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D. J. BARBULESCO ETAL
AUTOMATIC WASHER HAVING CONTROL MEANS REGULATING
THE SPEED AND TORQUE OF THE DRIVE MOTOR

3,018,649

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4 Sheets-Sheet 1

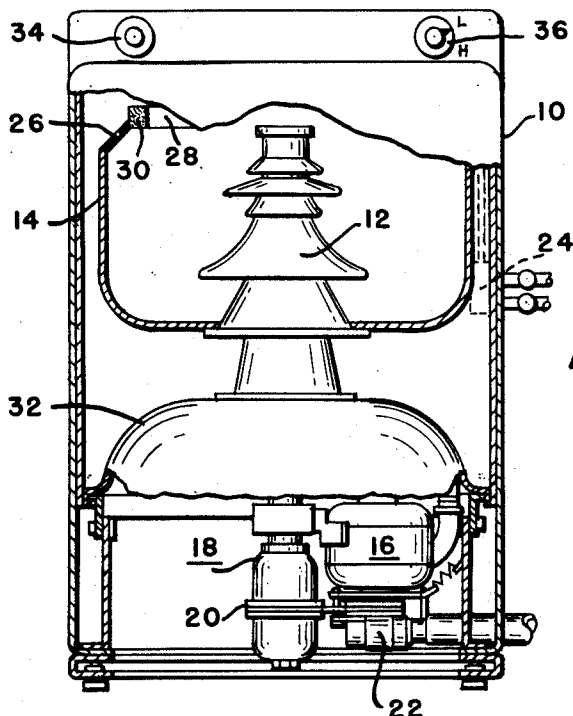


Fig. 1

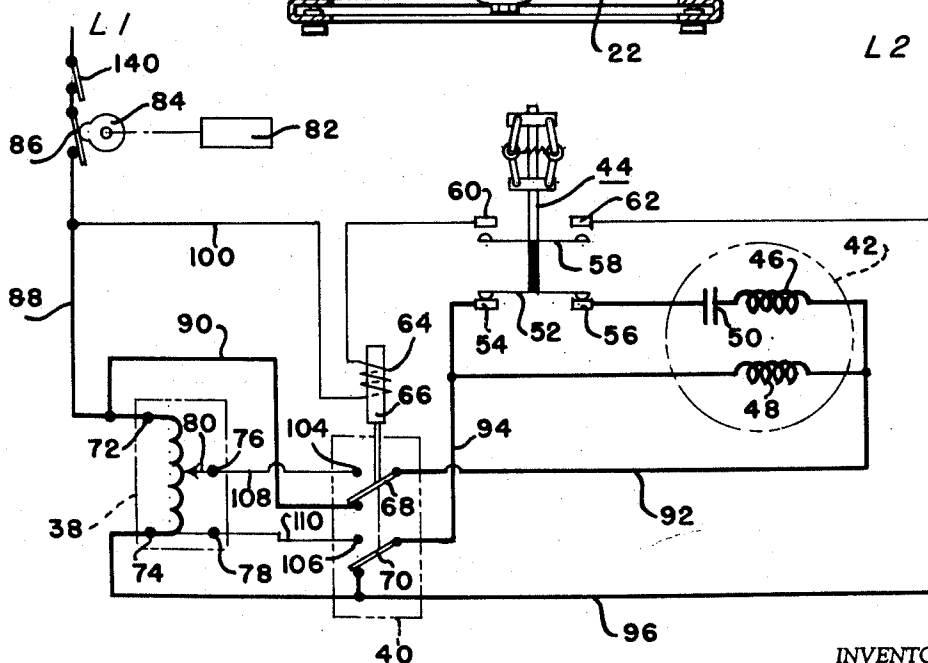


Fig. 2

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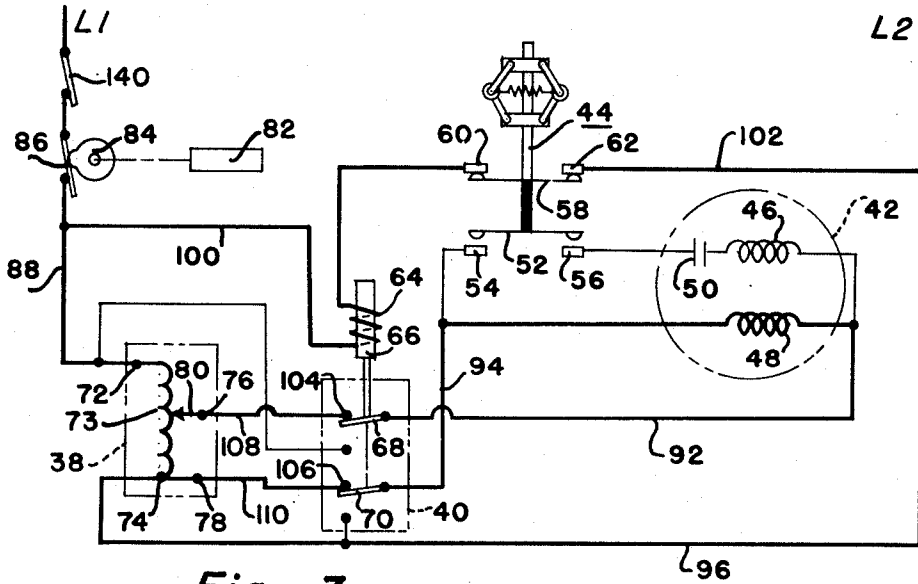


Fig. 3

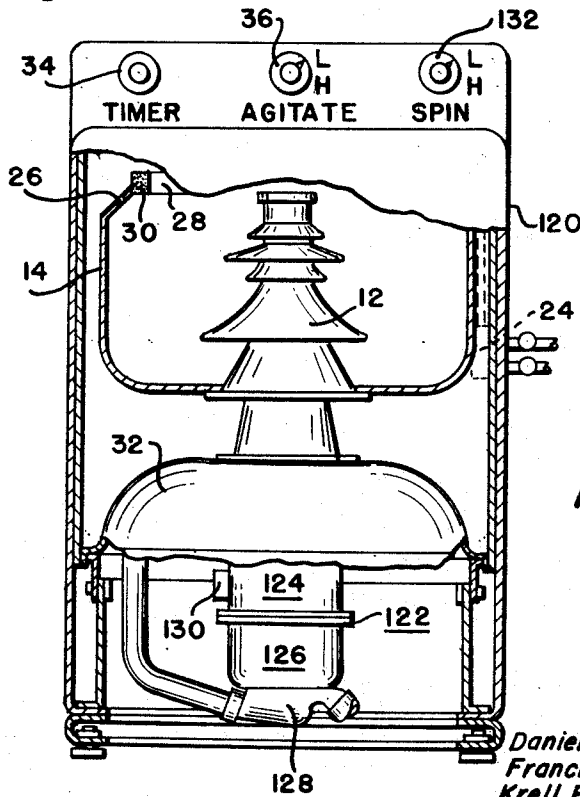


Fig. 4

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AUTOMATIC WASHER HAVING CONTROL MEANS REGULATING THE SPEED AND TORQUE OF THE DRIVE MOTOR

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This invention relates to a domestic appliance and more particularly to an improved clothes washing machine.

In the clothes washing art, past efforts have been directed primarily to a washing cycle in which the clothes were agitated in a washing solution to clean the clothes, rinsed in a clear solution, and dried in a centrifuging process. This procedure served the purpose so long as the clothing art utilized natural fabrics such as cotton. However, many man-made fabrics have been developed in recent years which are not best handled in a washing process utilizing procedures acceptable for the earlier natural fabric. For instance, some of the fabrics are so delicate that a regular speed agitation places an unwanted strain on the seams and fibers of the new fabrics. Also, a centrifuging or clothes wringing cycle, if carried out at speeds previously satisfactory, would cause wrinkles to be set in the new materials which are most difficult to remove. It thus has become apparent that a measure of flexibility is required in the design of clothes washing appliances to meet the varying characteristics of the material to be washed. The instant application discloses an improved washing machine in which the multiple speed agitation and spin action is accomplished with a conventional single speed motor controlled to operate at two or more speeds. On the other hand, copending application Serial No. 745,126 to Byron L. Brucken and Serial No. 745,152 to Bryon L. Brucken et al., filed concurrently herewith, are directed to such washing machines wherein the electrical control arrangement includes multi-speed motors.

