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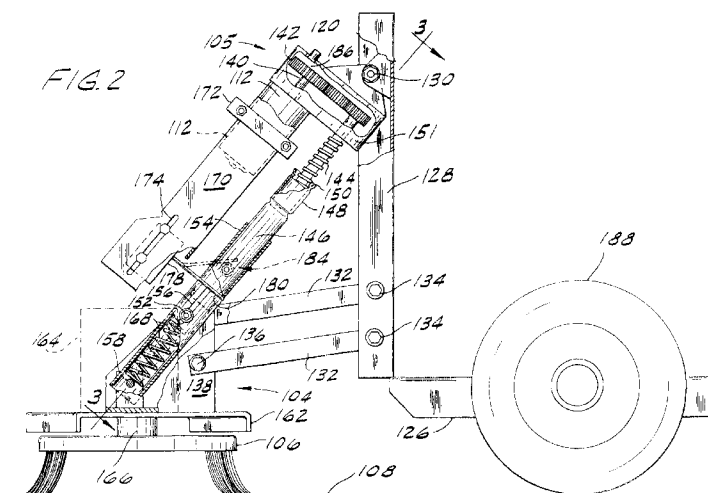
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(57) An apparatus for use on a surface (8;108;210) and responsive to an operator. A head assembly (4;104;204) is adapted to carry a brush (6;106;208) for engaging and treating the surface (8;108;210) of a floor. An actuator (12;112,142,144,146;212) raises and lowers the head assembly (4;104;204) relative to the surface (8;108;210) thereby controlling the relative engagement between the brush (6;106;208) and the surface (8;108;210) and thereby controlling the treatment of the surface (8;108;210) by the brush (6;106;208). A touchdown switch (120;178) detects a position of the head assembly (4;104;204) such as when the brush (6;106;208)

contacts the floor (8;108;210). A driving circuit (10;110;218) energizes the actuator (12;112,142,144,146;212) to raise or lower the head assembly (4;104;204) and brush (6;106;208) in response to a head position control (18;118;216) set by the operator. Alternatively, the driving circuit (10;110;218) may raise or lower the brush (6;106;208) an additional preset amount after the touchdown switch (120;178) detects that the brush (6;106;208) has touched the floor (8;108;210), the additional preset amount being defined by input from the operator. Torque and/or pressure control in combination with stroke control are also described.

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## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention.

[0001] The invention generally relates to an apparatus for treating a surface and responsive to an operator to position a head assembly relative to the surface. In particular, the invention relates to a brush head positioning system for a floor scrubber in which the brush head carries rotating brushes for cleaning the floor.

#### 2. Background of the Invention.

[0002] It is well known in the prior art that the torque of drive motors for driving brushes or other floor maintenance tools may be controlled in order to provide some type of consistency in the application of force to the floor. However, such systems tend to adjust the torque based on the type of surface of the floor or based on the condition of the floor. For example, such a system may over torque the application of a brush to a smooth floor and may under torque the application of a brush to a rough floor. In addition, a floor which has a sticky coating on it may be under torqued whereas a floor with a shiny coating on it may be over torqued.

[0003] Therefore, there is a need for a system which consistently positions the brush head relative to the floor so that the position is repeatable thereby permitting the repeatable cleaning of the floor.

### SUMMARY OF THE INVENTION

[0004] It is an object of the invention to provide a brush head cleaning system which repeatedly positions the brush head relative to the floor.

[0005] It is another object of this invention to provide a brush head cleaning system which is rugged and low in manufacturing costs but provides efficient positioning of the brush head assembly.

[0006] It is another object of this invention to provide a brush head cleaning system which permits the brush head to be positioned and which also permits the torque of the brush to be controlled after the brush head is positioned.

[0007] It is another object of this invention to provide a brush head cleaning system which permits the brush head to be positioned and which provides pressure control of the brush after the brush head has been positioned.

[0008] In one form, the invention comprises an apparatus for use on a surface and responsive to an operator. A head assembly is adapted to carry a device for engaging and treating the surface. A brush actuator raises and lowers the head assembly relative to the surface thereby controlling the relative engagement between the head assembly and the surface and thereby control-

ling the treatment of the surface by the head assembly. A sensor detects a position of the head assembly. A head position control is responsive to input from the operator and indicates a desired position of the head assembly. A driving circuit energizes the actuator to raise or lower the head assembly. The driving circuit responds to the sensor and the head position control.

[0009] Other objects and features will be in part apparent and in part pointed out hereinafter.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figures 1A and 1B are block diagrams of preferred embodiments of a system according to the invention.

[0011] Figure 2 is a side plan view, partially in cross section, of one preferred embodiment of a brush head positioning system according to the invention shown in combination with a vehicle for supporting the system and shown with a brush attached to the brush head.

[0012] Figure 3 is a partial front cross sectional view taken along lines 3-3 of Figure 2 of the brush head positioning system of the invention.

[0013] Figure 4 is a graph illustrating the relationship between pressure applied to the brush head, current (torque) driving the brush motors and position (actuator stroke) of the brush head of one preferred embodiment of a brush head positioning system according to the invention.

[0014] Figure 5 is schematic block diagram of one preferred embodiment of a brush head positioning system in combination with a vehicle according to the invention having controls for brush pressure, brush torque and brush position.

[0015] Corresponding reference characters indicate corresponding parts throughout the drawings.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Fig. 1A is a block diagram of one preferred embodiment of a system 1 according to the invention. The system 1 includes a brush up/down switch 2 which is controlled by an operator to raise and lower a lower head assembly 4 relative to an upper head assembly 5. The head assembly 4 includes a brush 6 for engaging and treating a floor surface 8. When the operator actuates or closes switch 2, this indicates to the driving circuit 10 that a drive motor 12 may be energized to raise or lower the head assembly 4. For example, switch 2 would be close circuited to indicate that the head assembly 4 should be lowered and switch 2 would be open circuited to indicate that the head assembly 4 should be raised. Initially, an operator would set a head position control 18 to indicate a desired position for the lower head assembly 4. For example, control 18 may be a potentiometer associated with a scale, display, index or other indicator indicating the desired position of the lower head

