CONTINUOUS LAUNDRY CLEANING APPLIANCE

Abstract

A household laundry appliance is provided for washing and drying individual pieces of laundry. The appliance includes a bin for holding laundry, wash and dry stations, and a robotic feeder mechanism to automatically convey laundry from the bin to the processing stations. The wash stations include a spray station for spraying the garments with a cleaning solution, and an ultrasonic station for applying ultrasonic vibrations to the garments. Rinse and extraction stations are provided upstream from the drying station to rinse the garments and then extract water from the garments. The garments are continuously transported through the appliance by a series of mesh conveyor belts between which the garments are sandwiched. The drying station includes fans for blowing heated air past the clothing to drive moisture out of the clothing. The temperature and velocity of the air may be adjusted to accommodate different garment materials and dampness. A controller interacts with sensors and actuators to control the operation of the appliance.
CONTINUOUS LAUNDRY CLEANING APPLIANCE

BACKGROUND OF THE INVENTION

[0001] Home laundry systems generally include two separate appliances, a washer and a dryer. The washer and dryer are batch systems designed to wash and dry a single load of laundry at a time.

[0002] Prior art exists which describes continuous laundry appliances, which typically require manual feeding of the laundry, such as sheets, into the appliance. The laundry passes through the appliance on conveyors. However, such systems are not designed for residential use, and do not automatically load the appliance with laundry to be cleaned. Such commercial continuous laundry appliances are large and not adaptable for use in the home. These prior art machines also are not typically used for clothing or garments.

[0003] Therefore, a primary objective of the present invention is the provision of a continuous laundry cleaning appliance for home use.

[0004] Another objective of the present invention is the provision of a residential continuous laundry processing appliance having multiple processing stations, including a cleaning solution spraying station, an ultrasonic cleaning station, a rinsing station, an extraction station and a drying station, with transport means for continuously transporting the laundry through the various stations.

[0005] A further objective of the present invention is the provision of a laundry cleaning appliance which continuously moves individual pieces of clothing and garments through washing and drying stations.

[0006] Another objective of the present invention is the provision of a garment feeder for a continuous laundry cleaning appliance which automatically moves individual pieces of laundry from a bin into the appliance.

[0007] A further objective of the present invention is the provision of a continuous laundry cleaning appliance including a bin for holding the laundry to be cleaned, and a robotic arm to acquire, separate, and transport individual pieces of laundry to a cleaning station.

[0008] Another objective of the present invention is the provision of a method of cleaning laundry in a continuous washing and drying system.

[0009] Yet another objective of the present invention is the provision of a method of cleaning laundry wherein individual pieces of laundry are acquired from a bin, separated, and then transported for cleaning and drying.

[0010] Still another objective of the present invention is the provision of a laundry appliance having a bin for holding laundry to be washed, a washing station, a drying station, and a garment feeder to automatically convey laundry from the bin to the washing station.

[0011] Another objective of the present invention is the provision of a continuous laundry processing appliance having a washing station which sprays cleaning solution on to the garments from opposite sides.

[0012] A further objective of the present invention is the provision of a continuous laundry processing appliance having an ultrasonic cleaning section having an ultrasonic head which traverses across the path of the moving laundry.

[0013] Still another objective of the present invention is the provision of a continuous laundry processing appliance having turbulent air moving across the laundry moving in a serpentine path.

[0014] Another objective of the present invention is the provision of a method of controlling a continuous laundry system, including the automated garment feed and transfer mechanism.

[0015] A further objective of the present invention is the provision of an improved continuous laundry cleaning appliance which is economical to manufacture, and durable and efficient in operation.

[0016] These and other objectives will become apparent from the following description of the invention.

SUMMARY OF THE INVENTION

[0017] The continuous laundry cleaning appliance of the present invention includes a bin for holding laundry to be cleaned. A pair of robotic arms automatically reciprocates between a lowered position within the bin and a raised position out of the bin. The robotic arms include a pair of nip rollers for picking up a single piece of laundry from a pile of laundry in the bin. As the robotic arms are moved from the lowered position to the raised upper position, the garment picked up by the nip rollers is separated from the other garments in the bin, and then transported to a washing or cleaning station within the appliance. The washing station may include one or more washing and rinse mechanisms. For example, a first washing station may include a manifold with a plurality of spray nozzles located on opposite sides of the garment so as to direct a spray of cleaning solution or water onto the garments or laundry. There may be a second cleaning station that includes one or more ultrasonic heads which move across the path of the garments in a traversing pattern. A rinsing station is also provided. An extraction station is provided to mechanically extract a majority of the water out of the clothes. A drying station is provided in the appliance for drying the individual pieces of laundry after each piece passes through the washing station or stations. The appliance is provided with transportation means, such as a pair of conveyor belts between which the garments are sandwiched, for transporting the garments to each of the stations for washing and drying.

[0018] In the continuous laundry method of the present invention, the laundry is loaded into the bin. Individual pieces of laundry are then automatically acquired from the bin and separated from other laundry in the bin. The acquired and separated piece of laundry is then automatically transported to the various processing stations for washing and drying.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 is a front perspective view of the continuous cleaning appliance having a first embodiment of the garment feeder of the present invention in the raised position and with the feeder conveyor belts removed for clarity.

[0020] FIG. 2 is a front perspective view of the appliance from the opposite side as shown in FIG. 1, and with the feeder conveyor belts removed for clarity.
FIG. 3 is a side elevation view of the laundry bin and garment feeder of the present invention in the raised position, and with the conveyor belts removed for clarity.