Along with the desire for machine speed flexibility for different fabrics, there is also a need for a prime mover or driving arrangement which can automatically meet the speeds and torques presented by a varying washing machine load. For instance, during a centrifuging process wherein the clothes are damp-dried, the spin cycle begins with a spin tub full of water and wet clothing. The rotation of the spin tub is initiated from a stationary start wherein the maximum in torque effort is necessary to initiate the tub rotation. As the tub accelerates, most of the water is centrifuged from the tub and the torque required to rotate the tub at high speeds is substantially reduced. Past efforts have been directed to a shift arrangement between the prime mover and the washing machine mechanism which could adjust the power source for the required torque. This arrangement is cumbersome, costly and oftentimes noisy. It is here also proposed to provide an electrical shifting arrangement which will automatically adapt and condition a washing machine motor for the varying load conditions encountered in an improved clothes washing cycle.

Accordingly, it is an object of this invention to provide a laundry appliance having a plurality of agitation speeds and spin or centrifuging speeds.

It is also a provision of this invention that a plurality of washing machine agitation and spin speeds be effected through a conventional single speed motor which is controlled to operate at a plurality of speeds.

It is an additional object of this invention that an electrical motor for a clothes washing machine be electri-

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cally shifted to meet changing load conditions within the washing machine.

A more particular object is the provision of a motor control arrangement for a clothes washer wherein a centrifugal device automatically senses a changing load condition within the clothes washer and electrically shifts the motor windings to meet this load.

Also a particular object of this invention is the inclusion of a multi-speed agitation cycle in a clothes washing machine, the speed of which may be selectively changed by varying the voltage across the motor utilized to power said agitation.

Another object of this invention is the inclusion of a spin cycle in a clothes washing machine wherein multi-speed operation is acquired through a single speed motor adapted to be intermittently energized by a current sensitive device.

Also an object is the provision of a current sensing device which may be selectively adjusted in accordance with the operator's demands to meet a desired spinning or centrifuging speed.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a sectional view, with parts broken away, of a clothes washing machine adapted for reversible motor operation and for which this invention is suitable;

FIGURE 2 is a schematic wiring diagram of a portion of the control circuitry directed to varying the agitation speeds of a clothes washing machine, the diagram illustrating a motor start or stall situation;

FIGURE 3 is a view similar to the circuit of FIGURE 1 wherein the diagram illustrates a motor running situation;

FIGURE 4 is a sectional view, with parts broken away, of a clothes washing machine adapted for unidirectional motor operation and suitable for use with this invention;

FIGURE 5 is a schematic wiring diagram of the tub spin portion of a washing machine control circuit adapted for multi-speed operation, the diagram illustrating a motor in start condition;

FIGURE 6 is a schematic wiring diagram similar to FIGURE 5 illustrating a circuit situation during motor acceleration;

FIGURE 7 is a schematic wiring diagram similar to FIGURE 5 illustrating a circuit situation with the motor deenergized;

FIGURE 8 is a graph of operation speed characteristics for a motor adapted for use with this invention; and

FIGURE 9 is a schematic wiring diagram of a washing machine control circuit embodying both the multi-speed agitation and tub spinning features of this invention.

Note: Energized conductors in the drawings are shown as heavy lines.

