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(54) **LAUNDRY APPLIANCE HAVING A FINE-PARTICLE FILTER FOR SEPARATING MICROFIBERS FROM PROCESS FLUIDS**

(57) A laundry appliance (12) includes a tub (18) positioned within an outer cabinet (20). A drum (22) is rotationally operable within the tub (18). A fluid pump (26) directs a process fluid (16) through a fluid path (14) that includes the tub (18). A fine-particle filter (10) is positioned within the fluid path (14). The fine-particle filter (10) separates microfibers (28) from the process fluid (16) to define captured microfibers (28).

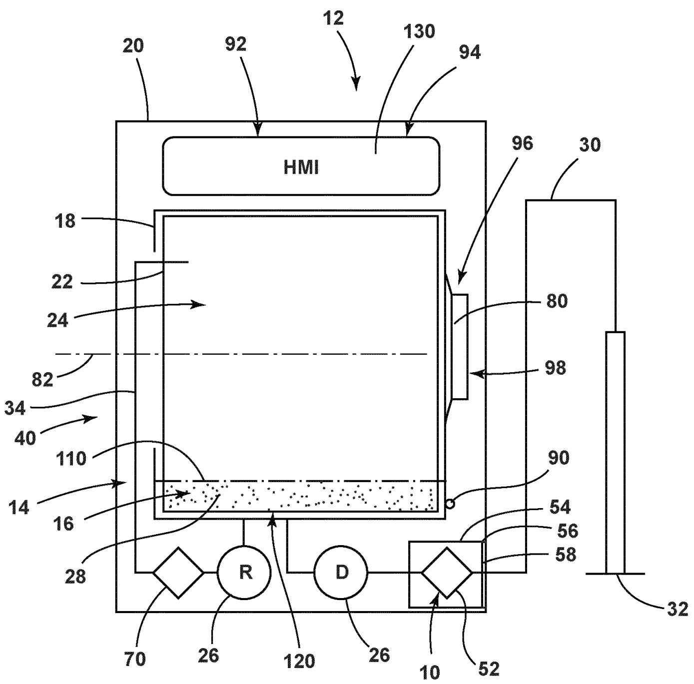

FIG. 4

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Description

FIELD OF THE DEVICE

[0001] The device is generally in the field of laundry appliances, and more specifically, a laundry appliance that includes a fine-particle filter for separating microfibers from process fluid so that the microfibers can be recycled.

SUMMARY OF THE DEVICE

[0002] According to one aspect of the present disclosure, a laundry appliance includes a tub positioned within an outer cabinet. A drum is rotationally operable within the tub. A fluid pump directs a process fluid through a fluid path that includes the tub. A fine-particle filter is positioned within the fluid path. The fine-particle filter separates microfibers from the process fluid to define captured microfibers.

[0003] According to another aspect of the present disclosure, a laundry appliance includes a tub positioned within an outer cabinet. A drum that is rotationally operable within the tub. A motor that operates the drum about a rotational axis. A fluid pump that directs a process fluid through a fluid path that includes the tub. A fine-particle filter is positioned within the fluid path. The fine-particle filter separates microfibers from the process fluid. Delivery of the process fluid through the fine-particle filter results in an accumulation of process fluid within the tub. A controller operates the motor. The controller operates the motor according to a predetermined operational sequence when a flow of the process fluid is below a threshold level with respect to the tub and the fluid pump. The controller operates the motor according to a diminished acceleration sequence when the flow of the process fluid reaches the threshold level.

[0004] According to yet another aspect of the present disclosure, a method for operating a laundry appliance includes beginning a laundry cycle and operating a motor for a drum according to a predetermined operational sequence. Process fluid is delivered through a fluid path that includes a tub and the drum that rotationally operates within the tub. The process fluid is filtered using a fine-particle filter. A flow of the process fluid is slowed within the tub and the drum to allow for increased filtration of the process fluid within the fine-particle filter. Operation of the motor is modulated to be a diminished acceleration sequence when the flow of the process fluid reaches a threshold level within the tub. The operation of the motor is modulated to be the predetermined operational sequence when the flow of the process fluid is below the threshold. The laundry cycle is completed. A fine-particle cartridge can be removed from the fine-particle filter when the fine-particle cartridge is saturated with micro fibers and a new fine-particle cartridge installed into the fine-particle filter.

[0005] These and other features, advantages, and objects of the present disclosure will be further understood and appreciated by those skilled in the art by reference to the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In the drawings:

FIG. 1 is a front perspective view of a front-load washing appliance that incorporates an aspect of the fine-particle filter;
FIG. 2 is a top-load washing appliance that incorporates an aspect of the fine-particle filter;
FIG. 3 is a schematic cross-sectional view of a laundry appliance that includes a fine-particle filter within an exterior portion of a drain conduit;
FIG. 4 is a cross-sectional perspective view of a laundry appliance that includes a fine-particle filter within a drain channel and within a filter receptacle that is accessible through the outer cabinet of the appliance;
FIG. 5 is a cross-sectional schematic view of a laundry appliance that includes a fine-particle filter within a recirculating fluid path, where the fine-particle filter is located within a receptacle that is accessible through the outer cabinet of the appliance; and
FIG. 6 is a schematic linear flow diagram illustrating a method for operating a laundry appliance that includes a fine-particle filter.

[0007] The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles described herein.

DETAILED DESCRIPTION

[0008] The present illustrated embodiments reside primarily in combinations of method steps and apparatus components related to a laundry appliance having a fine-particle filter within a fluid path for separating micro fibers from process fluid so that the micro fibers can be contained and recycled. Accordingly, the apparatus components and method steps have been represented, where appropriate, by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present disclosure so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein. Further, like numerals in the description and drawings represent like elements.

[0009] For purposes of description herein, the terms "upper," "lower," "right," "left," "rear," "front," "vertical," "horizontal," and derivatives thereof shall relate to the disclosure as oriented in FIG. 1. Unless stated otherwise, the term "front" shall refer to the surface of the element closer to an intended viewer, and the term "rear" shall refer to the surface of the element further from the intended viewer. However, it is to be understood that the disclosure may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

[0010] The terms "including," "comprises," "comprising," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element proceeded by "comprises a ... " does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

[0011] Referring now to FIGS. 1-5, reference numeral 10 generally refers to a fine-particle filter that is installed within a laundry appliance 12 for separating micro-sized particles, such as microfibers 28, that are carried through a fluid path 14 by a process fluid 16 as a result of processing laundry articles that are made from various micro-sized fiber materials. According to various aspects of the device, the laundry appliance 12 includes a tub 18 that is positioned within an outer cabinet 20. A drum 22 is rotationally operable within the tub 18 and defines a processing space 24 within which laundry articles are processed. A fluid pump 26 directs the process fluid 16 through the fluid path 14 that includes tub 18 and the processing space 24 of the rotating drum 22. The fine-particle filter 10 is positioned within the fluid path 14. The fine-particle filter 10 separates microfibers 28 from the process fluid 16. Within the appliance 12, the fluid path 14 can include at least a drain conduit 30 that delivers fluid from the tub 18 and to an external drain 32 outside of the appliance 12. Additionally, certain appliances 12 can also include a recirculating fluid path 34 that recirculates the process fluid 16 through the tub 18. It is contemplated that the fine-particle filter 10 can be positioned within either of the recirculating fluid path 34, the drain conduit 30, or both.

[0012] According to various aspects of the device, microfibers 28 are very small micro-sized fibers that are typically made of plastic fibers or plastic coated fibers that are too small for conventional filters to capture. Accordingly, these microfibers 28 typically pass through conventional filters and can be delivered from a laundry appliance 12 and into various external drains 32 for ultimate release or deposition within the environment. Because these microfibers 28 include a significant amount of plastic in each fiber, the prevalent use of microfiber materials has resulted in a large amount of plastics being released into the environment. The fine-particle filter 10 described herein provides a mechanism for capturing these particles of minute size. Additionally, because the microfibers 28 are made of plastic, recycling these fibers is a practical and responsible method for disposing of these microfibers 28. Accordingly, the fine-particle filter 10 described herein serves to capture and contain these microfibers 28 so that they can be delivered to a facility to be properly disposed of and/or recycled.