assembly 4. The indicator may indicate inches of downward movement, inches from the floor or a percentage of either, or some other indicator of position. The motor 12 drives the head assembly up or down, such as by a screw, and includes a position sensor 13 which indicates the position of the head assembly 4. For example, the motor may be Warner Actuator E150 position system. It includes an actuator internal position potentiometer which indicates the position of a screw which it drives. When switch 2 is closed by the operator to indicate that the head assembly should be lowered, driving circuit 10 continuously energizes motor 12 to lower the head assembly 4 until the head assembly 4 reaches a position corresponding to the position of the head position control 18. A comparator 24 or op-amp compares the signal provided by the position sensor 13 to a signal provided by the head position control 18. When these signals are nulled out or approximately equal, comparator 24 will provide a signal to the driving circuit 10 to discontinue energizing the motor 12. The driving circuit 10 will drive the head assembly up or down depending on which signal has a greater value. The comparator controls the driving circuit 10 to cause the motor 12 to rotate the screw driving the head assembly clockwise or counter clockwise to raise or lower the head assembly until its position matches the desired position as indicated by the control 18. If the operator sets control 18 to its maximum position, the driving circuit 10 will drive the head assembly to its fully extended position. If switch 2 is placed in the "up" position, the driving circuit 10 will drive the head assembly 4 to its fully retracted position. As shown in Fig. 1A, an optional input from the position sensor 13 to the driving circuit indicates the position of the head assembly to the driving circuit.

**[0017]** In one respect, the system 1 of Fig. 1A is a position follower system. An actuator (motor 12 plus driving screw) downwardly extends and upwardly retracts the head assembly 4 in response to an operator's command as indicated by head position control 18. As the operator turns control 18, the reversible motor 12 turns the screw driving the head until the position sensor 13 matches the setting of control 18. One way to accomplish this position follower system is to have identical potentiometers for position sensor 13 and control 18 feeding the inputs of an op-amp which functions as the comparator 24. If the inputs to the op-amp are the same, the driving circuit 10 does not energize the motor 12. If the inputs are different, the motor 12 will rotate in the appropriate direction until the inputs are equal. If full "up" is indicated, the motor is operated to raise the head assembly until the position sensor indicates a value corresponding to the fully retracted position.

**[0018]** Fig. 1B is a block diagram of another preferred embodiment of a system 100 according to the invention. The system 100 includes a brush up/down switch 102 which is controlled by an operator to raise and lower a lower head assembly 104 relative to an upper head assembly 105. The head assembly 104 includes a brush

106 for engaging and treating a floor surface 108. When the operator actuates or closes switch 102, this indicates to the driving circuit 110 that a drive motor 112 may be energized to raise or lower the head assembly 104. Preferably, switch 102 would be closed to indicate that the head assembly 104 should be lowered and switch 102 would be opened to indicate that the head assembly 104 should be raised. When switch 102 is closed to indicate that the head assembly should be lowered, driving circuit 110 continuously energizes motor 112 to lower the head assembly 104 until the head assembly trips a touchdown switch 114 indicating that the head assembly 104 and brush 106 have reached a repeatable position such as in contact with the floor 108.

**[0019]** Once the touchdown switch 114 is tripped, a counter 116 is reset and the driving circuit 110 continues to lower the head assembly 104 and brush 106 according to a head position control 118 set by the operator. Control 118 indicates to the system 100 the additional distance by which the head assembly 104 and brush 106 should be lowered after the brush 106 comes in contact with the floor 108 and the touchdown switch 114 is tripped. Control 118 may optionally include a display indicating a percentage of the maximum additional distance by which the head 104 should be lowered or a display which indicates the actual distance selected by the operator. A hall sensor 120, associated with the motor 112, monitors the rotations of the motor 112 thereby indicating the position of the head assembly 104 and the brush 106. The hall sensor 120 provides a series of pulses to counter 116 which are converted to an analog position signal by a digital to analog (D/A) converter 122. The analog signal is provided to a comparator 124 and indicates the distance which the head assembly 104 and brush 106 have been lowered past the repeatable preset position at which point the touchdown switch 114 was tripped. The head position control 118, which may be a potentiometer, generates a desired position signal indicating the desired distance that the head assembly 104 and brush 106 should be lowered beyond the repeatable position. When the analog position signal corresponds to the desired position signal provided by the head position control 118, comparator 124 signals driving circuit 110 to discontinue operation of motor 112 because the brush is now in the position relative to the floor 108 to begin treatment.

**[0020]** Figs. 2 and 3 illustrate one preferred embodiment of a brush head positioning system according to the invention shown in combination with a vehicle 126 for supporting the system 100. Figs. 2 and 3 illustrate the system 100 with the brush 106 attached to the head assembly 104 although it is contemplated that the head assembly 104 may carry any device for engaging and/or treating the surface of the floor 108. The upper head assembly 105 is pivotally supported by a bulkhead 128 carried on the vehicle 126 and is connected to the bulkhead 128 by a pivot pin 130. A lower portion of the head assembly 104 is connected to the bulkhead 128 by par-

allel pivoting rods 132 which are connected by pivot pins 134 to the bulkhead 128 and which are also connected by pivot pins 136 to a support 138 which is part of the head assembly 104.

**[0021]** The upper portion of the head assembly 105 includes the motor 112 which drives a motor shaft 140 for rotating a plurality of gears 142 which mesh with each other to rotate a screw 144. A traveling nut 146 threadably engaging the screw 144 is raised or lowered by rotation of the screw 144 as caused by the motor 112 rotating its motor shaft 140 to rotate the gears 142. The nut 146 is covered by an inner tube 148 which is crimped to and moves with the nut 146. The inner tube 148 has an upwardly extending portion 150 which extends above the top of the nut to partially cover the screw 144 and to act as a stop. When the nut 146 is in its highest position, portion 150 abuts against a housing 151 for gears 142 and prevents the nut 146 from moving upward.

**[0022]** The nut 146 supports the lower portion of the head assembly 104 by a traveling nut pin 152 which engages the nut 146 and also engages an outer slotted tube 154 coaxial with the inner tube 148 and coaxial with screw 144 and nut 146. The outer slotted tube 154 slides along the inner tube 148 depending on the position of the lower portion of the head assembly 104. Two slots 156 in opposing sides of the outer slotted tube 154 form a guide within which the bolt 152 is positioned and moves. As illustrated in Figs. 2 and 3, the head assembly 104 is in the down position so that the brush 106 is engaging the floor 108. As illustrated in the down position, the pin 152 is located in the lower portion of the slot 156. The screw 144 has been rotated to move the nut 150 downward thereby causing a downward force on the pin 152 which allows the outer slotted tube 154 and the lower portion of the head assembly 104 to drop downward to touch the floor.