In accordance with this invention, and with reference to FIG. 1, a washing machine 10 having an agitator 12 and a spin tub 14 is adapted to be powered by a single speed reversible motor 16. An agitating and spinning mechanism 18 of the type taught in the patent to Sisson, 2,758,685, issued August 14, 1956, is interposed between the motor 16 and the agitator 12 and spin tub 14. The motor 16 is a single phase, capacitor start, induction motor. With the motor 16 operating in one direction, the mechanism 18 is designed to effect a vertical reciprocation of the agitator 12. A reversal of motor rotation is transmitted through the mechanism 18 to initiate a spinning of tub 14. Other components of the washing machine 10 include a belt driving arrangement 20 for transmitting motion from motor 16 to the agitate and

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spinning mechanism 18, a pump 22 for removing water from the washing machine 10 to drain, and a water supply arrangement 24 for selectively admitting water to the spin tub 14 in accordance with well-known clothes washing practice. The spin tub 14 is formed with openings 26 about the periphery thereof which serve as passageways for water removed from the tub by the spinning thereof. An opening 28 serves to admit clothing to the interior of tub 14 and defines also a ballast ring 30 for stabilizing the spinning operation of the tub 14. Separating the motor 16 and the agitate and spinning mechanism 18 from the washing areas is a bulkhead 32. User control of the washing machine 10 is effected by means of a timer dial 34 of conventional design and an agitation speed control switch 36, the latter of which will be explained more fully hereinafter.

Briefly, the operation of the washing machine 10 is initiated after the placement of clothing within the tub 14 through the tub opening 28. Of course, a lid (not shown) is formed in the top of the machine 10 in line with the tub opening 28. The timer dial 34 is rotated to a position corresponding with the start of a washing cycle and, in accordance with general practice, pushed in to energize the circuit and start the timer motor. Water is automatically admitted to the tub 14 by way of the valve arrangement 24. In accordance with the pulsing action or sequential advance of the timer, the motor 16 will be energized to rotate in a direction to cause the mechanism 18 to reciprocate the agitator 12. The speed with which the agitator is reciprocated is determined by the setting of dial 36 in a manner to be described more clearly hereinafter. At the termination of the agitation portion of the wash cycle the motor 16 is reversed by the sequential advance of the timer, and spin tub 14 is in a clothes wringing centrifuging cycle. As tub 14 accelerates, water will leave the tub through passageways 26 from which point it will fall into the area above the bulkhead 32 for removal to drain. This procedure may be repeated or modified in accordance with the dictates of the timer design.

Reference may now be had to FIG. 2 wherein a full understanding may be gained of the circuit arrangement utilized to effect a multi-speed agitation from a single speed motor—a motor which is also electrically shifted to meet varying clothes washing load conditions during the agitation cycle. The circuit includes a voltage varying device or autotransformer 38, a double pole, double throw relay 40, a single speed motor 42 (equivalent to motor 16) and a centrifugal load sensing device 44. The motor 42 utilizes a phase or start winding 46 and a main or running winding 48. A capacitor 50 is included in series with the phase winding 46 in accordance with conventional motor design. The centrifugal device 44, shown schematically in the diagram, includes a moving contact bridge 52 for closing a circuit between start winding contacts 54 and 56. Moving with the bridging member 52 and insulated therefrom is a back contact bridging member 58 adapted to close a circuit across relay contacts 60 and 62. The relay 40 is of conventional design and includes an actuating coil 64 within which an armature 66 reciprocates to move a pair of switch blades 68 and 70. The voltage varying device or autotransformer 38 has input contacts 72 and 74 and output contacts 76 and 78. A movable regulator blade 80 is selectively positioned by the movement of dial 36 in accordance with the rate of speed desired by the operator for the agitation cycle—the lower the output voltage at 76, 78, the slower the agitation speed. Although the voltage varying device 38 has been described as an autotransformer which permits exacting voltage regulation, it should be understood that any fixed inductance or resistance could be utilized in conjunction with a selector switch to vary the voltage impressed across the motor 42, thereby to change the speed thereof.

