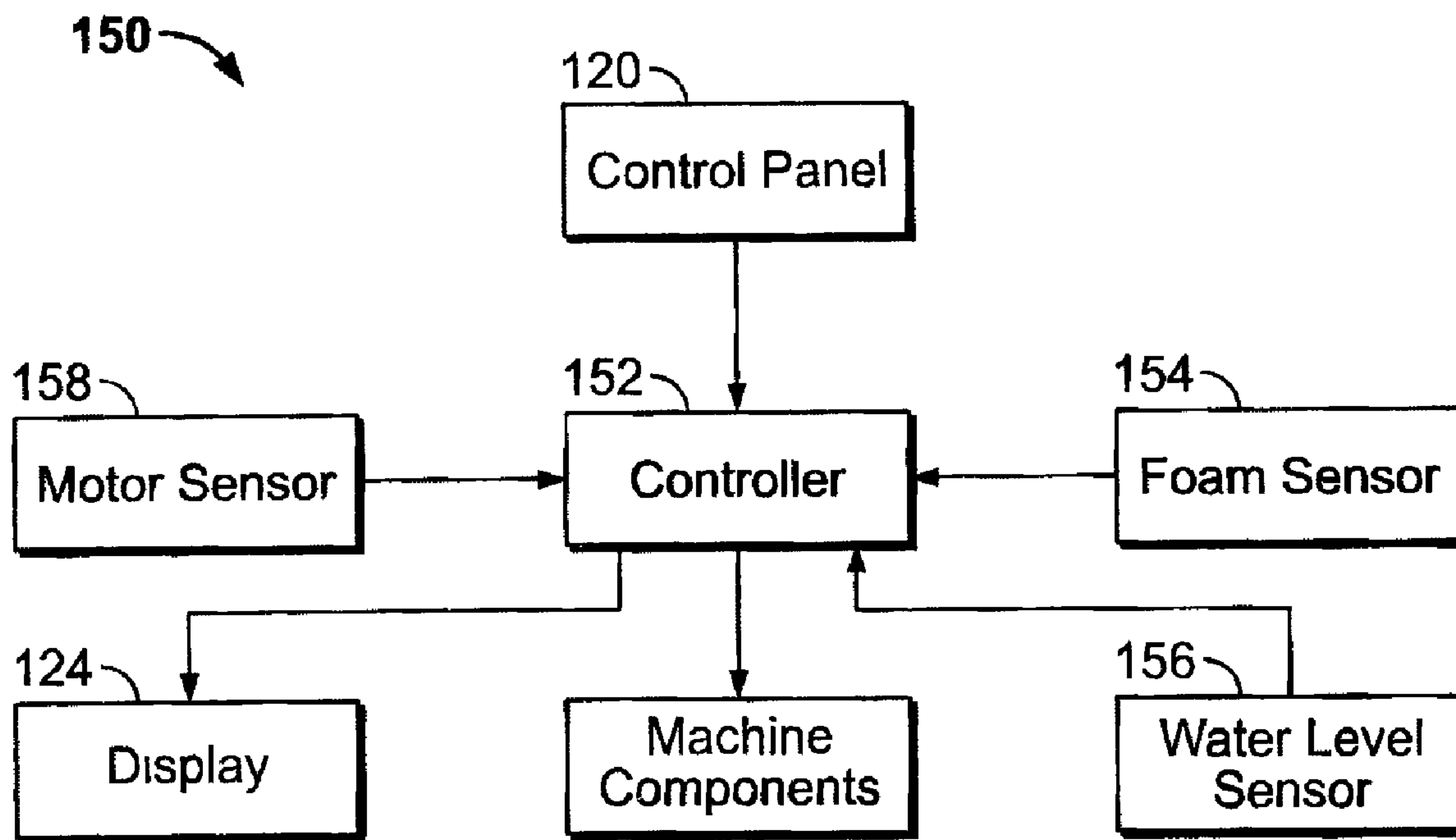




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 (54) Title: METHOD AND APPARATUS FOR OPERATING A WASHING MACHINE



(57) Abrégé/Abstract:

A control system for a washing machine operable in a wash cycle is provided. The control system includes a foam sensor and a controller operatively coupled to the foam sensor. The washing machine includes a cabinet and a wash tub positioned within the cabinet for receiving laundry therein. The foam sensor is configured to detect a level of foam within the wash tub. The controller is configured to introduce a softener into the wash tub upon the foam sensor detecting a threshold level of foam within the wash tub.

METHOD AND APPARATUS FOR OPERATING A
WASHING MACHINE

ABSTRACT OF THE DISCLOSURE

A control system for a washing machine operable in a wash cycle is provided. The control system includes a foam sensor and a controller operatively coupled to the foam sensor. The washing machine includes a cabinet and a wash tub positioned within the cabinet for receiving laundry therein. The foam sensor is configured to detect a level of foam within the wash tub. The controller is configured to introduce a softener into the wash tub upon the foam sensor detecting a threshold level of foam within the wash tub.