FIG. 4 is a view similar to FIG. 3 showing the conveyor belts of the garment feeder, with the arms removed for clarity.

FIG. 5 is a lower perspective view of the bin and feeder, with the conveyor belts removed for clarity.

FIG. 6 is an upper perspective view of the bin and the feeder in the raised position, with the conveyor belts removed for clarity.

FIG. 7 is an upper perspective view of the bin with the garment feeder in the lowered position for picking up a piece of laundry from the bin, and with the conveyor belts removed for clarity.

FIG. 8 is a side elevation view of one embodiment of the appliance showing the various laundry processing stations and the conveyor belt system for transporting the garments through the appliance.

FIG. 8A is a side elevation view of the conveyor belt assemblies for the cleaning appliance.

FIG. 9 is a side elevation view of the spray wash station showing the spray nozzles and conveyors.

FIG. 10 is a perspective view of the spray wash station.

FIGS. 11-13 are top, front and end elevation views of the spray nozzle manifold.

FIG. 14 is a perspective view of the ultrasonic cleaning station of the appliance front the downstream or outlet side.

FIG. 15 is a view similar to FIG. 14 from the upstream or inlet side.

FIG. 16 is a side elevation view of the ultrasonic station.

FIG. 17 is a front elevation view of the ultrasonic station.

FIG. 18 is an enlarged perspective view of the ultrasonic horn and fluid container.

FIG. 19 is an enlarged side view of the ultrasonic horn and fluid container.

FIG. 20 is a further enlarged view of the ultrasonic horn tip taken long line 20-20 of FIG. 19.

FIG. 21 is a side elevation view of the ultrasonic horn and spring loaded plate.

FIG. 22 is a partial perspective schematic view of the ultrasonic horn and spring loaded plate.

FIG. 23 is a side elevation view of the drying station of the appliance showing the conveyor belts for transporting the garments through the dryer station.

FIG. 24 is a side elevation view of an alternative feeder mechanism wherein the laundry is discharged out of the bottom of the bin.

FIG. 25 is a side elevation sectional view showing a further feeder mechanism wherein the clothing discharges laterally out of the bin.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The continuous laundry cleaning appliance of the present invention is generally designated in the drawings by the reference numeral 10. The appliance 10 includes a laundry bin 12 for holding laundry. The appliance 10 also includes a feeder mechanism 14 which is mounted for reciprocal movement between a raised position above the bin 12, as seen in FIGS. 1-6 and 8, and a lowered position within the bin, as shown in FIG. 7. The appliance 10 includes one or more internal washing stations and a drying station which terminates in an outlet 16 wherein the cleaned and dried garments are discharged, as discussed in more detail below. A control module 18 with a user interface 20 allows the user to select the desired operations of the appliance 10. The control module includes a microprocessor and software for controlling operation of the appliance 10.

The feeder mechanism 14 includes a robotic arm assembly 15 having opposite pairs of upper and lower arms 22, 24. As shown in FIGS. 5-7, a plate 25 or other brace extends between the opposite sides of the feeder mechanism 14 so as to interconnect the upper arms 22 and lower arms 24. The plate 25 is structural so as to provide rigidity to the arms 22, 24 and alignment of the belt tracking roller and driving roller. The plate 25 includes enlarged openings so as to minimize the weight of the plate. The arms 22, 24 are mounted on the appliance 10 for reciprocating movement by a motor 26 via the gears 28 as shown in FIG. 3. A feeder head 30 is provided at the upper ends of the arms 22, 24. A plurality of rollers 32, see FIG. 4, are mounted on the arms 22, 24, the head 30, and on the appliance 10. Upper and lower conveyor belts 34, 36 are trained about the rollers 32 so as to define a track or path between the belts 34, 36 through which garments pass when the belts are actuated. A motor 35 (FIG. 7) drives both sets of rollers 32.

A pair of nip rollers 38 are mounted on the lower end of the feeder head 30. The nip rollers 38 are driven by belts 34, 36 in opposite directions so as to pick up a single piece of laundry from within the bin 12 when the feeder mechanism 14 is in the lowered position. The nip rollers 38 feed the acquired garment into the track or channel between the upper and lower conveyor belts 34, 36 for transport to the washing station within the appliance 10. One or more sensors 39 adjacent the nip rollers 38 sees the laundry stack as the arm lowers and positions the rollers 38 so as to enable a garment acquisition and feed into the conveyor belts 34, 36. The sensors 39, such as photo electric sensors, determine when the rollers 38 have reached the laundry stack and when the nip rollers have acquired a garment from the bin 12. Additional sensors 29 may be positioned in the bin 12 to sense the presence of laundry in the bin. Preferably, sensors 29 are provided in the bottom of the bin 12 and additional sensors 31 at opposite ends of the nip rollers 38. Thus, the sensors 29, 31 sense the presence of laundry in the bin 12 and as picked up by the nip rollers 38. The sensors 29 are operatively connected to the control module 18 so as to automatically actuate the motor 26 for reciprocating the arms 22, 24 and the motor 35 for actuating the belts 34, 36.
and the nip rollers 38 when laundry is sensed in the bin. When no garments are in the bin 12, the motors 26, 35 are automatically shut off.

[0046] Thus, the feeder mechanism 14 acquires individual pieces of laundry from the bin 12 via the nip rollers 38 when the arms 22, 24 are lowered. The feeder mechanism separates the acquired piece of laundry from other laundry in the bin 12 when the arms 22, 24 are raised. The feeder mechanism also transports the acquired and separated piece of laundry to the washing station 40 via the conveyor belts 34, 36.