The timer may be of the sequentially advancing type

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wherein a knob or dial 34 is pushed in to close switch 140 and energize the clothes washing circuit and a timer motor 82 (see FIGS. 1 and 2). In accordance with the movement of the timer motor 82 a series of cams similar to 84 are pulsed in a rotational movement to actuate a series of cam actuated timer switches such as 86. In the circuit of FIG. 2 an agitation cycle is initiated when cam 84 closes a timer switch 86. The phase winding 46 of motor 42 is thus energized from L₁ through the On/Off switch 140, the cam actuated switch 86, line 88, line 90, relay switch blade 68, line 92, phase winding 46, capacitor 50, start winding contact 56, centrifugal device bridging member 52, start winding contact 54, line 94, relay switch blade 70, line 96 to L₂. Similarly, the main winding 48 of motor 42 is energized from L₁, switches 140 and 86, line 88, line 90, relay switch blade 68, line 92, main winding 48, line 94, relay switch blade 70, line 96 to L₂. The input terminals 72, 74 of the autotransformer 38 are simultaneously energized with the energization of motor 42, but the positioning of switch blades 68 and 70 in the de-energized relay 40 effectually bypasses the output side of this voltage varying device 38. Thus, the motor 42 is energized for maximum torque and rated speed. As the motor accelerates, the centrifugal device 44 is motivated to lift bridging member 52 in breaking the start winding circuit at 54, 56 and to complete a circuit across relay contacts 60, 62 in accordance with the circuitry of FIG. 3.

With the FIG. 3 circuitry thus established, the relay coil 64 is energized from L₁, On/Off switch 140, timer switch 86, line 100, contact 60, bridging member 58, contact 62, line 102 to L₂. The armature 66 is actuated to move relay switch blade 68 against relay contact 104 and relay switch blade 70 against relay contact 106, thus placing the voltage control device 38 in control relationship with the motor 42. The autotransformer 38 continues to be energized from L₁ through the On/Off switch 140, cam actuated switch 86, line 88, inlet contact 72, coil 73, inlet contact 74, and line 96 to L₂. Depending on the positioning of the voltage regulator or selector switch 80 within the transformer 38, a particular voltage is impressed across the main winding 48 of motor 42 which is thus energized from transformer output terminal 76, line 108, relay switch blade 68, line 92, main winding 48, line 94, relay switch blade 70, line 110 to the other output terminal 78 of the voltage varying device 38.

If the motor 42 is an induction motor, the speed change which may be effected through a voltage varying arrangement is not great. Normally, the start windings of such motors are dropped out at 75 to 80% of the synchronous running speed of the motor. In this regard, therefore, the reduced voltage produced by the autotransformer 38 to operate motor 42 is such that a selected slow speed is maintained above that speed at which the start winding 46 is again returned to the circuit by the action of centrifugal device 44. It should be apparent that the slow agitation speed thus initiated by the energization of motor 42 through voltage controller 38 may have any r.p.m. speed value between the start winding drop-out speed and the synchronous speed of the motor. For this reason, the positioning of agitate speed dial 36 will control the transformer regulator switch 80 to effect the desired agitate speed as per the output voltage selected. In this relationship of parts, the agitation cycle of the washing machine will continue so long as the timer motor 82 and cam 84 have the agitation portion of the control circuit energized (FIG. 3). If, during agitation, a blockage or increased load occurs, tending to stall the reciprocation of agitator 12, the resistance encountered will be reflected in a reduced rotational speed for the drive motor 42. Since the motor and agitation speed is sensed by a centrifugal device 44, any noticeable reduction in speed will cause the bridging member 52 to again close a circuit across start winding contacts 54 and 56 and to open the low speed relay circuit at contacts 60, 62, thereby deenergizing the