METHOD AND APPARATUS FOR OPERATING A WASHING MACHINE

BACKGROUND OF THE INVENTION

This invention relates generally to a washing machine and, more particularly, to methods and apparatus for eliminating or reducing foam production during operation of a washing machine.

Known washing machines typically include a cabinet that houses an outer tub for containing wash and rinse water. A perforated laundry basket is positioned within the tub and an agitator within the basket. A drive and motor assembly is mounted underneath the stationary outer tub to rotate the laundry basket and the agitator relative to one another. A pump assembly pumps water through the tub to a drain to execute a wash cycle.

Recently, horizontal axis or "front load" washing machines have become more desirable compared to the traditional vertical axis washing machines due to increased water efficiency. However, one potential drawback to the use of the horizontal axis washing machines is the build up of foam produced during a washing cycle due to a variety of reasons, such as using a wrong type and/or an excessive amount of laundry detergent. Excess foam may cause increased friction and/or load on the washing machine, which in turn cause the wash cycle to stop prematurely and/or damage to the motor. Moreover, excess foam often leads to an undesired laundry detergent residue on washed clothes.

Known processes to eliminate foam, such as adding cold water, extending stand still time during the wash cycle and/or reducing the amount of laundry detergent used, have adverse effects on the basket drive system and add time to the total wash cycle. Additionally, if the foam is not effectively eliminated, at least some known washing machines will terminate the wash cycle prematurely.

In addition, during a drain cycle following the wash cycle, excess foam may trigger a water level sensor to incorrectly indicate that the water within the tub is

above a predetermined level or that the water within the tub has reached a main water level. At least some conventional washing machines cannot discriminate between such a situation caused by excess foam or an amount of water remaining in the tub. As such, the conventional washing machines have an extended drain time to ensure that the water is completely pumped out of the tub. Such extended drain time undesirably increases the total time for a complete wash cycle.

BRIEF DESCRIPTION OF THE INVENTION

In one aspect, a control system for a washing machine operable in a wash cycle is provided. The washing machine includes a cabinet and a wash tub positioned within the cabinet for receiving laundry therein. The control system includes a foam sensor configured to detect a level of foam within the wash tub and a controller operatively coupled to the foam sensor. The controller is configured to introduce a softener into the wash tub upon the foam sensor detecting a threshold level of foam within the wash tub.

In another aspect, a washing machine operable in a wash cycle is provided. The washing machine includes a cabinet and a wash tub positioned within the cabinet. The wash tub is configured to receive laundry therein. A dispenser is positioned within the cabinet. A foam sensor is positioned within the cabinet and configured to detect a level of foam within the wash tub. A controller is operatively coupled to the foam sensor. The dispenser includes a plurality of independent compartments. A first compartment of the plurality of independent compartments is configured to receive an anti-foam component therein. The controller is configured to channel water through the first compartment and into the wash tub upon detecting a threshold level of foam within the wash tub.

In still another aspect, a method for assembling a washing machine operable in a wash cycle is provided. The method includes providing a cabinet and positioning a wash tub within the cabinet. A basket is rotatably positioned within the wash tub and configured to receive laundry therein. A dispenser is positioned within the cabinet and in fluid communication with the basket. The dispenser includes a first compartment configured to receive a washing detergent and a second compartment

configured to receive a softener. The second compartment is separate from the first compartment. A foam sensor is positioned with respect to the basket. The foam sensor is configured to detect a level of foam within the wash tub. A controller operatively coupled to the foam sensor is configured to channel water through the second compartment and into the wash tub when the foam sensor detects a threshold level of foam within the wash tub.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of an exemplary washing machine.

Figure 2 is a schematic view of an exemplary control system suitable for use with the washing machine shown in Figure 1.

Figure 3 is a flow chart of an exemplary foam eliminating program suitable for use with the washing machine shown in Figure 1.

Figure 4 is a flow chart of an exemplary foam detecting program suitable for use with the washing machine shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a perspective view of an exemplary washing machine 100. As shown in Figure 1, washing machine 100 is a horizontal axis washing machine 100. However, it is apparent to those skilled in the art and guided by the teachings herein provided that the present invention is applicable to other types of washing machines including, without limitation, vertical axis washing machines. The present invention is therefore not intended to be limited to any particular type or configuration of washing machine.

Washing machine 100 includes a cabinet 102 having a front panel 104, a top panel 106 and opposing side panels 108. Washing machine 100 includes a wash tub 112 positioned within cabinet 102 and a basket 114 rotatably positioned within and coupled to wash tub 112. A door 115 is hingedly mounted to front panel 104 and is movable about a hinge (not shown) between an open position (not shown), to

provide access to basket 114 and a closed position, as shown in Figure 1, forming a substantially sealed enclosure over basket 114.

Front panel 104 also includes a dispenser 116 for adding washing additives into wash tub 112. Dispenser 116 defines a plurality of independent compartments for separately storing suitable washing additives including, without limitation, laundry detergent, fabric softener and bleach. In one embodiment, dispenser 116 defines a first compartment 117 and a second compartment 118 separate from first compartment 117. In this embodiment, first compartment 117 and second compartment 118 are used to store different additives. For example, first compartment 117 stores laundry detergent and/or bleach, and second compartment 118 stores fabric softener. It is apparent to those skilled in the art and guided by the teachings herein provided that in alternative embodiments dispenser 116 includes more or less than two compartments for storing different additives. A drain pump 119 having a pump motor 121 is operatively coupled to wash tub 112 for facilitating pumping water from wash tub 112 to a drain (now shown).

