

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements relating to Washing Machines

We, HOOVER LIMITED, a Company registered under the Laws of Great Britain, of Perivale, Greenford, Middlesex, do hereby declare the invention, for which we pray

5 that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to washing machines and is particularly, though not exclusively, applicable to automatic washing machines of the kind which automatically perform a spin-drying operation in addition to a washing operation, and possibly one or more rinsing

10 operations.

According to the present invention a washing machine includes a basket to contain the clothes, constituting or located within a container for washing liquid and mounted to rotate about a horizontal or oblique axis, an impeller of disc-like form mounted in one end of the basket to rotate coaxially with the basket, and means for rotating the basket and the impeller simultaneously, and also

15 relatively to one another for washing the clothes. Preferably the driving means are arranged to rotate the impeller at a speed many times that of the basket for washing, and the driving means preferably are arranged to rotate the impeller and basket in opposite directions for washing.

If the machine is for washing only, the basket may be watertight. Alternatively where the machine serves also as a spin drier

20 it may be perforated, and mounted within a stationary watertight container. In the latter case the driving means may be arranged to drive the basket at a low speed for washing and rinsing and at a substantially higher speed

25 for spin drying.

In one arrangement the end of the basket remote from the impeller is open to provide

30 [Price 3s. 6d.]

a charging opening for the insertion of clothes.

In one form of the invention the axis of the impeller and basket is oblique, with the impeller in the lower end of the basket. For example the axis may be inclined to the horizontal at such an angle that the top of the impeller is not substantially above the bottom of the charging opening.

Preferably the rotating basket has in it a number of ribs arranged to lift the clothes and allow them to fall in the neighbourhood of the impeller. Where the axis is horizontal the ribs should be helically inclined but if the axis is oblique the vanes may be either helical or arranged in planes passing through the axis.

The basket may be closely surrounded by an outer casing which remains stationary while the basket rotates, the capacity of the lower part of the outer casing being not much greater than that of the basket so as to make the maximum space available for clothes in a given quantity of water.

The invention also includes a method of washing clothes which includes immersing them in washing liquid in a basket provided, in one end, with a disc-like impeller, and rotating both the basket and impeller simultaneously, about a horizontal or oblique axis and also relatively to one another, preferably in opposite directions, and with the impeller at a speed many times that of the basket.

Many types of washing machine have been employed in the past, including on the one hand a rotating basket or tumbler and on the other hand a disc-like impeller mounted in the side wall of a stationary casing. The former type of washing machine lends itself readily to spin drying since the water can be emptied from it and the basket then rotates at a higher speed in order to centrifuge liquid

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from the clothes. On the other hand the washing efficiency of such a machine tends to be relatively poor. The side wall disc impeller type of machine is extremely compact and gives good washing efficiency, but does not provide any means for spin drying.

The arrangement in accordance with the invention, having both a disc-like impeller and a rotary basket, with the axis inclined so that the access opening can be above the water level whilst the impeller is below it, has substantial advantages over either of the types referred to above. In particular it enables efficient washing to be carried out with a relatively small quantity of water.

In a modified form of the invention as applied to an automatic washing machine, the machine also includes a storage tank, means for transferring washing liquid from the container to the tank, and means for returning the liquid from the tank to the container.

The invention may be carried into practice in various ways but one specific embodiment will be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a perspective external view of a complete automatic washing and spin drying machine;

Figure 2 is a right front perspective view of the washing machine with the outer casing removed;

Figure 3 is a left rear perspective view;

Figure 4 is a longitudinal section of the main working parts of the washing machine;

Figure 5 is an enlarged fragmentary section on the line 5—5 of Figure 4 showing the cross-section of a rib;

Figure 6 is a view similar to part of Figure 4 showing the gearbox in section on a larger scale;

Figure 7 is a view of one of the coil spring clutches, progressively broken away or sectioned;

Figure 8 is a schematic circuit diagram; and

Figure 9 is a timing schedule of the complete washing and drying cycle.

As shown in Figure 1, the combined washing and spin drying machine comprises an outer casing 10 of generally rectangular form with a top forward corner edge cut off obliquely to provide a sloping access panel 11 having in it an opening 12 for the insertion and removal of clothes, the opening being normally closed by a door 13 which may if desired have in it an observation window. The door is mounted on hinges 14 at its lower edge and provided with a latch 15 at its upper edge to hold it closed. To the left and right of the opening are control dials 16 and 17 for a timer and a hot-automatic-cold switch respectively, these parts being referred to later.

As shown in Figures 2 and 3 the casing contains a frame 20, chiefly made up of channel section members, in which a stationary container 25 is suspended. Rigidly secured to one end of the container is a gearbox casing 29 which houses a gearbox and affords bearings for a rotary washing and spin drying basket 30, and a disc-like washing impeller 31 mounted coaxially in the end of the spin drying basket, as shown in Figure 4. The impeller may be of the form customarily used in the well-known Hoover washing machines and described for example in the present applicants' British Patent Specification No. 612,737 and British Patent Specification No. 624,191.

The container 25 is suspended in the frame 20 by means of rubber belts 32 and wire ties 33, and the frame is provided with upper and lower buffers or cushions 34 and 35 and side buffers 36. When the container is filled with liquid it rests gently against the lower buffer 35. When it is emptied prior to spin drying as described later, the container is lifted clear of the buffer, its weight being supported jointly by the wire ties and rubber belts whereof the latter provide resilience and damping. In the event of excessive vibration the container may engage any one of the buffers which will serve as a stop to check such vibration.

