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(54) Title: SEMI-AUTOMATIC HVAC COIL CLOG DETECTION AND CLEANING SYSTEM

(57) Abstract: A system (100) for servicing a heat exchanger is disclosed that includes a clog detection assembly (108) which further includes a light source (110) configured to be positioned on a first side of a component associated with the heat exchanger and illuminate the component. The clog detection assembly (108) further includes a light detector (112) configured to be positioned on a second side opposite the first side of the component to detect transmitted light and correspondingly generate a first signal. The system (100) further includes a processing device (102) communicatively coupled to the light detector (112). The processing device (102) analyzes the first signal to detect presence of a clog in association with the component. The processing device (102) may further cause a cleaning nozzle to move across the component, to perform a cleaning operation on the component.

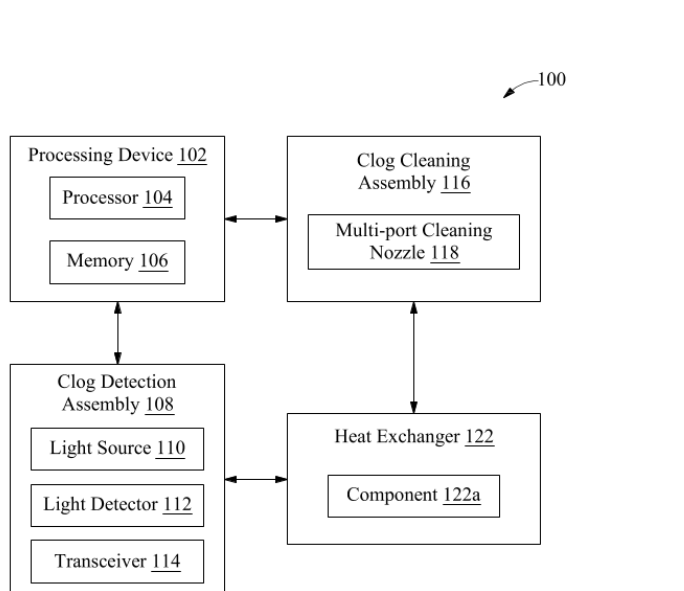


FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)

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The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

SEMI-AUTOMATIC HVAC COIL CLOG DETECTION AND CLEANING SYSTEM

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner in which it is to be performed

DESCRIPTION

Technical Field

5 [01] This disclosure relates generally to heat exchangers, and more particularly to a system and method for servicing a heat exchanger by detecting a clog in a heat exchanger component and cleaning the heat exchanger component.

BACKGROUND

10 [02] A heat exchanger component (for example, a Heating, Ventilation, and Air-Conditioning (HVAC) coil) installed in the heat exchanger may get clogged with dust and suspended particles in the air on an air side of the coil when exposed to air. Clogging may lead to reduced performance of a heat exchanger system and malfunctioning of the heat exchanger system further leading to complete failure.

15 [03] Therefore, for minimizing an impact of the clogging, coils are required to be cleaned regularly or whenever the coil gets clogged. However, manual cleaning and maintenance of the coils may require large amount of time and effort. Additionally, concept of periodic cleaning of the coils at regular intervals may not be an optimum way of cleaning, as the clogging of the coils depends on varied environmental conditions in which the heat exchanger is being operated.

20 [04] There is therefore a need in the art to provide a compact, an economically viable and effective automatic/semi-automatic system capable of detecting an extent of clogging on the coils, and the cleaning the coil in a minimal time span.

SUMMARY OF THE INVENTION

25 [05] In an embodiment, a system for servicing a heat exchanger is disclosed. The system may include a clog detection assembly. The clog detection assembly may include a light source configured to be positioned on a first side of a component associated with the heat exchanger and further configured to illuminate the component with a projected light beam. The clog detection assembly may further include a light detector configured to be positioned on a second side opposite the first side of the heat exchanger component and further configured to
30 detect transmitted light, in response to the projected light beam transmitting through the component, to generate a first signal corresponding to the transmitted light. The system may further include a processing device communicatively coupled to the light detector. The

processing device may further include a processor and a memory configured to store processor executable instructions, which, on execution, may cause the processor to receive a first signal corresponding to the transmitted light from the light detector. The processor-executable instructions, on execution, may further cause the processor to analyze the first signal to detect presence of a clog in association with the component

[06] In another embodiment a method of servicing a heat exchanger is disclosed. The method may include receiving a first signal corresponding to a transmitted light from a light detector. The light detector may be positioned on a second side of a component associated with the heat exchanger. Further, the light detector may be configured to detect transmitted light in response to a projected light beam projected by a light source and transmitting through the component to generate the first signal corresponding to the transmitted light. It should be noted that the light source may be positioned on a first side of the component opposite to the second side. The method may further include analyzing the first signal to detect presence of a clog in association with the component. The method may further include moving the cleaning nozzle across the component along a path upon detecting presence of the clog in association with the component. It should be noted that the path may be defined between a first position and a second position relative to the component. The method may further include causing the cleaning nozzle to spray a clog cleaning agent on the component during its movement along the path, from the first position (also referred to as homing position in this disclosure) to the second position (also referred to as path end position in this disclosure). The method may further include causing the cleaning nozzle to spray a pressurized fluid on the component during its movement along the path, from the second position to the first position relative to the component.

BRIEF DESCRIPTION OF THE DRAWINGS

[07] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

[08] FIG. 1 illustrates a block diagram of a system for servicing a heat exchanger, in accordance with an embodiment of the present disclosure.

[09] FIG. 2A illustrates a block diagram of a system representing a clog detection assembly including Light Dependent Resistors (LDRs) for detecting a clog present in a component association with a heat exchanger, in accordance with an embodiment of the present disclosure.

[010] FIG. 2B illustrates a schematic diagram of a system for conversion of luminance to resistance and conversion of resistance to voltage, in accordance with an embodiment of the present disclosure.

[011] FIG.3 illustrates a dashboard of a system for detecting a clog and cleaning the clog, in accordance with an embodiment of the present disclosure.

[012] FIG. 4 illustrates a framework of a system for detecting a clog and cleaning the clog, in accordance with an embodiment of the present disclosure.

[013] FIG. 5 illustrates a schematic circuit diagram of a sub-system of the system of FIG. 4 for triggering detection of a clog, in accordance with an embodiment of the present disclosure.

[014] FIG. 6 illustrates a schematic circuit diagram of a sub-system of the system of FIG. 4 for detecting the clog, in accordance with an embodiment of the present disclosure.

[015] FIG. 7 illustrates a schematic circuit diagram of a sub-system of the system of FIG. 4 for cleaning the clog, in accordance with an embodiment of the present disclosure.

[016] FIG.8 illustrates a path of movement followed by a cleaning nozzle for cleaning a clog present in association with a component associated with a heat exchanger, in accordance with an embodiment of the present disclosure.

[017] FIG. 9 illustrates graphical representations of movement of a cleaning nozzle, in accordance with an embodiment of the present disclosure.

[018] FIG. 10 illustrates a flow chart of a method for servicing a heat exchanger, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[019] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims. Additional illustrative embodiments are listed below.

[020] The disclosure pertains to detection of a clogging condition in heat exchanger components using a light source and a light detector (for example, a photodiode). For example, a heat exchanger component may be a Heating, Ventilation, and Air Conditioning (HVAC) coil. As light falls on the light detector or the photodiode, a voltage divider circuit may generate

a voltage that may be proportional to amount of light intensity of the light source. Further, a decreasing light intensity may increase resistance in Light Dependent Resistors (LDR). Resistance is inversely proportional to the voltage, and thus when light is blocked on the LDR by dust or debris, less voltage may be obtained. A threshold value (for received light) may be defined as conditions indicating the presence of clog. When there is less voltage value than the threshold value of light intensity, it may indicate that the component may be clogged. This indication may be sent to and displayed on a dashboard or any handheld device to intimate a user about the clogging, so that cleaning process may be initiated. Examples of the handheld device may include, but are not limited to, iPads and laptops).

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10 **[021]** In an embodiment, cleaning of the clog may be performed in two steps. In a first step, a spray clog cleaning agent may be used and in a second step, an air pressure may be used to remove debris from the clog. The steps may be performed by using a cleaning nozzle which may move along a predefined path controlled by a micro controller. Further, an air compressor or blower may supply pressurized air to the cleaning nozzle via a multiport valve which may be controlled by the micro controller. The multiport valve may be opened by the micro controller when a clog cleaning agent is to be sprayed for cleaning. Thus, one pipe may account for both delivery of gaseous fluid and cleaning agent. After cleaning, the clog debris along with the cleaning agent may be drained through a drainpipe.

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20 **[022]** Referring now to **FIG. 1**, a block diagram of a system 100 for servicing a heat exchanger 122 is illustrated, in accordance with an embodiment. The system 100 may be controlled via a control box hardware or even remotely using a phone, a laptop, and the like. The system 100 includes a processing device 102, a clog detection assembly 108, and a clog cleaning assembly 116. The processing device 102 may further include a processor 104 and a memory 106. The processing device 102 may process instructions to various modules 108-118 of the system 100.