[0013] Referring again to FIGS. 1-5, it is contemplated that the fine-particle filter 10 can be disposed within any one of various laundry appliances 12. Such appliances 12 can include, but are not limited to, front-load appliances 40, top-load appliances 42, washers, dryers, combination washers and dryers, and other similar appliances that are used for processing laundry and which may result in the release of microfibers 28 into a processing space 24 of the particular appliance 12.

[0014] Referring again to FIGS. 3-5, it is contemplated that the fine-particle filter 10 can include at least one container 52, such as a cartridge 50 or other collection space, that is selectively removed from the cabinet 20 for the appliance 12 so that the microfibers 28 can be transferred to a recycling facility or other disposal facility without being removed from the container 52 for the fine-particle filter 10. Accordingly, the fine-particle filter 10 is incorporated within a filter housing 54. The cartridge 50 can be positioned within the filter housing 54 and can also be selectively removed from the filter housing 54 and the fluid path 14 for disposing of the captured microfibers 28. This filter housing 54 is typically accessible via an exterior of the outer cabinet 20. In this manner, the outer cabinet 20 can include an aperture 56 and a door 58 or other panel that can be operated for accessing, removing and replacing necessary portions of the fine-particle filter 10 for capturing and containing the microfibers 28.

[0015] Referring again to FIGS. 3-5, the fluid path 14 for the appliance 12 can include a primary filter 70 that is configured for capturing larger-sized particles of lint and other material that may be separated from the articles being processed within the drum 22 of the appliance 12. Such larger particles can include lint, other particulate material, objects that may be left within clothing pockets, and other foreign items that may find their way into the processing space 24 of the appliance 12. This primary filter 70 has a mesh size that is larger than the size of the microfibers 28 that are intended to be captured by the fine-particle filter 10. Accordingly, during operation of the appliance 12, the process fluid 16 moves through the primary filter 70 where larger objects and larger particulate can be captured and separated from the process fluid 16. Subsequently, and downstream from the primary filter 70, the fine-particle filter 10 can be used to capture microfibers 28 and separate these microfibers 28 from the process fluid 16. Accordingly, the primary filter 70 is positioned upstream of the fine-particle filter 10.

[0016] Use of the primary filter 70 in capturing larger particles will extend the life of the fine-particle filter 10 by allowing only microfibers 28 to engage a filter member of the fine-particle filter 10. It is contemplated that the primary filter 70 will be cleaned or otherwise maintained after each load of laundry, daily, weekly or other similar short period of time. In this manner, only the microfibers 28 pass through the primary filter 70 to be captured by the fine-particle filter 10. Using this configuration, the fine-particle filter 10 may be cleaned, replaced or otherwise maintained monthly, every other month, or some other longer period of time.

[0017] Referring again to FIGS. 4 and 5, the primary filter 70 is typically located within a recirculating fluid path 34 and the fine-particle filter 10 is positioned downstream of the primary filter 70, either within the recirculating fluid path 34 or within the drain conduit 30, or both. During operation of the appliance 12, the recirculating fluid path 34 is utilized during an agitating phase wherein the drum 22 rotates at a relatively slow rate of speed, or oscillates at a relatively slow rate of speed. The drum 22 rotates at a much higher rate of speed during a spin cycle or other drain phase of the appliance 12 when process fluid 16 is delivered to an external drain 32.

[0018] It is contemplated that each of these filters can be selectively removed from the appliance 12. With respect to the fine-particle filter 10, removal of the fine-particle filter 10, or a portion thereof, is intended to prevent the release of the microfibers 28 that are contained within the fine-particle filter 10. Accordingly, the fine-particle filter 10 includes the container 52 that is meant to capture and secure the microfibers 28 for later disposal and recycling.

[0019] Referring again to FIGS. 3-5, the container 52 for the fine-particle filter 10 can be in the form of a removable cartridge 50 that includes one or more filtration layers through which the process fluid 16 is delivered for capturing and retaining the microfibers 28 from the process fluid 16. This cartridge 50 can be a removable member that can be removed from the filter housing 54 for the fine-particle filter 10. A cleaned, refurbished or new cartridge 50 can then be reinserted into the filter housing 54 for further filtration of the process fluid 16 to remove microfibers 28. The removed cartridge 50 that is saturated with microfibers 28 can be delivered to a particular facility for disposal and/or recycling of the microfibers 28.

[0020] According to various aspects of the device, the fine-particle filter 10 can include a container 52 within which microfibers 28 are delivered for storage and later disposal. This container 52 can be in the form of the cartridge 50, a collection drawer, a flexible collector or bag or other accumulating compartment into which the microfibers 28 are captured after being separated from the process fluid 16. Accordingly, the fine-particle filter 10 can include various filtration mechanisms that separate the microfibers 28 from the process fluid 16 and deliver these microfibers 28 into a removable container 52 that can be selectively removed from the filter housing 54 and replaced. This container 52 can operate in conjunction with one or more filter screens, various labyrinth-type filters, cyclonic filters, and other similar filtration mechanisms that can be used to separate the microfibers 28 from the process fluid 16. Once separated from the process fluid 16, the microfibers 28 are sequestered within the container 52. As discussed herein, when the container 52 is removed from the filter housing 54, the microfibers 28 remain within the container 52 to prevent further release of the microfibers 28 into the environment, before being disposed of or recycled at an appropriate facility.

[0021] Referring again to FIGS. 1-5, the laundry appliance 12 can include the tub 18 that is positioned within the outer cabinet 20. The drum 22 is rotationally operable within the tub 18. A motor 80 operates the drum 22 about a rotational axis 82. The fluid pump 26 directs the process fluid 16 through the fluid path 14 that includes the tub 18. The fine-particle filter 10 is positioned within the fluid path 14. The fine-particle filter 10 separates microfibers 28 from the process fluid 16. Delivery of the process fluid 16 through the fine-particle filter 10 can result in a slowed flow of the process fluid 16 through the fluid path 14. This slowed flow of the process fluid 16 can be a result of the finer mesh size of the fine-particle filter 10. The slowed flow of the process fluid 16 can also be the result of an accumulation and saturation of microfibers 28 within the fine-particle filter 10. This slowed flow of the process fluid 16 can lead to an accumulation of process fluid 16 within the tub 18.

[0022] When saturated with microfibers 28, the flow of process fluid 16 through the fine-particle filter 10 is slowed. Stated another way, as the process fluid 16 moves through the fine-particle filter 10, the flow of process fluid 16 can be slowed as the process fluid 16 passes through the fine-mesh or micro-sized apertures 56 that are used to separate the microfibers 28 from the process fluid 16. Because of the slowed velocity of the process fluid 16 through the fine-particle filter 10, the process fluid 16 can accumulate within the tub 18 due to the consistent velocity and flow of fluid into the tub 18.

[0023] Referring again to FIGS. 1-5, in order to accommodate the slowed flow of process fluid 16 from the tub 18 and through the fine-particle filter 10, as well as the increased fluid level of the process fluid 16 within the tub 18 during a microfiber capturing phase 94, various sensors 90 communicate with a controller 92 that operates the motor 80 and the one or more fluid pumps 26. These sensors 90 can be in the form of a fluid level sensor that is positioned within or near the tub 18. This fluid level sensor monitors an amount of process fluid 16 that has accumulated within the tub 18. The sensors 90 can also include a fluid flow sensor that measures an amount of process fluid 16 that is delivered either into the tub 18, away from the tub 18, or both. Other configurations and types of sensors 90 can be used for monitoring the handling of the process fluid 16 through the tub 18 and through the fine-particle filter 10.