Near its mouth the container is provided with four weights 37 to add to the inertia of the non-rotating part of the suspended system and hence reduce the effects of lack of balance in the rotating part.

As shown in Figure 4 the spin drier basket is of perforated sheet metal in the form of a surface of revolution comprising a generally flat circular rear wall 38 affording a recess 39 for the impeller, and merging at its outer periphery into a shallow frusto-conical wall 40 which has in it a narrow band of relatively large holes 41 to assist rapid filling. This in turn curves round into a generally cylindrical portion 42 in which most of the holes 43 are formed and which merges into a deeper tapered portion 44 tapering to a mouth, for insertion and removal of the clothes, situated at the end remote from the gearbox and presented adjacent the opening 12 in the sloping front upper panel of the casing. The outer stationary container 25 is of generally similar shape also comprising a conical end wall 47, a cylindrical portion 48 and a tapered portion 49, and closely encloses the basket. The stationary container is made in two portions having flanges secured together in a plane at right angles to the axis, so as to permit assembly. The lower part of the container is encircled by a sump 50 of the somewhat crescent-shaped form shown in Figures 2 and 3 and the wall of the container is slotted or omitted as shown in Figure 4 to afford communication between the

interior of the sump and that of the container. In the drawings the sump is shown as fabricated separately from the container but if preferred it may be made as part of it in the form of a gentle bulge or protuberance merging smoothly into the container.

The mouth of the tapered portion 49 of the container is connected to the opening 12 in the outer casing by means of an annular bellows 55 of moulded resilient material such as rubber forming a watertight seal whilst allowing swinging or vibrating movement of the stationary casing.

As shown in Figure 4 the rear edge of the bellows is formed by a rear ring 56 of moulded rubber which is secured to the container and extends into the mouth of the basket to cover the intervening gap. The front edge of the bellows is formed by a front-ring 57 of moulded rubber having a groove to receive the margin of the opening 12 in the sloping front access panel 11 and forming a seal with an annular rib 58 on the door 13. A drain pipe 59 extends from the bottom of the bellows to drain any liquid that may collect in it, down into the sump. A hole 61 is provided at the top of the bellows to act as a vent for the container.

The rotating basket has in it five ribs 60 of smoothly curved cross-section extending from the opening to the rear end of the cylindrical portion 42, generally lying in planes passing through the axis. Figure 5 shows the section of a rib at its deepest point.

The axis of the rotating basket is inclined to the horizontal at a convenient angle, say 35°, the dimensions being such that the lowest point of the access opening is slightly above the highest point of the impeller so that the water level may be above the impeller but below the access opening.

A main electric driving motor 70 is bolted to the gearbox 29 for the purpose of driving the impeller 31 and also driving the washing and spin drying basket 30 either at a slow speed in the opposite direction to the impeller for washing, or at a high speed for spin drying.

As shown in Figure 4 the motor casing carries a spigot 71 connected to a vibration damper or snubber 72. The latter comprises a rubber moulding consisting of inner and outer rings 73 and 74 connected together by a number of somewhat S-shaped arms 75. The outer ring is bonded into an angle section ring 76 secured to a sloping plate 77 carried by the frame 20 of the machine.

The arrangement of the gearbox is shown in Figure 6. From this figure it will be seen that the impeller 31 is in the form of a disc having on its exposed surface a number of smoothly curved radial ribs and is carried on a central shaft 81. The impeller shaft 81 is surrounded by a hollow shaft 82 to which is rigidly secured a hub 83 or spider serving to

reinforce and carry the end of the washing and spin drying basket 30. Rigidly mounted on the hollow basket shaft 82 is the driven member 84 of an overload friction clutch having a driving member 85 affording an inner forward sleeve 86 and an outer forward sleeve 87 referred to below.

The main driving motor has a shaft 90 driving a bevel 91 meshing with and driving a pair of driven bevels 92 and 93. The motor is mounted with its axis not quite at right angles to that of the impeller shaft 81 and the rear driven bevel 92 is slightly larger than the front driven bevel 93 so that the latter rotates slightly faster than the former. Each of the bevels 92 and 93 also affords a further set of bevel teeth 94 and 95 which have the same number of teeth and mesh with a pair of planet bevels 96 carried by radial shafts 97 constituting a spider integral with an inner rearward sleeve 98 whereof the forward end is presented end to end to the inner forward sleeve 86 referred to above. The forward driven bevel 93 affords an outer rearward sleeve 99 of which the forward end is presented end to end to the outer forward sleeve 87.

It will be appreciated that the rotation of the driving bevel 91 rotates the front driven bevel 93 in one direction whilst rotating the rear driven bevel 92 in the opposite direction at a slightly lower speed. The speed of the spider will correspond with half the algebraic sum of the speeds of the two driven bevels 92 and 93, and accordingly the spider will rotate in the same direction as the front driven bevel 93 but at a very much lower speed.

The inner forward and rearward sleeves 86 and 98 are coupled together by means of an inner helical coil clutch 104 which encircles them. This clutch is not under manual control and acts as a freewheel to transmit a drive from the spider to the basket at a slow speed at all times when there is no drive to the basket at a greater speed by other means.

At the same time the outer forward sleeve 87 and the outer rearward sleeve 99 are coupled together by an outer helical coil clutch 105. The coil clutch 105, shown on a larger scale in Figure 7, is under the control of a solenoid 106. The coil is surrounded by a collar 107 having in it a slot 108 through which projects the outturned leading end 109 of the coil. The collar also has a projection 110 punched out from it and the solenoid controls a stop 111 which can be projected by a spring (not shown) into the path of the projection or can be withdrawn by energising the solenoid.

