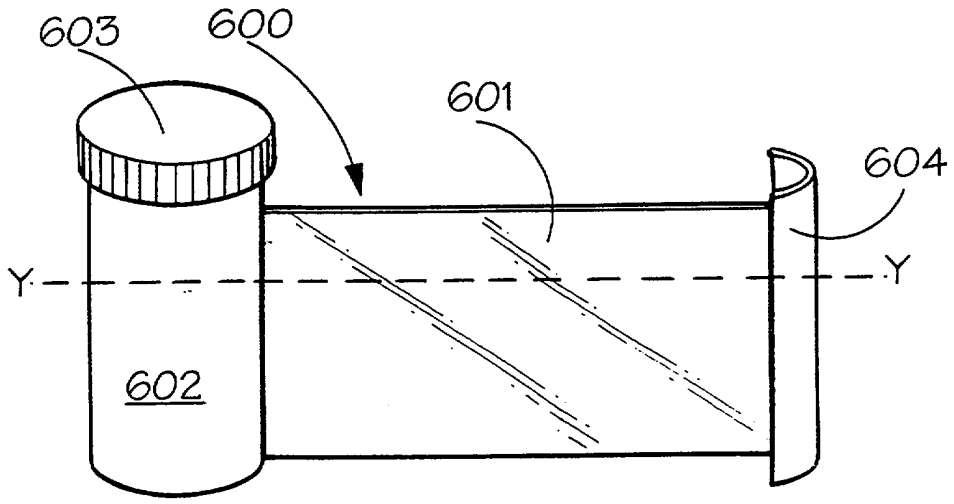

FIG.10.

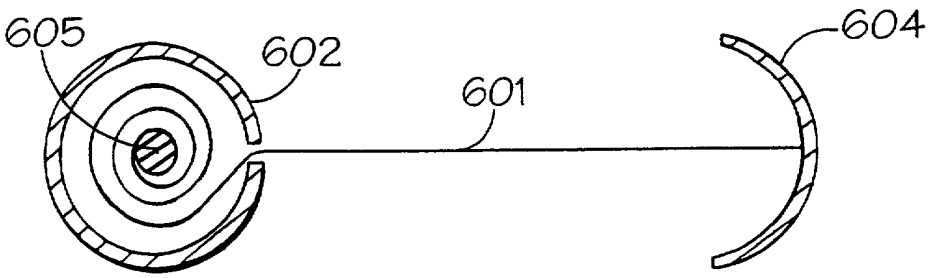

FIG.11.

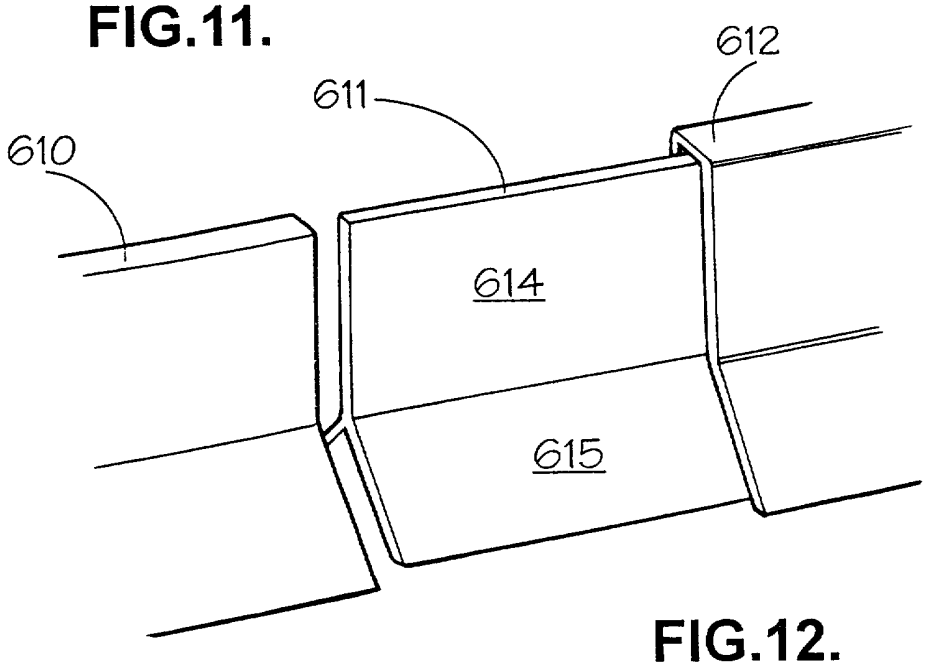

FIG.12.

