June 5, 1951 J. G. DE REMER 2,555,400

WASHING MACHINE WITH GYRATORY WASHING ACTION

Original Filed July 14, 1943 4 Sheets-Sheet 1

Fig. 8.

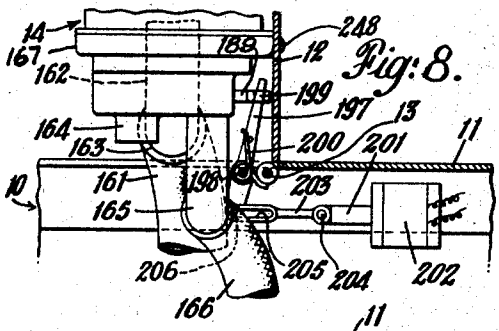


Fig. 1.

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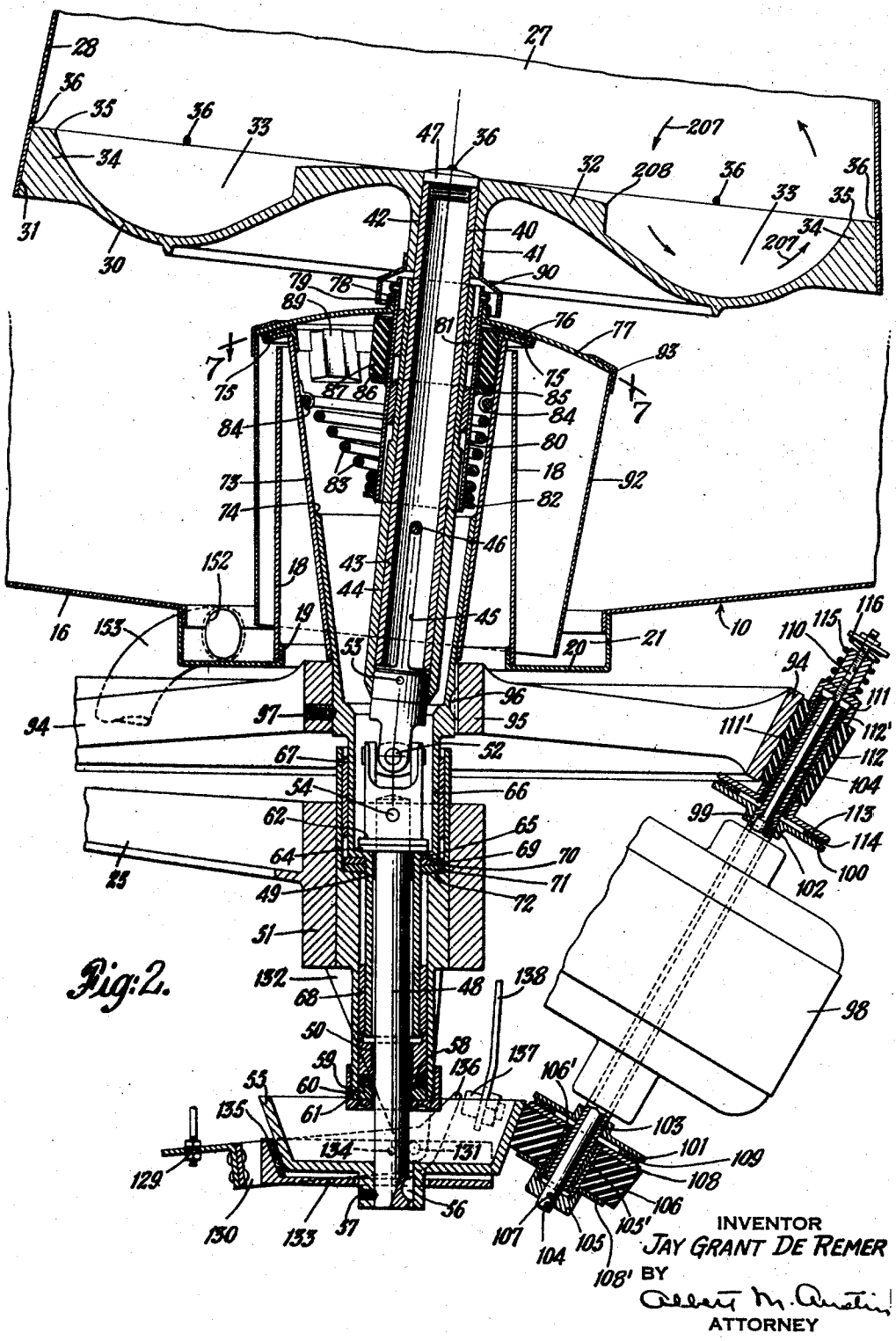


Fig. 2.

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WASHING MACHINE WITH GYRATORY WASHING ACTION

Original Filed July 14, 1943 4 Sheets-Sheet 3

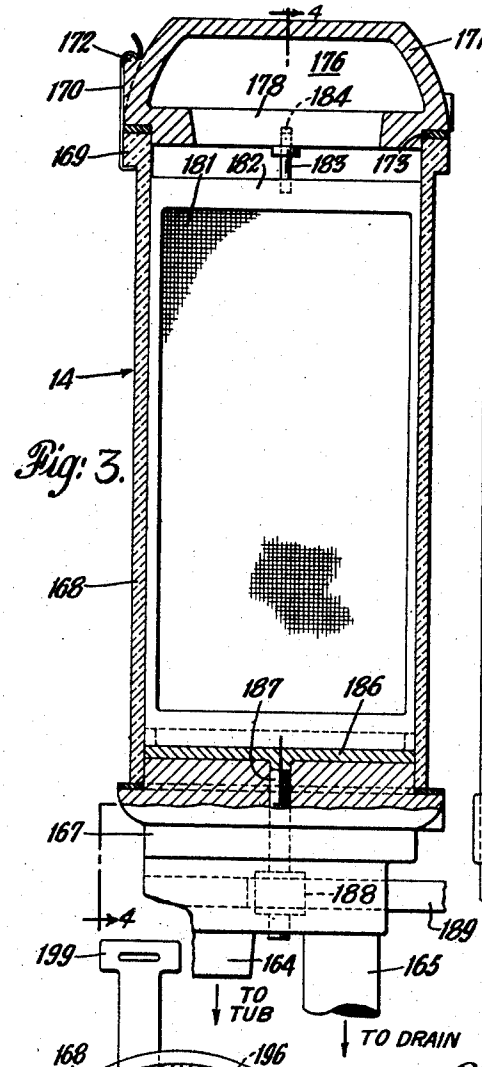


Fig: 3.