The operation of the clutch is that when the solenoid is energised to withdraw the stop the movement of the bevel 93 is such as to wind up the coil and tighten it around the outer



sleeves 87 and 99 so as to lock them together. When, however, the solenoid is de-energised the stop is moved by the spring into the path of the projection so as to arrest rotation of the collar, thereby stopping the movement of the leading end of the spring and causing it to unwind and expand so as no longer to grip the outer sleeves. Accordingly when the solenoid 106 is energised the basket will be coupled to the bevel 93 and as this is rotating very much faster than the spider the basket will be rotated at a correspondingly high speed and the inner helical coil clutch 104 will merely overrun, functioning as a free-wheel.

At its rear end the impeller shaft 81 carries a collar 113 whilst the rear driven bevel 92 carries a rear sleeve 114 and a rear helical coil clutch 115 encircles a part of the collar and a part of the rear sleeve so as to be capable of coupling the impeller shaft to the rear driven bevel 92. As in the case of the clutch 105 the clutch 115 is controlled by a solenoid 116 acting on a stop 117 which can be withdrawn by the solenoid from the path of a projection 118 on a collar 119. Accordingly if the impeller solenoid 116 is energised but the basket solenoid 106 is not, the impeller will be rotated at high speed with the rear bevel 92, whilst the basket will rotate slowly in the opposite direction with the spider 97.

In Figure 6 the stops controlled by the solenoids 106 and 116 are shown turned about the axis through a right angle, one one way and the other the other way, so as to appear in the figure. Actually, as shown in Figure 3, they lie in planes at right angles to that of Figure 6.

It will be appreciated that the arrangement of the gearbox described provides for a number of different speeds in a very compact compass. In particular the slow rotation of the basket for washing and rinsing requires a reduction ratio of the order of perhaps 30:1. The fast rotation of the basket requires very little reduction ratio and it is naturally desirable that it should be in the same direction as the slow rotation. On the other hand the rotation of the impeller requires very little reduction but it is desirable that it should be in the opposite direction to that of the basket. The arrangement described meets these requirements in a compact and simple manner.

Thus in one specific case with a motor speed of 1420 r.p.m. the bevel ratios are such as to give the bevel 92 a speed of 650 r.p.m. and the bevel 93 a speed of 745 r.p.m. (in the opposite direction). This gives the spider 97 a speed of about 47 r.p.m. in the same direction as the bevel 93.

For the purpose of automatically filling the machine it is provided with hot and cold inlet pipes 134 and 135 controlled by hot and cold inlet valves 136 and 137 actuated by hot

and cold solenoids 138 and 139. From the valves 136 and 137 further pipes 140 and 141 lead to the top of the machine and across and open into an atmospheric head pipe 142 of which the lower end communicates through a flexible corrugated pipe 143 with the sump 50.

For emptying the container, a pump 145 is provided (seen in Figure 2) which is driven by an electric motor 146 and serves to draw liquid from the sump 50 through a pipe 147 and discharge it through an outlet hose 148.

The whole operation of the machine is under the automatic control of a timer 150 and a pair of level-responsive switches 151 and 152 connected by pipes 153 and 154 to pressure accumulators 155 and 156 respectively. Certain of the controls form the subject of the present applicants' Specification No. 32523/57 (Serial No. 877,430). From the bottoms of both pressure accumulators a single pipe (not shown) runs round the bottom of the machine and opens into the pipe 147 so as to communicate with the bottom of the sump. Each pressure accumulator consists simply of a cylindrical vessel of which the upper part will contain air and the lower part liquid when the switch is to operate. Due to the cross-section of the accumulator a comparatively small change of level will produce the displacement of air needed to operate the switch 151 or 152, as compared with what would be required if the liquid surface were in a small pipe.

The switches 151 and 152 may be of known type comprising a flexible diaphragm acting against an adjustable spring to operate snap-action contacts.

The switch 151 has one pair of contacts which closes when the container is approximately empty whilst the switch 152 has two pairs of contacts one of which closes when the container is full and one of which closes when the container is not full.

The timer 150 consists of a small self-starting synchronous motor 170 driving a number of cams which serve to control eight pairs of contacts 171 to 178. The general construction of the timer is well known and the cams may be arranged in various ways, for example one cam may operate more than one of the pairs of contacts 171 to 178. The timer is connected by sprockets 158 and 159 and a chain 160 to the timer control dial 16.

Figure 8 is a schematic circuit diagram showing the arrangement of the circuit, whilst Figure 9 is a timing diagram indicating which contacts are closed during each of the seventy-two divisions of a complete washing and drying cycle. From the detailed description given below it will be observed that the seventy-two divisions do not quite represent the whole of the cycle since the timer is

switched off during filling and emptying stages as a result of the level-responsive switches 151 and 152. Accordingly a number of the divisions (actually Nos. 5 and 6, 18, 29 and 30, 36, 46 and 47 and 53) are prolonged by whatever periods are required for the hot and/or cold supply to fill the container through the hot and/or cold valves and whatever periods are required for the emptying pump 145 to empty the container.

It is believed that the electric circuit will be clear from Figure 8. Thus a supply 180 has one terminal connected through the timer contacts 171 to a busbar 181 whilst its other terminal is connected through the timer contacts 172 to a busbar 182. A door controlled busbar 184 is connected to the busbar 181 through a door-controlled switch 183 which is closed only when the door 13 is closed. The main driving motor 70 is connected between the busbars 184 and 182. The impeller solenoid 116 is connected in series with the timer contacts 173 across the busbars 184 and 182. The pump motor 146 is connected in series with the timer contacts 174 across the busbars 181 and 182.

