United States Patent

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[54] **SUDS SUPPRESSION METHOD**
10 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **8/158**
[51] **Int. Cl.** **D06f 39/06**
[50] **Field of Search** 68/23.5, 23.3, 148; 8/158, 159

[56] **References Cited**

UNITED STATES PATENTS

2,526,344	10/1950	Geldhof et al.	68/148
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3,387,310	6/1968	Marshall	8/158

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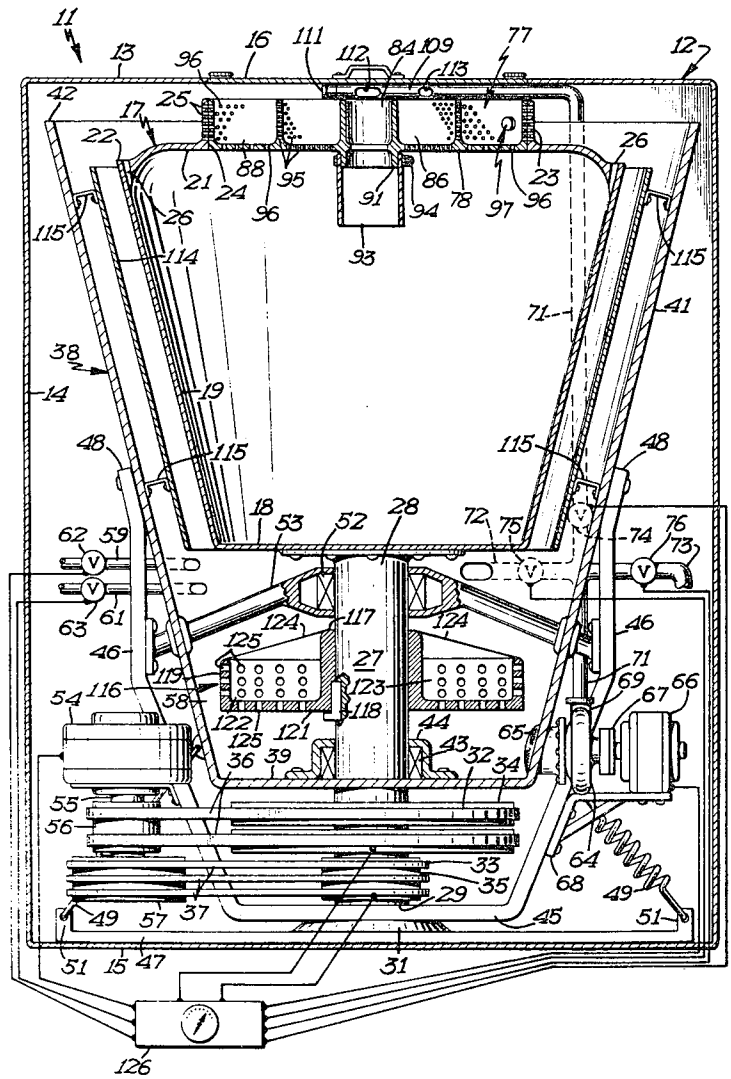
ABSTRACT: The improved washing machine method of the present invention is particularly adapted for washing clothes and the like in wash water having a relatively high concentration of sudsable soap or synthetic detergent. The improved method utilizes a rotatable, vertically disposed, inverted frustoconical washing chamber positioned in, but spaced from, the walls of a stationary reservoir chamber. The lower, closed end of the reservoir chamber forms a wash water reservoir. The upper open end of the washing chamber is substantially closed by a removable cover which includes means for introducing wash water into the interior of the washing chamber, means for permitting wash water to be removed from the washing chamber during high speed rotation of the washing chamber, and means for suppressing suds in the wash water removed from the washing chamber before the wash water is permitted to return to the reservoir. A suds shield is utilized to prevent suds from contacting the sides of the rotating washing chamber while the wash water is returning to the reservoir from the washing chamber. A rotating disc is positioned in the reservoir and is utilized to suppress suds formed in the wash water in the reservoir.

During operation, the washing chamber is rotated at a relatively high rotational speed about its vertical, central longitudinal axis so that the clothes and wash water in the washing chamber form an annular layer about the axis. Periodically, abruptly and briefly the rotational speed of the washing chamber is reduced to a rotational speed below that necessary to maintain the annular layer of clothes and wash water so that the clothes are tumbled and rearranged in the washing chamber. The rate of wash water being introduced and removed from the washing chamber is preselected so that during high speed rotation of the washing chamber, wash water in excess of that necessary to saturate the clothes is always present in the washing chamber.