[0024] Typically, the motor 80 operates according to a predetermined operational sequence 84. The predetermined operational sequence 84 is used under general or typical operating conditions. In the microfiber capturing phase 94, the controller 92 can be modulated to operate according to a filtering sequence 96. In the filtering sequence 96, typically during a spin cycle when the drum 22 rotates at a high rate of speed, the controller 92 instructs the motor 80 to operate at a decreased rotational acceleration about the rotational axis 82. In such a configuration, the ramp-up time period of the motor 80 to achieve a maximum rotational speed or a desired rotational speed is slowed to minimize agitation of the water by the rotation of the drum 22. The number of speed plateaus of the motor 80 and the steady state speed of the motor 80 is also adjusted to prevent unnecessary agitation of the process fluid 16 within the tub 18 and positioned between the tub 18 and the drum 22.

[0025] Under typical conditions within a conventional appliance, when process liquid accumulates between the wash tub and the wash drum, movement of the wash drum through the process liquid at a bottom of a wash tub can result in a phenomena commonly referred to as "suds lock" where detergent within the process liquid is agitated and causes a large amount of bubbles and suds to form within the space between the wash tub and the wash drum. This foam between the wash tub and the wash drum creates a large amount of drag or other resistance between the wash drum and the wash tub, preventing the wash drum from rotating relative to the wash tub. This, in turn, places the motor in an overload condition that can overheat and otherwise damage the motor over time.

[0026] As discussed herein, the occurrence of suds lock is typically found during a spin cycle or other draining phase when the drum 22 rotates at a high rate of speed within the tub 18. During an agitating phase of the appliance 12, the drum 22 rotates or oscillates at a relatively slow rate of speed to perform various cleaning operations.

[0027] Referring again to FIGS. 1-5, during the microfiber capturing phase 94 of the appliance 12, the motor 80 operates the drum 22 according to a diminished acceleration sequence 98 that slows the acceleration of the drum 22 to minimize the amount of agitation that occurs within the process fluid 16. This diminished acceleration sequence 98, in turn, diminishes the likelihood of the occurrence of suds lock.

[0028] Referring again to FIGS. 3-5, to monitor the flow of process fluid 16 through the fine-particle filter 10, various fluid flow sensors, fluid level sensors and/or fluid pressure sensors 90 can be positioned within the fluid path 14 or within the tub 18. These sensors can be positioned upstream of the fine-particle filter 10, downstream of the fine-particle filter 10, or both to determine whether the flow of the process fluid 16 through the fine-particle filter 10 is being impeded. The flow of process fluid 16, when slowed, can also result in an increase in the amount of process fluid 16 within the tub 18. As a result, the fluid level of the process fluid 16 within the tub 18 can be measured using pressure sensors 90 within the fluid path 14 of the appliance 12. Such a sensor 90 can measure the amount of process fluid 16 within the tub 18 based upon a ratio of a particular water column over time. It is also contemplated that the amount of process fluid 16 within the tub 18 can also be measured by various pressure monitors, floats, fluid flow monitors that monitor an amount of process fluid 16 entering the tub 18 versus an amount of process fluid 16 leaving the tub 18, and other similar sensors 90 that can be used for measuring, or estimating, an amount of process fluid 16 within the tub 18.

[0029] Referring again to FIGS. 3-5, the threshold level 110 that the process fluid 16 reaches within the tub 18 can be set to a wide range of levels with respect to the tub 18 and the drum 22 and the space defined therebetween. As illustrated in FIGS. 3-5, this exemplary threshold level 110 is shown to be at a level within a lower portion of the drum 22. Typically, the threshold level 110 at which the controller 92 modulates the operation of the motor 80 between the predetermined operational sequence 84 and the diminished acceleration sequence 98 will be when the process fluid 16 is at an upper end of the interstitial space 120 defined between the tub 18 and the drum 22 and in contact with the surface of the drum 22. Other levels of the process fluid 16 with respect to the drum 22 can be used to initiate this modulation depending on the design of the appliance 12.

[0030] Using the various sensors 90 within the fluid path 14, the flow of process fluid 16 through the fine-particle filter 10, and/or the fluid level of the process fluid 16 within the tub 18, are measured to determine whether the flow of process fluid 16, or an amount of process fluid 16 within the tub 18, has reached a particular threshold level 110. When the flow or amount of the process fluid 16 reaches the threshold level 110, the controller 92 modulates the operation of the motor 80 from the predetermined operational sequence 84 to the decreased rotational acceleration of the diminished acceleration sequence 98. This modulation of the operation of the motor 80 between the predetermined operational sequence 84 and the diminished acceleration sequence 98 can occur at the outset of a particular spin cycle of the drum 22 and the motor 80. This can be done as a proactive approach to avoid the onset of suds lock. This modulation can also occur during the performance of a particular cycle. As discussed herein, during a particular cycle, the sensor 90 or sensors 90 can detect a decrease in the flow of process fluid 16 through the fluid path 14 or an increase in the amount of process fluid 16 within the tub 18. When a particular threshold level 110 is reached, the controller 92 can initiate the modulation of the motor 80 during the cycle.

[0031] When the flow of the process fluid 16 is increased to a typical flow rate, this information is communicated to the controller 92 and the motor 80 is returned to the predetermined operational sequence 84. Alternatively or additionally, when the fluid level of the process fluid 16 drains to a point below the threshold level 110, this information is communicated from the sensors 90 to the controller 92. The controller 92, in turn, modulates the operation of the motor 80 to return to the predetermined operational sequence 84.

[0032] The predetermined operational sequence 84 can be a particular set of instructions or sequences that are performed by the motor 80 according to a predefined laundry cycle or a portion of a laundry cycle. When the diminished acceleration sequence 98 is activated, each of these predetermined operational sequences 84 are modulated to account for the slowed flow of the process fluid 16 and/or the higher fluid level of the process fluid 16 within the tub 18.

[0033] According to various aspects of the device, the diminished acceleration sequence 98 or filtering sequence 96 of the motor 80 can be characterized by an acceleration threshold that extends the time period necessary for reaching a particular rotational speed of the drum 22. Stated another way, the ramp-up time of the drum 22 for reaching a particular rotational speed is increased so that it takes a longer amount of time for the drum 22 to reach a particular rotational speed. The filtering sequence 96 or the diminished acceleration sequence 98 can also be characterized by a decreased maximum rotational speed of the various laundry cycles and portions of each laundry cycle. These changes in the operational parameters of the motor 80 are calibrated to minimize turbulence and agitation of the process fluid 16 in an interstitial area 120 between the tub 18 and the drum 22.

[0034] According to the various aspects of the device, when the filtering sequence 96 is activated, the time period necessary to complete the laundry cycle can be extended to account for the slowed flow of the process fluid 16 through the fine-particle filter 10. The modifications and the algorithms for operating the motor 80 are used to ensure that the quality of the particular laundry cycle is not diminished during use of the filtering sequence 96 or the diminished acceleration sequence 98.

[0035] According to the various aspects of the device, the filtering sequence 96 or diminished acceleration sequence 98 can be activated only when the fine-particle filter 10 is saturated with microfibers 28. In such a condition, the microfibers 28 decrease the space through which the process fluid 16 can flow through the fluid path 14. In turn, the flow of the process fluid 16 is slowed. Accordingly, when the fine-particle filter 10 is nearing the point where maintenance or replacement of the container 52 is necessary, the filtering sequence 96 can be used for extending the life of a particular container 52 of the fine-particle filter 10. The system also ensures that the container 52 is filled to a particular capacity of microfibers 28 before the cartridge 50 and/or container 52 is removed for disposal or recycling.

[0036] In certain aspects of the device, the one or more fluid pumps 26 can be adjusted to operate intermittently or at a slower speed to match or substantially match the flow of process fluid 16 through the fine-particle filter 10.

[0037] As exemplified in FIGS. 3-5, the controller 92 for the appliance 12 that operates the motor 80 typically operates under a standard operations sequence, in the form of the predetermined operational sequence 84. This predetermined operational sequence 84 is conducted when the flow of the process fluid 16 is above, at, or near a typical flow rate or when a fluid level of the process fluid 16 is below the threshold level 110 with respect to the tub 18. As discussed herein, the controller 92 operates the motor 80 according to the filtering sequence 96 or the diminished acceleration sequence 98 when the flow of process fluid 16 is sufficiently below a typical flow rate or when the fluid level of process fluid 16 reaches the threshold level 110 or extends above the threshold level 110 within the tub 18.