The timer motor 170 has one terminal connected to the busbar 184 and its other terminal connected by a conductor 185 which in turn is connected through the close-when-empty level-responsive switch 151 to the busbar 182. The basket spinning solenoid 106 has one terminal connected through the timer contacts 175 to the busbar 184 and its other terminal connected to the conductor 185. In addition the conductor 185 is connected through the timer contacts 176 and the close-when-full contacts 186 of the level-responsive switch 152 to the busbar 182.

The hot-automatic-cold switch 17 has pairs of contacts 191 to 196. In the normal automatic position the hot solenoid 138 has one terminal connected through the contacts 192 to the busbar 181 and the other terminal connected to a conductor 198 which is connected through the timer contacts 177 to the close-when-not-full contacts 187 of the level-responsive switch 152, and thence to the busbar 182. The cold solenoid 139 normally has one terminal connected through the contacts 195 of the hot-automatic-cold switch to the busbar 181 and its other terminal connected through a conductor 199 and through the timer contacts 178 to the conductor 193.

In the hot position of the hot-automatic-cold switch 17 the contacts 191 and 194 are closed whereof the contacts 191 are in parallel with the contacts 192 so that the operation of the hot solenoid is unaffected, whilst the contacts 194 are not connected so that the circuit of the cold solenoid 139 is in any event broken. In the cold position the contacts 193 and 196 are closed whereof the latter are in parallel with the contacts 195 so that the operation of the cold solenoid 139 is

unaffected. The contacts 193 are in parallel with the timer contacts 178 so that in this position the contacts 178 are short-circuited and the operation of the cold solenoid is not dependent upon the timer contacts 178, whilst the hot solenoid 138 is open-circuited.

The sequence of operation of the timer contacts may be followed with the aid of Figure 9 in which the left-hand column indicates the seventy-two successive intervals of the timer, whilst in the next eight columns a cross indicates whether each of the timer contacts 171 to 178 is closed during that particular interval. The columns on the right are thought to be self-explanatory and indicate respectively the various operations that occur, whether the container is empty or full and whether the timer is on or off.

PROGRAMME

The programme of the complete cycle will now be briefly described.

During the intervals 0—3 all contacts are open so that the whole circuit is isolated from the supply in order to start the cycle it is necessary to move the timer manually to position 4.

In order to start the cycle the user places a suitable charge of clothes in the basket together with an appropriate quantity of soap or detergent. She then closes the door thereby closing the switch 183, and manually moves the timer to position 4 by turning the dial 16.

In interval 4 contacts 171 and 172 close to connect the busbars 181 and 182 to the supply. As these contacts remain closed throughout the cycle from interval 4 to interval 68 inclusive it will not be thought necessary to mention them again. In intervals 5 and 6 contacts 176 and 177 also close. It will be appreciated that throughout the washing cycle, provided the door is left closed, the basket is continuing to rotate at a slow speed. Contacts 176 provide the return circuit for the timer motor through the close-when-full contacts 186 to ensure that the timer will start again when the container has been filled as referred to below. Contacts 177 close the return circuit for the hot solenoid 138 through the not-full contacts 187, thereby admitting hot water from the hot supply. As soon as the water level in the container rises above the empty mark the close-when-empty switch 151 opens and stops the timer, so that interval number 5 or 6 is prolonged for whatever period may be necessary to fill the container. When the container is full the switch 152 snaps over from the not-full contacts 187 to the full contacts 186 thereby releasing the hot solenoid and shutting off the supply of hot water, and at the same time restarting the timer motor 170. During the remainder of interval 6, or of intervals 5 and 6, nothing further happens and the basket merely rotates at a slow speed.

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115

120

125

intervals



The reason for allowing two intervals, Nos. 5 and 6, for filling, is that if the filling rate is very slow the first interval might expire before the empty mark had been reached and the timer stopped to prolong the interval. Without interval 6 the operation might then continue and washing begin with the container nearly empty of water. Moreover if the user should move the timer through interval 5 initially, interval 6 will still be available to allow the level to reach the empty mark.

During intervals 7-16 contacts 173 and 176 are closed. The latter serve as before to keep the timer running through the close-when-full contacts 186. They perform this function throughout the majority of the cycle and it will not be considered necessary to point it out again. Contacts 173 energise the impeller solenoid 116 and drive the impeller for a washing cycle.

In interval 17 only contacts 176 remain closed to keep the timer going.

In interval 18 contacts 174 are also closed, energising the pump motor 146 to drive the emptying pump 145 and start emptying the container. When the level has fallen below the "full" mark the close-when-full contacts 186 of the switch 152 will open, thereby stopping the timer motor so that interval 18 is prolonged as much as may be necessary to allow the container to be emptied. When the container is empty the close-when-empty contacts 151 will close and restart the timer motor 170.

In intervals 19 and 20 contacts 174 remain closed so that the pump continues to run but contacts 176 are opened. These contacts remain open throughout the spinning period about to take place, in order to ensure that the only return circuit for both the spinning solenoid 106 and the timer motor 170 is through the close-when-empty switch 151 as more fully explained below.