Accessory for a cleaning device

This invention relates to a barrier for use with an autonomous cleaning device, apparatus for cleaning a floor surface and to a method of cleaning a floor area using an autonomous cleaning device.

There has long been a desire for a vacuum cleaner which is capable of cleaning a room without the need for a human user to push or drag the cleaner around the room. A number of robotic or autonomous vacuum cleaners have been proposed and examples are shown in, *inter alia,* US 5,787,545 and WO 99/28800. The control mechanism for these cleaners include sensors for detecting obstacles and walls so that the vacuum cleaner is capable of guiding itself around a room so as to clean the carpet or other floor covering without human intervention. While autonomous cleaners are generally capable of dealing with most rooms, there are certain limits on what such cleaners are capable of and autonomous cleaners have been known to struggle with certain types of obstacle in a room. One particularly problematic type of obstacle is the threshold to a descending stairway. Some autonomous cleaners have been sold with instructions not to use them in rooms having certain types of feature. Clearly, this limits the usefulness of an autonomous cleaner.

The present invention seeks to allow an autonomous cleaner to be used in rooms having a wider range of room features or obstacles.

Accordingly, a first aspect of the present invention provides a barrier for use with an autonomous floor cleaning device to mark a threshold which the cleaning device should not cross, the barrier comprising a self-supporting structure having a surface which is capable of reflecting interrogatory radiation from distance sensors on the device back to the device.

The barrier allows the cleaning device to be used in rooms having a much wider range of features or obstacles, such as the threshold to a descending stairway or a plant with

branches trailing onto the floor. Thus, the cleaning device can be used in more rooms of a user's home.

Another aspect of the invention provides apparatus for cleaning a floor surface comprising: an autonomous floor cleaning device comprising a navigation system for navigating the device around the floor surface, which system includes distance sensors which, in use, emit interrogatory radiation and receive reflected radiation from a surface so as to determine distance of the device from an obstacle; and a barrier for marking a threshold which the cleaning device should not cross, the barrier comprising a self-supporting structure having a surface which can reflect the interrogatory radiation from the distance sensors on the device back to the device.

A further aspect of the invention provides a method of cleaning a floor area using an autonomous floor cleaning device, the method comprising:

- marking a threshold which the autonomous cleaning device should not cross by placing a barrier along the threshold; and

- operating the cleaning device to begin autonomously cleaning the floor area, the barrier comprising a self-supporting structure having a surface which can reflect interrogatory radiation received from distance sensors on the device back to the device as the cleaning device moves around the floor area.

The barrier can be used to mark a boundary around an obstacle that a user wishes the cleaning device to avoid, or it can be used to confine the cleaning device to a region of the room.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of an autonomous cleaning device;

Figure 2 is a front view of the autonomous cleaning device of Figure 1;

Figure 3 is a side view of the autonomous cleaning device of Figure 1;

Figure 4 is a plan view of a room in which the autonomous cleaning device can operate, showing the use of barriers;

Figure 5 shows one form of barrier for use with the autonomous cleaning device;

Figure 6 shows the hinge mechanism of the barrier of Figure 5;

Figure 7 shows a cross-sectional view along line X-X of Figure 6;

Figures 8 and 9 show two arrangements for a hinged barrier;

Figure 10 shows another type of barrier for use with the autonomous cleaning device;

Figure 11 shows a cross-sectional view along line Y-Y of Figure 10;

Figure 12 shows a further type of barrier for use with the autonomous cleaning device; and,

Figure 13 is a plan view of a room showing how barriers can be used to divide the room into smaller regions to confine the autonomous cleaning device..