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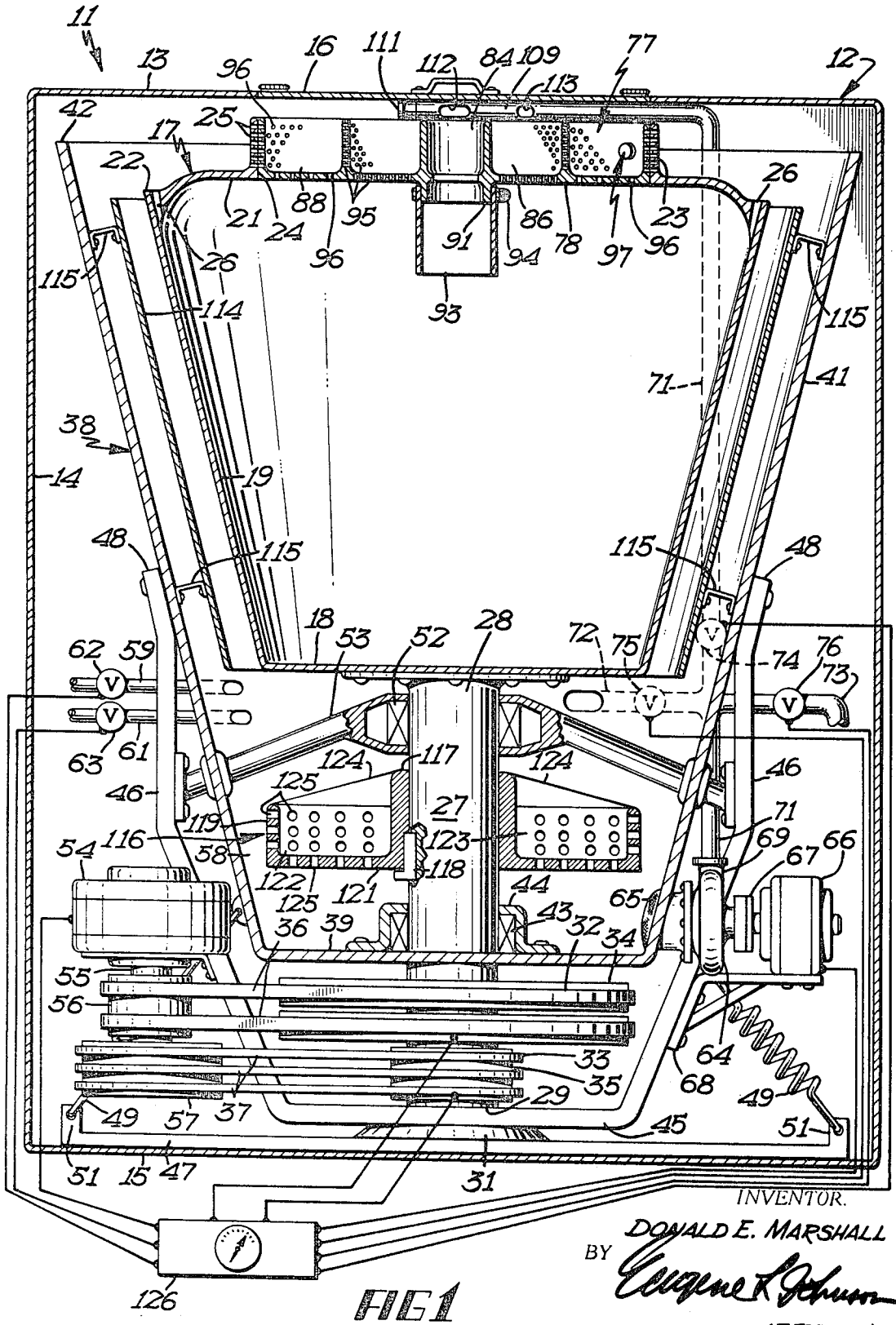

FIG 1

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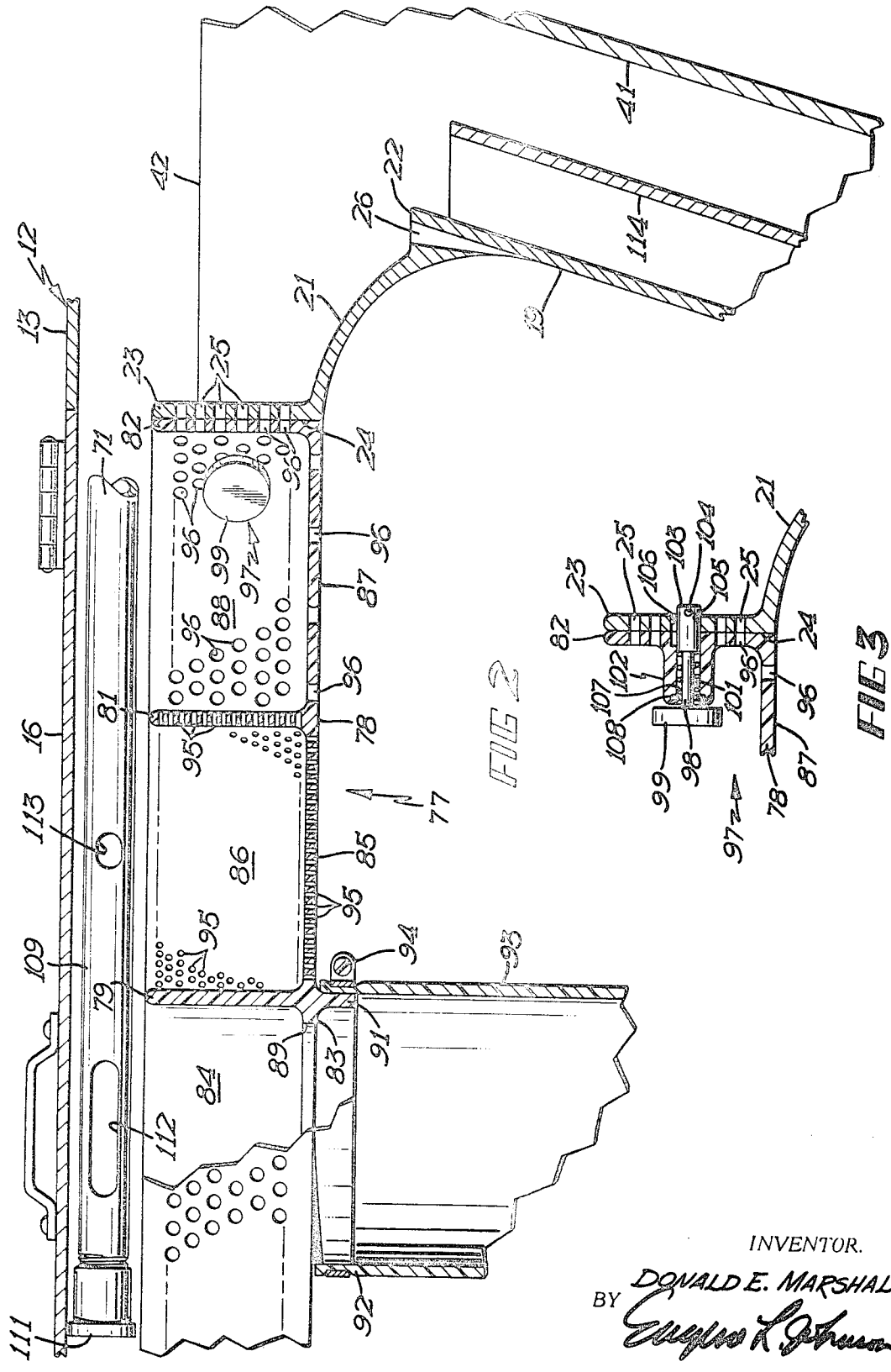