25
30 **[023]** Further, the clog detection assembly 108 may include a light source 110, a light detector 112, and a transceiver 114. The light source 110 may be configured to be positioned on a first side of a component 122a associated with the heat exchanger 122 and further configured to illuminate the component 122a with a projected light beam. It should be noted that the component 122a may be a coil fin structure. The light detector 112 may be configured to be positioned on a second side opposite to the first side of the component 122a and further configured to detect transmitted light, in response to the projected light beam transmitting through the component 122a, to generate a first signal corresponding to the transmitted light. Examples of light detector 112 may include but are not limited to a photodiode, a LDR, a

phototransistor or any photovoltaic devices. The transceiver 114 may be used to transmit and receive signals to and from the processing device 102. The clog detection assembly 108 may be operatively coupled to the clog cleaning assembly 116 via the processing device 102 and the heat exchanger 122.

5 **[024]** The processing device 102 may be communicatively coupled to the light detector 112 of the clog detection assembly 108. The processor 104 may receive a signal transmitted from the light detector 112 via the transceiver 114 and further processes the signals as executable instructions to be followed by the clog cleaning assembly 116 upon detection of the clog. Examples of the processor 104 may include, but are not limited to, a microprocessor, a
10 microcontroller, or a control logic. The memory 106 may be communicatively coupled to the processor 104 and store processor executable instructions. The processor executable instructions upon execution by the processor 104 may cause the processor 104 to receive a first signal corresponding to a transmitted light from the light detector 112 and analyze the first signal to detect presence of a clog in association with a component 122a.

15 **[025]** Further, the processing device 102 may interact with a clog cleaning assembly 116. The clog cleaning assembly 116 may further include a multi-port cleaning nozzle 118 and may optionally include a transceiver. In some embodiments, the multiport cleaning nozzle may be referred as a cleaning nozzle. The multiport cleaning nozzle may include a multiport valve, through which a user can choose between a clog cleaning agent (i.e. cleaning fluid) and
20 pressurized air. The clog cleaning agent may be retrieved from a cleaning agent reservoir, and the pressurized air may be obtained from a pressurized air source. The multiport cleaning nozzle may include a nozzle that may spray the fluid chose through the multiport valve, via a controller. It should be noted that the clog detection assembly 108, upon detection of a minimum clog threshold value (i.e. minimum voltage and maximum clog), may send
25 information to the processing device 102. The processing device 102 further processes the information to the clog cleaning assembly 116. The clog cleaning assembly 116 may be configured to initiate a cleaning process. The multiport cleaning nozzle 118 upon receiving the processor executable instructions may move across the component 122a across a path. Further, the multiport cleaning nozzle 118 may spray a clog cleaning agent on the component 122a
30 during its movement along the path, from a first position to a second position relative to the component 122a. Moreover, the multiport cleaning nozzle 118 may spray a pressurized fluid on the component 122a during its movement along the path, from the second position to the first position relative to the component 122a. The transceiver of the clog cleaning assembly 116 may be used to receive and send signals to the processing device 102.

[026] It should be noted that the path may be a predefined a path. The path may be defined between a first position (For example, a homing position) and a second position (loop end position) relative to the component 122a. Also, it should be noted that the path may be generated in real time based on an analysis of the coil area.

5 [027] Further, upon receiving the processor executable instruction, the processor 104 may first obtain a current position of the cleaning nozzle. In some embodiments, the processor 104 may cause the cleaning nozzle 118 to return to the first position, by moving along a reset path. The reset path may help in protecting the system 100 during a sudden power failure/power off/emergency stop condition. The reset path may be generated based on a predefined criterion.

10 The predefined criteria may be selected from a set of predefined criteria. In some embodiments, the predefined criteria may be a first predefined criteria which may be based on a shortest path between the current position and the first position. Thus, in case of sudden failure, the cleaning nozzle may quickly reach the homing position. Further, in some embodiments, the predefined criteria may be a second predefined criteria which may be based on a quickest travel path

15 between the current position and the first position. In some embodiments, the predefined criteria may be a third predefined criteria, which may be based on a least operation time of one or more motors configured to cause the cleaning assembly 116 move between the current position and the first position. In some other embodiments the processor 104 may cause the cleaning nozzle 118 to resume the path from the current position.

20 [028] Referring now to **FIG. 2A**, a schematic diagram of a system 200A representing a clog detection assembly 200 including Light Dependent Resistor (LDR) for detecting a clog in a component associated with a heat exchanger is disclosed, in accordance with an embodiment of the present disclosure. The system 200A may include LDR sensors 202. The sensors may further include a sensor 202a, which may include a Lux value 204a and a

25 resistance 206a. Similarly, the system 200A may include a sensor 2 202b, which may include a lux value 2 204b and a resistance 2 206b. Further the system 200A may include sensor 3 202c, which may include a lux value 3 204c and a resistance 3 206c. It may be noted that number of sensors is not limited to three. Other sensors may also be added to determine their average. It may also be noted that the lux value may range from 0 to 3000. The system 200A further

30 represents expended view of the sensor 1 202a, having lux value 1 204a and resistance 1 206a.

[029] The system 200A may include a light source (similar to light source 110) configured to be positioned on a first side of the heat exchanger component and illuminate the heat exchanger component. A light detector may be configured to be positioned on a second side opposite the first side of the heat exchanger component and receive the light transmitted by the

light source upon passing through the heat exchanger. The system 200A may be configured to receive a signal indicative of clog extent value, compare the clog extent value with a threshold clog value, and determine the presence of the clog cleaning based on the comparison.

[030] Referring now to **FIG. 2B**, a schematic diagram of a system 200B for conversion of luminance to resistance and conversion of resistance to voltage is illustrated, in accordance with an embodiment of the present disclosure. The system 200B may include a voltage divider 208. The voltage divider 208 may further include an input voltage (V_{in}) 210, a LDR 212, an output voltage (V_{out}) 214, a resistance R_2 216. The voltage divider 208 may activate upon receiving a light of intensity 218. It may further be noted that the output voltage 214 may be determined as per equation, given below:

$$V_{out} = V_{in} \times (R_2 / (R_{LDR} + R)) \quad \dots \text{equation (1)}$$

[031] It should be noted that in some embodiments, data acquisition (DAQ) may be used for conversion of luminance to resistance and for conversion of resistance to voltage. As such, a lookup table may be created and used via interpolation.

[032] Referring now to **FIG. 3**, a dashboard 300 of a system for detecting a clog and cleaning the clog is illustrated, in accordance with an embodiment of the present disclosure. As illustrated, the dashboard 300 may be designed using a simulation tool software which are commonly available in the market. Heat Exchanger cleaner dashboard may display a heat exchanger ON/OFF switch 302a, a Dashboard ON/OFF switch 302b, a clog detection ON/OFF switch 302c, a cleaning enable switch 302d, and an emergency stop switch 302e. In addition, different light intensity values 304 are shown. A light intensity value may be received at the LDRs along with clog percentage 312. A user may verify clog percentage 312 once again after the cleaning process is completed. Further, graphs 306 for various states of motors and valve controls along with a clog present signal 308 and a cleaning status 310 is displayed on the dashboard 300.

[033] In an embodiment, a process flow in automatic detection and cleaning of the heat exchanger component may include the steps of: (i) turning OFF the heat exchanger system, (ii) turning ON the heat exchanger cleaning system from the dashboard, (iii) turning ON the heat exchanger clog detection switch, (iv) detecting clog from dust and debris using light source which may be (LED) and LDRs. The detection may be done using a following method, where a light intensity may be converted to resistance using LDRs. Theoretically, resistance may be converted to voltage using a voltage divider and after a calibrated drop of voltage, the cleaning process may be started. (v) If voltage comes below a calibrated value, the 'Clog Detected' LED may turn ON and if display feature is available, a percentage of clog may be detected. Then, the

'Cleaning Enable Switch' may be turned 'ON'. On turning the switch 'ON' determine whether if the red LED appears indicating the presence of clog condition comes up. If the LED doesn't come up, it implies that the components are not fully clogged, and the cleaning process need not be initiated. (vi) An 'Emergency Stop Switch' may be present in the dashboard 300 to shut down the whole cleaning process in case of any emergency. If this is pressed, the whole cleaning process may be restarted by its own. This feature may enable the system to reset in case of any sudden power cut or any other unfavorable situations as well. (vii) Further, for the cleaning process to start first, the system may check for the compact box (containing the cleaning nozzle 118) in a homing position, and if the compact box is not in the homing position, the system may bring it to homing position first which is very necessary for the compact box to start executing the cleaning path. (viii) Once the compact box is in homing position which is detected by the stop switches, the cleaning process may start. (ix) Further, the cleaning process may make the compact box follow a specific optimized path to cover a specific coil area. The movement may be controlled by two motors with help of two lead screw rods. The movement may start from the homing position and the ending point may also be at same location. So, while traveling from the homing position, the compact box may spray a pressurized cleaning agent via a multiport valve and while returning the compact box may force pressurized gaseous fluid thus cleaning the coil clog. (x) Finally, after cleaning process, the system may be turned OFF.