Washing machine 100 includes a control panel 120 having a plurality of input selectors 122 positioned at an upper portion of front panel 104. Control panel 120 and input selectors 122 collectively form a user interface for operator selection of machine cycles and/or features. In one embodiment, a display section 124 indicates selected features, machine status and/or other items of interest to users.

Figure 2 is a schematic view of an exemplary control system 150 operatively coupled to control panel 120 suitable to control operation of washing machine 100. Control system 150 includes a controller 152 and a foam sensor 154 operatively coupled to controller 152. Foam sensor 154 is positioned with respect to wash tub 112 and basket 114 for detecting a level of foam within wash tub 112. Foam sensor 154 is configured to transmit at least one status signal indicative of a foam level within wash tub 112 to controller 152. In one embodiment, foam sensor 154 is reset when the foam level is reduced below a threshold level. In a particular embodiment, foam sensor 154 includes a plurality of sensors positioned with respect to wash tub 112 and/or basket 114 to detect a foam level therein.

Control system 150 includes a plurality of water level sensors 156 operatively coupled to controller 152 and positioned within wash tub 112 at suitable locations with respect to a bottom surface of wash tub 112, e.g., at different heights from the bottom surface. Each water level sensor 156 is used to sense whether the water reaches or approaches a corresponding level, such as an EMPTY, LOW, MEDIUM or HIGH water level. In one embodiment, at least one water level sensor 156 includes a pressure switch. Each water level sensor 156 is configured to transmit at least one signal indicative of a sensed water level to controller 152. In one embodiment, water level sensor 156 is reset when the water is below the corresponding water level. As such, controller 152 may detect the water level in wash tub 112 based on the signal received from water level sensor 156.

Control system 150 also includes a motor sensor 158 positioned with respect to pump motor 121 of drain pump 119 for detecting an operational status thereof. In one embodiment, motor sensor 158 is used to detect the angle phase of motor 121 and transmit at least one signal indicative of the angle phase of motor 121 to controller 152. As such, controller 152 may detect the load of drain pump 119 based on the detected angle phase of motor 121.

Controller 152 is also operatively coupled to input selectors 122 of control panel 120 located on front panel 104 of washing machine 100. Control panel 120 facilitates user manipulation of input selectors 122 to select washing machine cycles and/or features. Washing machine 100 also includes various components operatively coupled to controller 152 including, without limitation, a drive motor (not shown) for driving basket 114, motor 121 for driving drain pump 119 to drain water from wash tub 112 and a water valve (not shown) for controlling water flow within or through wash tub 112. In response to user manipulation of the user interface input, controller 152 operates the various components of washing machine 100 to execute selected machine cycles and/or features. In one embodiment, controller 152 is operatively coupled to the drive motor and/or motor 121 to sense or detect an operational status of the respective motor. In a particular embodiment, in response to signals received from foam sensor 154 and/or water level sensors 156, controller 152

controls operation of the drive motor to drive wash tub 112 and/or basket 114 and/or controls operation of motor 121 to facilitate draining water from wash tub 112.

Figure 3 is a flow chart of an exemplary foam reducing program 200 suitable for use with washing machine 100 shown in Figure 1. It is apparent to those skilled in the art and guided by the teachings herein provided that the methodology described herein may be implemented in various suitable programs.

During a normal wash cycle, foam sensor 154, shown in Figure 2, monitors the level of foam within wash tub 112 and controller 152 determines whether the level of foam within wash tub 112 reaches or approaches a threshold level based on a signal received from foam sensor 154. In one embodiment, if foam sensor 154 detects the level of foam approaching or reaching 202 the threshold level, foam sensor 154 generates and transmits a signal to controller 152. In response to the transmitted signal, controller 152 suspends the wash cycle and starts foam reducing program 200. Controller 152 initiates energizing 204 drain pump 119 to drain water from wash tub 112 for a suitable time, such as about 15 seconds to about 45 seconds, and in many cases about 25 seconds to about 35 seconds. Controller 152 opens 206 the water valve (not shown) to channel water into wash tub 112 for a suitable time, such as about 30 seconds to about 60 seconds, and in many cases about 40 seconds to about 50 seconds. In one embodiment, controller 152 channels 208 cold water through first compartment 117 of dispenser 116, which stores laundry detergent and/or bleach for about 20 seconds. Controller 152 also channels 208 cold water through second compartment 118, which stores softener, for the remaining time. If the softener is added to second compartment 118 prior to the wash cycle, the softener mixes and flows with the water into wash tub 112. Upon introducing the softener into wash tub 112, the foam within wash tub 112 is effectively reduced or eliminated.