FIG 2

FIG 3

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SUDS SUPPRESSION METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of my copending application, Ser. No. 784,050, filed Dec. 16, 1968, entitled "Washing Machine."

BACKGROUND OF THE INVENTION

This invention relates to an improved washing machine method for washing clothes and the like, and more specifically to an improved washing method which is particularly adapted for washing clothes and the like in wash water having a relatively high concentration of sudsable soap or synthetic detergent and which is capable of significantly reducing the time and volume of water required for the washing operation while obtaining relatively superior cleaning action.

My U.S. Letters Pat. Nos. 3,387,310 and 3,388,410, granted June 11, 1968 and June 18, 1968, respectively, disclose a significantly improved method of washing clothes and improved washing machines for performing this improved method. In summary, this improved method of cleaning clothes includes rotating the clothes and wash water in a washing chamber at a relatively high rotational speed so that the clothes and wash water form an annular layer about the axis of rotation; periodically, abruptly reducing the rotational speed of the washing chamber to a speed below that necessary to maintain the annular layer of clothes and wash water in the washing chamber so that the clothes will be tumbled and rearranged in the washing chamber; and then again rotating the washing chamber at the relatively high rotational speed so that the annular layer of clothes and wash water is reformed. While the washing chamber is rotated at the relatively high speed, wash water is continuously forced over and through the clothes.

The use of the improved washing method disclosed in my aforementioned patents provides superior cleaning action relative to the cleaning action provided by present, commercially available machines, and in addition utilizes less time and wash water in the washing operation.

SUMMARY OF THE INVENTION

The improved washing method of the present invention utilizes an improved design and structural arrangement, relative to the machines disclosed in the aforementioned patents and relative to the present, commercially available machines, that permits wash water having a relatively high concentration of sudsable soap or synthetic detergent to be used in the improved machine without excessive sudsing and the concomitant disadvantages of sudsing. Thus, the improved method of the present invention includes the advantages of the method disclosed in the aforementioned patents as well as permitting optimum cleaning action to be achieved as a result of the use of wash water having a high concentration of soap or synthetic detergent.

More specifically, the improved washing method of the present invention utilizes a rotatable, vertically disposed, inverted frustoconical washing chamber having a continuous sidewall and a closed lower end. The washing chamber is positioned within a substantially congruent, stationary reservoir chamber. A wash water reservoir is defined in the lower end of the reservoir chamber beneath the lower end of the washing chamber, and the upper end of the sidewall of the reservoir chamber extends above the upper end of the sidewall of the washing chamber. The washing chamber is adapted to be rotated at a relatively high rotational speed about its central longitudinal axis so that the clothes and wash water in the washing chamber form an annular layer about the axis. Periodically, abruptly the rotational speed of the washing chamber is reduced to a speed below that necessary to maintain the annular layer of clothes and wash water so that the clothes are tumbled and rearranged in the washing chamber. Thereafter, the rotational speed of the washing chamber is again returned to the relatively high speed so that the annular layer is reformed. Wash water is continuously introduced into and removed from the washing chamber during the high speed rotation thereof.

The upper open end of the washing chamber is closed during operation of the washing machine by a removable cover so that any suds formed in the washing chamber are substantially contained in the washing chamber in that the suds can only flow out of the washing chamber through the small holes provided in the cover, and the passage through these holes effectively suppresses the suds. The cover includes a bottom wall and a plurality of annular sidewalls which define a central compartment and radially inner and outer annular compartments. Wash water to be introduced into the rotating washing chamber is first introduced into the central compartment. The central compartment communicates with a hose which extends toward the center of the washing chamber and is used to introduce wash water into the washing chamber from the central compartment. The inner compartment is adapted to hold soap or synthetic detergent and also functions as a lint trap. The inner compartment has a plurality of relatively small diameter holes in the adjacent bottom wall portion and in the sidewall separating it from the outer compartment through which the water therein may pass into the washing chamber and outer compartment, respectively.