[034] Referring now to FIG. 4, a framework 400 of a system for detecting a clog and cleaning the clog automatically is illustrated, in accordance with an embodiment of the present disclosure. As illustrated, the framework 400 may include a clog initiation block 402, a clog detection block 404, and a clog cleaning block 406. The clog initiation block 402 may further include various switches (as illustrated in the dashboard 300) including a power switch 402a, an emergency stop-switch 402b, HVAC status 402c, UI clog detection switch 402d, a cleaning enable switch 402e. The framework 400 further includes various signals which supports the system to further initiate the detection and cleaning of the clog. The signals may include a clog present signal 402f a cleaning enabling signal 402g, a clog present signal 402d, and a detection enabling signal 402h. The clog present signal 402f may signify the presence of the clog and the detection enabling signal 402h, may signify the detection of the clog.

[035] Further the framework 400 may include a clog detection block 404. In some example embodiments, the clog detection block 404 may include three lux values, i.e. a lux value1 404a, a lux value2 404b, and a lux value3 404c. In alternate embodiments, any other number of three lux values may be used as well, i.e. the number of three lux values may vary based on the number of LDRs used. The clog detection block 404 may further include the clog

present signal 404d to detect the presence of clog and a clog percentage signal 404e, which may represent the percentage of the present clog (on the dashboard) and compare it further with a predefined clog threshold value. Further the framework 400 may include a clog cleaning block 406, which may initiate the clog cleaning process upon receiving the cleaning enable signal 402g
5 from the clog initiation block 402. The cleaning block 406 further includes a longitudinal motor I/P 406a to activate the longitudinal motor 408, a lateral motor I/P 406b to activate the lateral motor 410, a reservoir valve 406c, a compressor valve 406d, and a cleaning status 406e. Cleaning may be further explained in detail in conjunction with FIGs 5-10.

[036] Referring now to **FIG. 5**, a schematic circuit diagram 500 of a sub-system of the
10 system of FIG. 4 for triggering detection of a clog is illustrated, in accordance with an embodiment of the present disclosure. In an embodiment, conditions to start detection of the clog may include: (a) The system may be turned OFF before starting a detection and a cleaning process as it may hamper an ongoing process, and (b) user should turn on the switch for auto detection and cleaning. If the components are clogged, then the cleaning system may start
15 cleaning the components and for rest of the time, the system may be at rest. The clog detection system may be initiated by the user, upon activating the switches from the dashboard. The sub-system may include a switch for power 502, an emergency stop switch 504, an HVAC status506, a cleaning enable switch 508, and a clog present signal 510. The power 502, the emergency stop switch 504, the HVAC status506 may activate the detection enabling signal 514 upon receiving
20 a signal from a UI clog detection switch 512. A value at UI clog detection switch 512 may be determined by performing “AND” operation on values corresponding to the power 502, the emergency stop switch 504, the HVAC status506. Further, the cleaning enable switch 508 and the clog present signal 510 upon activation may generate the cleaning enabling signal 516. A value at the cleaning enabling signal 516 may be generated by performing an “AND” operation
25 on values corresponding to the cleaning enable switch 508 and the clog present signal 510. Further, the cleaning enabling signal 516 and clog present signal 510 may be responsible for a clog present signal 518.

[037] Referring now to **FIG. 6**, a schematic circuit diagram 600 of a sub-system of the
30 system of FIG. 4 for detecting the clog is illustrated, in accordance with an embodiment of the present disclosure. With respect to FIG. 6 the clog may be detected using a light source and a light detector which may be a photodiode. According to the light intensity, an output voltage may be obtained in a processing device And, by iterations over a cleaned component, a value of intensity of light may be passed through the cleaned component. Further, when less than calibrated voltage is obtained, it may be inferred that dust may be clogging the component. After

a threshold drop in the voltage, a cleaning process may be initiated. As may be appreciated, multiple LDRs may be used for cleaning the components. Further, an average of them may be taken for comparison and if found less than the threshold, a cleaning switch (similar to the cleaning switch 302d) may be pressed. Hence, the cleaning process may be executed. The sub-
5 system may include LEDs 602, LSR sensors 604, a resistance to voltage block 606.

[038] The LEDs 602 may be used to indicate presence and condition of the clog. The LDR sensors 604 may receive lights of various intensities as an input including a lux value1 604a, a lux value2 604b, and a lux value3 604c, depending on the number of LDRs used. As mentioned above, the number of the lux values may not be restricted to 3 and may vary based
10 on the number of LDRs used according to the requirement. Further, output of the LDR sensors 604 may be a resistance1 604d, a resistance2 604e and a resistance3 604f depending on the number of LDRs used. The number of resistances may vary corresponding to the number of lux values, and therefore may not be limited to 3. It may be noted that an average of the lux values and corresponding resistances may be determined. An average resistance value 606a may be
15 transmitted to the resistance to voltage unit 606. The resistance to voltage unit 606 may further output a voltage 606b. Further, based on the voltage 606b, a clog percent signal may be generated, and a clog percentage may be determined.

[039] Referring now to **FIG. 7**, a schematic circuit diagram 700 of a sub-system of the system of FIG. 4 for cleaning the clog is illustrated, in accordance with an embodiment of the
20 present disclosure. With respect to FIG. 7, the sub-system represents a cleaning block and in the cleaning block a counter may be maintained for keeping a count of time. Using the count of time maintained, all the processes of the system for servicing the heat exchanger may be synchronized. Both motors in 'x' and 'y' directions may be synchronized to cover whole area of duct and thus spray cleaning agent to the components (air side) and then clean the components
25 with a pressurized gaseous fluid (e.g., air) spray. In an embodiment, there may be an initial check of homing position before starting the cleaning path. In addition, a path for the clog cleaning may be generated in real time

[040] The cleaning block may include a counter 702 for keeping a count of a time 702a. The counter 702 may be coupled to motor modules, a cleaning agent reservoir, and a gas
30 compressor valve to initiate their respective timely responses. The cleaning block may further include a motor command 706, which may further include MotX 706a, MotY 706b and a cyclestart 706c. It should be noted that MotX and MotY are negative motion for the compact box to go to a homing position till the cycle start signal is actuated for the cleaning process startup. The motor command 706 may further receive information from the homing position (the

terms ‘homing position’ and ‘first position’ may have been used interchangeably in this disclosure) detection block 704. The homing position detection block may further include X axis Stop Switch 704a and a Y axis StopSwitch704b. The homing position detection block 704, upon receiving the processor executable instructions, may command the motors to locate and move
5 towards the homing position when required.

[041] The motor modules may include a longitudinal motor module 714 which may be associated with a longitudinal motor 714a. The motor modules may include may further include a lateral motor module 716 which may be associated with a lateral motor 716a. The cleaning block may include a valve key for cleaning agent spraying 718 associated with a reservoir valve
10 718a and a valve key for air compressor 720 associated with a compressor valve 720a. The system may further include represent a cleaning status 708.

[042] Referring now to **FIG. 8**, a path of movement 800 which may be followed by the cleaning nozzle (similar to the cleaning nozzle 118) for cleaning the heat exchanger component is illustrated, in accordance with an embodiment of the present disclosure. With respect to FIG.
15 8, the cleaning nozzle (within a compact box) may follow a “S type” path to cover the whole component area. In some embodiments, the path may be generated automatically based on an area of the component. It should be noted that information related to the area (length and breadth), for example the coil area, may be provided manually. The path shape may be optimized in case of larger component area in other models. A homing position 802 may be attained with
20 help of stop switches (for example, the X axis stop switch 704a and Y axis stop switch 704b). Further, movement may be controlled using two stepper motors, two stop switches, and two screw rods. As an example, time to cover each horizontal distance (of the “S type” path) of the component may be ‘5’ seconds and time to cover vertical distance (of the “S type” path) across the component may be ‘1’ second, based on the lead of screws and speed (RPM) of the motors.
25 Therefore, while going from the homing position 802 (the first position) to a path end position (the terms ‘path end position’ and ‘second position’ may have been used interchangeably in this disclosure) the second position) it may spray cleaning agent and while returning it may force gaseous fluid and thus complete the cleaning process. The flow of the cleaning agent through the air compressor or blower may be controlled by the multiport cleaning nozzle.

[043] The homing position 802 may be determined by a processing device, a component area 804, a path end position 806 (which may be a last working point of the component). It may be noted that the path of movement 800 may include a first cycle 808, which may be followed by the cleaning nozzle during the movement from the homing position 802 towards the path end position 806. Further, the path of movement 800 may include a return cycle 810, which may be
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followed by the cleaning nozzle during the movement from the path end position 806 towards the homing position **802**.

[044] Referring now to **FIG. 9**, graphical representations 900 of a movement of a cleaning nozzle are illustrated, in accordance with an embodiment of the present disclosure.

5 The cleaning nozzle may follow the paths depicted by the various graphs for performing the movement of the nozzle via the motor(s). The graphical representations 900 include a graph 902 which represents movement of a horizontal motor throughout the cycle. The horizontal motor may be a longitudinal motor 902a. Further, the graphical representations 900 include a graph 904 which represents movement of the vertical motor (a lateral motor 904a) throughout

10 the cycle. The graphical representations 900 further include a graph 906 which represents a time vs activation graph for the spraying of cleaning agent from the reservoir. The graph 906 may include a reservoir valve actuation value 906a, which is representative of fluid spray status. The graphical representations 900 may further include a graph 908 which represents a time vs activation graph for the spraying of compressed air from the compressor or blower.

15 The graph 908 may include a compressor valve actuation value 908a which is representative of compressed air status from the compressor.