**[0023]** The lower end of the outer tube engages a bolt 158 which engages two supports 160 on opposite sides of the outer slotted tube 154. The supports 160 are connected to a platform 162 which supports a brush motor 164 which engages the brush 106 via an interlock 166 and causes the brush to rotate.

**[0024]** A compressible member such as a spring 168 is located between the lower end of the nut 146 and the bolt 158. When the head assembly 104 is in its raised position, traveling nut pin 152 is held in place at the top of the slots 156 by the biasing action of the spring 168 between the nut 146 and the bolt 158. As the nut is moved downward by rotation of the screw 144 to lower the head assembly 104, the traveling nut bolt 152 continues to be held in place at the top of the slot 156 by the spring 168. However, when the brush 106 comes in contact with the surface of floor 108, further downward movement of the lower portion of the head assembly 104 is inhibited. As a result, the continued movement of the nut 146 downward causes the traveling nut pin 152 to slide downward in the slots 156 thereby compressing the spring 168.

**[0025]** A bracket 170 is mounted to the motor 112 by a U-clamp 172 and is supported in a position parallel to the screw 144 and nut 146. The lower portion of the bracket 170 includes a slot 174 which is engaged by two screws 176 which support a switch 178. The switch may be positioned anywhere along the slot 174 so that it may be moved up or down relative to the lower portion of the head assembly 104. The switch 178 has a trip bar 180 which extends toward the outer tube 154 and is positioned immediately above the traveling nut pin 152. The pin 152 has a sleeve or extension 182 which engages the underside of the trip bar 180. The position of switch 178 and trip bar 180 define a repeatable position to which the lower portion of the head assembly 104 may be moved. The trip bar 180 is a flexible member which has a fully extended, unflexed position and a flexed position. As shown in phantom in Fig. 2 and referred to by reference character 184, when the lower portion of the head assembly 104 and traveling nut pin 152 are in the raised position, trip bar 182 is in the flexed position. As the screw 144 rotates to move the nut 146 downward, nut pin 152 moves downward until it eventually reaches a point at which the trip bar 180 is in an unflexed, fully extended position. This point trips switch 178 and defines the repeatable position of the head assembly. When switch 178 is positioned within slot 174 so that it is tripped when the brush 106 touches the surface of floor 108, it functions as touchdown switch as illustrated in Fig. 1B. As a touchdown switch, it defines the repeatable position as the position at which the brush touches the floor.

**[0026]** Assuming that switch 178 is positioned as touchdown switch 114 to indicate when the brush 106 contacts the surface of floor 108, the system 100 would operate as follows. Initially, an operator would set the head position control 118 to define a preset distance by which the head assembly 104 should be lowered once it reaches the repeatable position in contact with floor 108. Next, the operator would position the brush up/down switch 102 in the down position indicating to the driving circuit 110 that motor 112 should be operated to rotate screw 144. This causes the traveling nut 146 to move downward relative to the screw 144 and the upper portion 105 of the head assembly 104. As the nut moves downward, traveling nut pin 152 also moves downward. When pin 152 reaches a point such that trip bar 180 is in its fully extended position, switch 178 is tripped to indicate that the brush 106 has reached the repeatable position and is in contact with the surface of floor 108. At this point, counter 116 is reset to zero and continued energization of the driving circuit is controlled by the comparator 124. Comparator 124 compares the desired position signal provided by head position control 118 to the analog position signal corresponding to the count in counter 116 and indicating the actual position of the lower portion of the head assembly 104 and brush 106. The count in counter 106 is generated by a magnet 186 positioned on one of the gears 142 which rotates with the

screw 144. As a result, the number of pulses or counts generated each time the magnet 186 passes the hall sensor 120 corresponds to the number of rotations of the screw 144 which in turn corresponds to the position of the nut 146. Additional magnets may be added to the gear to increase the resolution of the system. When the counter 116 includes a count of pulses which corresponds to a rotation of the screw 144 which corresponds to the position of traveling nut 146 which corresponds to the setting of the head position control 118, the comparator 124 shuts down the driving circuit 110. Essentially, the additional preset amount that the nut 146 is moved after the repeatable position is approximately equal to the distance or amount by which the spring 168 is compressed. Therefore, this amount is directly proportional to the amount of pressure that is being applied by the brush 106 to the surface of floor 108.

**[0027]** As illustrated in Figs. 2 and 3, the motor 112, gears 142, screw 144, and nut 146 constitute an actuator raising and lowering the head assembly 104 relative to the surface of the floor 108 thereby controlling the relative engagement between the head assembly and the surface and in particular, controlling the relative engagement between the brush 106 and the surface. This controls the treatment of the surface by the brush. Switch 178 constitutes a sensor for detecting the repeatable position of the head assembly. The driving circuit 110 is responsive to the switch to lower the head assembly an additional preset amount as defined by the head position control 118 after the switch 178 detects that the head assembly has reached the repeatable position. As a result, the additional preset amount has been defined by input from the operator.

**[0028]** The nut 146 constitutes a support which is connected to the actuator and is raised and lowered by the actuator. The spring becomes a compressible member between the nut 146 or support and the lower portion of the head assembly 104. By positioning the switch 178 as shown in Figs. 2 and 3 and noted above, it becomes a compression sensor detecting compression of the spring 168 when the support is lowered by the actuator. It is also contemplated that other types of compression sensors (or pressure sensors) may be used to detect compression of the spring 168. It is also contemplated that the switch 178 may be mounted directly on outer tube 154 to detect when the nut pin 152 leaves the up most position within slots 156.

**[0029]** It should be recognized that the touchdown switch 114 which is implemented in Figs. 2 and 3 as switch 178 is an optional aspect of the invention to determine the repeatable position. Those skilled in the art will recognize other ways for establishing a repeatable position such as other types of position sensors. In addition, the hall sensor 120 and magnet 186 function as an encoder (detector) to provide a continuous count indicating the position of the travelling nut 146. Therefore, a particular count corresponds to the repeatable position and could be determined by continuously monitor-

ing the count in counter 116. For example, if the driving circuit were a microprocessor based circuit it would be possible to continuously monitor the count of counter 116 knowing that one setting of the count would correspond to a repeatable preset position and another setting for the count would correspond to the additional preset amount defined by the head position control 118.

**[0030]** In another aspect of the invention, it has been found that it is preferable to support the vehicle 126 by a plurality of pneumatic tires 188 rather than some type of rigid tire or other rigid structure. It has been found that such pneumatic tires provide an added level of flexibility with regard to the positioning of the brush 106 on the surface of floor 108. This added flexibility allows the brush 106 to more easily float on the surface of the floor 108 providing a more even cleaning operation.