The wash water removed from the washing chamber flows from the chamber into the outer compartment through a plurality of holes formed in the adjacent portion of the bottom wall of the cover. A plurality of holes are also formed in the outer peripheral sidewall of the outer compartment. The water in the outer compartment is forced, by centrifugal force, to flow through these holes and the passage of water through these holes suppresses any suds entrained in the water. The holes in the bottom wall adjacent to the outer compartment are positioned relative to the upper end of the sidewall of the washing chamber, so that the water removed from the chamber flows from the radially inner surface of the annular layer.

The wash water expelled from the outer compartment of the cover impinges against the sidewall of the reservoir chamber and then runs down the sidewall of this chamber into the reservoir. A suds shield is positioned between the sidewalls of the washing chamber and the reservoir chamber, and this shield prevents any suds formed during the passage of the water down the sidewall of the reservoir chamber from contacting or causing "suds drag" on the rotating washing chamber.

An additional suds suppressing disc is positioned in the reservoir and rotates with the washing chamber. This suds suppressing disc includes a plurality of chambers which have perforated bottom and sidewalls through which the suds are forced to pass thereby suppressing the suds. Impeller blades are formed on the disc and are used to force the suds into the chambers.

Accordingly, it is a primary object of the present invention to provide an improved washing method in which wash water having a relatively high concentration of soap or synthetic detergent may be used to achieve optimum cleaning results without excessive sudsing.

Another object of the present invention is to provide an improved washing method wherein a rotatable, vertically disposed, inverted frustoconical washing machine is positioned within, but spaced from the walls of a relatively stationary reservoir chamber wherein the washing chamber is adapted to be rotated at a relatively high speed about the central longitudinal axis of the washing chamber so that the clothes and wash water therein form an annular layer about the axis; wherein periodically, abruptly and briefly the speed of the washing chamber is reduced to a rotational speed below that necessary to maintain the annular layer of clothes and wash water so that the clothes are tumbled and rearranged in the washing chamber; wherein the washing chamber is again rotated at the high speed so that the annular layer of clothes and wash water is reformed; and wherein during high speed

rotation, wash water is continuously introduced into and removed from the washing chamber.

These and other objects and features of the invention will become apparent from the following description of the preferred embodiment of the invention, taken in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial, vertical cross-sectional view of the improved washing machine of the present invention and also shows, schematically, the electrical control system for the improved washing machine.

FIG. 2 is a partial, vertical cross-sectional view of the cover utilized in the improved washing machine of the present invention.

FIG. 3 is a partial, vertical cross-sectional view of the locking means utilized to retain the cover in the upper end of the washing machine of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the improved washing machine of the present invention is shown generally at 11. This improved machine includes an outer sheet metal cabinet 12 having top, side and bottom walls 13, 14 and 15, respectively. The top wall 13 has a central aperture which is normally closed by a hinged door 16.

A rotatable, vertically disposed, inverted frustoconical washing chamber 17 is positioned within the housing 12 and includes a closed bottom end wall 18 and a continuous sidewall 19 which is inclined outwardly from the bottom wall 18 at an angle of approximately 15° with respect to the vertical. An annular flange 21 extends generally radially inwardly, with respect to the central longitudinal axis of the chamber 17 and is secured to the upper end 22 of the sidewall 19. The radially inner portion 23 of the flange 21 is bent so that it is positioned vertically and defines the periphery of a circular opening 24. A plurality of small diameter holes 25 are formed in the portion 23 for the purpose hereinafter described.

A plurality of relatively small diameter holes 26 are formed in the flange 21 adjacent the upper end 22 of the sidewall 19 of the chamber 17. These holes 26 are equispaced about the upper end 22, the wall 19 and are used to expel water from the washing chamber 17 during spin dry operation of the machine 11, although the wash water will, of course, flow therethrough at any time the chamber is rotated at high speed. However, the size and number of the holes 26 is such that the water expelled through these holes does not substantially affect the operation of machine 11, as described hereinafter, during the washing and rinsing operations.

The washing chamber 17 is supported for rotation about its central longitudinal axis by a power shaft 27. More specifically, the upper end 28 of the power shaft 27 is attached to the center of the bottom wall 18 of the chamber 17 so that the central longitudinal axes of the power shaft and washing chamber are coaxial. The lower end 29 of the power shaft 27 is journaled in a bearing housing 29 secured to the bottom wall 15 of the cabinet 12.

The large diameter and small diameter sheaves 32 and 33 are positioned on the shaft 27 adjacent the lower end 29 thereof and are adapted to be connected with the shaft 27 by a pair of conventional, electrically actuated clutches 34 and 35, respectively. An example of a commercially available clutch which may be utilized to connect the sheaves 32 and 33 with the shaft 27 are the clutches manufactured by Stearns Electric Corporation of Milwaukee, Wisconsin. The sheaves 32 and 33 are adapted to be driven by the V-belts 36 and 37, respectively.

A stationary, vertically disposed, inverted frustoconical reservoir chamber 38 is also positioned within the cabinet 12 and has a shape generally congruent to the shape of the washing chamber 17. More specifically the reservoir chamber 38 includes a closed bottom end wall 39 and a continuous sidewall 41 which is inclined outwardly from the bottom wall 39 at an angle of approximately 15° with respect to the vertical. The bottom wall 39 is positioned below the bottom wall 18 of the chamber 17 and the sidewall 41 is spaced radially outwardly from the sidewall 19 of the chamber 17, with the upper end 42 of the sidewall 41 being positioned about the upper end 22 of the wall 19.