[045] Referring now to **FIG. 10**, a method for servicing a heat exchanger is depicted via a flowchart 1000, in accordance with an embodiment. FIG. 10 is explained in conjunction with FIGS. 1-9. Each step of the flowchart 1000 may be executed by various modules (same

20 as the modules of the system 1000).

[046] At step 1002, a first signal corresponding to a transmitted light may be received. In particular, the signal may be received from a light detector (similar to the light detector 112). It should be noted that the light detector may be configured to detect transmitted light in response to a projected light beam projected by a light source (same as the light source 110) and

25 transmitted through a component associated with the heat exchanger. Additionally, it should be noted that the light detector may be positioned on a second side of the component associated with the heat exchanger.

[047] At step 1004, a first signal may be analyzed. The first signal may analyzed to detect presence of a clog in association with the component. It may be noted that the analysis of

30 the signal may be executed by a clog detection assembly (analogous to the clog detection assembly 108) and a processing device (same as the processing device 102).

[048] Thereafter, at step 1006, upon detection of the presence of the clog in a cleaning process may be performed to clean the clog detected in association with the component. Cleaning may be performed in various steps 1006a-1006c. At step 1006a, a cleaning nozzle (same as the

cleaning nozzle 118) may be moved across the component along a path. The path may be defined between a first position and a second position relative to the component. Thereafter, at step 1006b, a clog cleaning agent may be sprayed on the component during its movement along the path by the cleaning nozzle, from the first position to the second position. At step 1006c, a
5 pressurized fluid may be sprayed on the component during its movement along the path using the cleaning nozzle, from the second position to the first position relative to the component.

[049] The disclosed invention works using LDRs which may detect an amount of light and may detect that the components are clogged or not. As is known, that as luminance varies as resistance varies and may be captured by supplying voltage. Thus, voltage may also vary.
10 After a drop in voltage if a user switches to an auto clean, the system may start its automatic cleaning process. Further, the components may be cleaned by both a cleaning agent and pressurized air. Thus, whole cleaning process may be carried out without human efforts and in a very small span of time which may be calibrated by altering the codes.

[050] The disclosed invention may enable the disclosed system to be both retrofitted
15 and when given as an additional feature with heat exchanger systems would be a great impact to business. The system is very economical and may drastically reduce human effort for cleaning purposes. The system is robust and may need no maintenance of its own. The system may be able to clean the components in minimum amount of time. Further, the system may involve minimal cost and include multiple LDRs and LEDs, two stepper motors, two lead
20 screw rods, two stop switches, one compressed gaseous fluid source (e.g., a compressor or a blower) and one microprocessor which can be standard of the self and can be reprogrammed as per the logic. The system may be robust and thus may have no need of maintenance as only a cleaning agent may be filled. In addition, no human efforts may be needed for opening the ducts and cleaning manually. The system may be incorporated in the heat exchanger system
25 itself and thus may be powered from there or may be a separate unit be made for taking the power. The system may be calibrated depending on availability of light intensity present and may be configured separately for smooth detection of foreign particles such as dust and debris. As may be appreciated, if source of compressed gaseous fluid is present, then there may be no need to install a compressor or a blower and thus cost may be very less. Further, a smart
30 application may be made to clean the components remotely and get notifications on personal/handheld or any other devices for cleaning when the components are clogged.

[051] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

WE CLAIM:

1. A system for servicing a heat exchanger, the system comprising:

a clog detection assembly comprising:

a light source configured to be positioned on a first side of a component associated with the heat exchanger and further configured to illuminate the component with a projected light beam;

a light detector configured to be positioned on a second side opposite to the first side of the component and further configured to detect transmitted light, in response to the projected light beam transmitting through the component, to generate a first signal corresponding to the transmitted light; and

a processing device communicatively coupled to the light detector, the processing device comprising:

a processor; and

a memory configured to store processor-executable instructions, wherein the processor-executable instructions, upon execution by the processor, cause the processor to:

receive, from the light detector, the first signal corresponding to the transmitted light; and

analyze the first signal to detect presence of a clog in association with the component.

2. The system as claimed in claim 1 further comprising:

a clog cleaning assembly communicatively coupled to the processing device, the clog cleaning assembly comprising:

a cleaning nozzle configured to:

move across the component;

spray a clog cleaning agent on the component; and

upon spraying the clog cleaning agent, spray a pressurized fluid on the component.

3. The system as claimed in claim 2, wherein the processor-executable instructions further cause the processor to:

cause the cleaning nozzle to move across the component along a path,
wherein the path is a predefined path, and
wherein the path is defined between a first position and a second position
relative to the component.

4. The system as claimed in claim 2, wherein the path is generated in real time, based on the analysis.

5. The system as claimed in claim 3, wherein the processor-executable instructions further cause the processor to:

cause the cleaning nozzle to spray the clog cleaning agent on the component during its movement along the path, from the first position to the second position relative to the component; and

cause the cleaning nozzle to spray the pressurized fluid on the component during its movement along the path, from the second position to the first position relative to the component.

6. The system as claimed in claim 3, wherein the processor-executable instructions further cause the processor to:

cause the cleaning nozzle to return to the first position, by moving along a reset path,
wherein the reset path is generated based on a predefined criterion.

7. The system as claimed in claim 3, wherein the processor-executable instructions further cause the processor to:

obtain a current position of the cleaning nozzle; and
cause the cleaning nozzle to resume the path from the current position.

8. The system as claimed in claim 6, wherein the predefined criterion is selected from a set of predefined criteria, the set of predefined criteria comprising:

a first predefined criteria, based on a shortest path between the current position and the first position;

a second predefined criteria, based on a quickest travel path between the current position and the first position; and

a third predefined criteria, based on a least operation time of one or more motors configured to cause the cleaning nozzle to move between the current position and the first position.

9. The system as claimed in claim 1, wherein the light detector is a photodiode configured to:
detect intensity of the transmitted light to determine a detected intensity value, in response to the projected light beam transmitting through the component, to generate the first signal corresponding to the transmitted light.

10. The system as claimed in claim 9, wherein analyzing the first signal to detect presence of the clog comprises at least one of:

comparing the detected intensity value of the transmitted light with a rated intensity value associated with the light source; or

comparing the detected intensity value of the transmitted light with a predefined threshold intensity value.

11. A method of servicing a heat exchanger, the method comprising:

receiving, from a light detector, a first signal corresponding to a transmitted light,

wherein the light detector is positioned on a second side of a component associated with the heat exchanger, the light detector further configured to detect transmitted light in response to a projected light beam projected by a light source and transmitting through the component, to generate the first signal corresponding to the transmitted light, wherein the light source is positioned on a first side of the component opposite to the second side; and

analyzing the first signal to detect presence of a clog in association with the component;

upon detecting presence of the clog in association with the component, cause a cleaning nozzle to:

move across the component along a path, wherein the path is defined between a first position and a second position relative to the component;

spray a clog cleaning agent on the component during its movement along the path, from the first position to the second position; and

spray a pressurized fluid on the component during its movement along the path, from the second position to the first position relative to the component.

Dated this 21st day of July 2022

-- Digitally Signed--

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ABSTRACT

SEMI-AUTOMATIC HVAC COIL CLOG DETECTION AND CLEANING SYSTEM

A system (100) for servicing a heat exchanger is disclosed that includes a clog detection assembly (108) which further includes a light source (110) configured to be positioned on a first side of a component associated with the heat exchanger and illuminate the component. The clog detection assembly (108) further includes a light detector (112) configured to be positioned on a second side opposite the first side of the component to detect transmitted light and correspondingly generate a first signal. The system (100) further includes a processing device (102) communicatively coupled to the light detector (112). The processing device (102) analyzes the first signal to detect presence of a clog in association with the component. The processing device (102) may further cause a cleaning nozzle to move across the component, to perform a cleaning operation on the component.

[To be published with FIG. 1]