Controller 152 operates a foam reducing process after flushing dispenser 116. In one embodiment, controller 152 initiates 210 the rotation of basket 114 at a relatively low speed for about 3 minutes. Basket 114 is then maintained in a stationary position 212 for about 4 minutes. Controller energizes 214 drain pump 119

to drain the water from wash tub 112. Controller 152 then monitors 216 the level of foam after the foam reducing process.

If the level of foam is detected to be below the threshold level, controller 152 resumes 218 the wash cycle. If the level of foam is still at or above the threshold level, controller 152 continues to operate the foam reducing process. In one embodiment, controller 152 opens 220 the water valve and channels 222 water through first compartment 117 for about 45 seconds. Controller 152 rotates 224 basket 114 for a complete cycle. In a particular embodiment, controller 152 rotates basket 114 for about 15 seconds, pauses or terminates rotation for about 5 seconds, and then rotates basket 114 for about 15 seconds. Controller 152 then maintains 226 basket 114 stationary for about 5 minutes as water is drained 228 from wash tub 112.

Controller 152 then detects 230 the level of foam. If the level of foam is below the threshold level, controller 152 continues 218 the original wash cycle. If the foam is still at or above the threshold level, controller 152 initiates steps 220-228 again to wash the laundry within wash tub 112. Controller 152 then detects the level of foam. If the level of foam is below the threshold level, controller 152 continues 218 the original wash cycle. If the level of foam is at or above the threshold level, controller 152 continues 234 the wash cycle at a reduced rotational speed of basket 114. In this embodiment, controller 152 will operate washing machine 100 to complete the wash cycle when the level of foam is at or above the threshold level.

In alternative embodiments, foam reducing program 200 includes a plurality of steps not necessarily followed during the normal washing machine operation. Further, the operating time period for each step is varied according to different laundry types, washing features and/or washing machine configurations.

Figure 4 is a flow chart of an exemplary foam detecting program 300 suitable for use with washing machine 100 shown in Figure 1. In one embodiment, program 300 is executed at at least one step 216, 230 and/or 232 of program 200 shown in Figure 2. Further, in a particular embodiment, program 300 is executed at at least one drain cycle 204, 214 and/or 228 following the wash cycle. It is apparent to

these skilled in the art and guided by the teachings herein provided that the methodology described herein may be implemented in various suitable programs.

During a drain cycle, controller 152 initiates energizing drain pump 119 to drain water from wash tub 112 for a suitable time, such as about 30 seconds to about 120 seconds, and in many cases about 45 seconds to about 60 seconds. Controller 152 then determines 302 whether the level of foam within wash tub 112 reaches or approaches the threshold level and determines 304 whether the water within tub 112 is below the EMPTY water level in response to a signal received from at least one water level sensors 156. In one embodiment, foam sensor 154 sends a signal to controller 152 when detecting that the level of foam reaches the threshold level. In another embodiment, each water level sensor 156 sends a signal to controller 152 if the water reaches the corresponding water level. In this embodiment, if sensor 156 does not detect that the water level within wash tub 112 has reached the corresponding threshold water level, sensor 156 is not reset. Thus, if the detected water level does not reach sensor 156, sensor 156 will not transmit a signal to controller 152 and sensor 156 will not be reset.

In some situation, excess foam may trigger both foam sensor 154 and at least one of water level sensors 156. If controller 152 determines the threshold level of foam and a water level above EMPTY level (or another level), controller 152 determines 306 an operational status of drain pump 119. In one embodiment, motor sensor 158 detects an angle phase of pump motor 121, and generates and sends a signal indicative of the angle phase to controller 152. Since the angle phase represents the load of pump motor 121, controller 152 determines the load of pump motor 121 based on the received signal.

Foam and water result in different loads exerted on pump motor 121, such that controller 152 determines whether the remaining water within water tub 112 or the excessive foam triggers foam sensor 154 and/or water level sensors 156. If the detected angle phase matches the corresponding angle phase for water, controller initiates 308 operating a diagnostic step to determine why water has not drained

outside in the predetermined time period. If the detected angle phase matches the angle phase for foam, controller initiates 310 operating foam reducing program 200.

In one embodiment, the user adds the softener into dispenser 116. As such, controller 152 channels water through dispenser 116 upon detecting the threshold level of foam, which facilitates effectively and timely reducing the foam. Controller 152 completes the wash cycle in an excess foam situation, e.g., the level of foam within wash tub 112 is at or above the threshold level. In another embodiment, controller 152 detects the operational status of pump motor 121 when foam sensor 154 and at least one water level sensor 156 are triggered. As such, controller 152 determines whether the water remaining within washtub 112 or the foam triggers water level sensors 154, 156 and executes the corresponding process without undesirably terminating the wash cycle prematurely or extending the drain time.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

WHAT IS CLAIMED IS:

1. A control system for a washing machine operable in a wash cycle, said washing machine comprising a cabinet and a wash tub positioned within the cabinet for receiving laundry therein, said control system comprising:

a foam sensor configured to detect a level of foam within the wash tub;
and

a controller operatively coupled to said foam sensor, said controller configured to introduce a softener into the wash tub upon said foam sensor detecting a threshold level of foam within the wash tub.