[0047] To use the appliance 10, an operator loads the laundry into the bin 12. The sensor 29 in the bin senses the presence of laundry in the bin 12, which actuates the motor 26 to lower the feeder mechanism 14 from the raised position to the lowered position within the bin 12. The sensor 29 also actuates the motor 35 for driving the conveyor belts 34, 36 and nip rollers 38. When the sensors 39 determine that the nip rollers 38 have reached and are pressed against the garments in the bin, the motor 26 is stopped, while belts 34 and 36 continue to be driven. When an article of laundry is acquired by the nip rollers 38, as sensed by another sensor adjacent the rollers 38, the motor 26 is reversed so as to raise the feeder mechanism 14 out of the bin 12. As the feeder mechanism 14 rises, the individual laundry piece acquired by the nip rollers 38 is separated from the remaining laundry in the bin 12, and then transported through the conveyor belts 34, 36 to the washing or cleaning station 40 within the appliance 10.

[0048] Additional sensors may be provided to detect the position of the robotic arm assembly 15 that would enable the arm 15 to be lowered to acquire the laundry without bumping into the bottom of the bin 12, and to be raised to separate the clothing acquired from the pile remaining in the bin 12.

[0049] A thickness sensor may also be provided for detecting the thickness of the incoming garment and the possible jam situation at the entrance.

[0050] In accordance with exemplary embodiments of the present invention, effective feeder and transportation control is enabled through intelligent control logic and algorithm based on sensor signals. The machine is started (and ended) with the robotic arm 15 at its default high position above the bin 12. After loading the laundry into the bin 12 and selecting the preferred operation mode and parameters from the user interface 20, the user is prompted to select START to begin processing or EXIT to exit the process. If “START” is selected, the embedded controller detects if the bin 12 is empty. If the bin 12 is not empty, then the robotic arm 15 is lowered while tip sensor and the arm position sensor signals are watched for stopping the robotic arm 15. In normal operation, the tip sensor would detect the arm 15 reaching the top of the pile of garments inside the bin 12 before hitting the bottom of the bin 12. The arm 15 lowering motion is then stopped and the acquisition mechanism tries to acquire the garment. When acquisition of a garment is sensed or after a short period of time with no acquisition being sensed, the arm 15 is raised to separate the garment already acquired from the pile remaining in the bin 12. The tip sensor checks if the garment is really acquired during the process of raising the arm 15. If the garment is not detected at the tip, then the arm 15 is lowered again with a bit more downward travel after detecting the top of the garment pile to try again. Several re-trials are allowed until a garment is successfully acquired or an error is enunciated. Alternatively, the arm 15 may be lowered slightly further without first raising the arm 15.

[0051] Once a garment is acquired and separated, it is transferred to stations inside the continuous laundry machine by belts or other transfer mechanisms, as discussed below. The tip sensor detects the rear edge of the garment passing through it. The embedded controller 18 then lowers the robotic arm 15 again to fetch the next garment if the sensor in the bin indicates there are still garments inside the bin 12. The above process is repeated until all the garments inside the bin 12 are fed and transferred and no garments are sensed in the bin 12. The embedded controller controls the process with a real-time clock and the state machine that defines the states of the feeder automatic control.

[0052] Additional enhancements and alternatives may be provided for the garment feeder 14. For example, vision hardware and software can be provided to intelligently identify a single garment or piece of laundry. A stationary brush strip may also be used in conjunction with the nip rollers to help separate garments. An automatic jam clearance may also be provided, for example by reversing the nip rollers 38 when excessive thickness is detected. Jams may also be cleared manually by opening or spreading the nip rollers apart to relieve the nip normal forces. The bottom of the bin 12 may include air jets, as shown in FIG. 24, to center garments and laundry for easy pick up by the feeder 14. Covers, such as brush strips, may be provided on the ends of the rollers 32, 38 of the feeder 14 to protect garments in the bin 12 from the rotating shaft ends. Also, intelligent controls can be used to reduce the travel and feed time of the feeder 14 by enabling constant raising height above the laundry stack in the bin 12. As a further alternative, the nip rollers 38 can be eliminated and the individual garment pieces pick up by the conveyor belts 34, 36 adjacent the end rollers 32.

[0053] With reference now to FIG. 8, the appliance 10 includes one or more washing or cleaning stations and a drying station. Each station may be a module which can be easily installed or removed from the appliance 10 for installation and/or repair. More particularly, as shown in the drawings, the appliance 10 may include a spray washing station or module 40, an ultrasonic cleaning station or module 42, a rinse station or module 43, a water extraction station or module 45 and a drying station or module 44.

[0054] As shown in FIG. 13, one possible spray wash station 40 includes a pair of manifolds 46, each having a plurality of spray nozzles 48. The nozzles 48 are positioned on opposite sides of the garment, which is sandwiched between a pair of mesh conveyor belts 50, 51 which are trained about a plurality of rollers 52 in the wash station 40, and driven by a motor 41 (FIGS. 9 and 10). The manifolds 46 are plumbed to a cleaning solution supply line via fluid lines 54. As seen in FIGS. 11-13, each manifold 46 includes a plurality of pipes 56, such that the nozzles 48 are arranged in a grid or array for complete coverage of the garments passing along the conveyor belts 50.