[0038] According to various aspects of the device, the fine-particle filter 10 can be used within appliances 12 that have a drum 22 that rotates about a horizontal rotational axis 82 or a vertical rotational axis 82. In addition, the fluid pump 26 that delivers process fluid 16 through either the drain conduit 30 and/or the recirculating fluid path 34 can be separate fluid pumps 26 that operate at various times to recirculate the process fluid 16 and/or deliver the process fluid 16 to an external drain 32. It is also contemplated that a single fluid pump 26 can be used for selectively and alternatively delivering process fluid 16 through the recirculating fluid path 34 or the drain conduit 30, as required by the various operational sequences of the appliance 12.

[0039] Referring now to FIGS. 1-6, having described various aspects of the fine-particle filter 10, a method 400 is disclosed for operating a laundry appliance 12 that utilizes an aspect of the fine-particle filter 10. According to the method 400, step 402 includes initiating a laundry cycle and operating a motor 80 for rotating the drum 22 according to the standard operational profile, as directed by the controller 92 operating under the predetermined operational sequence 84. After the beginning of the laundry cycle, process fluid 16 is delivered through a fluid path 14 (step 404). Delivering process fluid 16 through the fluid path 14 includes delivering process fluid 16 to the tub 18 and the drum 22 that rotationally operates within the drum 22. Process fluid 16 is then filtered using the fine-particle filter 10 (step 406). In filtering the process fluid 16, the fluid pump 26 delivers the process fluid 16 either toward an external drain 32 or through a recirculating fluid path 34 back to the tub 18. In each of these instances, a fine-particle filter 10 is placed within the fluid path 14 for capturing microfibers 28 that are separated from articles being processed and then delivered through the process fluid 16. As discussed herein, the fine-particle filter 10 separates the microfibers 28 from the process fluid 16 and contains and retains these microfibers 28 within a cartridge 50 or container 52 of the fine-particle filter 10.

[0040] According to the method 400, over time, the fine-particle filter 10 can become saturated with microfibers 28 that can limit the amount of process fluid 16 that can pass through the fine-particle filter 10 and the flow of the process fluid 16 is progressively slowed over time. This slowing of the flow rate of the process fluid 16 continues to progress as the fine-particle filter 10 becomes more saturated with the microfibers 28. As a result, the amount of process fluid 16 passing through the fine-particle filter 10 after leaving the tub 18 is less than the amount of process fluid 16 entering into the tub 18 during operation of the appliance 12 (step 408). In turn, process fluid 16 tends to accumulate in the tub 18 and the fluid level of process fluid 16 within the tub 18 tends to elevate toward a threshold level 110. When the flow of the process fluid 16 reaches the threshold level 110, the operation of the motor 80 is modulated to be a diminished acceleration sequence 98 (step 410). In modulating the operation of the motor 80 according to the diminished acceleration sequence 98, various parameters of the motor 80 are typically decreased as the flow of process fluid 16 through the fine-particle filter 10 slows and the time period to perform various operations is extended. These parameters can include, but are not limited to, maximum acceleration level, maximum rotational speed, continuous operating time, time between operational plateaus, decreased acceleration and deceleration rates, combinations thereof, and other various parameters that limit the amount of agitation that the drum 22 provides to the process fluid 16 contained between the tub 18 and the drum 22. As discussed herein, by modulating the operating parameters of the motor 80, agitation of the process fluid 16 contained within the interstitial area 120 between the tub 18 and the drum 22 can be minimized to prevent suds lock and the resulting decrease in operational efficiency of the appliance 12.

[0041] The use of the diminished acceleration sequence 98 will typically continue until such time as the container 52 of the fine-particle filter 10 is cleaned or replaced and the flow of process fluid 16 through the fine-particle filter 10 is returned to a more typical flow rate, as will be described more fully below.

[0042] Referring again to FIGS. 1-6, in certain instances, the use of the diminished acceleration sequence 98 occurs when a fluid level of the process fluid 16 is above a threshold level 110. When the fluid level of the process fluid 16 within the tub 18 decreases below the threshold level 110, the operation of the motor 80 is again modulated to return to the predetermined operational sequence 84. Modulating the operation of the motor 80 back to the predetermined operational sequence 84 occurs when the fluid level within the tub 18 falls below the threshold level 110. It is contemplated that the modulation of the controller 92 and the motor parameters between the diminished acceleration sequence 98 and the predetermined operational sequence 84 can occur within a particular laundry cycle or can occur between separate laundry cycles. The modulating of the algorithms that the controller 92 uses to instruct the motor 80 can be adjusted based on the fluid level of the process fluid 16 within the tub 18. Various sensors 90 within the tub 18 and within the fluid path 14 are used to monitor and measure the amount of process fluid 16 within the tub 18.

[0043] According to the method 400, the laundry cycle is completed (step 412). Subsequently, where it becomes evident that the fine-particle filter 10 is saturated with microfibers 28 and other fine-particulate material, the method 400 includes removing a fine-particle cartridge 50 or similar container 52 from the fine-particle filter 10 (step 414). This step 416 of removing the fine-particle cartridge 50 occurs when the fine-particle cartridge 50 is saturated with microfibers. Afterward, a new fine-particle cartridge 50 that is typically new, refurbished or otherwise unused is installed into the fine-particle filter 10 to continue operation of the appliance 12 in a subsequent laundry cycle (step 416).

[0044] According to various aspects of the device, when the fine-particle filter 10 or a container 52 therefore are removed, various sensors 90 can be used to monitor whether the container 52 has been replaced so that microfibers 28 can continue to be filtered from the process fluid 16. In certain aspects of the device, it is contemplated that the washer laundry appliance 12 will not operate without the cartridge 50 or container 52 being reinstalled into the fine-particle filter 10. It is also contemplated that operation of the fluid pumps 26 can be adjusted to slow the flow of process fluid 16 within the appliance 12 until such time as the fine-particle filter 10 is placed back into an operational mode. By decreasing the flow of process fluid 16 within the appliance 12, a user seeking to circumvent the fine-particle filter 10 will be denied any advantage in the form of increased flow of process fluid 16. When the container 52 of the fine-particle filter 10 is reinstalled into the fine-particle filter 10, the fluid pump 26 can be returned to its normal operating state. Accordingly, the proper flow of process fluid 16 through the fine-particle filter 10 can be achieved.

[0045] In certain aspects of the device, when the fine-particle filter 10 is completely saturated and the process fluid 16 is substantially unable to pass through the fine-particle filter 10, a bypass can be utilized for allowing for the movement of the process fluid 16 around the fine-particle filter 10 so that a current laundry cycle can be completed. Upon completion of that laundry cycle, subsequent laundry cycles can be prevented from being initiated until such time as the fine-particle filter 10 is maintained to ensure proper flow of process fluid 16 therethrough.

[0046] According to various aspects of the device, where the fine-particle filter 10 includes a container 52 for capturing microfibers 28, it is contemplated that the filter screen for the fine-particle filter 10 can include a spray nozzle that is dedicated for removing microfibers 28 from the filter screen. Such a spray nozzle can be sprayed through a back side of the lint filter to ensure that the microfibers 28 are directed in an appropriate direction for being captured within a particular container 52 of the fine-particle filter 10. In such an embodiment, typical flow of process fluid 16 through the filter screen can occur in a first direction. When the lint screen is saturated with microfibers 28, a spray nozzle can spray cleaning fluid in a second direction that generally opposes or is oblique to the first direction. When cleaning fluid is sprayed in the second direction, microfibers 28 are removed from the front surface of the lint screen and directed away from the lint screen toward the container 52 for storage and ultimate recycling. Such a spray system for cleaning a filter screen of the fine-particle filter 10 can extend the operational cycle for the fine-particle filter 10. Additionally, a user will be notified when the container 52 is filled to capacity with microfibers 28, as well as when the lint screen is saturated with microfibers 28. In certain aspects of the device, instead of a cleaning fluid from a spray nozzle, the fine-particle filter 10 can use various brushes, scrapers, or other mechanisms for moving the microfibers 28 into a particular container 52.