The bottom wall 39 of the reservoir chamber 38 has a central aperture formed therein through which the power shaft 27 projects. A conventional bearing and seal 43 is positioned about the shaft adjacent to the bottom wall 39 and is secured in place by the conventional bearing support 44.

A heavy frame 45 is utilized to support the reservoir chamber 38 within the cabinet 12 and to minimize the vibration of the chamber 38 during operation of the machine 11. More specifically, the frame 45 includes a plurality of spider arms 46 and base members 47 which are mounted on the bottom wall 15 of the cabinet 12. The upper ends of the arms 46 are fastened to the exterior surface of the sidewall 41 of the chamber 38 at points spaced approximately midway between the upper and lower ends of the wall 41 and are equidistant from each other. Heavy duty coil springs, two of which are shown at 49, are attached to and extend between the chamber 38, adjacent to the bottom wall 39, and the outer ends 51 of the base members 47.

A conventional shaft bearing 52 is positioned about and supports the shaft 27 adjacent its upper end 28. The bearing 52 is held in place by tubular arms, two of which are shown at 53, that extend through sealed apertures in the sidewall 41 of the chamber 38 and are fastened to the arms 46 of the frame 45.

A conventional, two-speed electric motor 54 is mounted on one of the arms 46 of the frame 45. The motor 54 must be of the type which will permit the polarity of its windings to be reversed by changing the connections of the motor windings so that when the connections are changed, the motor will act as a brake. The output shaft 55 of the motor 54 has small diameter and large diameter sheaves 56 and 57, respectively, mounted thereon. The sheaves 56 and 57 receive the V-belts 36 and 47 and thus, by means of the V-belts, drive the sheaves 32 and 33, respectively.

The particular rotational speeds of the chamber 17 may vary depending on the size of the chamber and the weight of the clothes to be washed. In this connection, the intermediate speed is generally below 50 r.p.m. while the high speed rotation is generally above 60 r.p.m. and usually would be between 60—250 r.p.m.

A wash water reservoir 58 is formed in the bottom of reservoir chamber 38 below the bottom end 18 of the washing chamber 17. Hot and cold water, from sources not shown, may be introduced into the chamber 58 through conduits 59 and 61, respectively. Electrically actuated valves 62 and 63 control flow through the conduits 59 and 61, respectively.

A conventional pump 64 is mounted adjacent to the bottom of the reservoir chamber 38 so that its inlet 65 communicates with the wash water in the reservoir 58. The pump 64 is driven by a conventional electric motor 66 through a conventional connection 67. The motor 66 is mounted on a support 68 which in turn is mounted on one of the arms 46 of the frame 45. The outlet 69 of the pump communicates with one end of a conduit 71 and the other end of the conduit 71 is positioned adjacent to the opening 24 in the upper end of the washing chamber 17. A first branch conduit 72 connects the conduit 71 with the reservoir 58, and a second branch conduit 73 connects the conduit 71 with a sump, not shown. Electrically actuated valves 74, 75 and 76 control the flow through conduits 71, 72 and 73, respectively, with the valve 74 being positioned in conduit 71 downstream from the points at which the branch conduits 72 and 73 are connected to the conduit 71.

Referring now to FIGS. 1 and 2, a generally circular cover 77 is shown positioned in and completely blocking the opening 24 formed in the upper end of the washing chamber 17. The cover 77, which may be made of plastic, includes a bot-

tom wall 78 and three annular sidewalls 79, 81 and 82. The annular wall 79, together with the portion 83 of the bottom wall 78, defines a central compartment 84; the walls 79 and 81, together with an annular portion 85 of the bottom wall 78, define an inner annular compartment 86; and the walls 81 and 82, together with another annular portion 87 of the bottom wall 78, define an outer annular compartment 88. The height of the walls 79, 81 and 82 substantially equals the vertical height of the portion 23 of the flange 21 of the washing chamber 17.

An aperture 89 is formed in the portion 83 of the bottom wall 78, and the diameter of the aperture 89 is substantially equal to the diameter of the compartment 84. An annular flange 91 is formed on the bottom wall 78 between the portions 83 and 85 and extends a short distance below the plane of the bottom wall 78. The upper ends 92 of a flexible hose 93 is positioned about the flange 91 and is secured in place by a conventional hose clamp 94. The hose 93 extends toward the bottom wall 18 from the cover 77 so that the water flowing therethrough is introduced into the interior of the washing chamber 17. The cover 77 is designed so that the central longitudinal axes of the central compartment 84, the aperture 89 and the hose 93 are coaxial with the central longitudinal axis of the washing chamber 17.

The portion 85 of the bottom wall 78 and the wall 81 have a plurality of relatively small diameter holes 95 formed therein. These holes 95 are smaller than the holes 25 formed in the portion 23 of the flange 21, and are of such a size that they may be used to filter lint and particles of dirt entrained in the water. A plurality of holes 96 are formed in the portion 87 of the bottom wall 78 and the sidewall 82, and these holes have a diameter substantially equal to the diameter of the holes 25 formed in the portion 23 of the flange 21.