Figure 1 shows one example of a vacuum cleaner 100 that is capable of autonomously cleaning a room. The vacuum cleaner 100 has a supporting chassis 102 which is generally circular in shape and is supported on two driven wheels 104 and a castor wheel (106, Fig. 3). The chassis 102 is preferably manufactured from high-strength moulded plastics material, such as ABS, but can equally be made from metal such as aluminium or steel. The chassis 102 provides support for the components of the cleaner 100 which will be described below. The driven wheels 104 are arranged at either end of

a diameter of the chassis 102, the diameter lying perpendicular to the longitudinal axis of the cleaner 100. Each driven wheel 104 is moulded from a high-strength plastics material and carries a comparatively soft, ridged band around its circumference to enhance the grip of the wheel 104 when the cleaner 100 is traversing a smooth floor. The soft, ridged band also enhances the ability of the wheels 104 to mount and climb over small obstacles. The driven wheels 104 are mounted independently of one another via support bearings (not shown) and each driven wheel 104 is connected directly to a motor 105 which is capable of driving the respective wheel 104 in either a forward direction or a reverse direction. By driving both wheels 104 forward at the same speed, the cleaner 100 can be driven in a forward direction. By driving both wheels 104 in a reverse direction at the same speed, the cleaner 100 can be driven in a backward direction. By driving the wheels 104 in opposite directions, the cleaner 100 can be made to rotate about its own central axis so as to effect a turning manoeuvre. The aforementioned method of driving a vehicle is well known and will not therefore be described any further here.

Mounted on the underside of the chassis 102 is a cleaner head 122. The chassis 102 carries a plurality of sensors which are designed and arranged to detect obstacles in the path of the cleaner 100 and its proximity to, for example, a wall or other boundary such as a piece of furniture. The sensors comprise several ultra-sonic sensors and several infra-red sensors. The array of sensors will be described in more detail below. Control software, comprising navigation controls and steering devices for navigating and manoeuvring the cleaner 100 around a defined area in order to clean the carpet or other surface within the area, is housed within a housing 142 located beneath a control panel 144 or elsewhere within the cleaner 100. In the manner of known autonomous vehicles, the control software is able to receive the outputs of the sensors and to drive the motors 105 so that obstacles are avoided whilst following a path specified by algorithms appropriate to the nature of the vehicle. Any appropriate software can be used in this way to navigate the cleaner 100 around a room to be cleaned.

The vacuum cleaner 100 also includes a motor and fan unit 150 supported on the chassis 102 for drawing dirty air into the vacuum cleaner 100 via a suction opening in the cleaner head 122. The chassis 102 also carries a cyclonic separator 152 for separating dirt and dust from the air drawn into the cleaner 100. The cyclonic separator, which preferably comprises two cyclones in series, need not be described any further here, being known technology and described adequately elsewhere.

The vacuum cleaner 100 described above operates in the following manner. In order for the cleaner 100 to traverse the area to be cleaned, the wheels 104 are driven by the motors 105 which, in turn, are powered by the batteries 160. The direction of movement of the cleaner 100 is determined by the control software which communicates with the sensors which are designed to detect any obstacles in the path of the cleaner 100 so as to navigate the cleaner 100 around the area to be cleaned. The normal forward direction of the cleaner 100 is such that the cleaner head 122 trails behind the driven wheels 104. The battery packs 160 also power the motor and fan unit 150 which draws air into the cleaner 100 via the cleaner head 122 and passes it to the cyclonic separator 152 where the dirt and dust is separated from the airflow. The battery packs 160 are also used to power the motor which drives the brush bar 125 which, in turn assists with pick-up, particularly on carpets. The air which exits the cyclonic separator 152 is passed across the motor and fan unit 150 by appropriate ducting, as is common in many appliances, including vacuum cleaners.