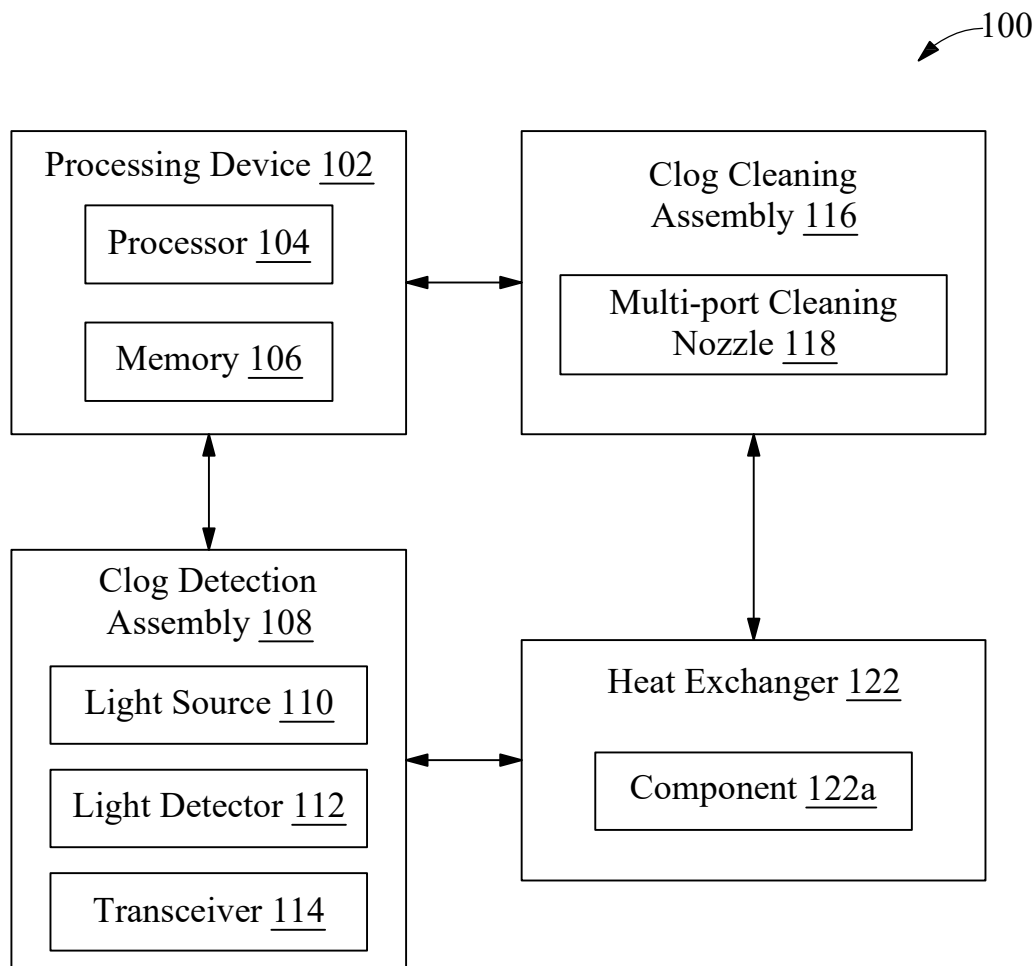


FIG. 1

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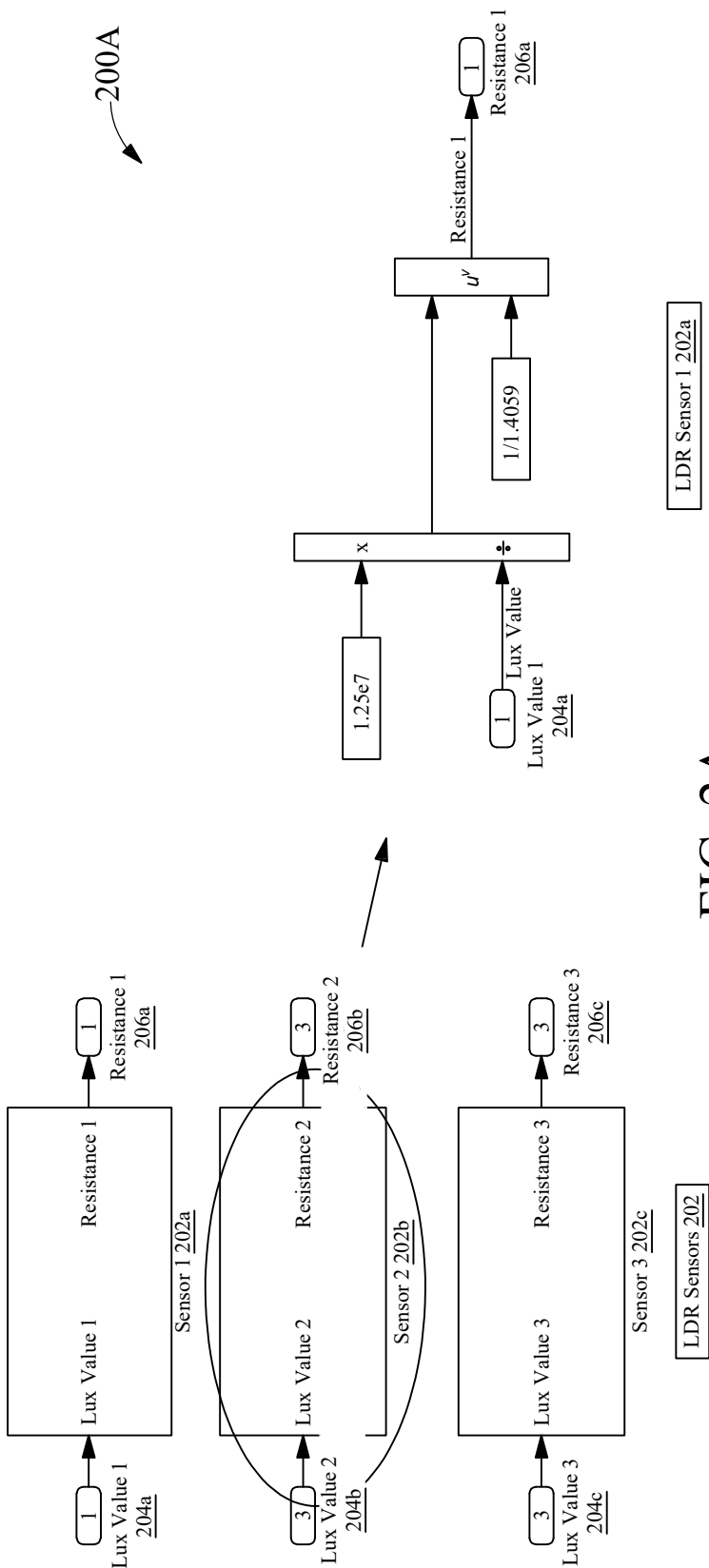


FIG. 2A

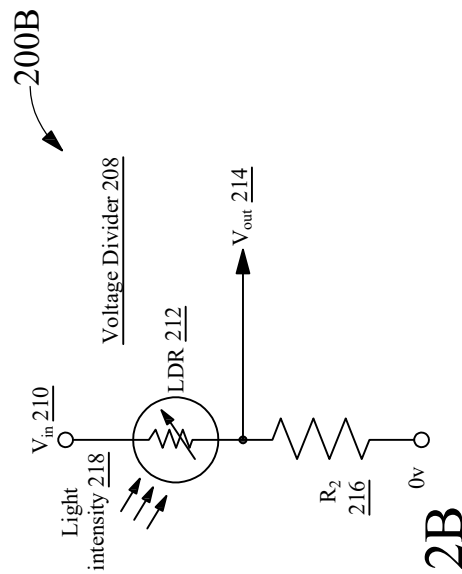


FIG. 2B

$$\text{lux} = (1.25 \times 10^7) \times R^{-1.4059}$$

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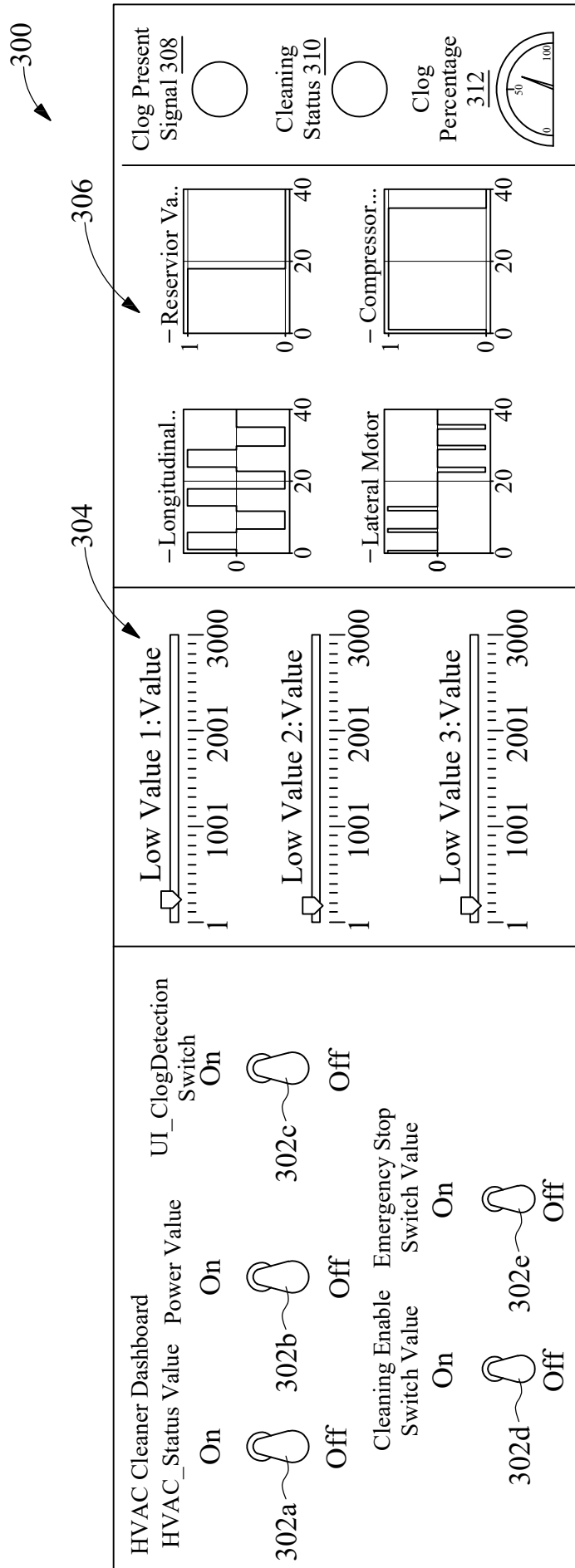