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relay 40. Thus, the motor 42 is restored to a condition in which a maximum torque effort is effected. Both the start winding 46 and the main winding 48 are energized in accordance with the circuitry of FIG. 2 to aid in overcoming the blockage encountered by the agitator 12. As soon as the blockage or hindrance is surmounted, the motor 42 will again accelerate until the centrifugal device 44 actuates to drop out the start winding 46 and energize the relay 40 to reinstate the agitate speed selected on dial 36, in accordance with the circuitry of FIG. 3. Thus, it is seen that an agitate circuit switching arrangement is provided wherein a motor 42 is automatically switched between a condition wherein a maximum torque effort is provided to accomplish acceleration and to overcome increased load encountered by the agitator 12 to another lesser load condition wherein a small amount of torque and a lower operating speed are desired. No gear shifting arrangement or complicated control sensing mechanisms are required in this arrangement. The addition of back contacts to a centrifugal start winding drop-out device together with the novel arrangement of components here set forth provides the additional circuitry necessary to effect this load responsive multi-speed motor control. It should be apparent that the voltage regulating or selecting device 38 may be of any type and need not be variable, as is the autotransformer. A fixed resistance placed in the circuit in accordance with the positioning of speed selector 36 will work equally well but has the disadvantage of creating heat within the washing machine 10.

If the user wishes high speed agitation, the dial 36 is set accordingly. The transformer regulating switch 80 is thereby positioned to effect an output voltage equal to the line voltage across L_1 , L_2 and the transformer, in effect, is bypassed. If a fixed resistance is used, the dial 36 when set for high speed, merely bypasses the resistance and causes the motor 42 to be energized on line voltage. In this relationship the motor then operates at synchronous speed.

Another type of washing machine 120 with which this control is particularly effective is seen in FIG. 4 wherein similar components are given identical numbers to those illustrated in connection with FIG. 1. Whereas the Sisson mechanism in FIG. 1 is adapted to be rotated in one direction to effect an agitation, and in a reverse direction to effect a spin, the prime moving arrangement of the machine 120 is powered by a unidirectional motor. The mechanism is shown generally at 122 and taught more particularly in the patents to Clark, 2,346,152, issued April 11, 1944, and 2,725,118, issued November 29, 1955. As disclosed in these last-mentioned patents, the mechanism 122 includes an agitating and spinning portion 124 and a unidirectional single speed motor 126. As in the FIG. 1 clothes washer, a pump 128 is associated with the motor 126 to remove water collecting above the bulkhead 32. In the Clark mechanism, the motor 126 is designed to operate in one direction only to effect either an agitation or pulsing action of the agitator 12 and a spinning of the tub 14. A shift arrangement, more fully taught in the Clark patents, is actuated to initiate a spin cycle whenever a solenoid 130 is energized. In addition to the user control of pulsate speeds set forth in connection with FIG. 1, the FIG. 4 washing machine 120 is provided with a third control dial 132 for adjusting the speed at which the spin tub 14 will be rotated. It is obvious that multiple speed operation can be effected through the application of multi-speed motors to the agitating and spinning mechanism of a clothes washer. However, multi-speed motors are costly, and, in this respect, disadvantageous. This invention has sought to provide the desired speed flexibility without changing the motor utilized to drive the clothes washer. In the pulsation cycle explained hereinbefore, line voltage was used when high speed agitation was selected, and if slow speed was selected, the voltage impressed across the motor was reduced to provide a reduced operating speed and thus a reduced or slower rate of agitation. In

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the spin portion of the cycle, the full speed of the motor is utilized in a conventional manner for high speed spinning while low speed spin, in accordance with the concepts of this invention is obtained by selectively and intermittently cycling a motor to create a lower speed. This novel arrangement—utilized to electrically shift a single speed motor for two-speed operation—will be explained more fully in connection with FIGS. 5, 6, 7 and 8.

In FIG. 5, that portion of the control circuitry which is directed to controlling the spinning portion of the clothes washing cycle, is illustrated. The circuit includes a single-pole, double-throw speed selector switch 134, a hot wire relay 136, and a single speed motor 126. A solenoid 130 is included for conditioning the agitating and spinning mechanism 124 for a spinning operation of tub 14. The circuit includes also the On/Off switch 140 actuated by the pushing or pulling of timer dial 34, a lid switch 142 for preventing a spinning of tub 14 whenever the clothes loading door (not shown) is opened, and a spin cycle cam actuated timer switch 144 which is adapted to be closed by a cam 146 in accordance with the sequential positioning of the cam by timer motor 82. As the washing machine cycle progresses in accordance with a conventional timing operation, the cam 146 operates to close timer switch 144. Thus, the solenoid 130 is energized from L_1 , On/Off switch 140, lid switch 142, timer switch 144, line 148, solenoid coil 130 to L_2 . The agitate and spinning mechanism 124 is shifted so that the motor 126 is adapted to drive the spin tub 14 in a clothes wringing or centrifuging operation.