In intervals 21 to 25 contacts 174 remain closed and contacts 175 close, so that the pump continues to run and in addition the spinning clutch is engaged and the basket rotates at high speed. It will be observed that the circuits of both the timer and the spinning solenoid 106 find a return path only through the close-when-empty switch 151. Accordingly if the water flung out from the clothes is sufficient to raise the level in the container above the empty mark the spinning clutch will be disengaged and in addition the timer will be stopped until such time as the pump (which is unaffected by the close-when-empty contacts) has had time to reduce the level again. This is a feature of very considerable importance since if an attempt is made to spin the basket at high speed when it is immersed in water to any substantial depth the motor is liable to be overloaded. By the arrangement described this is avoided without the necessity of pro-

viding a large sump or a large pump. A large pump would be wasteful since it would only be working at maximum capacity for a very small fraction of the cycle, whilst a large sump would be objectionable in that it would involve the use of a much larger quantity of hot water for washing, in addition to increasing the energy and time required for filling and emptying. By the arrangement described the size of the sump and the amount of water required can be reduced to a minimum.

Actual capacities may of course vary but in one case a machine taking a dry clothes load of 8 lbs. employs 7 gallons of water, of which only about $1\frac{3}{4}$ gallons is situated in the sump and in the space between the container and the basket. In other words 75% of the total water volume is within the basket.

The opening of the contacts 176 ensures that there is no return circuit through the close-when-full contacts 186 of the switch 152. This is a safeguard to ensure that the spinning solenoid 106 can only be energised when the container is empty and not when it is full. Thus for example if the user should manually advance the timer during the washing cycle so as to cut out the emptying cycle (interval 18) contacts 175 might be closed with the container full. Similarly if the emptying pump failed or became blocked interval 18 might finish and contacts 175 close with the container still full.

The fact that the timer is switched off whenever the spinning solenoid 106 is de-energised by opening of close-when-empty switch 151 ensures that the full period of spinning will be provided not taking into account any periods during which the spinning clutch is de-energised.

In interval 26 the contacts 175 open and disengage the spinning clutch whilst the contacts 174 remain closed so that the pump continues to run.

In interval 27 the contacts 174 open to shut off the pump and in fact none of the timer contacts are closed (except for contacts 171 and 172).

In interval 28 the contacts 176 again close preparatory to the next filling cycle for the purpose already explained above.

In intervals 29 and 30 contacts 177 and 178 also close, thereby opening both the hot valve and the cold valve so as to supply a mixture of hot and cold water. As soon as the level rises above the empty mark the close-when-empty switch 151 opens, thereby stopping the timer. When the container is full of tepid water the timer is started again through the contacts 176 and the close-when-full contacts 152. Two intervals Nos. 29 and 30 are provided for this filling as, and for the same reasons as, for the first filling in intervals 5 and 6.

In intervals 31 to 34 contacts 173 also

importance
60



- close so that the impeller is driven for a first rinsing period during which the operation is similar to the washing period of intervals 7—16 except that the first rinsing period is shorter, the water is not so hot, and there is of course no added soap in it.
- In interval 35 contacts 173 are open so that the impeller stops but contacts 176 remain closed.
- Interval 36, with contacts 174 and 176 closed, is a repetition of interval 18 during which the container is emptied.
- Intervals 37—45 are a repetition of intervals 19 to 28 except that the spinning is slightly shorter.
- Intervals 46 and 47, the second tepid filling cycle, are a precise repetition of intervals 29 and 30, the first tepid filling cycle.
- Intervals 48—52, the second rinsing cycle, are a precise repetition of intervals 31—35, the first rinsing cycle.
- Interval 53, emptying again, is a precise repetition of intervals 18 and 36.
- Intervals 54—68, the final long spinning, are similar to intervals 19—28 and intervals 37—45, the initial spinning periods, with the exception that the final spinning is more prolonged and the pump continues to run for an extra interval. Thus contacts 174 are closed during intervals 54 and 55 to run the pump; during intervals 56—65 these contacts remain closed and the pump continues to run whilst in addition contacts 175 are closed to run the basket at spinning speed. In intervals 66 and 67 contacts 175 are open so that the basket slows down again whilst contacts 174 remain closed so that the pump continues to run. In interval 68 contacts 174 are open so that the pump is shut off and in fact no timer contacts are closed (except for contacts 171 and 172).
- Finally at the end of interval 68 contacts 171 and 172 are opened thereby stopping the timer motor and isolating the whole circuit by cutting off the busbars 181 and 182 from the supply. Accordingly the timer remains in position 69 until it is manually moved on again to position 4 in order to begin the next cycle.
- The cycle has been described on the assumption that the hot-automatic-cold switch 17 is left in the automatic position. In this case the first filling for washing is with hot water, and each subsequent filling for rinsing is with tepid water, namely a mixture of hot and cold. This may be modified by the user at any moment by operation of the switch 17. For example, if a cold rinse is wanted she can move the switch to the cold position any time after the hot filling. Or again if the hot water is too hot for washing she can switch to cold during a portion of the hot filling period, and similarly to adjust the rinse temperature she can switch to hot or cold during the course of the tepid filling for as long as may be required to effect the desired adjustment.
- The door operated contacts 183 control all the circuits except the filling and pump circuits, so that if at any time the user opens the door and puts her hand into the machine the basket and the impeller will both stop and there is no danger of her hand coming into contact with moving parts. On the other hand since the filling circuits are independent of the door-controlled contacts the user can if she wishes open the door during a filling period to feel the temperature of the water without interfering with the filling operation. Also as the operation of the pump is independent of the door operated contacts it will continue to empty the container even if the user should open the door while it is doing so, for example during or immediately after the final stages of a spinning cycle.
- The actual time of the cycle and its various parts will vary with circumstances but in one specific case each of the 72 intervals of the timer (of which the cycle actually uses 65) represents $22\frac{1}{2}$ seconds, making a total of about 25 minutes. To this must be added the filling and emptying period, of which each hot filling period might be of the order of 2 minutes and each tepid filling period and each emptying period of the order of 1 minute, making a total cycle of the order of 32 minutes.
- On the other hand certain of the period may in some cases be reduced, without sacrifice, for example the early spinning periods and certain of the intervals, bringing the total cycle time down to perhaps 25 minutes.
- In a modified arrangement (not shown) a storage tank is provided to store the washing liquid after it has been used for washing one load of clothes, and keep it available for subsequently washing a further load of clothes. Such a machine may be arranged for manual or automatic control. In one machine for automatic control the construction is substantially the same as that shown in the drawings except that the frame and outer casing are somewhat higher in order to accommodate a storage tank underneath the container. The tank is shaped so as to occupy the available space as effectively as possible whilst keeping its centre of gravity as low as possible. Thus when the washing liquid is drained into the storage tank it will provide a stabilising weight to hold the machine firm whilst the basket is running at high speed for centrifuging the liquid.
- An additional valve is provided for causing the pump to pump to the tank instead of to the outlet hose and the pump and its motor are of a reversible type for filling the container from the tank instead of from the hot supply. This valve and a reversing switch for the pump motor are under the control of