**[0031]** In another aspect of the invention, it is contemplated that the touchdown switch 114 of Fig. 1B may be used in combination with the embodiment illustrated in Fig. 1A. For example, when an operator closes switch 2 to lower the head assembly 4, the driving circuit would energize the motor 12 until the head assembly 4 engages floor 8 and trips the touchdown switch. Thereafter, the driving circuit 10 would drive the head assembly upward or downward an amount corresponding to the setting of the head position control 18. In this embodiment, the control 18 would control the distance of the head above or below the point at which the brush 6 engages the floor 8.

**[0032]** It is also contemplated that the touchdown switch may be a pressure or position sensor which would sense when the brush contacts the floor. For example, the touchdown switch may be an optical sensor sensing that the brush is in contact with the floor, or it may be a proximity sensor, a current (torque) sensor or a pressure sensor on the head assembly and/or motor which would indicate that the head is in contact with the floor. When the head contacts the floor, any further downward movement of the head will result in an upward pressure on the head assembly and motor, which upward pressure may be detected by a pressure sensor on the head assembly or motor.

**[0033]** Fig. 4 is a graph illustrating the relationship between the pressure applied by the brush 106 to the surface of the floor 108, the current or torque driving the brush motor 166 and the position or actuator stroke of the brush 106 relative to the surface of floor 108. The z axis represents the amount of pressure being applied by the brush 106 to the surface floor 108. There is a point at which the pressure becomes a maximum. Beyond a maximum pressure  $P_{MAX}$ , damage to the brush or to the floor surface or to the brush motor or to another part of the system may occur. Therefore, the maximum pressure  $P_{MAX}$  defines a plane which constrains the operation of the system 100.

**[0034]** Current or torque applied to the brush motor 166 is graphed along the x axis. As with the pressure, there is a maximum current  $I_{MAX}$  or maximum torque

which is predefined. Beyond this maximum current  $I_{MAX}$ , damage to the brush motor 166 may occur or excessive torque may be applied to the floor or some other damage may occur to the system. The maximum current  $I_{MAX}$  defines a plane which constrains the operation of the system 100.

[0035] The stroke or distance by which the brush is moved is graphed along the y axis. As with pressure and current, there is a maximum stroke  $L_{MAX}$  beyond which damage to the head, system or floor may occur. This maximum stroke  $L_{MAX}$  defines a plane which constrains the operation of the system 100.

[0036] Viewing Fig. 4 as a whole, it can be seen that the operation of the system 100 is constrained by three orthogonal planes which define a rectanguloid R within which the system 100 is constrained to operate.

[0037] Fig. 5 is a schematic block diagram of one preferred embodiment of a brush head positioning system in combination with a vehicle according to the invention having controls for brush pressure, brush torque and brush position. Fig. 5 illustrates a system which operates within the constraints of the rectanguloid R of Fig. 4. The system 200 includes a vehicle 202 for supporting a head assembly 204. The head assembly includes a pressure sensor 206 for measuring the pressure which a brush 208 applies to a surface of a floor 210. The head assembly 204 also includes an actuator 212 for moving the brush 208 toward or away from the floor 210. In addition, the head assembly 204 includes a brush motor 214 for rotating the brush 208.

[0038] The pressure sensor 206 provides a signal to a controller 216 which controls the actuator 212 via a driving circuit 218 and which also controls the current of the brush motor 214 via a current control 220. By controlling the current, the torque of the brush 208 applied to the floor 210 is also controlled. Hence, the controller provides a torque control signal to the current control 220.

[0039] The system 200 also includes a memory 222 which is programmed with the maximum information illustrated in Fig. 4. In particular, the memory is programmed with the maximum current, maximum pressure, and maximum stroke. The system 200 also includes operator controls 224 including a torque control 226, a head position control 228 and a pressure control 230. The operator is permitted to set these controls anywhere within the acceptable operating region as defined by the rectanguloid R. In particular, the torque control 226 can be set between zero torque and the maximum torque ( $I_{MAX}$ ). The head position control 228 can be set by the operator anywhere between the zero stroke point and the maximum stroke point ( $L_{MAX}$ ). Also, the pressure control 230 may be set anywhere between zero pressure and maximum pressure ( $P_{MAX}$ ). By setting these three controls, the operator defines a point within the rectanguloid R for operation of the system 200.

[0040] In operation, the controller 216 responds to the

torque control 226 to provide a torque control signal to the current control 220 thereby controlling the torque and current of the brush motor 214. Similarly, the controller 216 is responsive to the head position control 228 for selectively energizing the driving circuit 218 to drive the actuator 212 to maintain a certain position for the brush 208 relative to the floor 210. In addition, the controller 216 is responsive to the pressure control 230 for selectively energizing the driving circuit 218 so that the actuator 212 positions the brush 208 on the floor 210 to maintain constant pressure.

[0041] Although not illustrated in Fig. 5, one of ordinary skill in the art will recognize that the actuator 212 may provide feedback information, such as encoder or position sensor information as noted above with regard to Figs. 1A, 2 and 3, to the controller 216 to indicate the position of the brush 208. In addition, the current control 220 may provide feedback information to the controller 216 to indicate the actual current of the brush motor 214. In another aspect of the invention, it is contemplated that any one of the three controls may be designated as a dominant control and that the other two controls may be designated as limit controls. For example, if torque control is of primary interest, the torque control 226 would be set by the operator to indicate the desired torque. The head position control 228 would be set by the operator to indicate the maximum stroke and the pressure control 230 would be set by the operator to indicate the maximum pressure. In operation, the torque control 226 would indicate the desired torque to the controller 216 which would control the current control 220 to maintain the desired torque of brush motor 214 as long as the stroke limit as indicated by head position control 228 and the pressure limit as indicated by pressure control 230 are not exceeded.

[0042] In another aspect of the invention, it is contemplated that all three controls may specify maximums or limits and that the system 200 would be permitted to operate according to some algorithm or other procedure within the limits set by the operator controls 224. For example, the controller 216 may be programmed with a cleaning algorithm which would optimize the torque, stroke, and pressure controls in order to accomplish the maximum cleaning capability of the brush 208 on floor 210. Alternatively, the controller 216 may also be programmed with a polishing algorithm which would optimize polishing. In these embodiments, the torque control 226 would specify the maximum torque, the head position control would specify the maximum stroke, and the pressure control 230 would specify the maximum pressure by which the algorithms would be permitted to operate.