[0047] According to the various aspects of the device, process fluid 16 can include, but is not limited to, water, detergent and other laundry chemistry, particulate and soil from processed articles, microfibers 28, and other ingredients and byproducts of laundry cycles.

[0048] Referring again to FIGS. 1-5, various notifications regarding the fine-particle filter 10 as well as the primary filter 70 can be delivered to the user via a user interface of the appliance 12 or other human machine interface (HMI) 130. The HMI 130 can interact with a user to inform the user concerning the status of the fine-particle filter 10 and the primary filter 70. The HMI 130 can also send messages to a portable computing device, such as a smart phone, tablet, wearable device, or other similar computing device. Messages can be sent from the HMI 130 to the portable computing device for alerting a user that a particular portion of the fine-particle filter 10 and/or the primary filter 70 requires maintenance or otherwise requires some form of attention.

[0049] It is contemplated that the use of the fine-particle filter 10 is meant to capture microfibers 28 from the process fluid 16. By capturing these microfibers 28, they can be prevented from being released into the environment. Because these microfibers 28 include significant amounts of plastic, and because of the prevalence of microfiber materials in clothing and other textiles, the amount of microfibers 28 that are released into the environment are significant. Use of the fine-particle filter 10 in capturing these microfibers 28 can diminish the amount of microfibers 28 that are released into the environment and also provide a supply of microfiber material for creating additional clothing and textiles in the future.

[0050] According to another aspect of the present disclosure, a laundry appliance includes a tub positioned within an outer cabinet. A drum is rotationally operable within the tub. A fluid pump directs a process fluid through a fluid path that includes the tub. A fine-particle filter is positioned within the fluid path. The fine-particle filter separates microfibers from the process fluid to define captured microfibers.

[0051] According to another aspect, the fluid path includes a recirculating fluid path that recirculates the process fluid through the tub. The fine-particle filter is positioned within the recirculating fluid path.

[0052] According to yet another aspect, the fine-particle filter is incorporated within a housing that is selectively removable from the fluid path for disposing the captured microfibers. The housing is accessible via an exterior of the outer cabinet.

[0053] According to another aspect of the present disclosure, the drum is operated via a motor and a controller that operates the motor according to a predetermined operational sequence. During a microfiber capturing phase, movement of the process fluid is slowed and a fluid level of the process fluid within the tub increases. When a flow of the process fluid is below a threshold, sensors communicate with the controller to operate the motor according to a filtering sequence.

[0054] According to another aspect, the filtering sequence includes at least a decreased rotational acceleration of the drum about a rotational axis.

[0055] According to yet another aspect, the fluid path includes a primary filter that separates larger fibers and larger particles from the process fluid and wherein the primary filter is upstream of the fine-particle filter.

[0056] According to another aspect of the present disclosure, the fluid path includes a drain conduit. The fine-particle filter is positioned within the drain conduit and within the outer cabinet.

[0057] According to another aspect, the primary filter is within a recirculating fluid path.

[0058] According to yet another aspect, the fine-particle filter is in a form of a removable cartridge that is selectively disposed within a filter receptacle of a filter housing.

[0059] According to another aspect of the present disclosure, the filtering sequence of the motor is characterized by an acceleration threshold that increases a time period for the motor and the drum to reach a desired rotational speed.

[0060] According to another aspect, the filtering sequence is characterized by a decreased maximum rotational speed of the motor and the drum.

[0061] According to another aspect, a laundry appliance includes a tub positioned within an outer cabinet. A drum that is rotationally operable within the tub. A motor that operates the drum about a rotational axis. A fluid pump that directs a process fluid through a fluid path that includes the tub. A fine-particle filter is positioned within the fluid path. The fine-particle filter separates microfibers from the process fluid. Delivery of the process fluid through the fine-particle filter results in an accumulation of process fluid within the tub. A controller operates the motor. The controller operates the motor according to a predetermined operational sequence when a flow of the process fluid is below a threshold level with respect to the tub and the fluid pump. The controller operates the motor according to a diminished acceleration sequence when the flow of the process fluid reaches the threshold level.

[0062] According to yet another aspect, the fluid path includes a recirculating fluid path that recirculates the process fluid through the tub. The fine-particle filter is positioned within the recirculating fluid path.

[0063] According to another aspect of the present disclosure, the diminished acceleration sequence includes at least a decreased rotational acceleration of the drum about the rotational axis.

[0064] According to another aspect, the fluid path includes a primary filter that separates larger fibers and larger particles from the process fluid.

[0065] According to yet another aspect, the fluid path includes a drain conduit. The fine-particle filter is positioned within the drain conduit and within the outer cabinet. The fluid pump operates to selectively and alternatively deliver the process fluid through the recirculating fluid path and the drain conduit.

[0066] According to another aspect of the present disclosure, the fine-particle filter is in a form of a removable cartridge that is selectively disposed within a filter receptacle of a filter housing.

[0067] According to another aspect, the diminished acceleration sequence of the motor is characterized by one of an acceleration threshold that increases a time for the motor and the drum to reach a desired rotational speed, and a decreased maximum rotational speed of the motor and the drum.

[0068] According to yet another aspect, a method for operating a laundry appliance includes beginning a laundry cycle and operating a motor for a drum according to a predetermined operational sequence. Process fluid is delivered through a fluid path that includes a tub and the drum that rotationally operates within the tub. The process fluid is filtered using a fine-particle filter. A flow of the process fluid is slowed within the tub and the drum to allow for increased filtration of the process fluid within the fine-particle filter. Operation of the motor is modulated to be a diminished acceleration sequence when the flow of the process fluid reaches a threshold level within the tub. The operation of the motor is modulated to be the predetermined operational sequence when the flow of the process fluid is below the threshold. The laundry cycle is completed. A fine-particle cartridge can be removed from the fine-particle filter when the fine-particle cartridge is saturated with micro fibers and a new fine-particle cartridge installed into the fine-particle filter.

[0069] According to another aspect of the present disclosure, the flow of the process fluid is measured using one of a fluid flow sensor and a fluid pressure sensor.

Claims

1. A laundry appliance (12) comprising:

a tub (18) positioned within an outer cabinet (20);
a drum (22) that is rotationally operable within the tub (18);
a fluid pump (26) that directs a process fluid (16) through a fluid path (14) that includes the tub (18); and
a fine-particle filter (10) positioned within the fluid path (14), wherein the fine-particle filter (10) separates microfibers (28) from the process fluid (16) to define captured microfibers (28).

2. The laundry appliance (12) of claim 1, wherein the fluid path (14) includes a recirculating fluid path (14) that recirculates the process fluid (16) through the tub (18), wherein the fine-particle filter (10) is positioned within the recirculating fluid path (14).

3. The laundry appliance (12) of any one of claims 1-2, wherein the fine-particle filter (10) is incorporated within a housing (54) that is selectively removable from the fluid path (14) for disposing the captured microfibers (28).

4. The laundry appliance (12) of claim 3, wherein the housing (54) is accessible via an exterior of the outer cabinet (20).

5. The laundry appliance (12) of any one of claims 1-4, wherein the drum (22) is operated via a motor (80) and a controller (92) that operates the motor (80) according to a predetermined operational sequence (84).

6. The laundry appliance (12) of claim 5, wherein during a microfiber capturing phase (94), movement of the process fluid (16) is slowed and a fluid level of the process fluid (16) within the tub (18) increases.

7. The laundry appliance (12) of claim 5 or 6, wherein when a flow of the process fluid (16) is below a threshold, sensors (90) communicate with the controller (92) to operate the motor (80) according to a filtering sequence (96).

8. The laundry appliance (12) of claim 7, wherein the filtering sequence (96) includes at least a decreased rotational acceleration of the drum (22) about a rotational axis (82).