the timer subject to a manual master control.

Accordingly for the first cycle for the first load of clothes the container will be filled from the hot supply, and after the washing period the washing liquid will be emptied into the storage tank, after which the cycle will proceed as described with reference to the drawings. For the second load of clothes the container will be filled from the storage tank and after the washing period will again be emptied to the storage tank. When the washing liquid is exhausted the user will turn the manual master control so that the washing liquid is discharged to the drain instead of to the storage tank.

The storage tank may be provided with an electric heater. This may be of two-rate type capable of being operated either at maximum load, for heating the water as rapidly as the supply of current will allow, or at low load for merely making up for loss of heat and maintaining the initial temperature.

It will be appreciated that a similar heater may be incorporated in the sump of the embodiment shown in the drawings.

Moreover the invention can also be applied to a machine for washing only, without spin drying, in view of the very efficient washing effected and the economical use of hot water. In this event the stationary container may be dispensed with, the rotating basket being made watertight.

In each of the arrangement described, with the axis oblique, it is believed that the efficient and economical washing is to a large extent due to the feeding of the clothes longitudinally as they are picked up successively and then allowed to fall vertically, namely in a direction having a component along the axis towards the impeller. A similar feeding movement can however also be produced by arranging the machine with the axis horizontal and providing vanes arranged along helices or otherwise oblique to the axis.

WHAT WE CLAIM IS:—

1. A washing machine including a basket to contain the clothes, constituting or located within a container for washing liquid and mounted to rotate about a horizontal or oblique axis, an impeller of disc-like form mounted in one end of the basket to rotate coaxially with the basket, and means for rotating both the basket and the impeller simultaneously and also relatively to one another, for washing the clothes.

2. A washing machine as claimed in Claim 1 in which the driving means are arranged to rotate the impeller at a speed many times that of the basket for washing.

3. A washing machine as claimed in Claim 1 or Claim 2 in which the driving means are arranged to rotate the impeller and basket in opposite directions for washing.

4. A washing machine as claimed in any

one of the preceding claims in which the end of the basket remote from the impeller is open to provide a charging opening for the insertion of clothes.

5. A washing machine as claimed in any one of the preceding claims in which the axis of the impeller and basket is oblique, with the impeller in the lower end of the basket.

6. A washing machine as claimed in Claims 4 and 5 in which the axis is inclined to the horizontal at such an angle that the top of the impeller is not substantially above the bottom of the charging opening.

7. A washing machine as claimed in any one of the preceding claims in which the rotating basket has in it a number of ribs arranged to lift the clothes and allow them to fall in the neighbourhood of the impeller.

8. A washing machine as claimed in Claim 7 in which the ribs are helically inclined.

9. A washing machine as claimed in Claim 7 in which the axis is oblique and the ribs are arranged in planes passing through it.

10. A washing machine as claimed in any one of the preceding claims in which the basket is watertight and thus requires no outer container for the liquid.

11. A washing machine as claimed in any one of Claims 1 to 9 intended to serve also for spin drying, in which the basket is perforated and is mounted within a stationary watertight container.

12. A washing machine as claimed in Claim 11 in which the driving means are arranged to drive the basket at a low speed for washing and rinsing and at a substantially higher speed for spin drying.

13. A washing machine as claimed in Claim 12 including a gearbox having a driving shaft generally transverse to the basket axis coupled by a bevel drive to a pair of coaxial driven bevels so as to rotate them in opposite directions at slightly different speeds, a differential gear coupling the driven bevels to a planet carrier so as to drive the latter at a greatly reduced speed, and means for coupling the impeller to one driven bevel and the basket of the carrier for washing, and for coupling the basket to one of the driven bevels for spinning.

14. A washing machine as claimed in any one of the preceding claims including a storage tank, means for transferring washing liquid from the container to the tank and means for returning the liquid from the tank to the container.

15. A method of washing clothes which includes immersing them in washing liquid in a basket provided, in one end, with a disc-like impeller, and rotating both the basket and impeller simultaneously about a horizontal or oblique axis and also relatively to



the timer subject to a manual master control.

Accordingly for the first cycle for the first load of clothes the container will be filled from the hot supply, and after the washing period the washing liquid will be emptied into the storage tank, after which the cycle will proceed as described with reference to the drawings. For the second load of clothes the container will be filled from the storage tank and after the washing period will again be emptied to the storage tank. When the washing liquid is exhausted the user will turn the manual master control so that the washing liquid is discharged to the drain instead of to the storage tank.