The cover 77 is secured within the opening 24 by three locks, one of which is shown generally at 97 in FIGS. 2 and 3. The lock 97 includes a central shaft 98 which has a knob or head 99 secured at one end thereof and which extends through a bore 101 formed in an integral projection 102 on the wall 82. The other end of the shaft 87 has an enlarged diameter portion 103 which has a wall pin 104 projecting therefrom in a direction perpendicular to the central longitudinal axis of the shaft 98. When the cover is positioned, as shown in FIG. 2, the bore 101 is aligned with a bore 105 formed in the portion 24 of the flange 21. A groove 106, adjacent to the bores 101 and 105, is formed in the wall 82 and in the portion 24 and is designed to receive the pin 104. A light coil compression spring 107 is positioned in the bore 101 between the portion 103 of the shaft 98 and a snap ring 108 secured in the radially inner end of the hub 102 and urges the shaft to the position shown in FIG. 3.

Rotation of the knob 99 through a 90° arc, from the position shown in FIG. 3, aligns the pin 104 with the groove 106 so that the shaft 98 can be retracted out of the bore 105, i.e., moved radially inwardly. When the shaft is thus retracted, relative movement between the cover 77 and the portion 23 of the flange 21 is possible and the cover 77 may be removed from the opening 24. Of course, when the knob 99 is released, the spring 107 causes the shaft 98 to move radially outwardly with respect to the wall 82 and into the bore 105, provided, of course, that the bores 101 and 105 are aligned, as shown in FIG. 3.

A plug 111 is utilized to block the end 109 of the conduit 71 which is adjacent to the opening 24. A pair of apertures 112 and 113 is formed in the end 109 with aperture 112 being positioned so as to permit wash water to flow therefrom into central compartment 84 and the aperture 113 being positioned so as to permit wash water to flow therefrom into the inner compartment 86. The size of the aperture 112 is greater than the size of aperture 113 so that the major portion of the wash water flowing through conduit 71 flows through aperture 112.

As note above, the wash water from aperture 112 flows first into compartment 84 and then, through aperture 89 and hose 93, into the interior of the washing chamber 17. The wash water from aperture 113 flows first into compartment 86 and then flows through the openings 95 into the washing chamber 17. Because of the rotation of the chamber 17 and the cover 77, a portion of the wash water in compartment 86 flows through the holes 95 in the wall 81 into compartment 88.

Wash water also flows into compartment 88 through the holes 96 in the portion 87 of the bottom wall 78 of the cover 77 during high speed rotation of the chamber, i.e., during the time when an annular layer of wash water and clothes has been formed in the chamber. The holes 96 in the portion 87 are positioned, relative to the sidewall 19 of the chamber 17, so that the wash water flowing into the compartment 88 is generally the water in the radially inner portion of the annular layer.

Because of the rotation of the cover, the wash water in compartment 88 is expelled from the compartment through the aligned holes 96 and 25 and impinges against the upper sidewall 42 of the reservoir chamber 38. Thereafter, this water flows or runs down the sidewall 41 into the reservoir 58.

A frustoconical suds shield 114 is positioned substantially equispaced between the sidewall 19 of the chamber 17 and the sidewall 41 of the chamber 38 and is mounted on the sidewall 41 by a plurality of brackets 115. The shield 114 prevents any suds in the wash water running down the sidewall 41 from contacting or causing "suds drag" on the rotating chamber 17.

To suppress sudsing in the reservoir, a disc 116 is mounted on and rotates with the power shaft 27 between the bearing 43 and 52. More specifically, the disc 116 includes a central hub 117 through which the power shaft 27 extends, with a conventional key and key way 118 used to secure the hub 117 against rotation with respect to the shaft 27. The disc 116 also includes an annular sidewall 119, a bottom wall 121, and four radially extending walls, two being shown at 122. These walls 119, 121 and 122, together with the hub 117, divide the disc 116 into four equal compartments, two of which are shown at 123. A plurality of holes 125 are formed in the walls 119, 121 and 122, and these holes are approximately the same diameter as the holes 25 formed in the portion 23 of the flange 21 of the chamber 17.

Formed integrally with the wall 122 are four blades or impellers, two of which being shown at 124, designed to direct or force the suds in the reservoir into the compartments 123. Any suds in the compartment 123 are forced, because of the rotation of the shaft 27 and thus the disc 116, through the holes 125 in the sidewall 119, and the passage of the suds through these holes breaks down or suppresses the suds.

The operation of the motors 54 and 66, the clutches 34 and 35 and the valves 62, 63, 74, 75 and 76 are controlled by a timing mechanism which is shown schematically at 126. The timing mechanism 126 employs an electric motor which sequentially operates a plurality of switches in a preselected sequence. Such timing mechanisms are old and well known in the art, and for this reason further description of the mechanism 126 has not been included herein.

OPERATION

The operation of the washing machine 11 of the present invention is generally as follows:

The clothes or materials to be washed are placed in the interior of the washing chamber 17, and the cover 77 is locked in place. Conventional soap or synthetic detergent may be placed in the inner compartment 86, and the wash water introduced into the compartment from the aperture 113 dissolves the soap or synthetic detergent. Alternatively, concentrated soap or detergent beads may be introduced directly into the reservoir 58 either manually or by dispensing mechanism means, not shown. These beads may be similar to the beads produced by the bead producing machine and method disclosed in my U.S. Pat. application entitled "Machine and Method for Producing Laundry Products" filed Nov. 5, 1968, and identified in the U.S. Patent Office by Ser. No. 773,585.