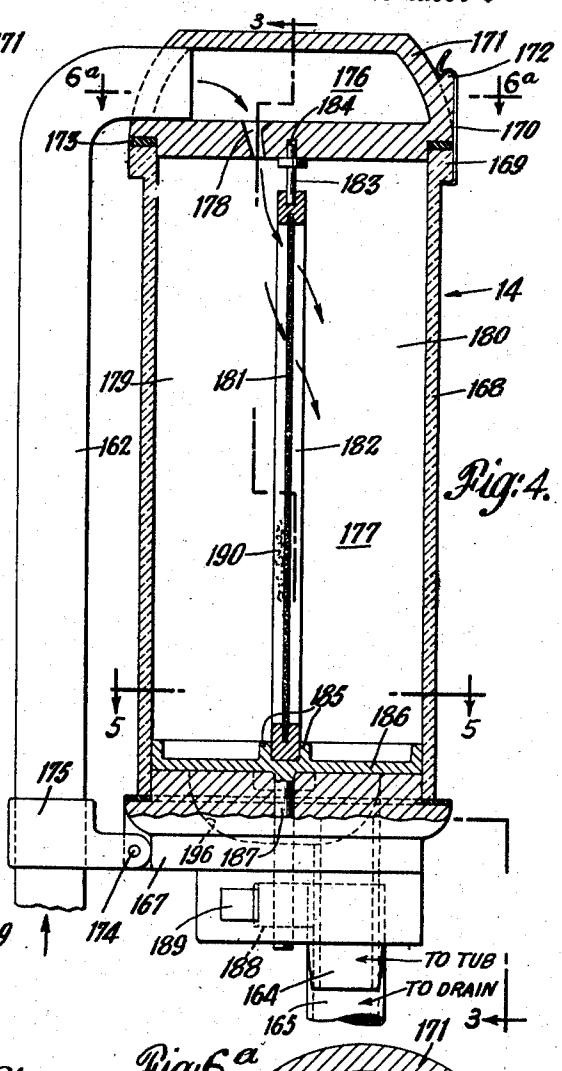


Fig: 4.

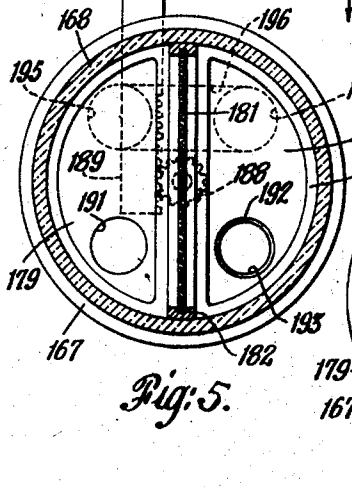


Fig: 5.

Fig: 6.

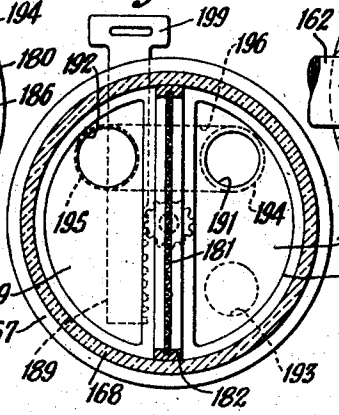
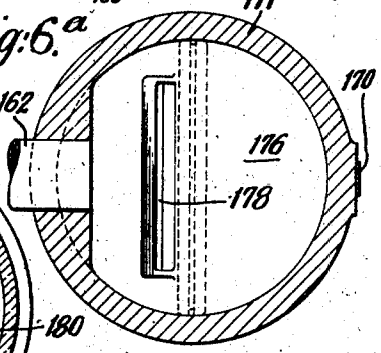


Fig: 6a.



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WASHING MACHINE WITH GYRATORY WASHING ACTION

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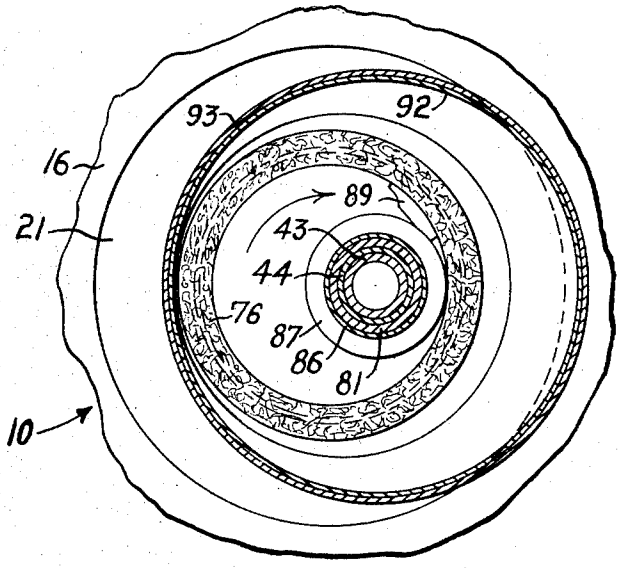


Fig. 7.

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Patented June 5, 1951

2,555,400

UNITED STATES PATENT OFFICE

2,555,400

WASHING MACHINE WITH GYRATORY WASHING ACTION

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Original application July 14, 1943, Serial No. 494,598. Divided and this application September 12, 1944, Serial No. 553,761

4 Claims. (Cl. 68—23)

1

This invention relates to washing machines, and more particularly to washing machines in which the laundry is washed and centrifugally dried in a single basket. This application constitutes a division of my application Serial No. 494,598 filed July 14, 1943 now Patent No. 2,533,722 December 12, 1950.

The present application relates to an improved washing action, circulation and automatic control features. In its preferred form the washing action comprises an imperforate type basket which is gyrated about a universal support located under the basket to cause the basket axis to describe a conical surface. The basket comprises a bottom wall having an annular trough, and an upwardly converging conical side wall. The bottom trough has inner and outer ledges and the side wall has helical blades which assist the gyrating motion to give the clothes a particularly effective cleaning operation. Provision is made to subject the clothes to continuous circulation of filtered water during washing. To this end a circulating pump and filter mechanism are provided, the filter being reversible for self-cleaning when water is discharged from the machine. Provision is also made for bypassing the water should the filter clog up accidentally. Suitable electric control mechanism is also provided for changing the basket movement for washing and centrifugal extraction; for reversing the filter mechanism; and for admitting hot and cold water, circulating the water and discharging it from the machine.