[0055] Referring now to FIGS. 14-22, the optional ultrasonic cleaning station 42 includes one or more ultrasonic heads 58 adapted to direct ultrasonic vibrations through the
garments. The garments are sandwiched between a pair of conveyor belts 60, 61 which are trained around a plurality of rollers 62 in the ultrasonic station 42. The belts 60, 61 are driven by a motor 98 (FIGS. 14 and 17). FIGS. 14 and 16 show a single ultrasonic head 58, though it is understood that multiple heads can be used. The head 58 is mounted on a threaded rod or shaft 64 for travel along the rod as the rod 64 is rotated by a motor 55 and belt 57 (FIG. 15). A smooth, non-rotating guide or support rod 64A is provided to facilitate movement of the ultrasonic head 58. The motor 55 is reversible, such that the rod or shaft 64 can be rotated in opposite directions, such that the ultrasonic head 58 will traverse back and forth substantially across the width of the ultrasonic station 42 as the laundry moves through the station 42 between the conveyor belts 60, 61. Limit switches 66 are provided at opposite ends of the rod 64 for controlling the movement of the ultrasonic head 58. As an alternative to the reversible shaft or screw 64, a double helix screw may be used to cause the ultrasonic head 58 to traverse back and forth across the path of the garments.

More particularly, the head 58 preferably has a piezoelectric ultrasonic transducer 53 that operates at approximately 35 kHz frequency. The frequency may range between about 20 kHz and about 40 kHz. The lower frequencies enable greater cleaning power through the formation of larger cavitation bubbles while the higher frequencies tend to clean better on higher thread count textiles. Although the head 58 may use a single transducer operating at a single frequency, the preferred embodiment uses multiple transducers that can operate at variable or different frequencies. The general frequency range associated with these is from about 20 kHz to about 80 kHz.

The transducer is mechanically coupled to an exponential profile ultrasonic horn 59, which preferably is fabricated out of titanium. The horn 59 is mechanically tuned to the frequency of the transducer 53 to amplify the transducer displacement. The horn 59 has an amplification gain factor selected to interact with the transducer 53 and provide an ultrasonic amplitude output at the tip of the horn of at least 20μ (peak to peak).

The transducer and the horn 59 are mechanically fixed to a carrier device 63 coupled to the shaft 64 so as to allow the surface of the horn 59 to traverse back and forth across the surface of the items passing through the ultrasonic station 42. This transverse arrangement offers the advantage of using lower power, smaller size and lower cost arrangement than a single transducer/horn combination having dimensions sufficient to cover the width of the traverse distance of the ultrasonic station 42. The range of traverse motion for the ultrasonic horn 59 may be, for example, 20 inches. Over this range the surface of the front tip 67 of the horn 59 is in close proximity to the surface of the conveyor belt 60.

As shown in FIGS. 18 and 19, head 58 also features a container 65 surrounding the output surface of the horn 59 to regulate the amount of fluid that the horn 59 will use to create cavitation. Controlling the amount of fluid also creates a control range of the reflected power load that the horn 59 will experience. Maintaining a fixed relatively small volume of cleaning solution enhances the effective cleaning function of the horn 59. Exposing the horn 59 to larger or random amounts of liquids will require more power and could potentially stall the horn 59.

By limiting the fluid amount, cavitation at lower power levels is achieved. The cavitation fluid is typically water but it can also be a combination of water and detergents. The container 65 controls the quantity of solution that the horn 59 is exposed to and it helps reducing the amounts of power needed to create cavitation at the target cleaning area while providing a surface for the material to be cleaned to pass at a controlled distance from the output surface of the horn 59.

Preferably, the belts 60, 61 in the ultrasonic cleaning station 42 are constructed from specialized materials that have high characteristic velocity, i.e. high tensile strength to density ratio, and that have very low attenuation of ultrasonic power, such as Spectra® (by Honeywell) or Kevlar®. Spectra® fiber is made from ultra-high molecular weight polyethylene. The belts 60, 61 may be solid or mesh.

To achieve the highest effectiveness in the cleaning process, the horn 59 has to be in close proximity with the target-cleaning surface, even with the resulting thickness variation from the randomly loaded clothing between the transport belts 60, 61. The belts 60, 61 that transports the laundry items preferably are 20" wide, though wider or narrower belts may be utilized. As shown in FIGS. 19-22, the close proximity between the top belt 60 and the surface of the horn 59 is achieved by incorporating a spring-loaded plate 69 that maintains the distance from the surface of the bel 60 to the surface of the horn 59. The belts 60 and 61 both pass on top of the spring-loaded plate 69.

A speed control mechanism and drive system adjust the traverse speed of the head 58 independently of the speed of the transport belts 60, 61. The preferred embodiment of the ultrasonic head 58 uses sensors to identify the type of material and related properties of the garments to be cleaned, therefore enabling the individualized application of cleaning protocols for each garment.

FIG. 18-20 show enlarged views of the ultrasonic head 58. As seen in FIG. 18, the tip 67 of the ultrasonic horn 59 extends into a cavity 70 of the fluid control container or block 65. A flexible inlet line 72 extends into the container 65 to supply water or other cavitation fluid to the tip 67. An outlet port 74 in the container 65 maintains the water or fluid level within the cavity 70 at a desired level. The arrow 76 in FIG. 18 indicates the direction of travel of the belts 60, 61, while the arrows 78 indicate the traverse movement of the ultrasonic head 58. The upstream or leading edge 80 of the container 65 is tapered or beveled, so as to provide a smooth movement of the upper belt 60 beneath the container 65, even with material thickness variations of the garment 71 sandwiched between the belts 60, 61. The container 65 is secured to the carrier 63 by a bracket 84.