The sensor array forming part of the vacuum cleaner 100 will now be described in more detail. The array comprises a plurality of ultra-sonic sensors and a plurality of infra-red sensors. The majority of the sensors are located in a forward surface 180 of the vacuum cleaner 100. The forward surface 180 is substantially semi-circular in plan view, as can be seen from Figures 5a and 5b. However, further sensors are located at the uppermost extremity of the cleaner 100, at the rear of the cleaner 100, immediately over the brush bar 122, and on the underside of the cleaner 100. Details are given below.

Three ultra-sonic sensors 202, 204 and 206, each consisting of an ultra-sonic emitter and an ultra-sonic receiver, are positioned in the forward surface 180. A first of the said ultra-sonic sensors 202, comprising an emitter 202a and a receiver 202b, is directed in a forward direction so that the emitted signals are transmitted in the normal forward direction of travel of the cleaner 100. A second ultra-sonic sensor 204, comprising an emitter 204a and a receiver 204b, is directed such that the emitted signals are transmitted outwardly to the left of the cleaner 100 in a direction which is perpendicular to the direction of transmission by the ultra-sonic sensor 202. A third ultra-sonic sensor 206, comprising an emitter 206a and a receiver 206b, is directed such that the emitted signals are transmitted outwardly to the right of the cleaner 100 in a direction which is perpendicular to the direction of transmission by the ultra-sonic sensor 202 and opposite to the direction of transmission by the ultra-sonic sensor 204. A fourth ultra-sonic sensor (not shown) is located in the rear of the cleaner 100 and is directed rearwardly so that the emitted signals are transmitted parallel to the normal forward direction of travel of the cleaner 100 but in the opposite direction. These four sensors 202, 204, 206, 208 detect the presence of walls and obstacles to the front, left, right and rear of the cleaner 100.

A fifth ultra-sonic sensor 210 is located in the forward surface 180. The fifth ultra-sonic sensor 210 comprises an emitter 210a and a receiver 210b. The fifth ultra-sonic sensor 210 is positioned so that the emitter 210a transmits at an angle which is substantially midway between the directions in which the forward- and left-looking sensors 202, 204 transmit. In the embodiment, the sensor 210 transmits in a direction of 45° to the normal forward direction of travel of the vacuum cleaner 100. As can be seen from Figure 1, the sensor 210 transmits to the side of the cleaner 100 on which the cleaner head 122 protrudes.

The inclusion of the sensor 210 provides the vehicle 100 with greater angular control as it moves along a wall or other obstacle with the cleaner head 122 thereagainst or parallel thereto. The sensor 210 is able to detect the presence of a wall or similar large obstacle and, if the wall or other obstacle alongside which the vehicle is moving disappears (for

example, when a corner is encountered), then the vehicle 100 is made aware of the change earlier than it would have been if the sensor 210 had not been present. This allows the vehicle to take account of corners and other changes in its environment with greater accuracy and manoeuvrablity.

A plurality of infra-red sensors are also included in the forward surface 180. The infra-red sensors comprise emitters 220 and receivers 230. Most of the emitters 220 are arranged in four groups of three which are spaced substantially evenly around the forward surface 180. Two additional emitters 226 are positioned close to the central axis of the cleaner 100 and are directioned so that they emit signals in a substantially forward direction with respect to the normal direction of travel.

Further infra-red sensors 260, 262 are positioned on the chassis 102 immediately above the protruding end of the cleaner head 122. Each sensor 260, 262 comprises an emitter and a receiver. The first of these sensors 260 is directioned so that the emitter emits a signal in a direction parallel to the longitudinal axis of the cleaner head 122. The direction of the signal from the sensor 260 is therefore perpendicular to the forward direction of travel and parallel to the direction of the signal emitted by emitter 221. The sensor 260 is thus able to detect the distance of a wall or other obstacle along which the cleaner 100 is intended to travel. In combination with the emitter 221 and the receiver 230a, the sensor 260 is also able to maintain the direction of travel of the cleaner 100 parallel with the wall or other obstacle along which the cleaner 100 is intended to travel. This is achieved by way of the parallel signals being maintained essentially identical. Any variation between the two signals can be easily recognised and the path of the cleaner 100 can then be adjusted to compensate for the discrepancy. As will be seen from the figure, the distance between the directions of the two signals is approximately one half of the length of the cleaner 100, although this can be varied to a considerable extent. Preferably, the distance will not be less than a quarter of the length of the vehicle nor more than three quarters thereof.