These and other features and improvements will appear from a consideration of the detailed description which follows, accompanied by drawings showing for purely illustrative purposes preferred embodiments of this invention.

The invention also consists in certain new and original features of construction and combination of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, its objects and advantages and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part hereof, in which

Fig. 1 is an elevation partly in section of a washing machine embodying features of this invention, the position of the parts being that occupied at the beginning of the drying operation;

Fig. 2 is an enlarged sectional elevation showing in greater detail elements of the drive of the machine shown in Fig. 1;

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Fig. 3 is a front view of a filter of the machine shown in Fig. 1, a section being taken on line 3—3 of Fig. 4;

Fig. 4 is a side view of the filter shown in Fig. 3, a section being taken on line 4—4;

Fig. 5 is a plan view, partly in section, of the filter shown in Figs. 3 and 4, the plan view showing the port and valve arrangement, a section being taken on line 5—5 of Fig. 4;

Fig. 6 is a plan view corresponding to Fig. 5 with the port and valve arrangement in a different position after reversal of the filtering element;

Fig. 6*a* is a section on the line 6*a*—6*a* of Fig. 4;

Fig. 7 is a section taken on the line 7—7 of Fig. 2, but showing the projection on the gyrator shaft engaged against the roller on the spin shaft for gyrating the basket for the washing operation;

Fig. 8 represents an enlarged detail of the operating mechanism for the reversible filter, the solenoid being unenergized.

In the following description and in the claims various details will be identified by specific names for convenience. The names, however, are intended to be as generic in their application as the art will permit.

Like reference characters denote like parts in the several figures of the drawings.

In the drawings accompanying and forming part of this specification, certain specific disclosure of the invention is made for the purpose of explanation, but it will be understood that the details may be modified in various respects without departure from the broad aspect of the invention.

Referring now to the drawings and more particularly to Figs. 1 and 2, the laundry machine according to the invention comprises, in general, a tank 10 containing a clothes basket 27. The basket is centrifugally driven by a spin shaft made up of vertical drive shaft 48 and rotor shaft 49 connected by a universal joint. The basket is gyrated by a gyrator shaft indicated in general by 66. Electric motor 98 drives the gyrator shaft 66 through gyrator gears 94, 112 and the spin shaft through spin shaft gears 55, 106. It will be noted that the spin shaft and gyrator shaft are driven in the same direction. This direction is clockwise in plan as will be more apparent as the description proceeds. Pump 151 circulates water from the bottom of tank 10 into filter 14 and thence the water may be delivered

either into the basket 27 or into a drain pipe 166. The details of the above apparatus will be described more in detail hereinafter.

Referring now further to Figs. 1 and 2, the washing machine has an outer tank or casing 10 closed by a cover 11. The cover 11 has a central lid 12 hinged at 13. The lid 12 serves as a support for a filter 14 and may be closed during non-use of the machine causing the filter to move into a horizontal position inside the casing 10.

The casing 10 has an outer wall 15 connected to a tapered bottom 16 at 17. The bottom, in turn, is connected to a substantially cylindrical inner wall 18 at 19 and has an annular trough or depression 20 about the inner wall 18 forming a sump 21.

The casing is supported by a base 22 consisting of an annular member 23 of L-shaped cross section and a plurality of legs 24, preferably three or four. A spider 25 is connected to the base by screws 26 and supports various shafts and bearings for a basket or receptacle 27 in which laundry and other articles are washed and centrifugally dried.

The basket or receptacle 27 has a tapered side wall 28 provided with an inturned flange 29 at its upper and narrow end. The wide end of the side wall 28 is connected to a relatively heavy bottom wall 30 at 31. The bottom wall 30 has a raised central portion 32 surrounded by an annular trough 33 which is bordered at the outside by a raised peripheral portion 34 forming a ledge at 35. Adjacent the ledge and at the widest part of the receptacle 27 a plurality of bleeder holes 36 are provided in the side wall 28. The bleeder holes are preferably 6 in number and have a diameter of about .18 inch for a household washing machine of the specifications given below.

Helical blades 37 are mounted on the inside of the wall 28 in order to impart, in connection with the ledge 35 and trough 33, a certain desirable vortex motion to the contents of the receptacle, as will be later described. The blades extend upwardly in the direction of spin movement of the basket. The blades are preferably of triangular cross section as shown at 38. A balance ring 39 (Fig. 1) is secured to the receptacle and helps to distribute the total mass of the receptacle such that the center of the mass of the empty receptacle lies in substantially the same horizontal plane as the center of the mass of the normal full charge of wet laundry treated therein. This mass distribution together with the relatively heavy weight of the empty receptacle 27 minimizes the effects of unbalance of laundry placed in the receptacle and of varying weights of laundry.

The receptacle 27 is supported by a rotor shaft 40 secured to the hub 41 of the receptacle at 42. The rotor shaft 40 is made in two telescoping parts 43 and 44 for convenient assembly. The inner part 43 of the rotor shaft 40 is forked at 45 to receive a pin 46 in the outer part 44. The pin 46 prevents turning between the two parts 43 and 44 of the rotor shaft 40 which at its upper end is closed by a plug 47.

The rotor shaft 40 is mounted for rotation with, and freedom to tilt relatively to, a substantially vertical drive shaft 48 mounted in oilless bearing 49 in gyrator shaft 66 and in oilless bearing 50 in the hub 51 of the spider 25. The rotor shaft 40 and drive shaft 48 are connected by a universal joint 52 secured to the shafts by pins 53 and 54 respectively. The flexible shaft for rotating the basket on its own axis including the rotor shaft 40, and drive shaft 48 with universal joint therebetween is sometimes referred to, for convenience, as the spin shaft.

At its lower end the drive shaft 48 carries a beveled friction gear 55 secured thereto by a key 56 and set screw 57. The hub 51 of the spider 25 is sealed at its lower end by a packing ring 58 compressed by a washer 59 and ring-nut 60 threaded on the hub 51 at 61.