2. A control system in accordance with Claim 1 wherein said controller is operatively coupled to at least one of a drive motor configured to drive the wash tub and a pump motor configured to facilitate draining water from the wash tub.

3. A control system in accordance with Claim 1 wherein said controller is configured to suspend the wash cycle upon detecting the threshold level.

4. A control system in accordance with Claim 1 wherein said controller is configured to initiate rotation of said wash tub and channel water through said wash tub after introducing the softener.

5. A control system in accordance with Claim 4 wherein said controller is configured to detect the level of foam within said wash tub after channeling the water.

6. A control system in accordance with Claim 5 wherein said controller is configured to continue the wash cycle with the level of foam below the threshold level.

7. A control system in accordance with Claim 5 wherein said controller is configured to operate a foam reducing process upon detecting the level of foam at the threshold level.

8. A control system in accordance with Claim 5 wherein said controller is configured to continue the wash cycle at a reduced rotational speed upon detecting the level of foam at the threshold level.

9. A control system in accordance with Claim 1 wherein said controller is configured to determine a foam threshold level based on an operational status of a pump motor.

10. A control system in accordance with Claim 1 further comprising a water level sensor configured to detect a water level within said wash tub, said controller configured to detect the operational status of a pump motor upon detecting the foam threshold level and the water level above a predetermined empty level.

11. A washing machine operable in a wash cycle, said washing machine comprising:

a cabinet;

a wash tub positioned within said cabinet and configured to receive laundry therein;

a dispenser positioned within said cabinet, said dispenser comprising a plurality of independent compartments, a first compartment of said plurality of independent compartments configured to receive an anti-foam component therein;

a foam sensor positioned within said cabinet and configured to detect a level of foam within said wash tub; and

a controller operatively coupled to said foam sensor, said controller configured to channel water through said first compartment and into said wash tub upon detecting a threshold level of foam within said wash tub.

12. A washing machine in accordance with Claim 11 wherein said controller is configured to suspend the wash cycle upon detecting the threshold level.

13. A washing machine in accordance with Claim 11 wherein said controller is configured to operate a foam reducing process upon detecting the threshold level.

14. A washing machine in accordance with Claim 13 wherein said controller is configured to drain water from said wash tub during the foam reducing process.

15. A washing machine in accordance with Claim 13 wherein said controller is configured to detect the level of foam within said wash tub after the foam reducing process.

16. A washing machine in accordance with Claim 15 wherein said controller is configured to resume the wash cycle upon detecting the level of foam below the threshold level.

17. A washing machine in accordance with Claim 15 wherein said controller is configured to continue operating the foam reducing process upon detecting the threshold level.

18. A washing machine in accordance with Claim 15 wherein said controller is configured to continue the wash cycle at a reduced rotational speed upon detecting the threshold level.

19. A washing machine in accordance with Claim 11 further comprising a pump motor configured to drain water through said wash tub, said controller configured to determine a foam level based on an operational status of said pump motor in a drain cycle.

20. A washing machine in accordance with Claim 19 further comprising a water level sensor configured to detect a water level within said wash tub, said controller configured to detect an angle phase of said pump motor upon detecting the threshold level of foam and the water level at a predetermined level.

21. A method for reducing a foam level within a washing machine during a wash cycle, said method comprising:

positioning a foam sensor within a cabinet of the washing machine configured to detect a level of foam within a wash tub positioned within the cabinet;

positioning a dispenser within the cabinet and in fluid communication with a basket rotatably positioned within the wash tub, the dispenser including a first compartment configured to receive a washing detergent and an independent second compartment configured to receive a softener; and

operatively coupling a controller to the foam sensor, the controller configured to channel water through the second compartment and into the wash tub upon detecting a threshold level of foam within the wash tub.

22. A method in accordance with Claim 21 wherein operatively coupling a controller comprises coupling a controller configured to suspend the wash cycle upon detecting the threshold level.

23. A method in accordance with Claim 21 further comprising initiating a foam reducing process upon detecting the threshold level.

24. A method in accordance with Claim 23 further comprising detecting the level of foam within the wash tub after the foam reducing process.

25. A method in accordance with Claim 24 further comprising resuming the wash cycle at a reduced rotational speed of the basket upon detecting the threshold level.

26. A method in accordance with Claim 21 further comprising detecting an operational status of a pump motor upon detecting the threshold level of foam and the water level at a predetermined level.