After the clothes and soap have been placed in the machine, the cover **16** is closed.

Either while the clothes are being placed into the washing chamber or after the loading of the clothes has been completed, the valves **62** and **63** are opened so that wash water may be introduced into the reservoir **58**. Also, if soap or detergent beads have been used, the motor **66** is energized, the valve **75** is opened, and the valves **74** and **76** are closed so that the wash water in the reservoir **58** is recirculated through the conduits **71** and **72** to insure complete dissolving of the beads before the washing operation begins. After the loading has been completed and if used, the beads are completely dissolved, the motor **54** and the clutch **34** are energized so that the chamber **17** begins rotating at low speed. At the same time, the valve **74** is opened and valve **75** is closed so that wash water flows through conduit **71** and into the chamber **17**. After a sufficient volume of water has been pumped into the washing chamber **17**, i.e., in excess of that necessary to saturate the clothes in the washing chamber, the clutch **34** is deenergized, the clutch **35** is energized, and the motor **54** is operated at its higher speed so that the chamber **17** begins rotating at the relatively high rotational speed whereby the clothes and wash water in the chamber **17** form an annular layer about the central longitudinal axis of the chamber.

While the chamber is rotating at the relative high speed, the wash water is continuously introduced into the chamber through the hose **93** and the holes **95** formed in the portion **85** of the bottom wall **78** of the cover **77**. As noted above, water is continuously removed from the chamber **17** during high speed rotation of the chamber through the holes **96** formed in the portion **87** of the bottom wall **78** of the cover **77**. The water in the compartment **88** is expelled almost immediately from the compartment through the aligned holes **96** and **25**, and the passage of the water through these holes suppresses any suds entrained in the water so that the expelled water impinging upon the sidewall **41** of the chamber **38** is substantially suds free.

As the water runs down the sidewall **41**, the suds shield **114** prevents any suds from contacting or "dragging" against the rotating chamber **17**. When the water returns to the reservoir **58**, the disc **116** suppresses any suds formed therein. More specifically, any excessive suds in the reservoir are forced by the impellers **124** into the compartments **123**, and the passage of the suds through the holes **125** in the wall **119** breaks down or suppresses the suds. The wash water in the reservoir is again pumped back into the chamber, and because of this continuous recirculation of the water, a very small volume of water is present in the reservoir at any time.

Periodically, abruptly during the washing operation, the clutch **35** is deenergized, the clutch **34** is energized and the motor **54** is braked and then operated at its lower speed so that the speed of the rotating chamber is abruptly reduced from the relatively high rotational speed to a rotational speed below that necessary to maintain the annular layer of clothes and wash water in the chamber. Since at least part of the clothes will have "climbed" the sidewall **19** of the chamber during high speed rotation thereof, the clothes are tumbled and rearranged in the chamber as a result of their falling away from the sidewall when the speed of the chamber is abruptly reduced. After such an abrupt reduction of speed, the clutch **35** is again energized, the clutch **34** is deenergized and the motor **54** operated at its high speed so that the chamber again rotates at high speed and the annular layer of clothes and wash water is reformed. This washing cycle, i.e., forming an annular layer of clothes and wash water, tumbling and rearranging the clothes by reducing the speed of the chamber and then reforming the annular layer, is repeated a number of times during the washing operation.

After the washing operation has been completed, the valve **74** is closed and the valve **76** is opened so that the pump **64** pumps the water in the reservoir **58** to the sump. Thereafter, clean rinse water can be introduced into the reservoir through the conduits **59** and **61** with the valve **74** opened and the valve **76** closed. The rinsing operation is substantially the same as the washing operation except that, of course, there is no soap or synthetic detergent added to the water. After the rinsing operation has been completed, the rinse water is pumped to the sump through the branch conduit **73** and the chamber **17** is rotated at the relatively high speed so as to spin dry the clothes. The openings **26** permit the water remaining in the chamber **17** and in the clothes to be expelled out of the chamber during the spin dry operation. As noted above, the size and number of the openings **26** are sufficiently small so that the flow of water through the openings **26** does not substantially affect the above-described operation of the machine **11** during the washing and rinsing cycles.

A more specific example of the times required to perform typical washing, rinsing and spin drying operations in a washing machine embodying the present invention is set forth in Table 1 hereinbelow. The washing machine used for the cleaning operations described in Table 1 includes a washing chamber having a mean tub diameter of 18 inches and a depth of 17 inches and with the sidewall of the chamber sloping at an angle of 15°. Approximately 16 pounds of clothes (dry weight) are placed in the rotating chamber, and at any given time during the high speed rotation of the chamber, there are between 28 and 68 pounds of wash water plus 32 pounds of saturated clothes in the chamber, i.e., 16 pounds of clothes and 16 pounds of water to saturate the clothes. Wash water is recirculated in the machine at the rate of about 15 gallons per minute or approximately 1.45 pounds per second due to the aeration of the wash water by the pump.

The high speed of the chamber is 100 r.p.m. while the intermediate or reduced speed is 45 r.p.m. The machine utilizes a three-fourths hp., electric motor, corresponding to motor **54**, that can accelerate the washing chamber from 45 r.p.m. to 100 r.p.m. in about 4 seconds. The washing chamber can be braked from 100 r.p.m. to 45 r.p.m. in about 2 seconds.