The universal joint 52 has a flange 62 resting on an oilless thrust ring 64 supported by a shoulder 65 of a gyrator shaft 66. The gyrator shaft 66 carries oilless bearing 49 for the drive shaft 48. The gyrator shaft 66 is journaled in radial bearings 67 and 68 in the hub 51 of the spider 25. The gyrator shaft 66 has also a shoulder 69 resting against oilless thrust rings 70 and 71 on a corresponding shoulder 72 in the hub 51. Thus the weight of the basket and clothes is taken by the hub 51 and has no effect on the pressure between the friction plate 77 and friction head 75 described more in detail hereinafter.

The gyrator shaft 66 has an upper flared portion 73 which is connected to the main portion of the gyrator shaft 74 and carries a spherically curved friction ring 75 at its widest portion. The surface of friction ring 75 has its center of curvature at the center of the universal joint 52. A ring 76 of friction material such as clutch or brake-lining is secured to the friction ring 75 and is acted upon at the other side by a corresponding spherically curved friction plate 77. The friction plate 77 is secured to a sleeve 80 having self-lubricating or oilless bearings 81 rotatable and axially slidable on the outer part 44 of the rotor shaft 40. A collar 78 overhanging flange 79 secures friction plate 77 and sleeve 80 together.

The sleeve 80 has a lower flange 82 welded to it against which a tapered helical compression spring 83 rests whose other end is secured to the upper flared portion 73 of the gyrator shaft 66 by clamps 84.

The spring 83 through the sleeve 80 exerts a combined vertical and horizontal thrust on the frictional erection assembly 75, 76, 77. The thrust against the friction surfaces may be of the order of 25 to 30 pounds for an average family size washing machine of the specification given below. The centering force measured at the level of the friction plate 77 may be of the order of 20 to 25 pounds when the basket is in its extreme tilted position with the machine at rest. In general, the spring 83 may exert a centering force sufficient to maintain the basket 27, filled with laundry and water, upright with the machine at rest, but insufficient to prevent the basket from tipping over when the gyrator shaft is rotated for washing. The action of the centering spring will be discussed more at length hereinafter.

The sleeve 80 carries a further flange 85 forming an abutment against which the hub 86 of a resilient roller 87 rests, the roller being held in place by the plate 77. The roller 87 serves to cushion the shock when the rotor shaft 40 of the loaded receptacle 27 tilts against the flared portion of the gyrator shaft 66.

A projection or lug 89 is provided on the flared portion 73 of the gyrator shaft 66 in the path of the roller 87. When the gyrator shaft 66 is rotated while the rotor shaft 40 supporting the loaded receptacle 27 is in a tilted position, the projection 89 rests against the side of the roller 87 carrying the rotor shaft 40 along, as indicated by the arrow in Fig. 7, and producing a gyrating or

wobbling motion of the receptacle and its contents.

In order to prevent washing liquid from entering the space inside the flared portion 73 of the gyrator shaft 66, a cup-shaped splash ring 90 is secured to the hub 41 of the receptacle. Under certain conditions, depending upon the type of water or soap, considerable foam or froth may be formed by the agitation. To prevent this foam or froth from getting inside wall 18, a bell-shaped skirt or body 92 is connected to the friction member 77 at 93 extending into the sump 21 below the level of the liquid normally filling the sump during the soaking, washing and rinsing periods of the machine.

The gyrator shaft 66 carries a beveled friction gear 94, the hub 95 of which is secured to the shaft by a key 96 and held in place by a set screw 97.

Motive power is supplied to the beveled friction gears 55 and 94 on the drive shaft 48 and the gyrator shaft 66, respectively, by a motor 98 having a hollow armature shaft 99 carrying fixed clutch disks 100 and 101 secured thereto by keys 102 and 103. An inner shaft 104 extends through the hollow armature shaft 99 and has secured thereto, at its lower end, the thimble 105 of a small friction gear 106 held in place by a pin 107. The gear 106 is provided with a complementary clutch disk 108 bearing against a friction ring 109 secured to one of the clutch disks 108 or 101. The thimble 105 is rigidly secured to a sleeve 105', to a disk 108', and to clutch disk 108, these parts forming a unitary hub structure to support the relatively soft friction gear 106 to insure it turning with thimble 105. This structure is journaled on hollow shaft 99 by an oilless bearing 106'.

The other end of the inner shaft 104 is squared as at 110 and carries the thimble 111 of a second friction gear 112, having a square hole permitting the thimble 111 to move axially of, but not to turn relatively to, the shaft 104. The second friction gear is also provided with a clutch disk 113 bearing against a friction ring 114 secured to one of the clutch disks 100 or 113. A compression spring 115 bearing against a collar 116 on the inner shaft 104 and against the thimble 111 of the friction gear 112 forces the clutch elements of both gears 106 and 112 together. Since both gears 106 and 112 are fixed on the shaft 104 against rotation, they rotate equi-angularly regardless of the slip of the spin shaft clutch 101, 109, 108 and of the gyrator shaft clutch 100, 114, 113. The thimble 111 is rigidly secured to a sleeve 111' which in turn is rigidly secured to clutch disk 113 to form a unitary hub structure to support and hold the relatively soft friction gear 112 to insure the gear 112 turning with thimble 111. This structure is journaled on hollow shaft 99 by oilless bearings 112'.

Thus, arrangement is made for a cooperative action between the spin shaft clutch 101, 108 and the gyrator shaft clutch 100, 113. The clutch plates 100 and 101, being rigidly secured to the hollow shaft 99, must rotate together. Similarly, the clutch plates 108 and 113 being rotatively secured to the inner shaft 104 must rotate together. This means that one clutch cannot slip without the other also slipping. This insures a constant predetermined relationship between the speeds of the gyrator gears 94, 112 and of the spin gears 55, 106 during acceleration of the spin shaft 48, the friction gears 94, 112 and 55, 106 being so constructed and arranged that no substantial slippage takes place between the gears themselves, but all of the slippage takes place in the clutches. The amount of slippage in the clutches is controlled by the tension of spring 115.

Thus the spin shaft and gyrator shaft clutches might be termed constant ratio clutches. These clutches have the advantage of reducing the load on the motor while the spin shaft 48 is being accelerated and also assist in increasing the lifting torque on the basket at the beginning of the spin-drying period when the basket is being accelerated from zero to spin drying speed, as will be hereinafter explained more in detail. The hollow motor shaft on which the motor gears are journaled provides the necessary strength to press the sets of friction gears together to obtain friction driving without slipping of the gears.