9. The laundry appliance (12) of any one of claims 1-8, wherein the fluid path (14) includes a primary filter (70) that separates larger fibers and larger particles from the process fluid (16) and wherein the primary filter (70) is upstream of the fine-particle filter (10).

10. The laundry appliance (12) of claim 1 or any of claims 3-8 when depending from claim 1, wherein the fluid path (14) includes a drain conduit (30), wherein the fine-particle filter (10) is positioned within the drain conduit (30) and within the outer cabinet (20).

11. The laundry appliance (12) of claim 9 or 10, wherein the primary filter (70) is within a recirculating fluid path (14).

12. The laundry appliance (12) of any one of claims 1-11, wherein the fine-particle filter (10) is in a form of a removable cartridge (50) that is selectively disposed within a filter receptacle of a filter housing (54).

13. The laundry appliance (12) of any one of claims 7-12, wherein the filtering sequence (96) of the motor (80) is **characterized by** an acceleration threshold that increases a time period for the motor (80) and the drum (22) to reach a desired rotational speed.

14. The laundry appliance (12) of any one of claims 7-13, wherein the filtering sequence (96) is **characterized by** a decreased maximum rotational speed of the motor (80) and the drum (22).

15. A method (400) for operating a laundry appliance (12) of any one of claims 1-4, the method (400) including steps of:

beginning a laundry cycle and operating a motor (80) for the drum (22) according to a predetermined operational sequence (84);
delivering the process fluid (16) through the fluid path (14) that includes the tub (18) and the drum (22) that rotationally operates within the tub (18);
filtering the process fluid (16) using the fine-particle filter (10);
slowing a flow of the process fluid (16) within the tub (18) and the drum (22) to allow for increased filtration of the process fluid (16) within the fine-particle filter (10);
modulating operation of the motor (80) to be a diminished acceleration sequence when the flow of the process fluid (16) reaches a threshold level within the tub (18);
modulating the operation of the motor (80) to be the predetermined operational sequence (84) when the flow of the process fluid (16) is below the threshold;
completing the laundry cycle.