As described above, the spring loaded plate 69 maintains a small gap 75 between the horn tip 67 and the top belt 60, with fluid 73 filling the gap. Such a small gap 75 controls the cavitation level of the fluid, and is dependent upon the operating frequency of the horn 59. For example, the gap 75 may approximately of 0.010 inch or more. Alternatively, there may be direct contact between the horn tip 67 and the belt 60, which enhances cleaning performance.

FIGS. 21 and 22 show the details of the spring-loaded plate, 69. More particularly, the ultrasonic station 42
includes a frame 86 with bolts 88 extending upwardly on opposite sides of the station 42. The plate 69 is secured to the bolts 87, with springs 88 residing on each bolt between the plate 69 and the frame 86.

[0067] The rinse station 43 is adjacent the outlet 47 (FIG. 16) of the ultrasonic station 42. The rinse station 43 includes spray nozzles 49 located on opposite sides of the garments, as seen in FIG. 23. Preferably, there is a plurality of spray nozzles 49 on both sides of the garment, and the nozzles may be a part of a manifold, similar to that described above with respect to the manifold 46.

[0068] The extraction station 45 consists of one or more wringers. With multiple wringers, the wringers are located adjacent to each other in a manner which allows garments exiting the initial wringer to immediately enter the input side of the secondary wringer. Each wringer is comprised of two rollers 94 pressed together by an adjustable spring mechanism which can be easily engaged and disengaged. Each roller 94 is covered with an elastomeric material which can be of various hardness and diameter. As garments are passed between the rollers 94, excess water is pressed out. The rollers 94 are located utilizing spherical bearings to allow for the large degree of misalignment encountered as garments are fed between the rollers 94. The rollers 94 are driven by an electric motor (not shown) and gear train. The motor is reversible to allow for the clearance of any garments which happen to get jammed between the rollers 94. Alternatively, each roller may be driven by an independent electric motor.

[0069] The drying station 44, illustrated in FIG. 23, includes in one possible embodiment, one or more fans 89 for blowing air into the station for drying garments passing there through. A heater (not shown) is provided for heating the air. The air is preferably heated to a relatively high temperature that is greater than the temperature of the air in a conventional tumble dryer. The garments are sandwiched between a pair of mesh conveyor belts 90, 91 trained about rollers so as to form a serpentine path through the drying station 44.

[0070] The drying station 44 may include a plurality of internal plates or baffles 92 extending substantially across the width of the station between the serpentine tracks of the conveyors 90, 91. The baffles 92 enhance the flow of air laterally across the conveyor belts 90, 91. Also, the air flow is turbulent within the station 44. Such turbulence enhances the drying effect of the air. Since the garments are passing through the drying station 44 in a relatively short period of time, increased air temperatures relative to that of a typical tumble dryer are necessary to drive moisture from the garments. The clothes are discharged from the drying station through to outlet 16 shortly after the vapor is driven out of the clothes, such that the clothes are not exposed to excessive heat after being dried, which could cause burning of the clothes.

[0071] The drying station 44 may include controls for adjusting the air flow temperature and velocity, in accordance with the dampness of the clothing and/or the material of the clothing. Also, the drying air may be re-circulated in the drying station 44. A moisture exchanger may be provided in the drying station 44 to remove vapor from the air, if necessary, prior to recirculation.

[0072] The conveyor belts 34, 36, 50, 51, 60, 61 and 90, 91 define a transport means or system for the appliance 10 to move individual pieces of laundry through the various stations of the appliance 10. As best seen in FIG. 8, each set of belts discharges the garments into the next adjacent set of belts for transport through the respective stations. Thus, the garments move continuously through the appliance from the bin 12 to the outlet 16 of the drying station 44. As discussed above with respect to the feeder mechanism 14, other transport means may be utilized in conjunction with, or in place of the various conveyor belts. Different transport means may be utilized for each station. The belts throughout the appliance 10 may be actuated and deactivated simultaneously or sequentially. The operation of the belts is controlled by the microprocessor and software logic, and the various sensors which may be included in each station of the appliance 10. The motors for driving the belts may include a clutch.

[0073] The arrangement of the various stations or modules allows the appliance 10 to be built into a compact unit with dimensions approximating those of a conventional household washer or dryer placed side-by-side. Thus, the appliance 10 is adapted for use in a home. Individual pieces of laundry can be quickly automatically cleaned and dried with the household appliance 10 of the present invention in a cycle time significantly less than with a standard washer and dryer.

[0074] It is understood that the various components of the appliance 10 may be modified or substituted with other components for achieving the same functional results. For example, the bin 12 may be changed to a drawer to pull out for loading, or a laundry basket. The various sensors in the appliance may be any known type of sensor, such as a photo-electric eye or a proximity sensor.

[0075] The feeder mechanism 14 may include other means for acquisition of the garment from the bin 12. For example, as an alternative to, or in combination with the nip rollers 38, the feed mechanism 14 may include a vacuum port to provide an inlet suction; an adhesive surface on rollers; a hook surface, similar to Velcro hook and loop material, on the surface of rollers; a statically charged surface on rollers; a brush roller set to facilitate pick up of a garment from the bin 12; a belt set over the nip rollers 38 or over the brush rollers; a mechanical pinching claw; or other means for acquiring a garment from the bin 12.