FIG. 3

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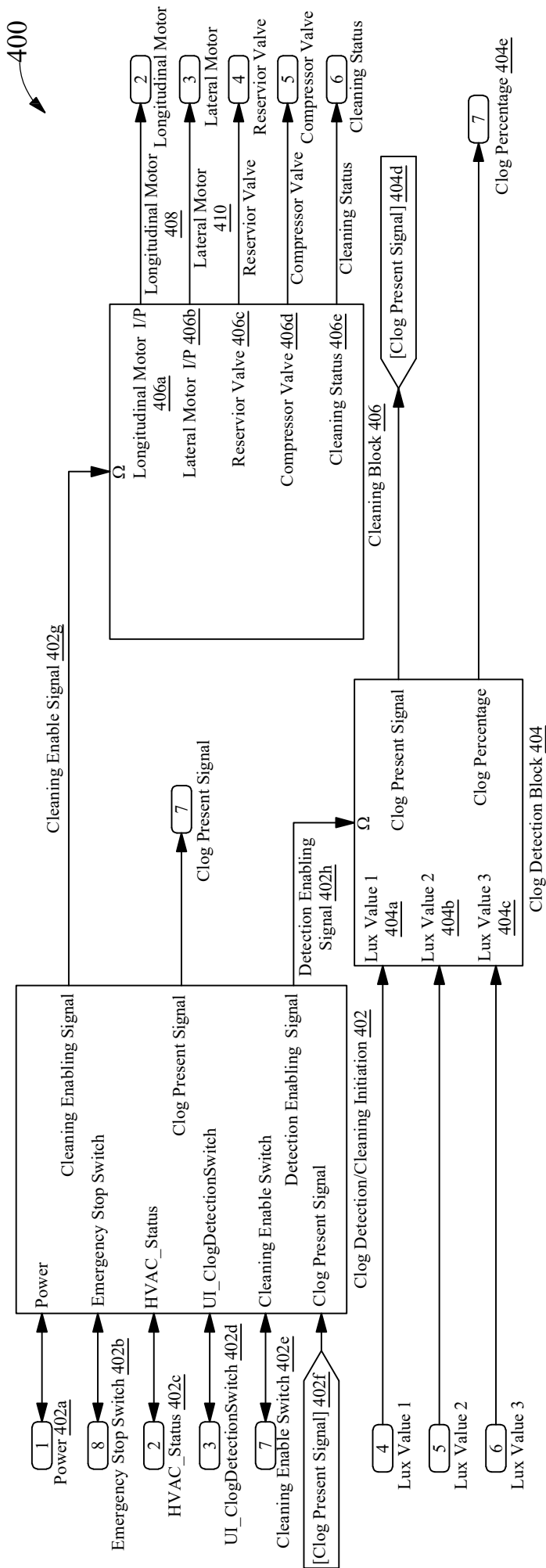


FIG. 4

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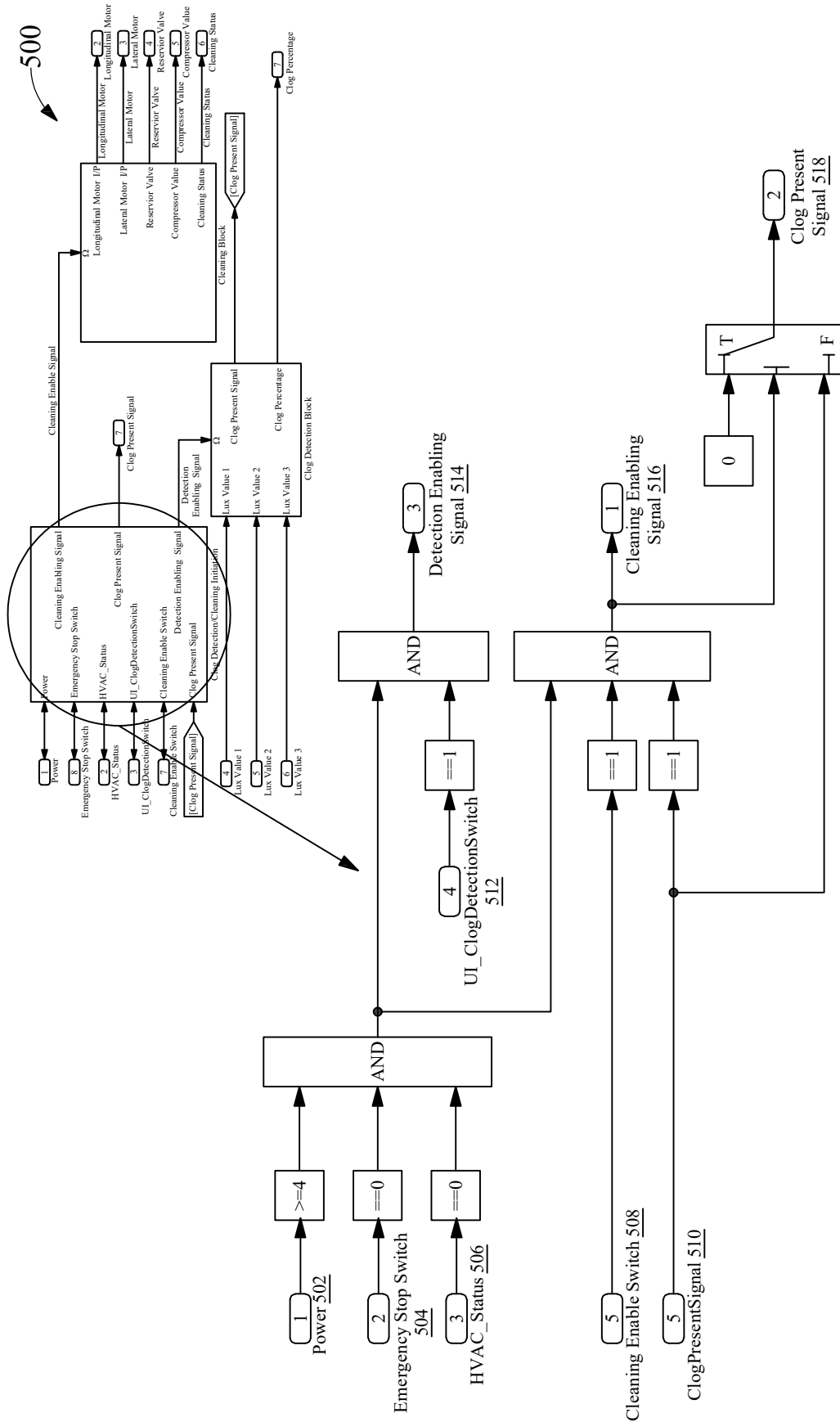


FIG. 5

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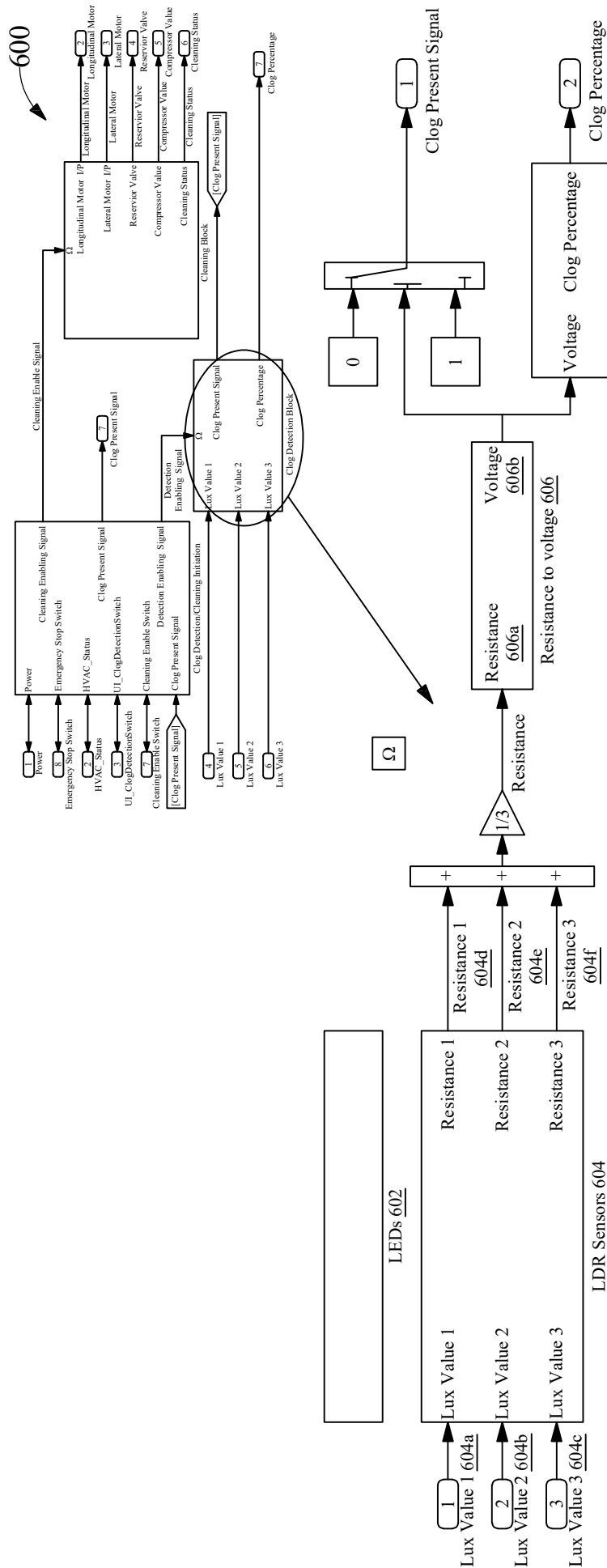