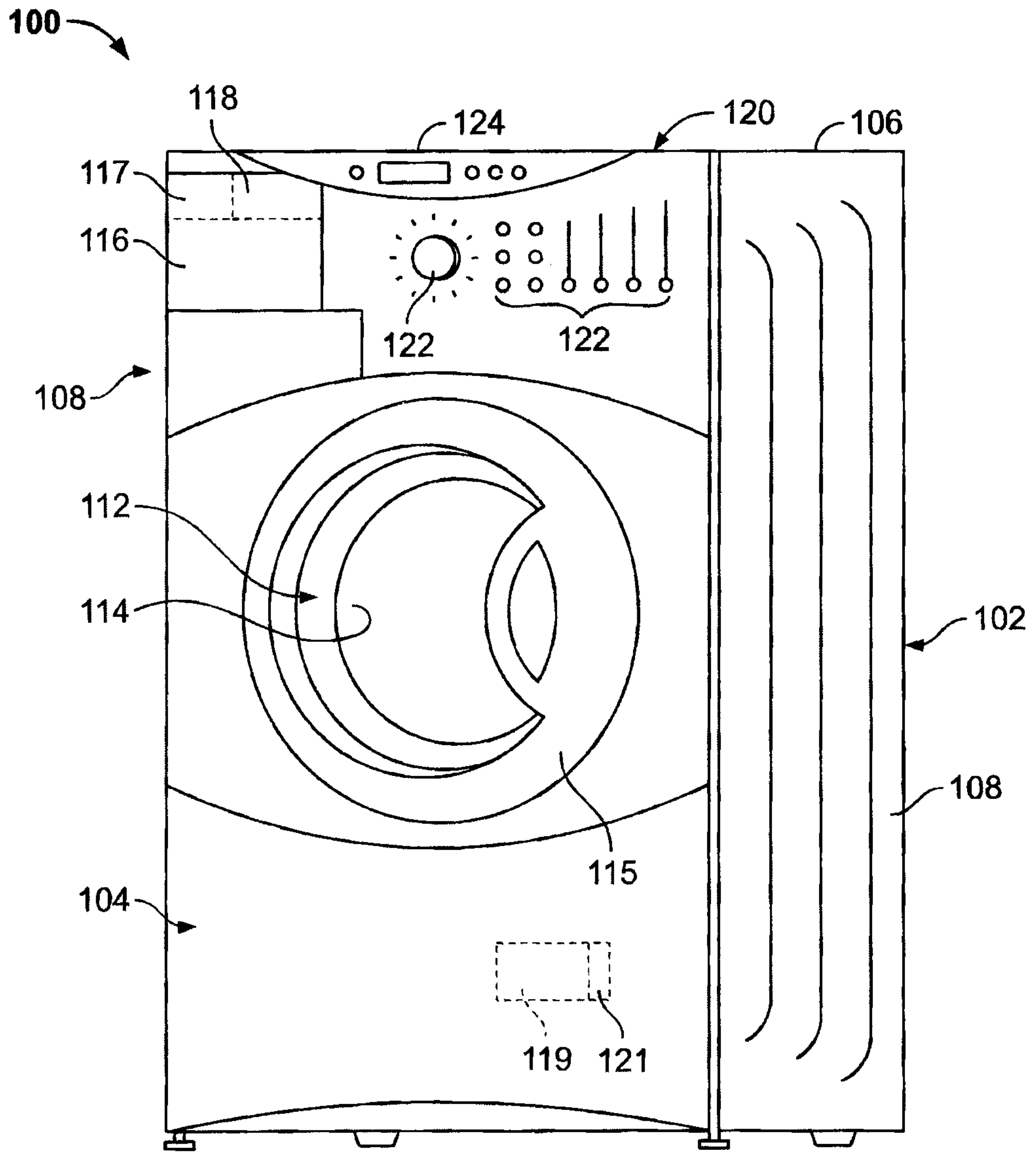


FIG. 1

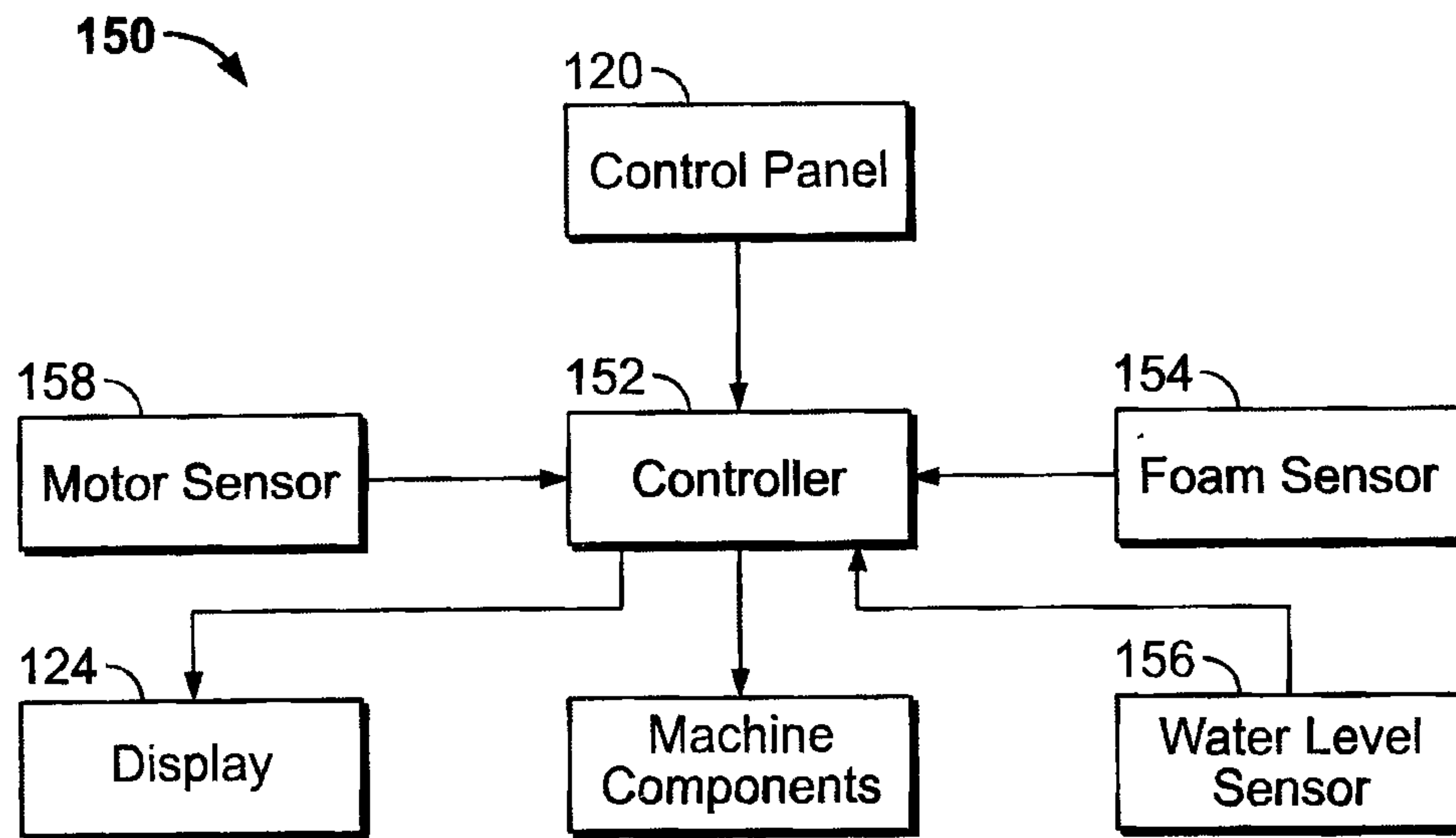


FIG. 2