Passive infra-red detectors 240a, 240b, are located in the forward surface 180 for the purpose of detecting heat sources such as humans, animals and fires. The passive infra-red detectors 240 are directioned so that they look in a forward direction to detect heat sources in the path of the cleaning device 100.

Two forward-looking ultra-sonic sensors 250, each comprising an emitter 250a and a receiver 250b, are positioned at an uppermost extremity of the cleaner 100 so that they are able to sense obstacles immediately in front of the cleaner and at or near an uppermost extremity thereof. In this case, the sensors 250 are positioned in the casing of the fan and motor unit 150 so that they both look along the uppermost edge of the cyclonic separator 152. The direction of each sensor 250 is parallel to the direction of the other sensor 250. The sensors 250 are able to detect any obstacles which are at a sufficiently high level not to be detected by the sensors arranged in the forward surface 180 but which would constitute an obstruction to the forward movement of the cleaner 100. Rearward-looking sensors could also be provided at a high level if required, but none is shown in the embodiment illustrated in the drawings. It will be appreciated that a similar effect can be achieved using sensors (preferably ultra-sonic sensors) positioned lower on the cleaner than the uppermost extremity but directioned so as to look towards the appropriate area adjacent the uppermost extremity in front of the cleaner 100.

Figure 4 shows a room 420 in which the cleaner can be used. Room 420 has an open fireplace 401, a descending stairway 402 and a plant 403 with branches that trail onto or near to the floor of the room. These features may present a problem for an autonomous cleaner as the cleaner may not be able to recognise these obstacles or be able to avoid them using its array of on-board sensors. The fireplace 401 will usually be successfully detected by pyroelectric or passive infra-red (PIR) sensors on the cleaner, but hot ashes may damage the cleaner if it strays too close to the fire. The stairway 402 may not be successfully recognised by some types of cleaner, which could lead to the cleaner becoming stuck at the top of the stairs 402 or falling down the stairs. The trailing branches of plant 403 may not present a distinct boundary that the cleaner can

recognise, which could cause the cleaner to become stuck due to the branches becoming wound around the cleaner brushbar or wheels.

The dashed lines 405, 406, 407 represent the positioning of barriers which a user sets up in the room. The user positions these barriers around the obstacles that the cleaner is likely to have a problem in avoiding. The cleaner can detect the presence of these barriers using its on-board sensors and, in traversing the floor area, will travel around the barrier thus safely avoiding the obstacle 401, 402, 403 hidden behind the barrier.

It will be appreciated that other room features or obstacles can be guarded using the barrier in the same manner as described above.

Various forms of barrier will now be described with reference to Figures 5 to 12.

Figure 5 shows a barrier 500 comprising a plurality of planar strips 501, 502, 503 that are hinged 504, 505 together. The hinges 504, 505 allow the strips to be rotated through 360° with respect to one another. This allows the strips 501, 502, 503 to be positioned in various configurations, as required by the obstacle that is being guarded, and it also allows the strips to be folded in a concertina fashion so as to lie against one another for compact storage. As shown in Figure 6, the barrier is hinged by forming ends of the planar strips 501, 502 with a pair of hook-like portions 510, 511 which can hook onto a tubing piece 504. Figure 7 shows the cross-section along line X-X in Figure 6. It will be appreciated that there are many other possibilities for hinging the strips together. Each end of a strip 501 may have a plurality of spaced apart holes and connecting rings can be passed through holes in adjacent strips. Alternatively, adjacent ends of strips 501, 502 may be joined by a length of tape to form a flexible hinge or the hinge may be a weakening line in the strip itself.