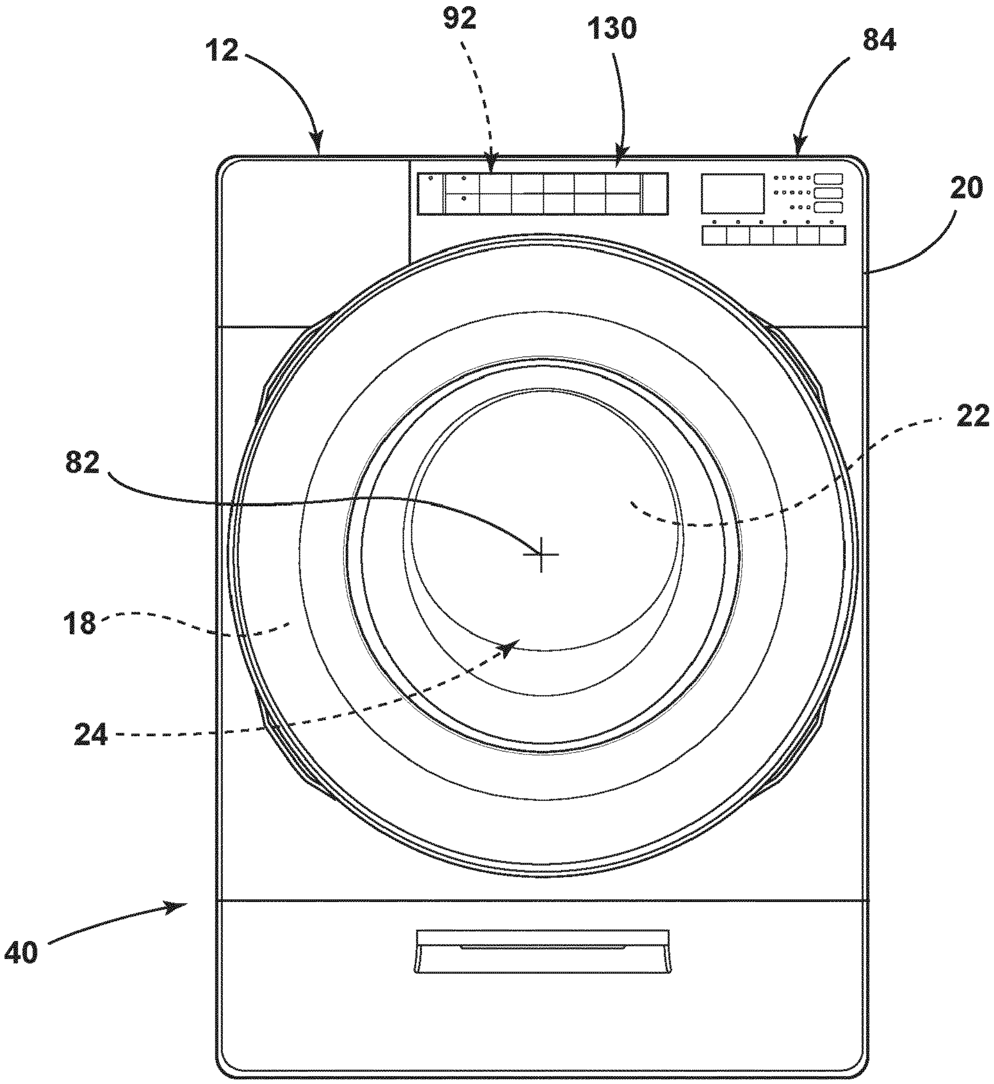

FIG. 1

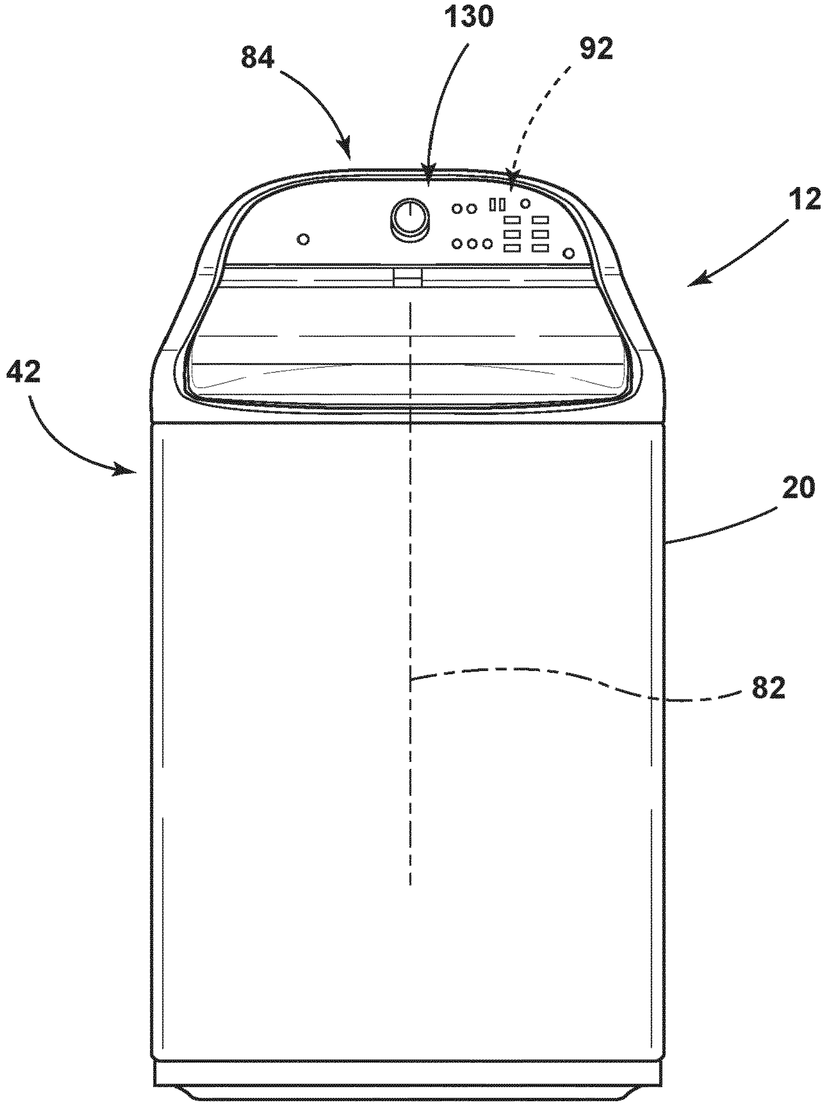

FIG. 2

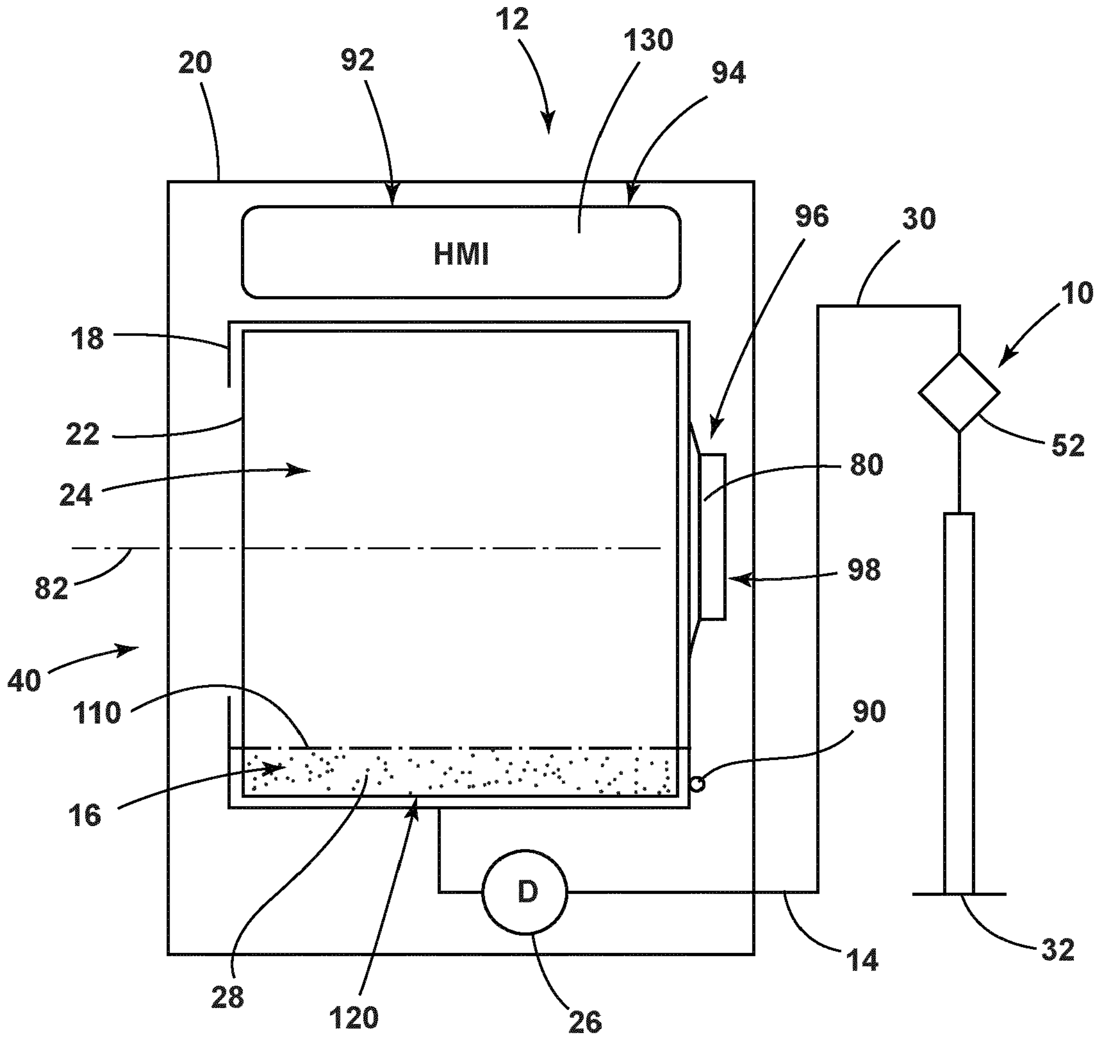
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FIG. 3

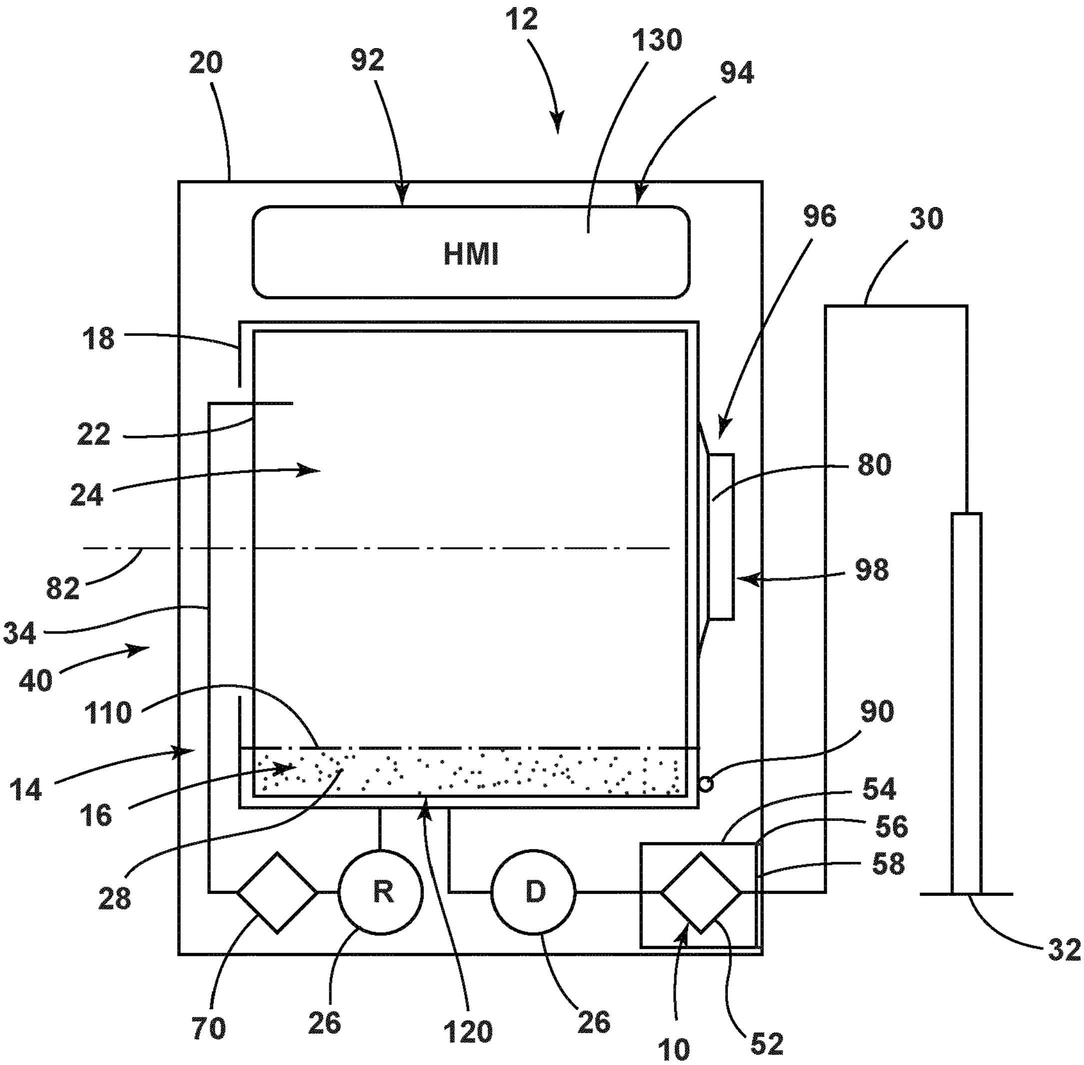
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FIG. 4