The motor 98 is mounted on a tiltable support 117 hinged at 118 to a channel-like link 119, as shown in Fig. 1. The link 119 is pivoted at 120 to the hub 51 of the spider 25. A bracket 121 is secured to the link 119 between the pivots 118 and 120. A pair of drawbars 122 are fastened to the bracket 121 at 123, the open ends of which are hooked to coil springs 124 connected to brackets 125 riveted to the spider 25. The force of the springs 124 urges the motor 98 towards the hub 51 of the spider 25 and tends to maintain the pairs of friction gears 55, 106 and 94, 112 in engagement.

The spin gears 55 and 106 may be temporarily disengaged and the gear 55 arrested by a solenoid 127 having an armature 128 adjustably connected at 129 to the center of a substantially U-shaped double armed lever 130. The lever is pivotally mounted at 131 to a pair of brackets 132 secured to the hub 51 by screws 133'. In Fig. 1 only one of the brackets 132 is visible. The lever 130 supports a cradle 133 in trunnions 134. The cradle is fitted with a brake lining 135 bearing against the periphery of the gear 55 when the solenoid 127 is energized and the cradle 133 is lifted. The free end 136 of the lever 130 bears against a pair of adjustable studs 137 on a pair of arms 138 secured to the tiltable support 117 at 139. If the armature 128 is drawn into the solenoid 127, the free end 136 of the lever 130 moves clockwise about the pivot 131, disengaging spin gears 55 and 106 without, however, disturbing the engagement of gyrator gears 94 and 112. The solenoid 127 is mounted on a bracket 140 secured to the spider 25.

Cold and hot water is supplied to the washing machine from a suitable source (not shown) through conduits 142 and 143 respectively. The cold water conduit 142 is equipped with a valve 144 operated by a solenoid 145 of conventional construction. The hot water conduit 143 is controlled by a valve 146 operated by a solenoid 147. The conduits 142 and 143 lead into a mixing manifold 148 equipped with a thermostatically operated switch 149 for controlling the proper water temperature. The manifold 148 leads to the intake 150 of a centrifugal pump 151 which is also connected to an outlet 152 of the sump 21 through a duct 153.

The pump 151 is mounted in trunnions 154 in brackets 155 secured to the spider 25 and has a friction gear 156 on the pump rotor shaft 157. A spring 158 connected to a pin 159 in the pump housing 151 and to the hub 51 of the spider 25 tends to tilt the pump about its pivot axis so as

to maintain the friction gear 156 on the pump shaft in engagement with the gear 94 of the gyrator shaft. The pump 151 has an outlet 160 to which a hose 161 is connected leading to an intake duct 162 of the filter 14 having a hose coupling 163. The filter has an outlet spout 164 for discharging filtered washing liquid into the receptacle and an outlet duct 165 for discharging liquid and impurities into a hose 166 leading to a point of liquid disposal such as a drain (not shown).

Referring to Figs. 3 to 6, the filter has a base 167 suitably secured to lid 12 (Fig. 1) as by screws 248. Base 167 supports a cylindrical transparent wall 168 of a suitable material such as heat resistant glass. The wall 168 has a top ring 169 mounting a plurality of spring fasteners 170 for holding in place a removable top member 171 having lugs 172 for the fasteners 170. The top ring 169 is also secured to lid 12 by screws 248. The top member 171 has a gasket 173 against which the rim 169 of wall 168 bears for tightly sealing the filter. The inlet duct 162 has a sliding fit with bracket 175 which is connected to base 167 by pivot 174. After loosening the fasteners 170 the filter may be opened by raising the top member 171 and swinging it about pivot 174, the sliding fit between inlet duct 162 and bracket 175 permitting this operation.

The top member 171 forms an inlet chamber 176 to which inlet duct 162 is connected. The bottom wall of chamber 176 has an elongated nozzle 178 adapted to discharge a jet of liquid into the interior 177 of the filter. A suitable size for the nozzle of a household washing machine is approximately ⅛ by 2 inches measured at the narrowest portion.

The interior 177 is subdivided into two chambers 179 and 180 by a filtering member or screen 181 mounted in a frame 182. The frame 182 fits snugly with its sides against the inside of the transparent wall 169 and is held in the top member 171 by a pivot pin 183 inserted in a bore 184 in the top member. The top of the frame 182 is spaced from top member 171 to provide an overflow space from one side of the filter to the other. The bottom of the frame 182 is held between projections 185 of a rotary base member 186 having a shaft 187 and a pinion 188 thereon. The overflow space at the top of frame 182 handles the water flow in the event an unusually dirty wash clogs up the screen.

The pinion 188 meshes with a rack 189 in the base 167 permitting rotation of the filtering screen through an arc of 180°. The arrangement of the rotating mechanism 188, 189 is such that in one end position the filtering screen 181 is parallel to the elongated nozzle which is so inclined as to discharge a jet of fluid against the one side of the filter at a relatively sharp angle of approximately 7 degrees. In the other extreme position the filtering screen 181 is reversed so as to receive the jet of fluid on the other side to remove the impurities 190 which may have collected on the one side.

The rotary base member 186 has two control ports 191 and 192 therein cooperating with three discharge ports 193, 194 and 195 in the base 167 forming a valve arrangement. Discharge port 193 leads to the outlet spout 164 and discharge ports 194 and 195 which are interconnected by a duct 196 lead to the outlet duct 165.

In the position shown in Fig. 5 washing liquid is discharged into the input chamber 179 causing impurities to collect in the chamber 179 and on the side of the screen 181 facing the chamber 179 as shown at 190. The liquid is filtered through the screen 181 and leaves the outlet chamber 180 through the discharge port 193 registering with the control port 192 in the rotary base member 186. In this position the control port 191 does not register with a discharge port and the discharge ports 194 and 195 are closed.

After reversal of the filtering screen 181 by rotation of the base member 186 through an arc of 180° the discharge port 193 is closed and the ports 194 and 195 are opened by control ports 191 and 192 registering therewith. The impurities are now at 190, the side of the screen 181 facing the outlet chamber 180 and further impurities may have collected at the bottom of the inlet chamber 179. The jet of liquid discharged from the nozzle 178 now serves to remove the impurities 190 from the screen 181, and both chambers 179 and 180 are flushed through discharge ports 195 and 194, respectively, leading to the outlet duct 165 and thence to a point of liquid disposal.