[0043] It is also contemplated that the pressure control could be a separate control from the actuator. For example, a hydraulic system may be used to determine and monitor the pressure of the brush 208 on the floor 210 independent of the position of the actuator 212.

[0044] It is also contemplated that any of the above

described embodiments may include displays indicating actual pressure, torque (or current) and/or position to assist the operator in setting or adjusting the controls. For example, a 10 segment bar graph may be positioned adjacent the head position control to indicate motor current. This would also permit the operator to repeat the same cleaning parameters. Alternatively, the systems of the invention may include a memory for storing various operator settings so that the operator could program the memory and recall the parameter settings as needed.

[0045] In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

[0046] As various changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

## Claims

1. An apparatus for use on a surface (8;108;210) and responsive to an operator, said apparatus comprising:
  - a head assembly (4;104;204) adapted to carry a device (6;106;208) for engaging and treating the surface (8;108;210);
  - an actuator (12;112,142,144,146;212) raising and lowering the head assembly (4;104;204) relative to the surface (8;108;210) thereby controlling the relative engagement between the head assembly (4;104;204) and the surface (8;108;210) and thereby controlling the treatment of the surface (8;108;210) by the head assembly (4;104;204);
  - a sensor (13;120;206) detecting a position of the head assembly (4;104;204);
  - a head position control (18;118;216), responsive to input from the operator, indicating a desired position of the head assembly (4;104;204); and
  - a driving circuit (10;110;218) energizing the actuator (12;112,142,144,146;212) to raise or lower the head assembly (4;104;204), said driving circuit (10;110;218) being responsive to the sensor (13;120;206) and the head position control (18;118;216).
2. An apparatus according to claim 1 wherein the driving circuit (110) lowers the head assembly (104) an additional preset amount after the sensor (120) detects that the head assembly (104) has reached a predefined position, the additional preset amount being defined by input from the operator.
3. An apparatus according to claim 1 or claim 2, further comprising:
  - a support (146) connected to the actuator (112,142,144,146) and being raised and lowered by the actuator (112,142,144,146);
  - a compressible member (168) between the support (146) and the head assembly (104); wherein the sensor (120) comprises a compression sensor (178) detecting compression of the compressible member (168) when the support (146) is lowered by the actuator (112,142,144,146); and
  - wherein the driving circuit (110) responds to the compression sensor (178) to lower the support (146) the additional preset amount after the compression sensor (178) detects a compression of the compressible member (168) thereby compressing the compressible member (168) by the additional preset amount.
4. An apparatus according to any one of claims 1 to 3, wherein the actuator (112,142,144,146) comprises a motor (112) rotating a screw (144) driving a traveling nut (146) engaging the screw (144), said nut (146) being raised and lowered by rotation of the screw (144), and further comprising:
  - a slotted tube (154) having a slot (156) at one end receiving a pin (152) sliding within the slot (156) and connected to the traveling nut (146), the tube (154) supporting the head assembly (104) at its other end; and
  - a compressible member (168) within the tube (154) between the pin (152) and the head assembly (104); wherein the sensor (120) comprises a compression sensor (178) detecting the compression of the compressible member (168) when the traveling nut (146) is lowered by the actuator (112,142,144,146); and
  - wherein the driving circuit (110) responds to the compression sensor (178) to lower the support (146) the additional preset amount after the compression sensor (178) detects the compression of the compressible member (168) thereby compressing the compressible member (168) by the additional preset amount.
5. An apparatus according to claim 4, further comprising an inner tube (148) coaxial with and slidable within the slotted tube (154), the inner tube (148) connected to and moving with the support (146).
6. An apparatus according to claim 4 or claim 5 wherein the sensor comprises a detector (186,120,116) for providing a count corresponding to the position of the head, and further comprising a head position

control (118) being set by the operator to indicate the additional preset amount and a comparator (124) for comparing the count to the additional preset amount, said driving circuit (110) being responsive to the comparator (124) to lower the traveling nut (146) below the repeatable position when the count corresponds to a position which is higher than the additional preset amount as indicated by the head position control (118).

7. An apparatus according to claim 6, wherein the detector (186,120,116) comprises a magnet (186) adapted to rotate in synchronism with the screw (144), a Hall sensor (120) detecting rotation of the magnet (186) and providing a pulse, and a counter (116) for counting the pulses of the Hall sensor (120), and wherein the comparator (124) compares the count of the counter (116) to the additional preset amount.

8. An apparatus according to claim 7, further comprising a switch (178) for detecting when the nut (146) is in the repeatable position and wherein the switch (178) resets the counter (116) and wherein the driving circuit (110) is responsive to the comparator (124) to lower the traveling nut (146) a number of counts corresponding to additional preset amount.

9. An apparatus according to any one of claims 4 to 8, wherein the sensor comprises a switch on the tube (154) for detecting compression of the compressible member (168) wherein the repeatable position corresponds to the position of the device (6;106;208) when it engages the surface (8;108;210).

10. An apparatus according to any one of claims 1 to 8, wherein the sensor comprises a switch (178) on the actuator (112,142,144,146) for detecting a position of the head assembly (104).

11. An apparatus according to any one of claims 1 to 10 further comprising a vehicle (126;202) having pneumatic tires (188) for riding on the surface (108;210), said vehicle supporting the actuator such that the head assembly (104) is above or on the surface (108;210).

12. An apparatus for use on a surface (210) and responsive to an operator, said apparatus comprising:

a head assembly (204) adapted to carry a device (208) for engaging the surface (210);  
an actuator (212) raising and lowering the head assembly (204) relative to the surface (210);  
a position control (228) responsive to operator input for indicating a position or range (R) of positions of the device (208) relative to the surface (210); and

a controller (216) responsive to the position control (228) for selectively actuating the actuator (212) to maintain the device (208) in the position or within the range (R) of positions.

13. An apparatus according to claim 12, further comprising:

a motor (214) on the head assembly (204) for rotating the device (208);  
a torque control circuit (220) having an input receiving a signal for controlling the torque of the motor (214);  
a torque control (226) responsive to operator input for indicating a desired torque or a desired range (R) of torques for the motor (214); and  
wherein the controller (216) is responsive to the torque control (226) for providing a torque control signal to the input of the torque control circuit (220) to maintain the motor (214) at the desired torque or within the desired range (R) of torques.