The speed selector switch 134 has a switch blade 150 which is positioned by the turning of spin dial 132. The switch 134 includes also a high speed spin contact 152 and a low speed spin contact 154. Conventional motor design is incorporated for motor 126 and includes a main winding 156, a start winding 158, a capacitor 160 and a centrifugal switch 162 adapted to drop out the start winding upon the attainment of a predetermined motor speed.

The hot wire relay 136 is taught more fully in the patent to Werner, 2,242,769, issued May 20, 1941. For the purposes of this disclosure, the relay 136 is comprised of a motor acceleration switch blade 164 and a motor cycling switch blade 166 loosely interconnected with the switch blade 164 by means of a joining strip 167. The Werner relay includes a hot wire 168 for sequentially actuating the switch blades 164 and 166. To the Werner switch has been added a shunt or resistance 170 of predetermined size to give the desired low speed spin. In this regard the shunt 170 together with the hot wire 168 provides a parallel flow path for the motor current and determines the point at which the acceleration switch blade 164 will open from contact 172. After switch blade 164 breaks from contact 172, the full current flow through the relay 136 will be in the hot wire 168, which then operates to open cycle switch 166 from its contact 174. It should be apparent that, with a given current flow through the relay 136, acceleration switch blade 164 will open at a delayed time after energization of the relay in accordance with the resistance utilized for 170. The duration of this delay period substantially determines that point in the acceleration of motor 126 that the cycling switch 166 becomes effective for low speed spin control.

Let us now assume the operator has selected high speed spin at the time the washing cycle is initiated on timer 34. Both the phase winding 158 and main winding 156 of the motor 126 will then be energized from L_1 through On/Off switch 140, lid switch 142, timer spin switch 144, line 176, speed selector switch blade 150, high speed spin contact 152, line 178, motor 126 to L_2 . The motor 126 will thus be accelerated in accordance with conventional design until a speed approximately 75 to 80% of its synchronous running speed, at which point the centrifugal switch 162 will open to drop out the phase winding 158. This operation, of course, is conventional motor operation in a clothes washer circuit.

However, where low speed spin is selected, the motor 126 is supplied with power by way of the hot wire relay 136, as seen in FIGS. 5 and 6. The spin selector solenoid 130 still remains energized and the switches 140, 142 and 144 remain closed in accordance with the spin cycle operation. With this circuitry established, the motor 126 is energized from L₁ through switches 140, 142 and 144, line 176, speed selector switch 150, line 180 to a contact 182 in the relay. To better understand the current flow through the hot wire relay 136, the following contact points will be defined. The acceleration switch blade 164 and cycling switch blade 166 are joined at a common junction-point 184. Biasing the switch blades 164 and 166 is a spring support 186 adapted to cause the over-center switch blades 164, 166 to open whenever hot wire 168 is elongated.