[0076] Other means may also be utilized to achieve the separation function. For example, separation of the acquired garment may be achieved by using a small acquisition zone in the bin 12 to limit access to the stack of laundry in the bin 12, i.e. a short length nip roller or vacuum roller; using a vacuum flow induced by a vacuum flow port adjacent to or through the acquisition rollers so as to move the garment toward the rollers and away from the remaining articles in the bin 12; a vision system to locate a single item in the group of items in the bin 12, with recognition according to color, pattern, or texture; using static forces to attract a single item in the stack of articles in the bin 12; restraining items other than the one acquired by the pick up mechanism, by holding the other items back as the acquired item is fed away; moving the acquired items through an aperture in a surface surrounding the acquisition mechanism; flushing the stack of laundry items to be fed so as to lubricate and separate the items; and/or using air jets to move items in the bin 12.
The transport function of the feeder mechanism 14 may be accomplished by other means, including a conveyor belt wherein the individual items are held in place by gravity, vacuum rollers or forces, static forces, Velcro hook and loop material, adhesive forces, or other forces; a surface having angled air jets to force the items along a path using air pressure forces and air flotation; a belt using wave motion to move items along the path; a chute using gravity forces to move and position the items; a chute using air lubrication and gravity to position the items; a belt having cross directional ribs to urge the items along the path of movement; vacuum cups attached to a moving belt, arm or linkage; an auger or screw mechanism; or a combination of these mechanisms.

The appliance 10 includes a pan or basin 96 (FIG. 8) in the base to receiver water or cleaning fluids from the various stations. The basin 96 may include a drain to discharge the water. Alternatively, the water collected in the basin 96 may be recycled for further use in the spray station 40 or rinse station 43. Recycling may include filtering or treatment in a water softener or other chemical treatment.

It is understood that alternative feeder mechanisms can be utilized with the appliance 10 of the present invention. For example, the feeder mechanism may be located beneath the bin 12 and feed individual laundry pieces by gravity. Another alternative is a side feeder mechanism which is fed from one side of the bin 12. As another alternative, the nip rollers 38 can be eliminated, and the operator manually feeds individual pieces of laundry into the path between the upper and lower conveyor belts 34, 36, such that the acquisition and separation steps are performed manually, rather than automatically, as with the feeder mechanism 14.

FIG. 24 shows an alternative bottom feeder mechanism 100. The feeder 100 is positioned beneath the bin 102 which has an opening 104 along the bottom portion thereof. A sensor 106, such as a phototransistor, is positioned below the opening 104 in the bin 102 so as to detect the presence of clothing or garments 108 in the bin 102. A pair of acquisition rollers 110 are positioned adjacent the opening 104 at the bottom of the bin 102. A pair of conveyor belts 112, 113 are trained about rollers 114 and positioned beneath the conveyer belts 112, 113 so as to receive garments from the acquisition rollers 110, and sandwich the individual garments between the conveyor belts 112, 113 for transport to the wash station 42 of the appliance 10. Preferably, acquisition rollers 110 and the conveyor belts 112, 113 are mounted on a pivotal robotic arm, similar to robotic arm 15, so that the rollers 110 and the belts 112, 113 can be moved toward and away from the opening 104 at the bottom of the bin 102, as indicated by the arrow 116 in FIG. 24. However, the rollers 114 and 110 may be stationarily mounted at the bottom of the bin 12.

The operating sequence for the bottom feeder mechanism 100 shown in FIG. 24 starts with the bin 102 being filled with garments 108. The sensor 106 detects the presence of garments 108 in the bin 102. Fluffing air may be forced through holes 118 in the wall of the bin 102. The fluffing air can be provided in any convenient manner, such as with air nozzles or through an air plenum. When the sensor 106 senses the presence of garments 108 in the bin, the feeder mechanism 100 is pivoted from a rest position spaced apart from the bin opening 104 to an operating position adjacent the bin opening 104. Simultaneously, the acquisition rollers 110 are actuated to acquire a lead edge of the garment 108 at the bottom of the bin 102. The acquisition rollers 110 feed the acquired garment 108 into the conveyor belts 112, 113 so as to be sandwiched therebetween for transport to the wash station 40. The exit opening 104 in the bottom of the bin 102 helps guide the garments 108 to fill the width of the acquisition rollers 110 and belts 112, 113. The acquisition, separation, and transport steps are repeated until the bin 102 is empty, as detected by the sensor 106. After the last garment is transported by the conveyers 112, 113, the acquisition rollers 110 and belts 112, 113 are turned off, the fluffing air supply is shut off, and the robotic arm supporting the rollers 110 and the belts 112, 113 is retracted to the rest position.

Another alternative embodiment of a feeder mechanism 120 is shown in FIG. 25. In FIG. 25, the bin 122 includes a side opening 124 at a lower edge of the bin 122. The bottom of the bin 122 is defined by a conveyor belt 126. The belt 126 preferably is mesh, so that fluffing air can pass therethrough, as indicated by the arrows passing through the belt 126. A sensor 128, such as a photo electric eye, is positioned adjacent the side discharge opening 124 of the bin 122. A pair of acquisition rollers 130 are positioned adjacent the opening 124. Transport conveyors 132, 133 are trained about rollers 134. Preferably, the acquisition rollers 130 and the conveyors 132, 133 are mounted on a reciprocating robotic arm, similar to robotic arm 15 described above, so as to be moveable between a rest position spaced apart from the bin opening 124, and an operative position adjacent the bin opening 124. Alternatively, rollers 130, 134 may be stationary related to the bin 12.