14. An apparatus according to claim 13, further comprising:

a pressure sensor (206) detecting the pressure of the device (208) on the surface (210);  
a pressure control (230) responsive to operator input for indicating a desired pressure or a desired range (R) of pressures for the device (208) on the surface (210); and  
wherein the controller (216) is responsive to the pressure control (230) and the pressure sensor (206) for selectively actuating the actuator (212) to maintain the pressure of the device (208) on the surface (210) at the desired pressure or within the desired range (R) of pressures.

15. An apparatus for use on a surface (210) and responsive to an operator, said apparatus comprising:

a head assembly (204) adapted to carry a device (208) for engaging the surface (210);  
an actuator (212) raising and lowering the head assembly (204) relative to the surface (210);  
a position control (228) responsive to operator input for indicating a repeatable position or repeatable range (R) of positions of the device (208) relative to the surface (210); and  
a controller (216) responsive to the position control (228) for selectively actuating the actuator (212) to maintain the device (208) in the repeatable position or within the repeatable range (R) of positions.



FIG. 1A

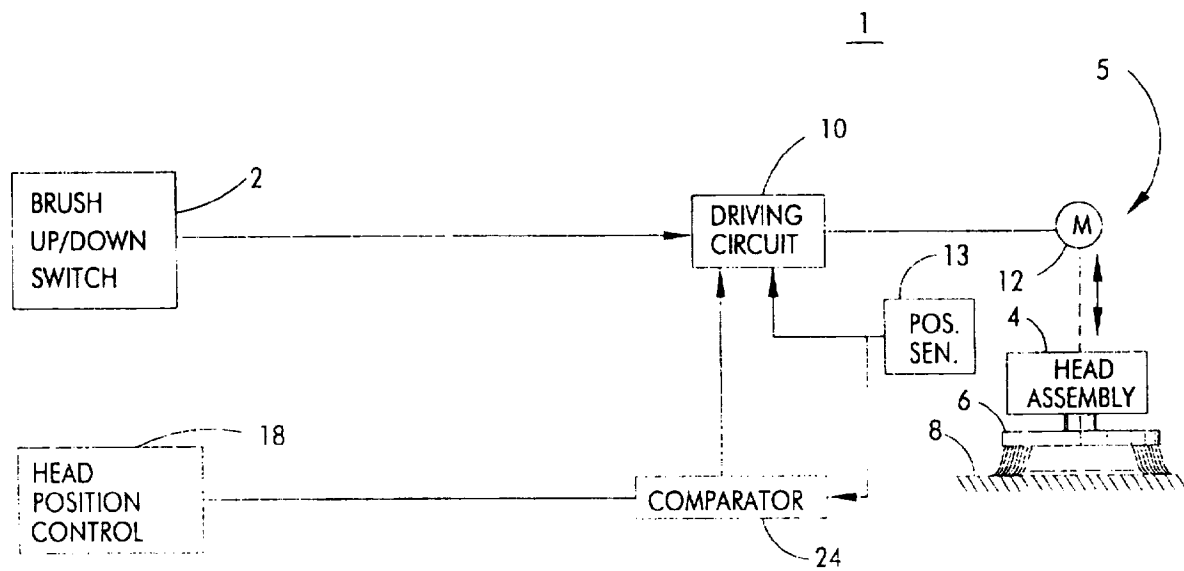


FIG. 1B

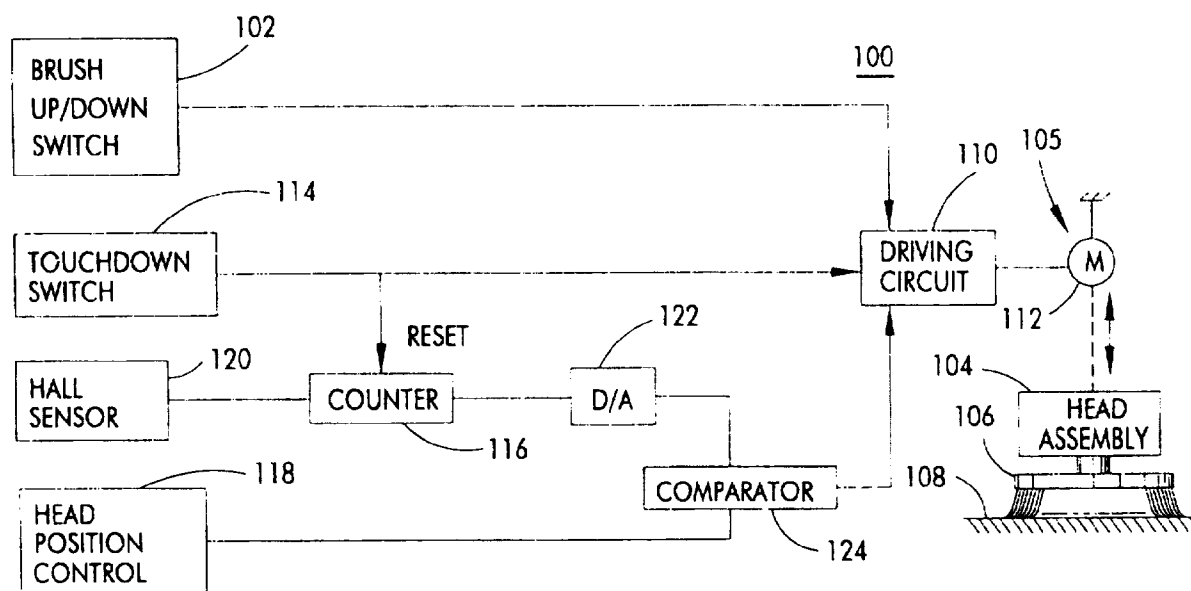
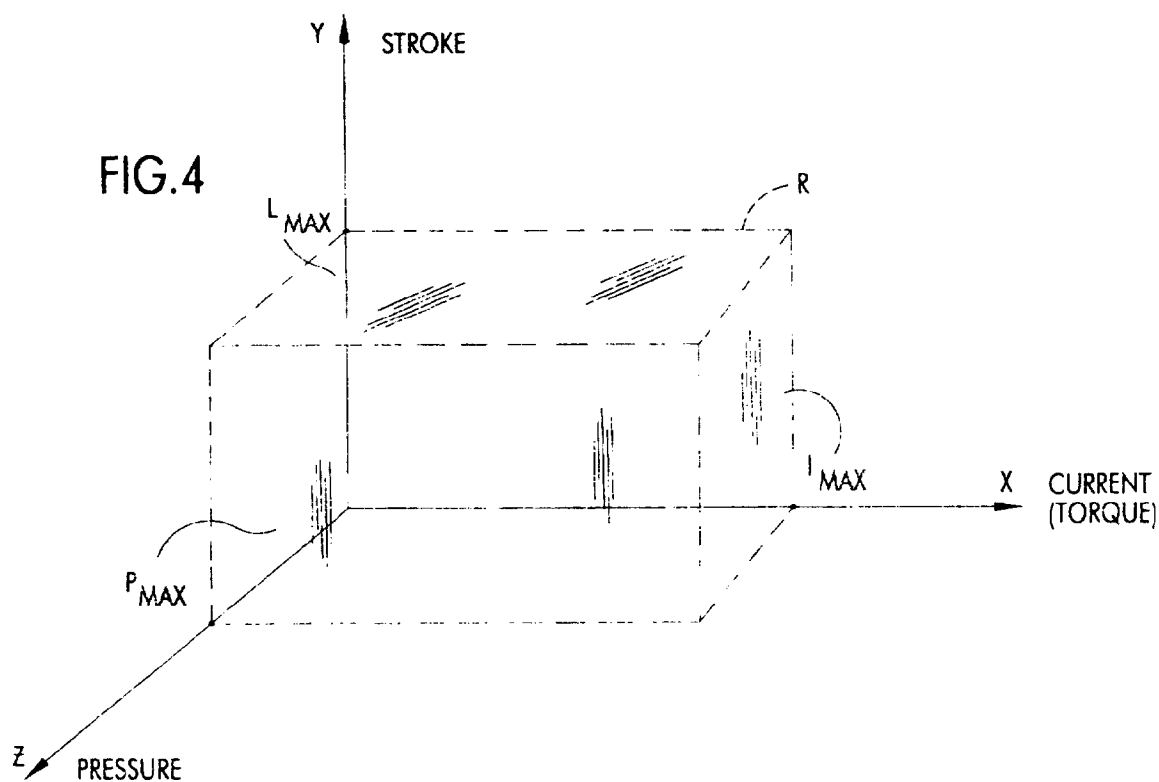