Referring now also to Fig. 8, the rack member 189 for reversing the screen 181 and actuating the valve arrangement 191 to 195 is operated by a double armed lever 197 which is pivoted at 198 on the lid 12 and engages the rack member 189 at 199. A spring 200 urges the lever 197 in a clockwise direction against the action of the armature 201 of a solenoid 202. The armature 201 is connected to link 203 by pivot 204, the link 203 having an elongated slot 205 engaging a pin 206 on the lever 197. In Fig. 1 the solenoid 202 is energized while in Fig. 8 it is de-energized. Slot 205 permits the pin 206 to move therein, which together with the movement of plunger 201 into its retracted position in solenoid 202, permits closing of the lid 12. The horizontal swivel connection 163 between flexible supply tube 161 and inlet duct 162 and the corresponding connection between outlet duct 165 and drain hose 166 facilitate opening and closing the lid 12. The lid may be held in open position in any suitable manner.

It will be understood that this invention may be applied to any size machine either for household purposes or for commercial laundry purposes and that the various dimensions and the proper speeds of the spin and gyrator shafts will be determined by those skilled in the art depending upon the particular size and design desired.

However, for purposes of disclosure, a specific example of house laundry machine is given. This example applies to the type in which the gyrator shaft rotates during the drying period. The spinner basket may be approximately 20 to 22 inches in diameter at the bottom and its height may be approximately 10 to 12 inches. The weight of the empty basket including balance ring may be 30 to 40 pounds. The weight of the clothes and water remaining in the clothes, when maximum spinning speed is reached, may be approximately 20 pounds. The distance between the center of the universal joint and the center of mass of the basket may run about 15 or 16 inches. The spinning speed of the spin shaft may run about 900 to 1100 R. P. M. and the gyrating speed of the gyrator shaft may run about 110 to 115 R. P. M. The maximum amplitude of gyration (diameter of the path of basket axis) measured at the top of the basket may be 4 to

5 inches. The machine may hold 6 to 8 gallons of water with about 8 pounds of dry clothes and the machine may circulate water at the rate of 12 to 15 gallons of water per minute.

The operation of the washing machine so far described is as follows:

After opening the lid 12 and placing the filter in an upright position laundry is placed in the receptacle 27. Cold and hot waters are admitted from the supply lines 142 and 143 through the solenoid controlled valves 144 and 146. The water flows through the manifold 148 to the intake 150 of the pump 151 and also into the sump 21 of the tank or casing 10. Soap flakes or powder may be placed in the tank 10 where it mixes with the water, or into a receptacle through which water flows, such as the chamber 179 of the filter 14. The motor 98 is then started which in the starting phase of the operations is tilted about the pivot 118 such that only gyrator gears 112 and 94 are in engagement while spin gears 106 and 55 are disengaged. The motor 98 is held in this adjustment by the lever 130 bearing with its free end 136 against the arms 138 of the tiltable motor support 117. At the same time the cradle 133 carrying the brake lining 135 rests firmly against the periphery of the spin gear 55 arresting the same.

The motor 98 driving the gear 94 also drives the pump 151 the friction gear 156 of which rests against the periphery of the gear 94. The pump 151 feeds the washing liquid from the sump 21 of the casing 10 through the hose 161 to the filter 14. The washing liquid enters the filter 14 through intake duct 162, is discharged through the nozzle 178 into input chamber 179, passes through the filtering screen 181 into outlet chamber 180 and is directed into the receptacle 27 through the outlet spout 164.

At the same time washing motion is imparted to the receptacle 27 through the gyrator shaft 66. Due to rotation of the gyrator shaft and under the weight of the laundry placed into the receptacle 27 and of the washing liquid flowing into it through the outlet spout 164 of the filter 14, the rotor shaft 40 of the receptacle 27 tilts about the center of the unversal joint 52 against the centering action of the spring 83. In this tilted position the roller 87 rests against the flared portion 73 of the gyrator shaft 66 and the roller 87 comes to rest against the projection 89 (Fig. 7) on the inside of the gyrator shaft 66, 73 causing the rotor shaft 40 with the receptacle 27 to make a wobbling or gyrating motion about the universal joint 52, in the direction of the arrow in Fig. 7.

The washing liquid fed by the pump 151 fills the basket 27 faster than the liquid drains off through the bleeder holes 36 causing excess washing liquid constantly to spill over the inturned flange 29. The speed of gyration during washing may be sufficiently high to prevent the basket from retaining much water because the centrifugal force, due to gyration of the basket, causes the water to bank up along the side wall of the basket and move around the basket in the direction of basket movement. This excess liquid carries with it floating impurities such as lint, curd and other matter which otherwise would adhere to the laundry. The excess liquid overflows into the casing 10 where it collects in the sump and is recirculated through the filter 14 which removes the impurities.

The laundry inside the receptacle 27 is thoroughly agitated and partakes of two distinct major motions imparted to the contents due to the novel shape of the inside surface of the receptacle. Firstly the ring of clothes moves continuously about the rotor axis, or axis of the ring of the clothes, in a direction opposite to the movement of water and the direction of gyration. In addition, the baffles or helical blades 37 together with the trough 33 and the ledge 35, set up a vortex motion on the clothes as indicated by arrows 207 in Fig. 2. During these two major movements the laundry is further agitated by moving past the ledge 35 and the edge 208 of the raised central portion 32.

The conical shape of the basket, the inclined baffles 37 and the raised central disk 32 assist in giving the clothes the vortex movement. The central disk tends to shove the clothes to the outer edge of the smooth bottom 33 of the basket. The helical baffles 37 serve to knock the clothes up the side of the basket and the outer ledge 35 at the bottom of the basket serves to boost the clothes every time it hits them. The inertia of the clothes tends to hold the mass more nearly in a central position while the gyrating basket moves under it, batting the clothes to obtain the vortex action.

At the end of the washing cycle the machine is shifted from the washing to the drying position. For this purpose the solenoid 127 controlling the brake arrangement 130, 135 for the drive shaft 48 and the tilt of the motor 98 is deenergized, causing the brake to release the drive shaft 48 for free rotation and further causing engagement between the gear 55 on the drive shaft and the corresponding gear 106 on the motor shaft. The drive shaft 48 driven by the motor 98 through the torque limiting clutch 101, 109, 108 is gradually accelerated and causes the rotor shaft 40 and the receptacle 27 to spin. The high spinning speed of the receptacle 27 causes the washing liquid to be discharged therefrom through bleeder holes 36 by centrifugal force leaving the contents in a semi-dry state.