The operating sequence of the feeder mechanism 120 shown in FIG. 25 begins by filling the bin 122 with garments 136. A sensor (not shown) within the bin 122 senses the presence of garments 136 therein, and actuates a fluffing air supply to force air upwardly through the bin so as to lubricate and reduce garment load drag. The bin belt 126 is also actuated by the internal bin sensor so as to move a garment 136 partially out of the bin 124. When the sensor 128 detects the garment 136, the bin conveyor 126 is shut off, and the robotic arm is moved from the rest position to the operative position, such that the acquisition rollers 130 are adjacent the opening 124. The acquisition rollers 130 are also actuated by the sensor 128 so as to acquire the garment 136, which is then fed into the conveyor belts 132, 133 so as to be sandwiched therebetween and transported to the wash station 42 of the appliance 10. The robotic arm may reciprocate, as indicated by arrow 138 in FIG. 25, so as to facilitate separation of the garment 136 exiting the side opening 124 from the remaining garments in the bin 122. When the sensor 128 detects a gap or the end of the first garment, the bin conveyor 126 is actuated to carry the next garment through the opening 124, with the acquisition, separation, and transport steps being repeated 136 until the bin 122 is empty. After the bin 122 is empty, the fluffing air supply is turned off and the robotic arm with the acquisition rollers 130 and conveyors 132, 133 is retracted to the rest position.

The continuous cleaning appliance 10 provides many benefits over the standard, and separate, batch washers and dryers. For example, the entire operation of the appliance 10 may be automated, such that one or more dirty garments can simply be dropped into the bin 12, and then automatically be conveyed through the appliance 10 for washing and drying, with no user intervention. The appliance is always “on” for “on demand” operation. Also, the appliance control module 18 may include a microprocessor.
for adjusting operation of each station, including times and temperatures. The microprocessor may also include a time delay, so as to actuate the appliance at a pre-set designated time, such as at night during off-peak energy consumption for energy efficiency. The appliance 10 eliminates the need to sort clothing or garments according to color or other factors, since each garment passes through the appliance individually. Clothes can be randomly thrown into the bin, without the need of laundry room baskets. The user does not have to move or change the clothes from a separate washer and dryer, as in conventional home laundry systems.

[0085] The invention has been shown and described above with the preferred embodiments, and it is understood that many modifications, substitutions, and additions may be made which are within the intended spirit and scope of the invention. From the foregoing, it can be seen that the present invention accomplishes at least all of its stated objectives.

What is claimed is:

1. A laundry appliance for cleaning laundry, comprising:
   a bin for holding laundry to be cleaned;
   an acquisition member adjacent the bin to automatically obtain a single piece of laundry from the bin; and
   a transport member adjacent the acquisition member to move the single piece of laundry to a cleaning station.

2. The laundry appliance of claim 1 wherein the bin includes a top opening through which garments pass to the acquisition member.

3. The laundry appliance of claim 1 wherein the bin includes a bottom opening through which garments pass to the acquisition member.

4. The laundry appliance of claim 1 wherein the bin includes a side opening through which garments pass to the acquisition member.

5. The laundry appliance of claim 1 wherein the acquisition member is a pair of nip rollers.

6. The laundry appliance of claim 1 wherein the acquisition member is selected from a group consisting of a set of nip rollers, a vacuum system, an adhesive surface, a hook surface, a statically charged surface, a brush roller set, and a pinching mechanism.

7. The laundry appliance of claim 1 further comprising a separation member adjacent the acquisition member to separate the single piece of laundry from other laundry in the bin.

8. The laundry appliance of claim 1 wherein the separation member is a reciprocating robotic arm movable between a laundry pick up position and a laundry separating position.

9. The laundry appliance of claim 8 wherein the acquisition member is mounted on the robotic arm.

10. The laundry appliance of claim 1 wherein the transport member is a conveyor system.

11. The laundry appliance of claim 10 wherein the conveyor system includes a pair of belts between which the one piece of laundry is sandwiched.

12. The laundry appliance of claim 11 wherein the acquisition member is a pair of nip rollers, the separation member is a robotic arm having the nip rollers mounted thereon for movement between a first position within the bin and a second position out of the bin, and the transport member includes a conveyor system operatively mounted within the robotic arm to receive the single piece of laundry from the nip rollers.

13. The laundry appliance of claim 12 wherein the conveyor system includes a pair of belts between which the single piece of laundry is sandwiched.

14. A method of cleaning laundry, comprising:
   loading laundry into a bin;
   acquiring an individual piece of laundry from the bin; and
   transporting the separated piece of laundry to a cleaning station.

15. The method of claim 14 wherein the piece of laundry is acquired from the top of the bin.

16. The method of claim 14 wherein the piece of laundry is acquired from the bottom of the bin.

17. The method of claim 14 wherein the piece of laundry is acquired from the side of the bin.

18. The method of claim 14 wherein the acquisition step is accomplished with a pair of nip rollers.

19. The method of claim 14 further comprising separating the acquired piece of laundry from other laundry in the bin.

20. The method of claim 14 wherein the separating step is accomplished with a reciprocating robotic arm movable between a laundry pick up position and a laundry separation position.

21. The method of claim 14 wherein the transport step is accomplished with a conveyor system.

22. The method of claim 21 wherein the conveyor system includes a pair of belts, and the transport step includes sandwiching the piece of laundry between the belts for transport.

23. The method of claim 14 wherein the acquisition step is accomplished with a pair of nip rollers, the separation step as accomplished with a reciprocating robotic arm having the nip rollers mounted thereon for movement between a first position in the bin and a second position out of the bin, and the transport step is accomplished with a conveyor system operatively mounted within the robotic arm to receive the piece of laundry from the nip rollers.

24. The method of claim 23 further comprising sandwiching the piece of laundry between a pair of belts in the conveyor system.