The height of each strip 501, 502 is chosen so as to be sufficient to reflect the interrogatory radiation, such as ultrasound or infra-red radiation, received from the sensors on the cleaning device 100. As shown in Figure 2, cleaning device 100 has a

belt of sensors around its periphery, and the barrier 500 extends at least as high as the sensors. Typically the barrier has a height of around 70mm. The surface of barrier 500 is supported so that it extends generally vertically with respect to the floor, and the material from which the barrier 500 is formed should be one that is reasonably good at reflecting radiation of the type used by the sensors on the cleaning device 100. Polypropylene and other plastics or metals are particularly suitable materials. These materials also have the advantage that the barrier 500 is strong enough to withstand repeated use and a user accidentally treading on or kicking the barrier. The planar strips 501, 502, 503 present a smooth surface that the cleaning device can easily follow. The joins 504, 505 between each pair of strips also present a smooth transition that the cleaning device can follow.

The total length of the barrier 500 is chosen so as to be sufficient to span most obstacles usually encountered in a room, typically 1m. Of course, several barriers 500 can be used together where it is necessary to span a wide obstacle. The length of each individual strip 501 is chosen so that the length of the barrier, when collapsed, is short enough to be easily stored. Figures 8 and 9 show two preferred arrangements for the strips forming the barrier. In Figure 8, the strips 501, 502, 503, 504 are alternately of long and short lengths. Thus strip 501 is longer than strip 502, and strip 503 is longer than strip 502. This allows the hinges, which are relatively bulky pieces, to concertina into a flatter form than would be possible if the strips were all of equal length, since in Figure 8 hinges do not stack against one another in the folded state. The same advantage is achieved by the arrangement shown in Figure 9, where the strips 515, 516, 517, 518, 519 are of progressively decreasing length.

The arrangement of hinged parts is self-supporting in most configurations. However, where additional support is required, such as when the strips 501, 502, 503 are all aligned with one another, it is possible to use additional support means. The support means can comprise parts which lie on the floor surface and have a groove to accept the strip 501 and support it in a vertical position.

Figure 10 shows another form of barrier. A length of flexible material 601 such as strong paper, plastic sheeting or fabric, is wound inside a housing 602. A free end of the strip 601 is secured to a support 604 that is capable of standing, unaided, on a floor. Support 604 is arc-shaped to fit snugly against the side of the cylindrical housing 602 when the strip is completely withdrawn inside the housing. Alternatively, the side of housing 602 may be recessed to accommodate the support 604. A knob 603 on housing 602 allows a user to rewind an extended length of the strip 601. Figure 11 shows a cross-section along line Y-Y of Figure 10. Alternatively, the strip 601 may be resiliently biased into a wound state inside the housing 602, and withdrawn from the housing and held in the withdrawn state, similar to a cable rewind for a vacuum cleaner. To use this type of barrier, a user grasps support 604 and withdraws a sufficient length of the strip 601 from the housing 602. Both the housing 602 and the support 604 stand on the floor and the strip 601 presents a smooth continuous surface that can reflect radiation from a cleaner's sensor array.

Figure 12 shows a further form of barrier. A plurality of parts 610, 611, 612 telescope together so as to present a continuous surface to the cleaning device 100. The parts 610, 611, 612 can be slidingly moved apart from one another to extend to a required length for guarding an obstacle or slided over one another to telescope together for storage. Two, three or more parts can be used as necessary. The parts have a generally 'Y'-shaped cross-section, the arms 615 providing a stable support while the vertically extending surface 614 provides a good surface for reflecting interrogatory radiation from cleaner 100.

While the barrier is particularly useful in guarding obstacles that the cleaner may not be able to avoid itself, Figure 13 shows another use for the barrier in dividing a large area. A barrier 421 is placed across a large room 420, the barrier 421 extending between opposing walls of the room. This divides the room 420 into two smaller regions 422, 423. The cleaner can then be set to clean one of the regions 422. If needed, the cleaner can then be set to clean the other region 423. The barrier may alternatively be used across the threshold dividing two rooms. There may be various reasons for doing this.