Simultaneously with the shifting of the machine to the centrifugal drying position, the filter solenoid 202 is energized, reversing the filtering screen 181, closing the outlet spout 164 and causing the washing liquid fed by the pump 151 to clean the screen 181 and flush the two filter chambers 179 and 180. The two chambers 179 and 180 are connected to the outlet duct 165 through the open valves 191, 194 and 192, 195 and the liquid contained in the casing 10 thus drained through drain pipes 165, 166.

After the spin-drying the laundry may be rinsed in one or several changes of hot or cold rinse water. For this purpose the machine is shifted to the washing position in which the drive shaft 48 is arrested, the spin gears 106 and 55 disengaged, and the valves of the filter 14 adjusted so as to cause the rinse water supplied by conduits 142 and 143 to flow into the receptacle 27 through the spout 164. During the rinsing the receptacle 27 is gyrated to make the hereinbefore described wobbling motion. Throughout the rinsing period the water is circulated and filtered to remove impurities which otherwise would adhere to the laundry.

After the rinsing the water is again drained, the filter 14 cleaned and the laundry centrifugally dried, as hereinbefore explained in connection with the final phase of the washing action. The time of the final drying may be somewhat extended to remove moisture to a higher degree than between washing and rinsing or between rinses.

When the basket and its contents are spinning for centrifugal extraction, they act as the rotor of a gyroscope. Normally, the contents of the basket are not evenly distributed, giving the basket a certain unbalance. Hence, the center of mass of the spinning mass, including the basket, its contents and everything spinning therewith, will not always coincide with the geometrical axis of the basket. Therefore, the spinning mass rotates about its actual center of mass and not necessarily about its geometrical axis. The rotating gyroscope, which is the spinning mass, under certain conditions will tend to precess, that is, its axis will move in a spiral path departing more and more away from vertical. Upon departure of the basket axis from vertical, the rotating gyrator shaft, through the spherical friction members, exerts an accelerating force on the basket tangential to the path precession of the basket, causing the basket to move toward vertical.

Thus, the basket and its contents is free to spin about its actual center of mass and the stabilizing devices maintains the basket in upright position. The action of the centering spring, in balancing the dead weight of the basket and its contents, assists in the stabilizing action.

The centering spring operates to increase the lifting torque or restoring torque under all conditions of operation, that is to say, both while the spin shaft is accelerating for a centrifugal drying operation and after the spin shaft has acquired centrifugal drying speed; and the machine is also enabled to handle increased out-of-balance forces due to an undistributed load or other causes. The centering spring increases the lifting force caused by the rotating gyrator shaft at all usable gyrator shaft speeds, or in other words, causes the gyrator shaft to exert any given value of lifting torque at lower gyrator shaft speeds.

The amount of centering torque exerted by the centering spring depends upon the design of the machine and the results it is desired to accomplish. With the use of a rotating gyrator shaft for both drying and washing, the centering spring should not exert too great a centering force or else the basket will not take an off-center position for the gyrating washing action. Furthermore, if the centering spring exerts too much centering action, considerable vibration may be transmitted to the outer tank from the basket during centrifugal drying. Thus, with a machine of the type of Figs. 1 and 2, the centering spring may exert a sufficiently strong centering torque to hold the basket and its contents stably in central position with spin and gyrator shafts stationary, provided the centering torque exerted by the centering spring is sufficiently weak to enable the centrifugal force caused by the rotation of the gyrator shaft for washing to throw the basket outwardly so that the roller engages the gyrator shaft.

The centering spring improves operation when the basket mounting is unstable and also when it is stable. It will be understood that, where the centering force exerted by the spring is sufficient to prevent the basket and its contents from tipping over from central upright position or is sufficient to return the basket and contents to central position from its maximum off-center position, these results being obtained with spin shaft and gyrator shaft stationary, and with the spherical friction members exerting no friction, the basket mounting is referred to as a stable mounting. Where the centering force exerted by the centering spring is insufficient to accomplish this result, the mounting will be referred to as unstable. It will be understood that the spring may exert a centering force of such value as to obtain a stable mounting when the basket is empty and unstable when the basket is filled with clothes and water; or, stable when the basket is filled with clothes holding residual water remaining after draining and unstable when the basket is filled with clothes and undrained water. In all of these cases, the spring improves gyroscopic stabilization. In the preferred case, the centering spring should exert a centering force sufficiently strong to make the mounting stable with the basket filled with clothes and excess undrained water, the spring exerting centering torque approximately fifty percent more than the tipping torque caused by the weight of the basket and contents acting through the distance from central position to full off-center position.

The constant ratio motor clutches **101**, **108** and **100**, **113** improve the operation of the machine at the beginning of a centrifugal drying period. These slip clutches not only reduce the load torque on the motor caused by accelerating the basket and its contents from zero spin, but also act to increase the lifting or restoring torque on the basket during this period. At the end of a rinsing or washing operation, wherein the spin shaft is held stationary and the gyrator shaft rotates, when the machine is shifted to the drying position, the gyrator shaft continues to rotate and the stationary spin shaft begins to accelerate. This substantially increases the load torque on the motor and for this reason the gyrator shaft would ordinarily slow down somewhat. However, I have found that greatly improved operation can be obtained by deliberately slowing down the gyrator shaft to a predetermined extent during the acceleration of the spin shaft. By the use of the constant ratio clutches the spin drive gear and gyrator drive gear are coupled together and must rotate as a unit. This imposes a predetermined speed ratio between the spin and gyrator shafts which exists, regardless of the speed of the motor or the slippage of the motor clutches. This slows down the gyrator shaft to a more efficient stabilizing speed while the spin shaft is accelerating.

In practice this speed ratio may be taken to be about 10 to 1 on the basis of about 1100 R. P. M. spin speed and a 110 R. P. M. gyrator shaft speed during the centrifugal drying period with a full load and after the basket has acquired drying speed.