FIG. 6

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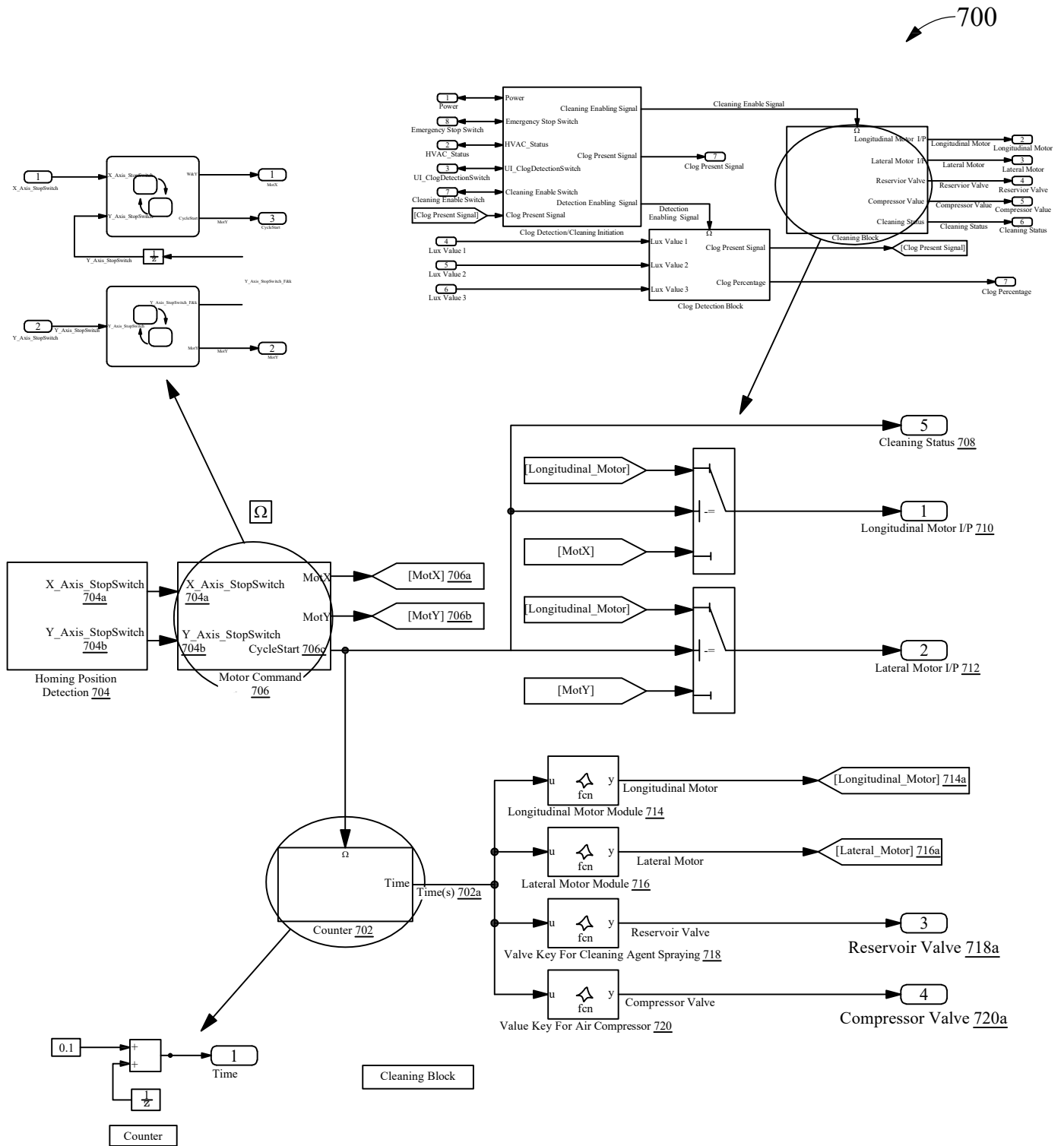


FIG. 7

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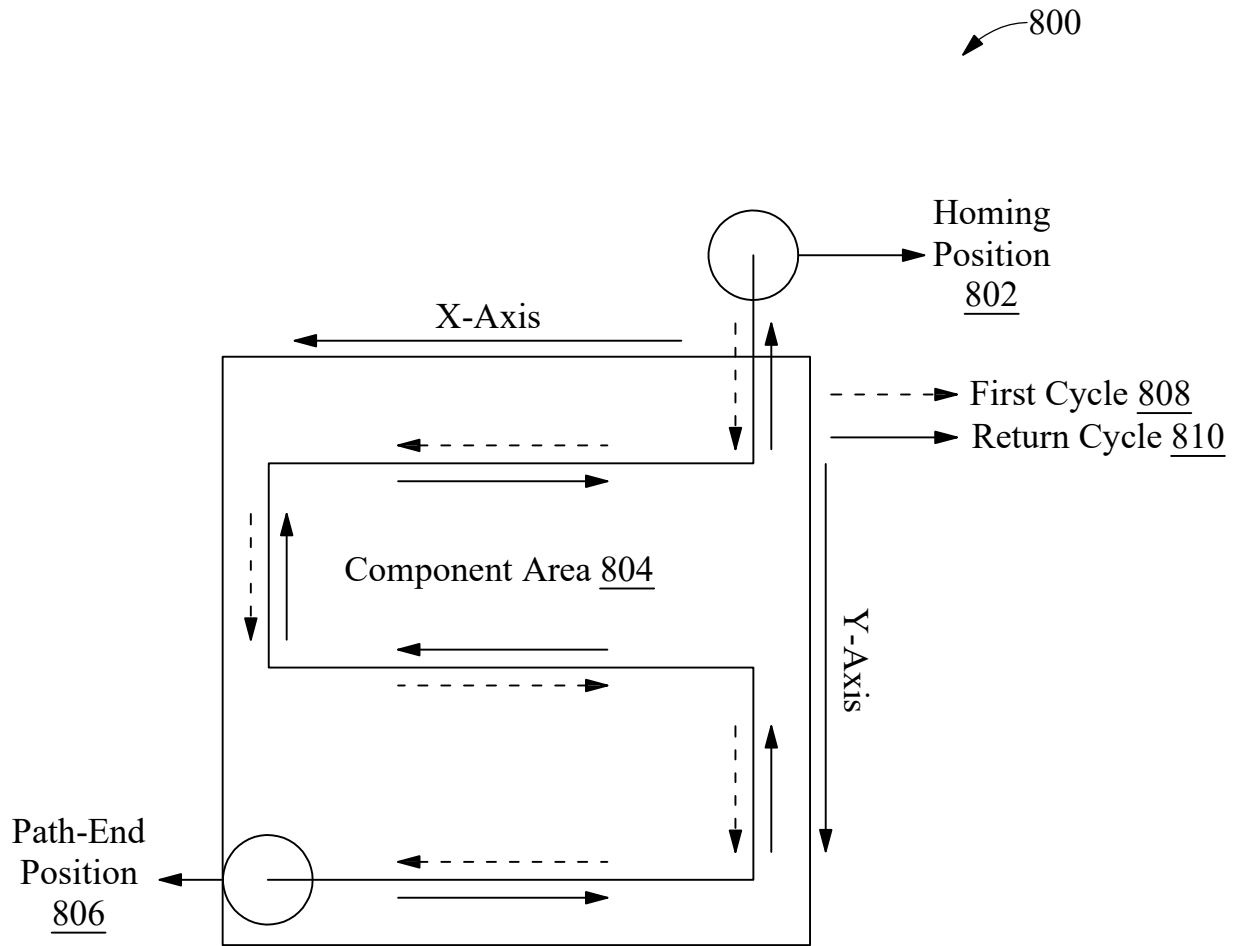