25. The method of claim 14 further comprising sensing the presence of laundry in the bin.

26. The method of claim 14 further comprising sensing the presence of a piece of laundry in the acquisition step.

27. The method of claim 14 further comprising sensing the presence of a piece of laundry in the transport step.

28. The method of claim 14 wherein the automated feeder acquisition is accomplished with sensors and embedded control with a real-time clock and various software methods.

29. A laundry appliance, comprising:
   a bin for holding laundry to be washed;
   a wash station for washing the laundry; and
   a feeder to automatically convey laundry from the bin to the wash station.

30. The laundry appliance of claim 29 further comprising a drying station to dry the laundry that has been washed.

31. The laundry appliance of claim 30 further comprising an ultrasonic station upstream from the drying station for cleaning the laundry.

32. The laundry appliance of claim 30 further comprising a rinse station upstream of the drying station for rinsing laundry.
33. The laundry appliance of claim 30 further comprising an extraction station upstream of the drying station to remove water from the laundry.

34. The laundry appliance of claim 30 wherein the laundry moves continuously through the wash and dryer stations.

35. The laundry appliance of claim 29 wherein the bin has a top discharge of garments to the feeder.

36. The laundry appliance of claim 29 wherein the bin has a bottom discharge of garments to the feeder.

37. The laundry appliance of claim 29 wherein the bin has a side discharge of garments to the feeder.

38. The laundry appliance of claim 29 wherein the feeder includes a robotic arm assembly movable to and from the bin to retrieve laundry from the bin.

39. The laundry appliance of claim 38 wherein the arm assembly includes means for acquiring individual pieces of laundry from the bin.

40. The laundry appliance of claim 39 wherein the arm assembly includes nip rollers to acquiring individual pieces of laundry from the bin.

41. The laundry appliance of claim 38 wherein the arm assembly includes a conveyor system for transporting laundry from the bin to the wash station.

42. The laundry appliance of claim 38 wherein the arm assembly includes a sensor to detect the presence of laundry.

43. The laundry appliance of claim 29 further comprising sensors, an embedded controller and hardware and software control logic and algorithms that control the operation of various processing stations inside the machine.

44. The laundry appliance of claim 29 further comprising a sensor in the bin to detect garments in the bin and automatically actuate the feeder.

45. A laundry bin for holding laundry to be processed; feed means to automatically pick up a piece of laundry from the bin;

a water spray station adapted to receive a piece of laundry from the feed means for cleaning the laundry;

an ultrasonic station for cleaning the laundry;

a rinse station for rinsing the laundry;

an extraction station for removing water from the laundry;

a drying station for drying the laundry; and

transport means for continuously transporting the laundry one piece at a time through the water spray, ultrasonic, rinse and drying stations.

46. The laundry appliance of claim 45 wherein the bin has a top discharge to the feed means.

47. The laundry appliance of claim 45 wherein the feed means reciprocates between a pick-up position within the bin and a separation position outside the bin.

48. The laundry appliance of claim 45 wherein the transporting means includes belt conveyors passing through each station.

49. The laundry appliance of claim 48 wherein the belt conveyors include upper and lower tracks between which the laundry pieces are sandwiched.

50. The laundry appliance of claim 49 wherein the tracks are mesh to allow water and air to pass through.

51. The laundry appliance of claim 45 wherein the water spray stations includes spray nozzles positioned on opposite sides of the laundry.

52. The laundry appliance of claim 45 wherein the water spray stations includes a pair of manifolds each supporting a plurality of the spray nozzles on opposite sides of the laundry.

53. The laundry appliance of claim 45 wherein the transport means moves the laundry along a path, and wherein the ultrasonic station includes an ultrasonic head moving across the path of the moving laundry.

54. The laundry appliance of claim 53 wherein the ultrasonic head is supported on a screw for traversing the laundry path.

55. The laundry appliance of claim 54 wherein the screw has a double helix to control movement of the head in opposite directions across the laundry path.

56. The laundry appliance of claim 54 wherein the screw is reversible, with limit switches to control movement of the head in opposite directions across the laundry path.

57. The laundry appliance of claim 45 wherein the extraction station includes wringer rollers.

58. The laundry appliance of claim 45 wherein the drying station includes an air supply to blow air across the laundry.

59. The laundry appliance of claim 45 wherein the drying station includes a heater to heat the air.

60. The laundry appliance of claim 45 wherein the drying station includes internal walls to define a serpentine path of air flow.

61. The laundry appliance of claim 58 wherein air turbulence is created within the drying station.

62. A residential method of processing laundry, comprising:

loading laundry into a bin;

automatically feeding individual pieces of laundry from the bin into a water spray station;

spraying water onto the laundry in the spray station;

exposing the laundry to ultrasonic vibrations in an ultrasonic station;

rinsing the laundry in a rinse station;

extracting water from the laundry in an extraction station;

drying the laundry in a drying station; and

continuously transporting the laundry pieces through the spray, ultrasonic, rinse, extraction and drying stations.

63. The method of claim 62 wherein the transporting of the laundry pieces is accomplished by belt conveyors passing through each station.

64. The method of claim 63 further comprising sandwiching the laundry between opposing tracks of the belt conveyors.

65. The method of claim 62 wherein the spraying of water is directed to opposite sides of the laundry.

66. The method of claim 62 wherein the ultrasonic vibrations are generated by an ultrasonic head traversing across the laundry as the laundry moves through the ultrasonic station.

67. The method of claim 62 wherein the rinsing is directed to opposite sides of the laundry.

68. The method of claim 62 further comprising recirculating drying air in the drying station.