This improved operation results from the relationship between the various gyroscopic forces set up. If the gyrator shaft speed be too high as compared with the spin shaft speed, the lifting or restoring force, available to move the spinning mass toward central position, is considerably reduced so that, in some cases at the beginning of the drying operation, where there is considerable out-of-balance, the restoring force may be so small as to cause bumping of the roller against the inside of the gyrator shaft. With the gyrator shaft speed kept down within the proper relation to the spin shaft speed, the restoring or lifting torque generated is considerably increased and will effectively prevent bumping of the roller and cause the basket to approach centering position even when the load in the basket is considerably unbalanced and the spin shaft is rotating at a relatively low speed.

The features and advantages of structure and operation of the washing machine hereinbefore described are numerous.

The construction of the movable receptacle **27** for the articles to be washed results in a highly efficient washing action. During the washing, soaking or rinsing process the laundry is vigorously agitated without the use of a mechanical agitator in the receptacle which are commonly found in conventional washing machines. In the receptacle **27** the contents are agitated by currents or turbulence of the liquid produced by the peculiar wall and bottom configurations of the receptacle, more particularly the helical blades **37**, the ledge **35**, the circular trough **33** and the raised central portion **32**.

By providing bleeder holes **36**, large enough for quick and efficient draining during the spin drying phase, but small enough in relation to the amount of washing liquid circulated and fed into the receptacle during the washing, soaking or rinsing periods, there is a constant overflow of washing liquid during said phases. The overflow effectively removes from the receptacle scum, curd, lint and other floating impurities which otherwise would be caught in the laundry during the spin drying following each of the washing, soaking and rinsing phases. The advantage of thus removing impurities will be apparent when it is seen that during the spin drying, the laundry is thrown against the side walls of the receptacle covering the bleeder holes **36** and acts in this position as a filter for the liquid which is being drained therethrough by centrifugal force.

The effectiveness of the washing action of the machine is further enhanced by the filter **14** removing insoluble impurities from the washing liquid and feeding filtered liquid into the receptacle. The progress of the washing process may conveniently be observed at the transparent filter housing in which the impurities accumulate. A particular advantage of the filter structure is the self-cleaning arrangement by means of which the filtering member **181** is automatically cleaned and its chambers **179** and **180** flushed at the end of each washing, soaking or rinsing operation. It is notable that the filter **14** is extremely compact, does not interfere with the placing into or removing of laundry from the receptacle **27** and that at all times the delicate filtering screen **181** is enclosed and protected against injury.

Quietness of operation and freedom from vibration are achieved by the peculiar mass distribution of the receptacle **27**, more particularly by the arrangement of the heavy weight bottom wall **30** having a trough **29** therein and the balance ring **39**, the mass distribution being such that center of gravity of the empty receptacle lies substantially in the same horizontal plane as the center of the mass of the normal full charge of the laundry placed therein. Hence, the center of mass of the loaded basket does not shift very much vertically with different amounts of laundry nor does it shift very much horizontally due to uneven distribution of the laundry.

A high degree of quietness and smoothness of operation of the washing machine is further attained by the hereinbefore described frictional erection device **75**, **76**, **77** in connection with the centrally arranged spring **83**. The central spring **83**, it will be noted, serves a double purpose. It firstly tends to maintain the rotor shaft **40** vertical, counteracting a tipping of the same, and cushioning the impact of the rotor shaft **40**, tipping against the flared end **73**, of the gyrator shaft

66, at the end of the spinning period. Secondly, the spring **83** forces the spherically curved friction plate **77** into engagement with the friction ring **76**.

The rotation of the gyrator shaft in the same direction as the direction of rotation of the spin shaft exerts a force on the basket tangential to its path of precession and in a direction tending to accelerate or hurry the precession, causing the basket to approach vertical until the center of the rotating mass comprising basket assembly and contents is directly over the universal joint **52**. When the friction members **76** and **77** are concentric, no erecting torque is exerted on the rotor shaft **40**, **40'** by the frictional erecting means.

In general, spring centering force, either sufficient or insufficient to make the mounting stable, increases the restoring torque generated by the forward rotation of the gyrator shaft at any speed and increases the range of gyrator shaft speed over which a restoring torque is generated. This spring centering force also causes a restoring torque to be generated at lower gyrator shaft speeds than without this centering force. In addition, this centering force makes it possible to obtain an appreciable restoring torque with a stationary gyrator shaft or even with the gyrator shaft rotating backwardly.

While certain novel features of the invention have been disclosed and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a washing machine, an open top basket having an annular, trough-shaped bottom forming a central raised hub-like portion and having an annular upstanding side wall, said hub-like portion being relatively smooth circumferentally, said basket being adapted to hold washing liquid for the washing operation, a series of substantially helical ribs disposed on the inside of said upstanding wall, means for imparting a gyratory movement to said basket during washing to cause its axis to describe the surface of a cone whose apex is below the basket, said ribs extending upwardly in the direction of gyration of the basket, and means for preventing the rotation of the basket about its own axis during washing.

2. In a washing machine, an open top basket having an annular, trough-shaped bottom forming a central raised hub-like portion, and having an annular upstanding side wall, said basket being adapted to hold washing liquid for the washing operation, a series of substantially helical ribs disposed on the inside of said upstanding wall, means for imparting a gyratory movement to said basket during washing to cause its axis to describe the surface of a cone whose apex is below the basket, said ribs extending upwardly in the direction of gyration of the basket, means for preventing the rotation of the basket about its own axis during washing, and means for spinning said basket for drying.

3. In a washing machine, an open top basket having an annular upstanding side wall portion and a central, raised hub-like portion, said portions forming an annular trough-shaped bottom portion, a series of substantially helical ribs disposed on the inside of said side wall portion, said basket being adapted to hold washing liquid for the washing operation, means for imparting a gyratory movement to said basket during wash-

ing to cause its axis to describe the surface of a cone, said ribs extending upwardly in the direction of gyration of the basket, and means for preventing the rotation of the basket about its own axis during washing.

4. In a washing machine, an open top basket having an annular upstanding side wall portion, a central, raised hub-like portion, said portions forming an annular, trough-shaped bottom portion, a series of substantially helical ribs disposed on the inside of said side wall portion, means for imparting a gyratory movement to said basket during washing to cause its axis to describe the surface of a cone, said ribs extending upwardly in the direction of gyration of the basket, said basket being adapted to hold washing liquid for the washing operation, and means for controlling the rotation of the basket about its own axis during washing, whereby to cause the clothes to take the form of a ring lying in said trough-shaped portion, in which the clothes move upwardly at the outside of the ring and downwardly at the center of the ring, simulating a vortex.

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