The storage tank may be provided with an electric heater. This may be of two-rate type capable of being operated either at maximum load, for heating the water as rapidly as the supply of current will allow, or at low load for merely making up for loss of heat and maintaining the initial temperature.

It will be appreciated that a similar heater may be incorporated in the sump of the embodiment shown in the drawings.

Moreover the invention can also be applied to a machine for washing only, without spin drying, in view of the very efficient washing effected and the economical use of hot water. In this event the stationary container may be dispensed with, the rotating basket being made watertight.

In each of the arrangement described, with the axis oblique, it is believed that the efficient and economical washing is to a large extent due to the feeding of the clothes longitudinally as they are picked up successively and then allowed to fall vertically, namely in a direction having a component along the axis towards the impeller. A similar feeding movement can however also be produced by arranging the machine with the axis horizontal and providing vanes arranged along helices or otherwise oblique to the axis.

WHAT WE CLAIM IS:—

1. A washing machine including a basket to contain the clothes, constituting or located within a container for washing liquid and mounted to rotate about a horizontal or oblique axis, an impeller of disc-like form mounted in one end of the basket to rotate coaxially with the basket, and means for rotating both the basket and the impeller simultaneously and also relatively to one another, for washing the clothes.

2. A washing machine as claimed in Claim 1 in which the driving means are arranged to rotate the impeller at a speed many times that of the basket for washing.

3. A washing machine as claimed in Claim 1 or Claim 2 in which the driving means are arranged to rotate the impeller and basket in opposite directions for washing.

4. A washing machine as claimed in any

one of the preceding claims in which the end of the basket remote from the impeller is open to provide a charging opening for the insertion of clothes.

5. A washing machine as claimed in any one of the preceding claims in which the axis of the impeller and basket is oblique, with the impeller in the lower end of the basket.

6. A washing machine as claimed in Claims 4 and 5 in which the axis is inclined to the horizontal at such an angle that the top of the impeller is not substantially above the bottom of the charging opening.

7. A washing machine as claimed in any one of the preceding claims in which the rotating basket has in it a number of ribs arranged to lift the clothes and allow them to fall in the neighbourhood of the impeller.

8. A washing machine as claimed in Claim 7 in which the ribs are helically inclined.

9. A washing machine as claimed in Claim 7 in which the axis is oblique and the ribs are arranged in planes passing through it.

10. A washing machine as claimed in any one of the preceding claims in which the basket is watertight and thus requires no outer container for the liquid.

11. A washing machine as claimed in any one of Claims 1 to 9 intended to serve also for spin drying, in which the basket is perforated and is mounted within a stationary watertight container.

12. A washing machine as claimed in Claim 11 in which the driving means are arranged to drive the basket at a low speed for washing and rinsing and at a substantially higher speed for spin drying.

13. A washing machine as claimed in Claim 12 including a gearbox having a driving shaft generally transverse to the basket axis coupled by a bevel drive to a pair of coaxial driven bevels so as to rotate them in opposite directions at slightly different speeds, a differential gear coupling the driven bevels to a planet carrier so as to drive the latter at a greatly reduced speed, and means for coupling the impeller to one driven bevel and the basket of the carrier for washing, and for coupling the basket to one of the driven bevels for spinning.

14. A washing machine as claimed in any one of the preceding claims including a storage tank, means for transferring washing liquid from the container to the tank and means for returning the liquid from the tank to the container.

15. A method of washing clothes which includes immersing them in washing liquid in a basket provided, in one end, with a disc-like impeller, and rotating both the basket and impeller simultaneously about a horizontal or oblique axis and also relatively to



one another.

16. A method as claimed in Claim 15 in which the impeller is rotated at a speed many times that of the basket.

- 5 17. A method as claimed in Claim 15 or Claim 16 in which the impeller and basket are rotated in opposite directions.

18. A washing machine as specifically described herein with reference to the accompanying drawings.

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10

PROVISIONAL SPECIFICATION

Improvements relating to Washing Machines

We, HOOVER LIMITED, a Company registered under the Laws of Great Britain, of Perivale, Greenford, Middlesex, do hereby declare the invention to be described in the following statement:—

15 This invention relates to washing machines and is particularly, though not exclusively, applicable to automatic washing machines of the kind which automatically perform a spin-drying operation in addition to a washing operation, and possibly one or more rinsing operations.

20 According to the present invention a washing machine includes a basket to contain the clothes, constituting or located within a container for washing liquid and mounted to rotate about a horizontal or oblique axis, an impeller of disc-like form mounted in one end of the basket to rotate coaxially with the basket, and means for rotating the basket and the impeller simultaneously but at different speeds and/or in different directions for washing the clothes. The driving means may be arranged to drive the basket at a low speed for washing and rinsing and at a substantially higher speed for spin drying.

25 In one arrangement the end of the basket remote from the impeller is open to provide a charging opening for the insertion of clothes.

30 In one form of the invention the axis of the impeller and basket is oblique, with the impeller in the lower end of the basket. For example the axis may be inclined to the horizontal at such an angle that the top of the impeller is not substantially above the bottom of the charging opening.

35 Preferably the rotating basket has in it a number of ribs arranged to lift the clothes and allow them to fall in the neighbourhood of the impeller. Where the axis is horizontal the ribs may be helically inclined, but if the axis is oblique the vanes may be arranged in planes passing through it.

40 The basket may be closely surrounded by an outer casing which remains stationary while the basket rotates, the capacity of the lower part of the outer casing being not much greater than that of the basket so as to make the maximum space available for clothes in a given quantity of water.