FIG. 8

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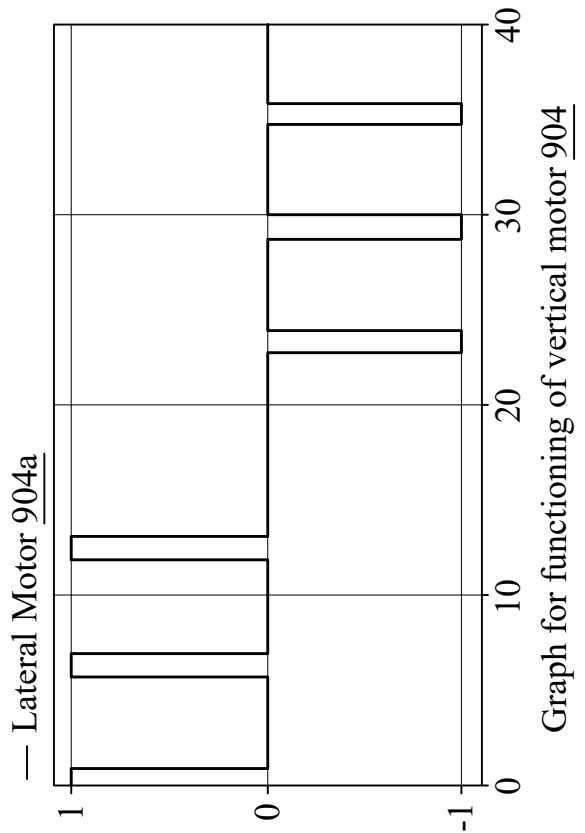
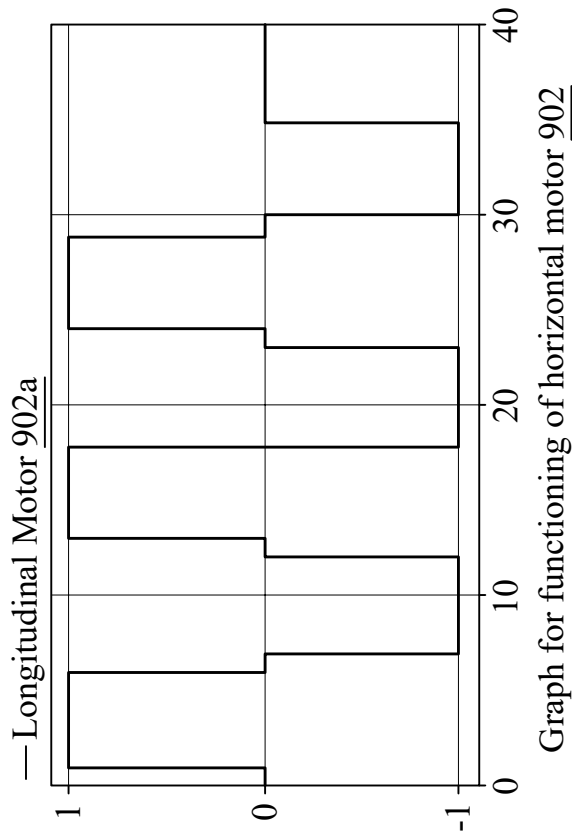
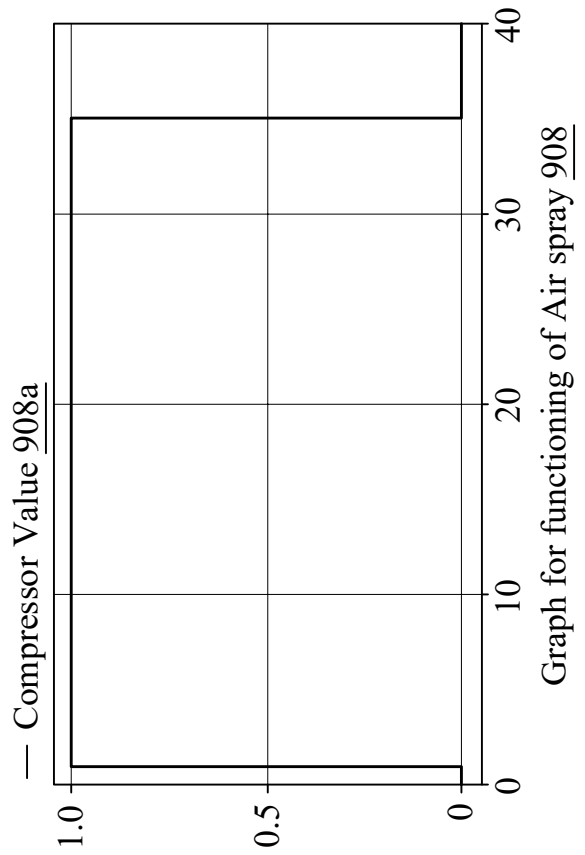
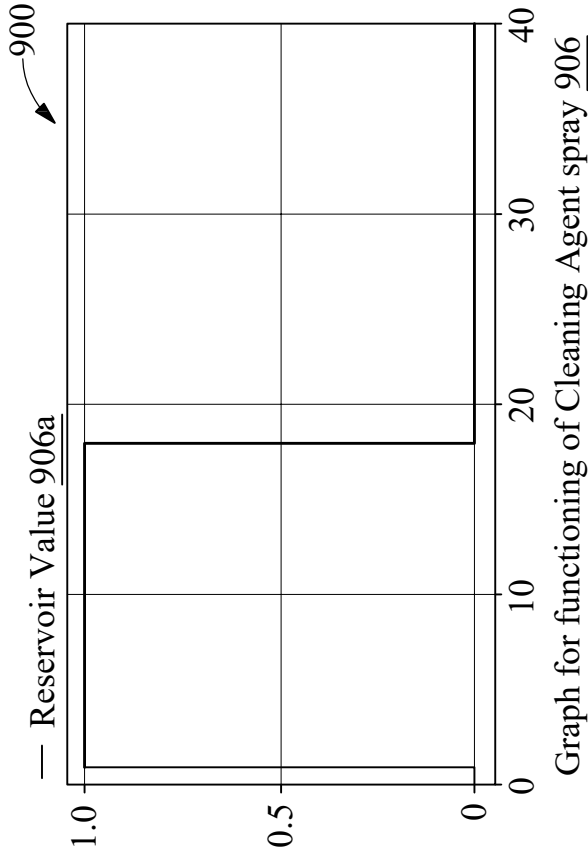


FIG. 9

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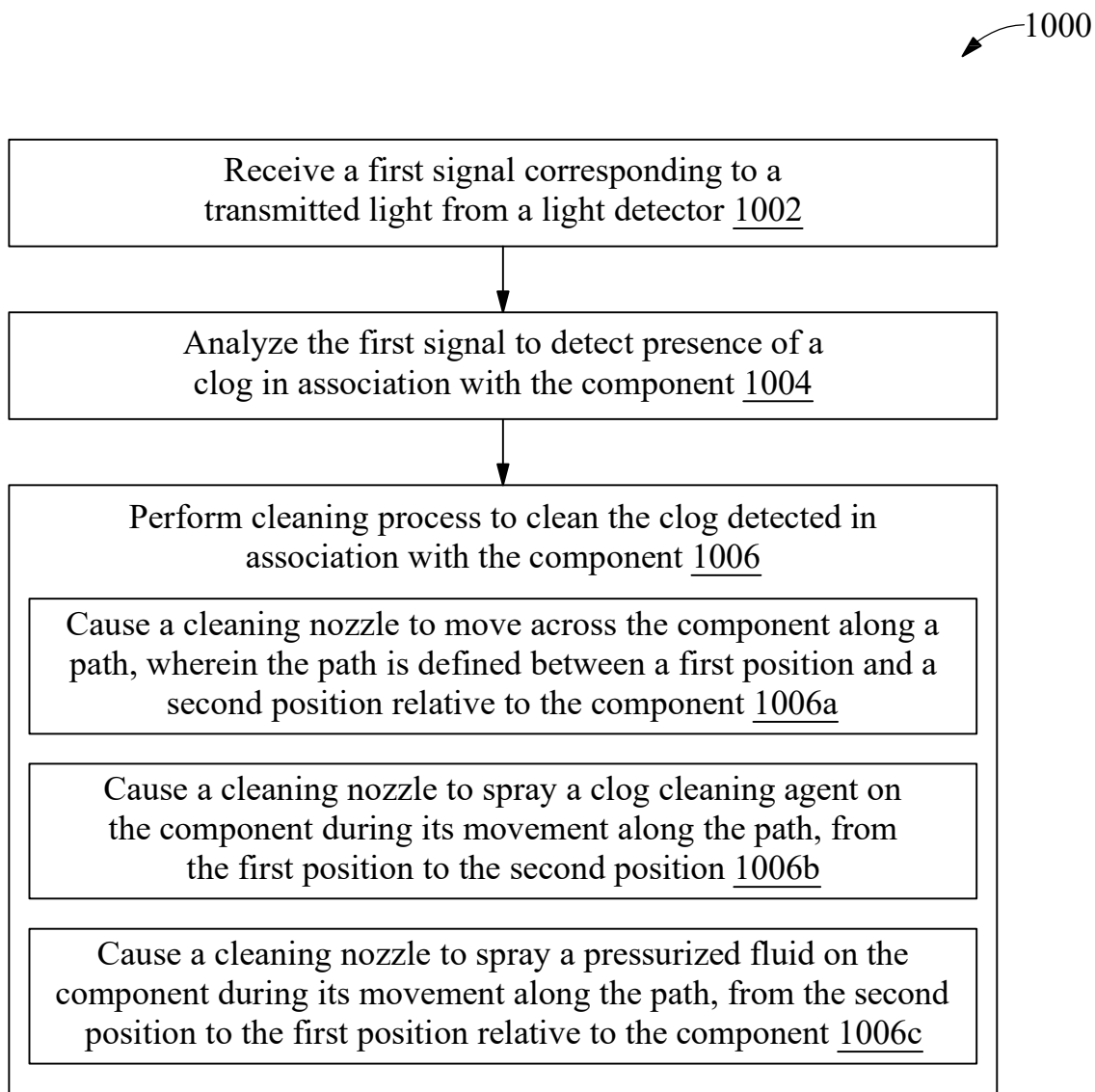


FIG. 10

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