There may be a need to operate the cleaner in a room that is being used by humans or animals. By placing the barrier across the room 421, a human or animal can continue to use region 423 while the cleaner operates unhindered in region 422. A particular region of the room may require cleaning more regularly than the entire room, such as a region of the room that is subject to high traffic, where an animal is kept, or a dining area. The barrier 421 can be placed across the room so that the cleaner is confined to the region that requires the regular cleaning. Also, it may be known that the cleaner has insufficient battery power to traverse the entire room, so the room is divided into regions 422, 423, with the cleaner being able to completely traverse one of the regions without stopping to have its batteries recharged.

Claims:

1. A barrier for use with an autonomous floor cleaning device to mark a threshold which the cleaning device should not cross, the barrier comprising a self-supporting structure having a surface which is capable of reflecting interrogatory radiation from distance sensors on the device back to the device.

2. A barrier according to claim 1 wherein the surface is reflective to infra-red radiation.

3. A barrier according to claim 1 or 2 wherein the surface is reflective to ultrasonic radiation.

4. A barrier according to any one of the preceding claims wherein the surface is substantially continuous along the length of the barrier.

5. A barrier according to any one of the preceding claims wherein the surface is supported so that it is substantially vertical with respect to the floor.

6. A barrier according to claim 4 or 5 comprising a plurality of parts which cooperate to form a substantially continuous surface.

7. A barrier according to claim 6 comprising a plurality of parts which telescope together.

8. A barrier according to claim 6 comprising a plurality of hinged parts.

9. A barrier according to claim 8 wherein the hinged parts are arranged such that the hinges allow the parts to lie flat against one another.

10. A barrier according to claim 9 wherein the hinged parts are of progressively shorter lengths.

11. A barrier according to claim 9 wherein the hinged parts are alternately of first and second lengths.

12. A barrier according to claim 4 or 5 comprising a length of flexible strip with supports at each end.

13. A barrier according to claim 12 wherein a first of the supports is a housing for the strip from which the strip can be withdrawn.

14. A barrier according to claim 13 wherein the housing houses the strip in a rolled form.

15. Apparatus for cleaning a floor surface comprising:

- an autonomous floor cleaning device comprising a navigation system for navigating the device around the floor surface, which system includes distance sensors which, in use, emit interrogatory radiation and receive reflected radiation from a surface so as to determine distance of the device from an obstacle; and,

- a barrier for marking a threshold which the cleaning device should not cross, the barrier comprising a self-supporting structure having a surface which can reflect the interrogatory radiation from the distance sensors on the device back to the device.

16. Apparatus according to claim 15 wherein the barrier has a height which is greater than the height of the distance sensors on the device.

17. Apparatus according to claim 15 or 16 comprising a barrier according to any one of claims 2 to 14.

18. A method of cleaning a floor area using an autonomous floor cleaning device, the method comprising:

- marking a threshold which the autonomous cleaning device should not cross by placing a barrier along the threshold; and

- operating the cleaning device to begin autonomously cleaning the floor area, the barrier comprising a self-supporting structure having a surface which can reflect interrogatory radiation received from distance sensors on the device back to the device as the cleaning device moves around the floor area.

19. A method according to claim 18 comprising placing the barrier around an obstacle which a user wishes the cleaning device to avoid.

20. A method according to claim 19 wherein the obstacle is one of: the top of a stairwell, an open doorway, a plant with trailing branches.

21. A method according to claim 18 comprising placing the barrier across a room so as to divide the room into regions and operating the cleaning device to clean a first of the regions.

22. A barrier for use with an autonomous floor cleaning device, apparatus for cleaning a floor surface or a method of cleaning a floor surface using an autonomous floor cleaning device substantially as described herein with reference to the accompanying drawings.

10

Application No: GB 9928652.8 **Examiner:** John Wilson
Claims searched: 1-22 **Date of search:** 18 April 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): A4F[FC FCCB FCCX FFC FSCX FSSX]

Int Cl (Ed.7): A47L 9/00 11/40

Other: Online:- WPI, EPODOC, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO 99/59042 A1 Friendly Machines Ltd. - Whole document	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.