45 The invention also includes a method of washing clothes with the aid of a basket and a disc-like impeller rotating coaxially and

simultaneously but at different speeds and/or in different directions. 65

Many types of washing machine have been employed in the past, including on the one hand a rotating basket or tumbler and on the other hand a disc-like impeller mounted in the side wall of a stationary casing. The former type of washing machine lends itself readily to spin drying since the water can be emptied from it and the basket then rotated at a higher speed in order to centrifuge liquid from the clothes. On the other hand the washing efficiency of such a machine tends to be relatively poor. The side wall disc impeller type of machine is extremely compact and gives good washing efficiency, but does not provide any means for spin drying. 70 75 80

The arrangement in accordance with the invention, having both a disc-like impeller and a rotary basket, with the axis inclined so that the access opening can be above the water level whilst the impeller is below it, has substantial advantages over either of the type referred to above. In particular it enables efficient washing to be carried out with a relatively small quantity of water. 85 90

Thus in a preferred form of the invention as applied to an automatic washing machine the machine also includes a storage tank, means for transferring washing liquid from the container to the tank, and means for returning the liquid from the tank to the container. 95

The invention may be carried into practice in various ways but one specific embodiment will be briefly described by way of example. In this embodiment the washing machine comprises an outer casing of generally rectangular form with a top forward corner edge cut off obliquely to provide an access panel. Within the top part of the casing is mounted a stationary container in the form of a surface of revolution within which is mounted a rotary basket of substantially the same shape, the basket being mounted to rotate about its axis which slopes downwards and backwards from the centre of the access panel. At its upper forward end the basket is open to receive the clothes and the stationary casing has a corresponding opening in it as has the access panel, the opening in the access panel being covered by a suitable hinged door. An annular bellows of 100 105 110 115



5 moulded resilient material interconnects the margin of the opening in the access panel with that in the stationary casing and an annular flange projects from the bellows, towards the opening in the rotary basket.

10 At the lower rear end of the axis of the basket a disc-like impeller is mounted co-axially with the basket. This may be of the form customarily used in the well known Hoover washing machines and described for example in the present applicants' British patent specifications Nos. 612,737 and 624,191 (Cases 353 and 366). The basket which is of sheet metal, has a generally flat circular rear wall affording a recess for the impeller. The flat rear wall merges at its outer periphery into a shallow frusto-conical wall which in turn curves round into a generally cylindrical wall which is perforated and which merges at its forward edge into a deeper frusto-conical wall which curves in to the access opening where the edge may be somewhat re-entrant. The stationary container is of similar shape closely enclosing the basket so that its volume only slightly exceeds that of the basket. The stationary container is made in two portions having flanges secured together in a plane at right angles to the axis, so as to permit assembly.

30 The rotating basket has in it five ribs of smoothly curved cross-section extending from the opening to the rear end of the cylindrical portion.

35 The rotating basket and the impeller are carried by suitable bearings at their lower rear end and provided with separate gears to enable them to be driven at different speeds. The axis is inclined to the horizontal at a convenient angle, say 32° , the dimensions being such that the lowest point of the access opening is slightly above the highest point of the impeller so that the water level may be above the impeller but below the access opening.

45 In the bottom of the outer casing, below the stationary container, is a storage tank for the liquid having in it an electric heating element. This tank may be of triangular longitudinal section or may be otherwise shaped so as to occupy the available space as effectively as possible, whilst keeping its centre of gravity as low as possible. Thus when the washing liquid is drained into the storage tank it will provide a stabilising weight to hold the machine firm whilst the basket is running at high speed for centrifuging the liquid. An electric motor may conveniently be mounted on the inclined top of the storage tank with its axis parallel to that of the impeller and basket. The motor

is arranged to drive a pump for delivering liquid from the storage tank, the outlet from the pump being provided with valves through which it can be directed either into the stationary container or to a drain, or can be closed to prevent delivery. A gravity drain, also provided with a valve, is provided for draining water from the stationary container into the storage tank.

Means is provided for transmitting a drive from the motor to the impeller and to the basket. The driving means are arranged to be capable of driving the impeller in one direction at high speed and the basket in the other direction at a lower speed for washing, or alternatively driving the basket at a higher speed with or without the impeller for centrifuging. To change from one operation to the other suitable clutches may be employed, or alternatively the driving means may include free wheels or unidirectional clutches and a reversing switch for reversing the motor to change from one operation to the other.

An automatic timing switch is provided for causing the machine to perform successive operations for a complete washing, rinsing and spin drying cycle. Thus the user charges the basket with clothes and soap or detergent and with hot water. The hot water may either be drawn from a hot water supply, or the tank may be charged with cold water some time beforehand, and this, when heated, may be pumped into the container. The user then switches on the machine. Washing is effected by rotating the impeller in one direction and the basket more slowly in the opposite direction, and it is found that very effective washing is achieved with but little wear and with a relatively small quantity of washing liquid. The ribs in the basket serves to lift the clothes rearwardly and allow them to fall in the neighbourhood of the impeller, thereby maintaining the circulation of clothes so that all parts of them are efficiently washed. When the washing period is finished, for example after four minutes, the machine is stopped and the washing liquid is allowed to drain into the storage tank. After a short centrifuging operation rinsing water is admitted from the supply and the machine operated to rinse. The rinsing water is then discharged to the drain and the centrifuging operation is effected by rotating the basket and impeller together at relatively high speed. The rinsing operation may be repeated, followed by a final centrifuging operation.

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