FIG. 4



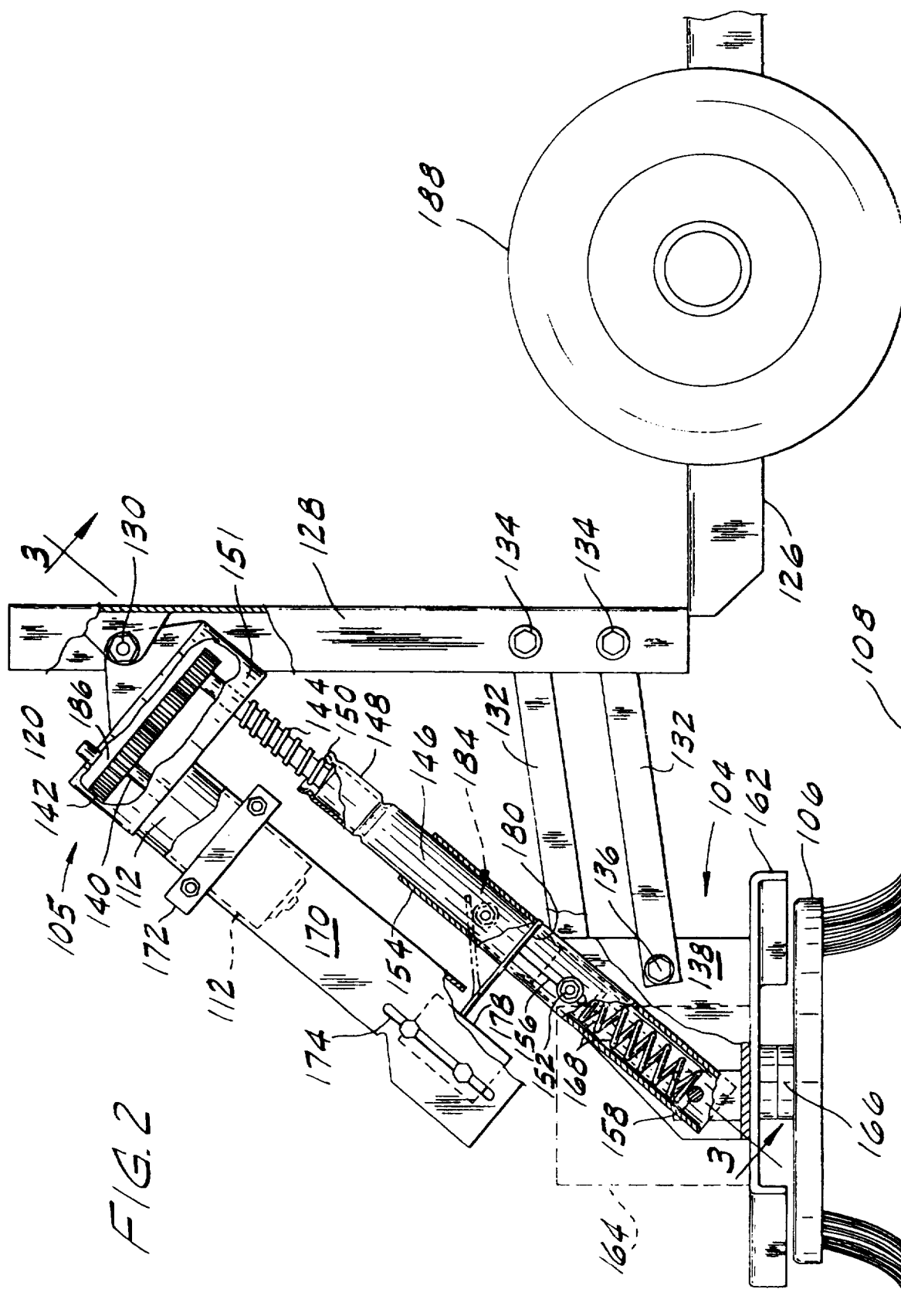


FIG. 3

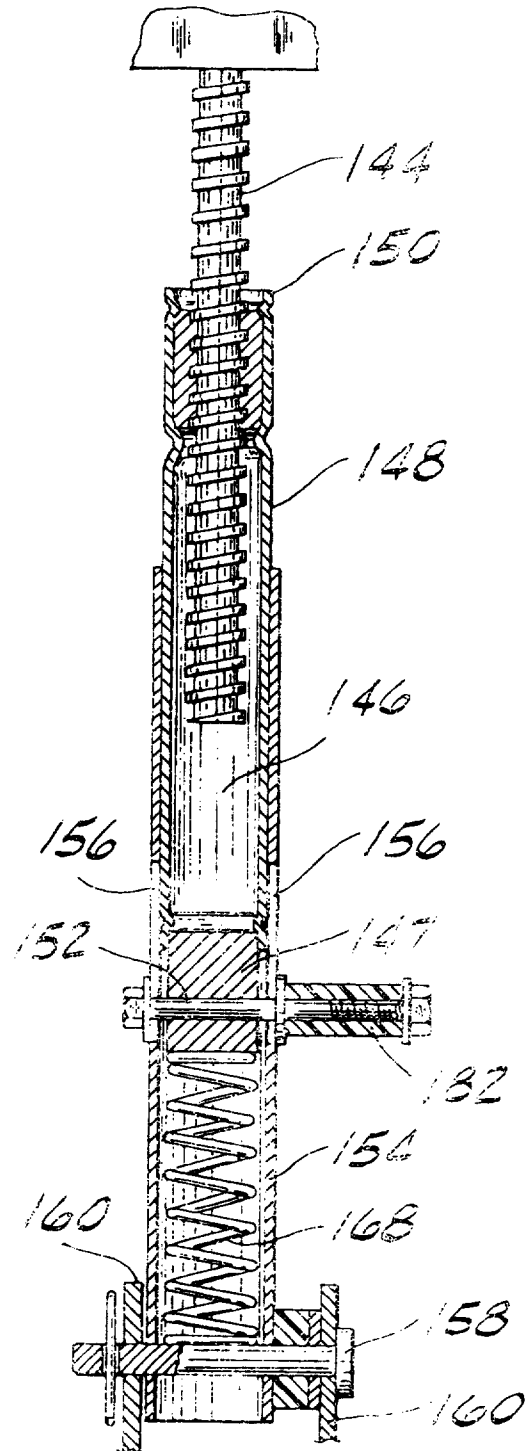
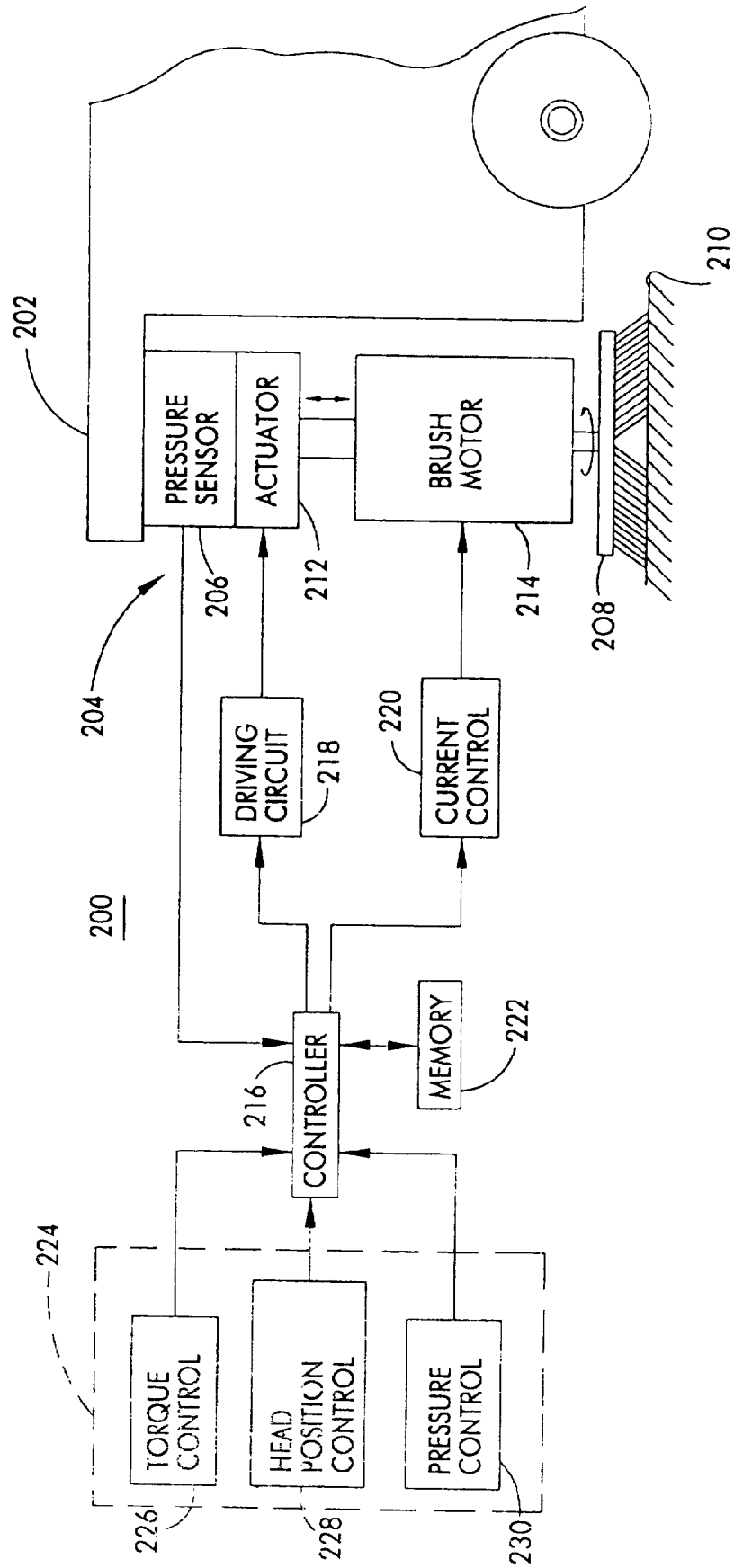


FIG. 5





European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 98 30 8714

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 673 450 A (BRISCOE WILLIAM ANTHONY) 7 October 1997	1,11,12	A47L11/40
Y	* column 1, line 57 - column 2, line 20 *	13-15	
A	* column 2, line 45-55 *	2,3	
	* column 6, line 32 - column 8, line 8 *		
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			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
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The present search report has been drawn up for all claims			
Place of search <b>MUNICH</b>		Date of completion of the search <b>9 February 1999</b>	Examiner <b>Laue, F</b>
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons</p> <p>&amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
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