TABLE I

Steps	Time, seconds	Water (in pounds)			
		In	Out	In system	Recirculating
Clothes in (16 lbs. clothes):					
Partial fill (at 45 r.p.m.)	60	60		60	[1] 44
Speed-up to 100 r.p.m	4	4		64	48
Wash cycle No. 1:					
Brake	2				
Clothes drop (45 r.p.m.)	4				
Speed-up (100 r.m.p.)	4				
Total	10	10		74	58
Wash cycle No.:					
2	10	10		84	68
3	10			84	68
4	10			84	68
5	10			84	68
6	10			84	68
Drain to sewer	15		45	39	23
Drain and add rinse	5	5	15	29	13
Sub-total washing operation	144	89			

Table I—Continued

Steps	Time, seconds	Water (in pounds) In	Out	In system	Recirculating
Partial fill	15	15		44	28
Rinse cycle No.:					
1	40	40		84	68
2-4	30			84	68
Rinse and drain No. 5-6	20	20	60	44	28
Sub-total rinse operations	105	75	103	44	
Total wash and two rinse operations	354	239			
Dry spin operation	300		8		
Total	[2] 654				

[1] 16 pounds in clothes.
[2] Or 10.9 minutes.

By calculation, it has been found that a washing machine of the present invention can provide approximately 34 times the amount of relative movement between the clothes and wash water as can be provided by conventional agitator type washing machines operating at 100 cycles per minute and moving the clothes 3 inches on each stroke, in both directions, of the agitator. Moreover, the total time for the complete washing operation in the washing machine of the present invention may be as little as one-half the time required for the same cleaning operation in commercially available washing machines.

As noted above, one of the advantages of the improved washing machine of the present invention is that it can use wash water having a relatively high concentration of soap or synthetic detergent without having any problems with excessive sudsing. In addition and as compared with the washing machines disclosed in the aforementioned patents using the same wash water, the improved washing machine of this invention required relatively less power to operate. This results because the washing chamber **17**, with the enough **77**, is effectively a closed container with respect to the suds formed in the washing chamber, i.e., suds can only escape from the chamber **17** through the holes **96** and **25** which suppress the suds. Therefore, although the washing chamber could be rotated at a sufficiently high speed, i.e., above 300 r.p.m., so that no suds could be formed in the chamber, the chamber **17** does not need to be rotated at that high a rotational speed. In fact, the chamber **17** may be rotated at a "lower" high speed, i.e., a speed just high enough to form an annular layer of clothes and wash water, since even if some suds are formed in the chamber **17**, these suds will not cause any particular problem. Thus, because the washing chamber **17** is effectively closed, the machine **11** can rotate at a "lower" high speed and this, of course, conserves power, particularly in view of the frequent changes in the rotational speed of the chamber **17** during the washing and rinsing operations.

Thus, in view of the foregoing, it will be apparent that the improved washing machine of the present invention enables clothes and the like to be thoroughly cleaned in a relatively short period of time as compared with present commercially available machines. Moreover, the improved washing machine of the present invention permits the use of wash water having a relatively high concentration of soap or synthetic detergent which, of course, promotes cleaning while suppressing the detrimental sudsing of the wash water.

Also, it should be noted that various modifications may be made in the improved washing machine of the present invention described hereinabove. For example, the specific design and arrangement of the cover may be modified; and in fact, it is contemplated that as the size of the washing chamber varies, the size and arrangement of the holes in the cover **77**, and particularly the holes **96** in the portion **87** of the bottom wall **78**, will be varied in size and spacing. Of course, it would also be obvious that other means could be used to secure the cover **77** within the opening **24** and that the angle of inclination of the sidewalls of the washing and reservoir chambers may be varied although it is believed that the angle of 15° is an optimum angle. Likewise, the frame utilized to support the reservoir chamber **38** may be modified as well as the positioning and the arrangement of the bearings journaling the power shaft **27**. For this reason, the preferred embodiment of the present invention described hereinabove is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than by the foregoing description. And all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. The method of suppressing the suds of soap or synthetic detergent in water used to wash clothes and the like comprising the steps of removing the wash water from the washing chamber to a separate rotatable compartment and forcing the wash water to flow in said rotatable compartment under centrifugal pressure out of said compartment through a plurality of small diameter holes.

2. The method of suppressing suds described in claim **1** including the steps of rotating the washing chamber and compartment about a central axis so that centrifugal force forces the wash water into said compartment and out through the holes.

3. The method of suppressing suds described in claim **2** wherein the wash water is removed from the washing chamber as a result of rotation thereof.

4. The method of suppressing suds described in claim **3** and the steps of conducting the wash water by gravity downwardly past the exterior of said washing chamber and returning said water to said washing chamber.

5. The method of claim **4** and the step of shielding said wash water from said washing chamber as said wash water is conducted downwardly past the exterior of said washing chamber.

6. The method of claim **2** wherein said separate compartment is located above said washing chamber, and the step of conducting the wash water by gravity downwardly past the exterior of said washing chamber and forcing at least a portion of said wash water to flow through a plurality of small diameter holes in a second compartment disposed below said washing chamber.

7. The method of claim **6** and the step of rotating said second compartment to force said wash water to flow through said plurality of small diameter holes.

8. The method of claim **7** wherein said washing chamber, upper compartment, and lower compartment are rotated coaxially at the same rate of rotation.

9. The method of claim **8** and the step of shielding said wash water from said washing chamber as said wash water is conducted downwardly past the exterior of said washing chamber.

10. The method of claim **8** and the step of returning said wash water to said washing chamber.