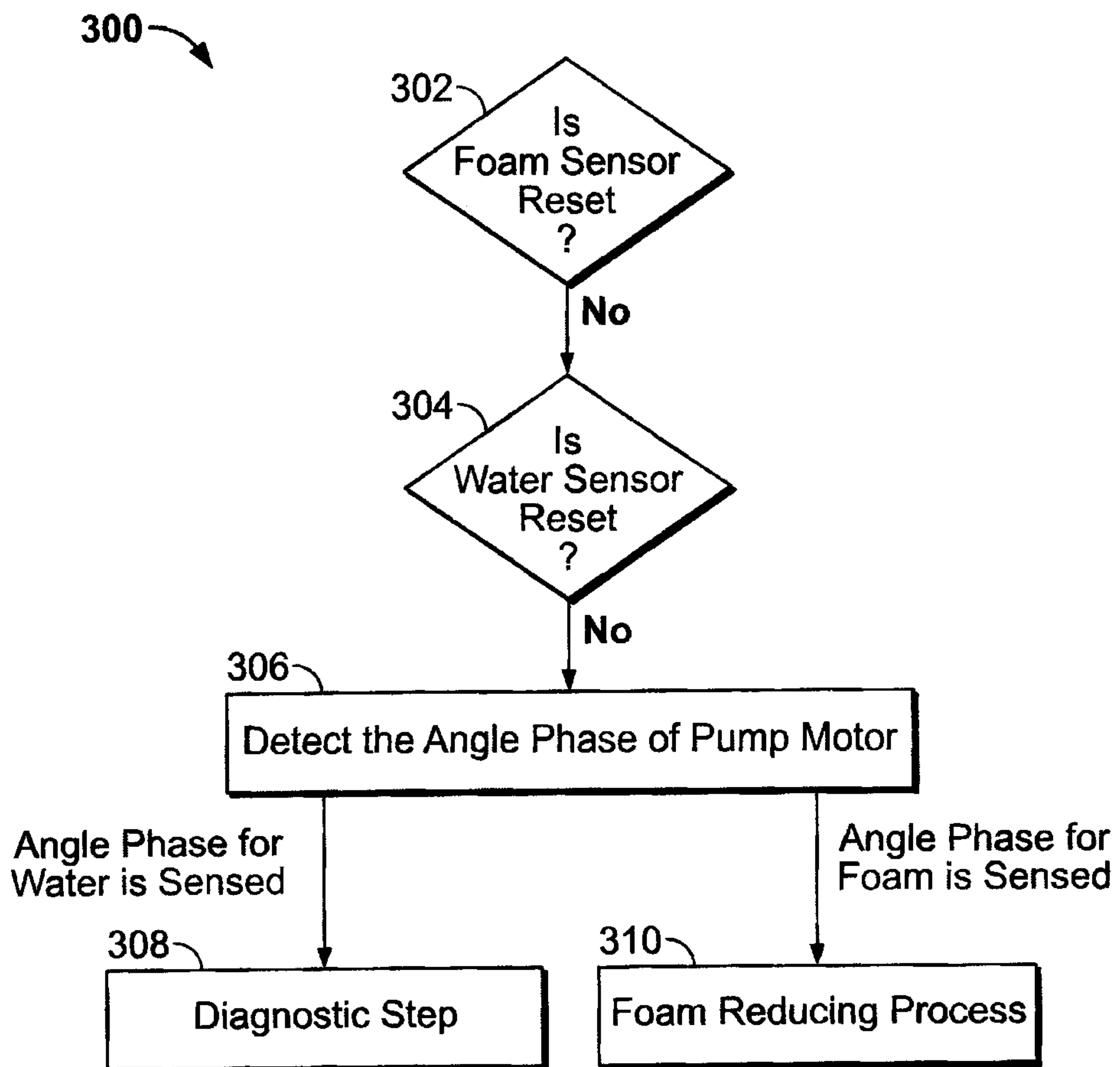


FIG. 4

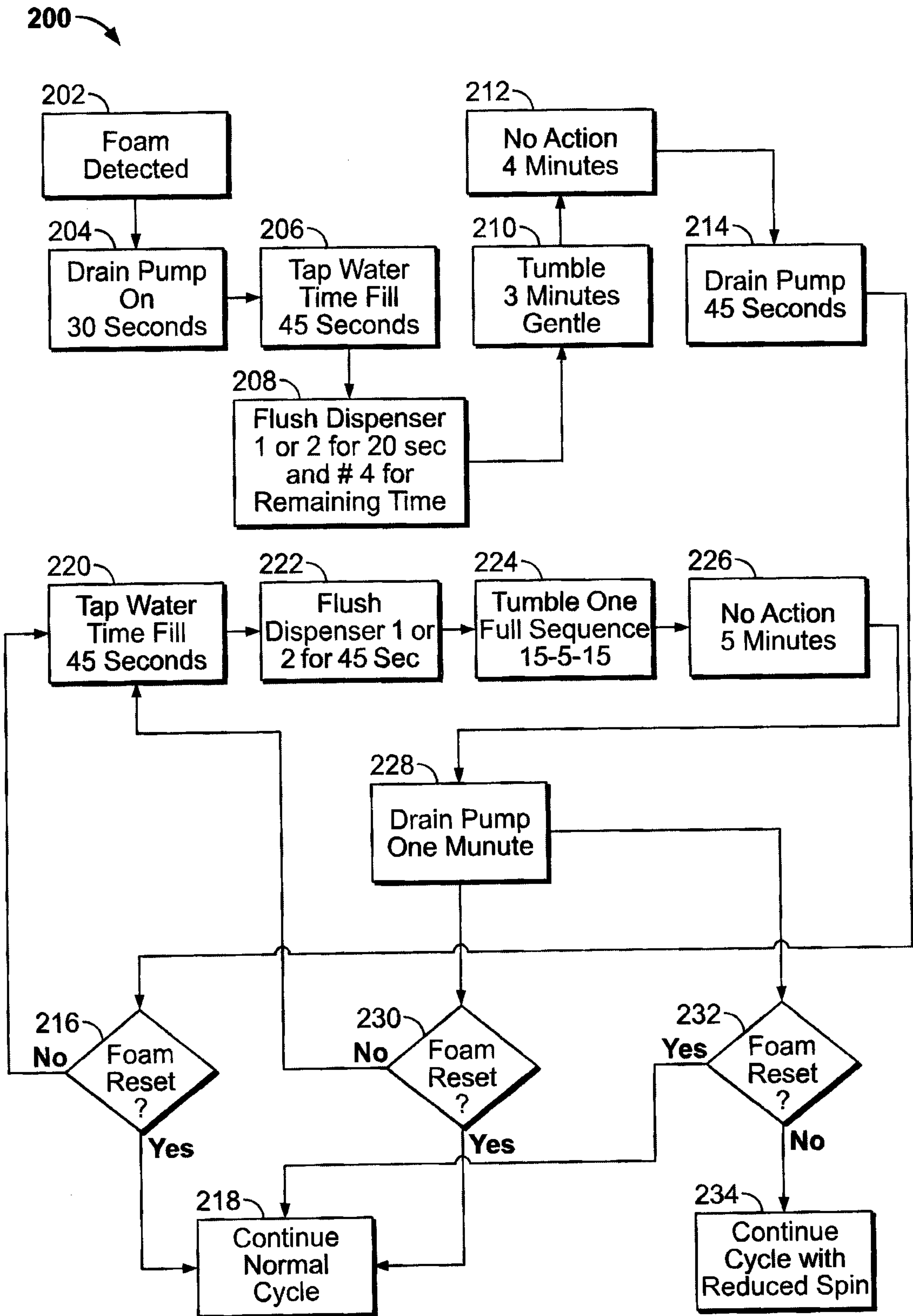


FIG. 3

150

120
Control Panel

158
Motor Sensor

152
Controller

154
Foam Sensor

124
Display

Machine Components

156
Water Level Sensor