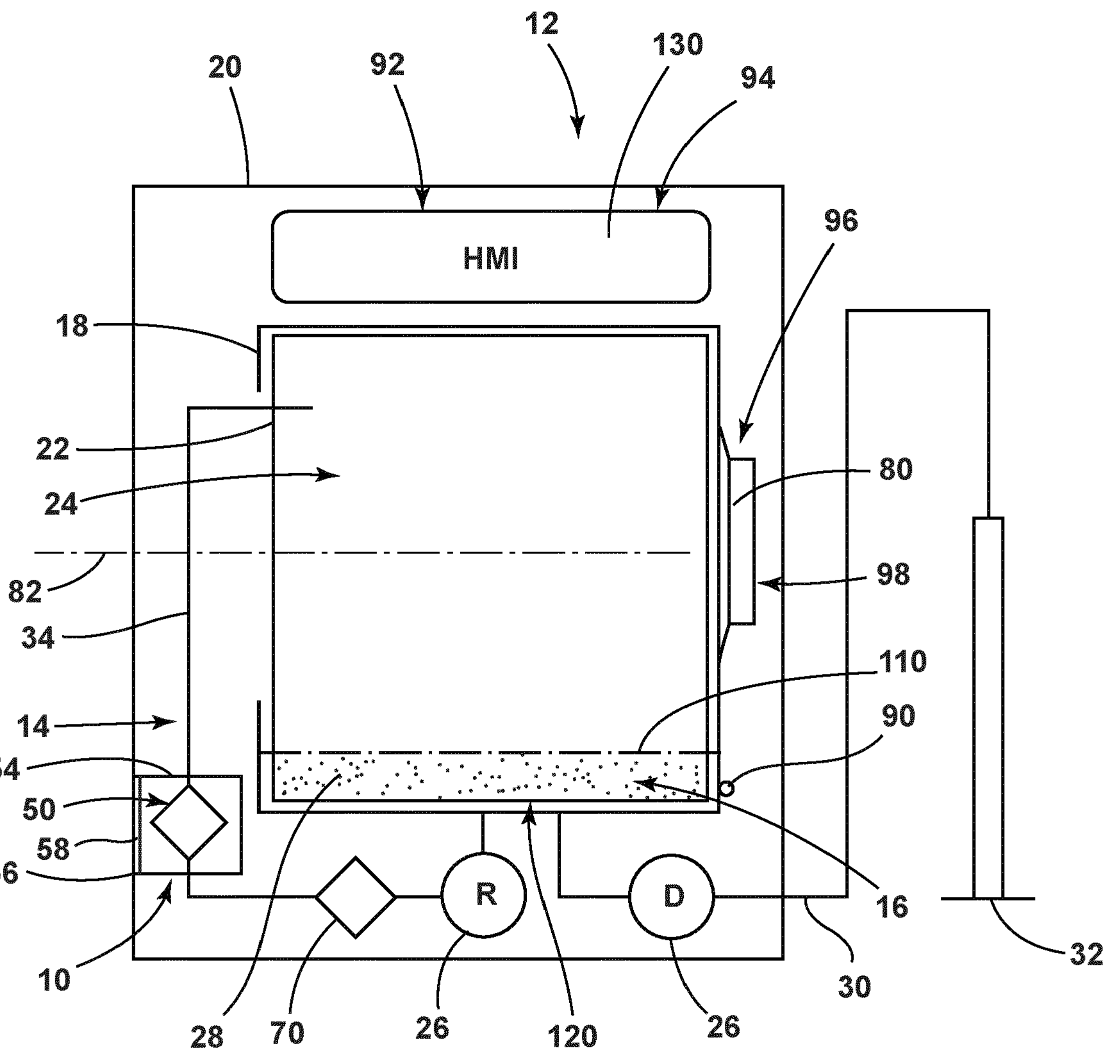
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FIG. 5

Method 400 for Operating an Appliance Having a Fine-Particle Filter

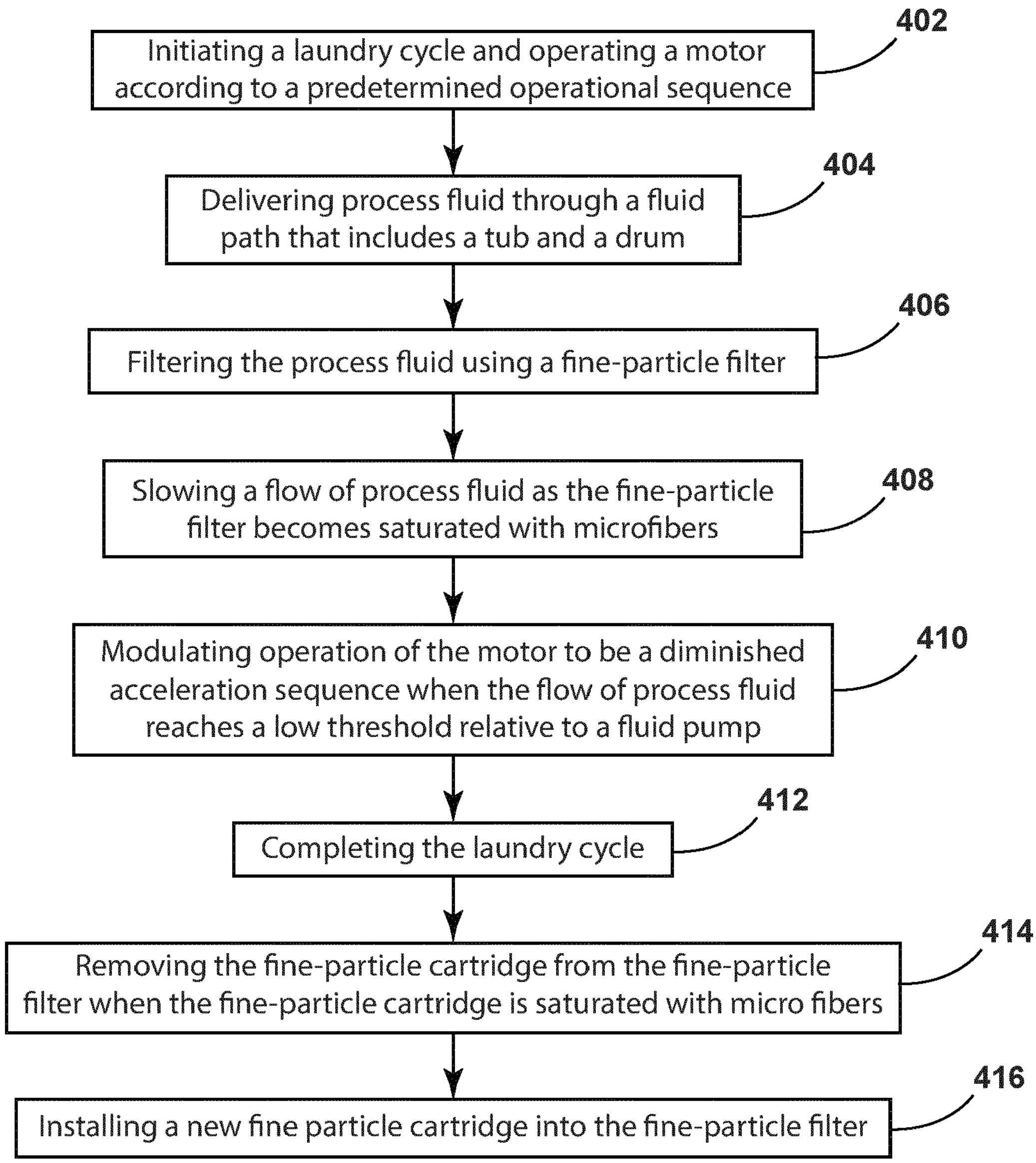

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 0039

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			D06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 January 2023	Diaz y Diaz-Caneja

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82