With reference to FIG. 5, the motor 126 is placed in the circuit receiving power from L₁, switches 140, 142 and 144, line 176, speed selector switch blade 150, line 180, hot wire relay 136, line 178, and motor 126 to L₂. Thus, motor current is introduced to the hot wire relay 136 at contact point 182 and is taken from the relay at contact 174. At the moment of energization current flowing to the motor 126 proceeds from relay contact 182 as follows: In a parallel relationship the current is divided between shunt 170 and the hot wire 168. For instance, current flows through the shunt 170, contact 172, acceleration switch blade 164 to the switch blade junction 184. Similarly, current flows from point 182, hot wire 168 and support 186 to the junction 184. The amount of current flowing through the hot wire 168 depends on the size of shunt 170, which will therefore set the rate at which wire 168 elongates in actuating the acceleration switch blade 164. From the junction 184 the current travels in the cycling switch blade 166 to the outflow contact 174. Immediately upon energization of the spin circuit, the hot wire 168 begins heating and expanding until the acceleration switch blade breaks the circuit completed with contact 172 (see FIG. 6). This takes the shunt 170 out of the current flow path and the entire current flow passes through the hot wire 168, the support 186, the cycling switch blade 166 to the outflow contact 174 of the relay 136. The motor 126 continues to be fed in this fashion until the hot wire 168 elongates sufficiently to break the circuit which cycling switch blade 166 makes with the outflow contact 174, as seen in FIG. 7. In this relationship, it is now obvious that the power circuit to the motor 126 has been completely interrupted and the motor will coast to a slower speed. During the period that the circuit is established in accordance with the illustration of FIG. 7, the hot wire 168 cools and contracts until the cycling switch blade 166 again makes the circuit on contact 174 to reenergize the motor 126 (see FIG. 6). So long as the low speed motor operation is desired, cycling switch blade 166 will make and break with contact 174, providing a pulsing operation which results in the low speed motor operation.

A better understanding of this form of two-speed spin operation with a single speed motor is believed best understood in connection with the graph of FIG. 8. It is only during high speed operation wherein the speed selector switch 150 is in contact with speed selector contact 152, that the motor 126 is operated in a manner to cause the start winding 158 to drop out upon the attainment of the speed sufficient to cause centrifugal switch 162 to open. So long as low speed is selected with selector switch blade 150 on contact 154, the motor 126 will operate with both the main winding 156 and the start winding 158 in the circuit. This produces maximum torque for the low speed spin operation. It should therefore be obvious that a slow speed spin must be selected which is below that point in the motor's acceleration at which the centrifugal switch 162 will open. Considering FIG. 8 for a motor having a synchronous running speed of approximately 1140 r.p.m., the sloping line 190 is generally representative

of the acceleration rate of any induction motor such as motor 126. If the speed selector 134 has been set for high speed operation, the motor 126 will accelerate along the curve 190 until the synchronous running speed of approximately 1140 r.p.m. has been reached. In this operation and in accordance with conventional motor operation, the centrifugal start winding to centrifugal switch 162 will cause the start winding 158 to drop out at approximately 900 r.p.m. The motor thus will continue to operate on the main winding 156 at its synchronous speed.

If, however, low speed has been selected, the hot wire relay is placed in series with the current supply for motor 126 and the power supply will be interrupted in accordance with the cycling of switch blade 166 making and breaking contact 174. Let us assume that a low speed spin operation of approximately 450 r.p.m. is desired for the spin tub 14. A shunt 170 must be selected which, when placed in parallel with the hot wire 168, will cause the acceleration switch blade 164 to maintain a closed circuit with contact 172, and cycling switch 166 a closed circuit with contact 174 for approximately eighteen seconds or that period which is necessary for the motor 126 to accelerate to approximately 500 r.p.m. as illustrated by point 192 on the graph of FIG. 8. At this instant the motor is deenergized and starts coasting along a deceleration segment 193 of the graph for approximately sixteen seconds until the cycling switch 166 again energizes the motor at approximately 400 r.p.m. The acceleration cycling segments 194 on the graph are indicative of the two-second time periods which it takes for the hot wire 168 to cause cycling switch 166 to break with contact 174 whenever the entire current supply for motor 126 flows through the hot wire 168 and during which the motor 126 is accelerating. Thus, the shunt 170 may be selected to cause the acceleration switch 164 to break with contact 172 after approximately sixteen seconds from the initial motor energization at about point 196 on the graph. The remaining two-second interval between point 196 and 192 in the initial acceleration of the motor relates to the period within which hot wire 168 operates when passing the entire current flow. With a shunt 170 selected to produce a 450 average r.p.m., the acceleration switch 164 opens at point 196 and the cycling switch 166 opens at point 192. At the point 192 motor 126 is deenergized and immediately decelerates for approximately 16 seconds until the laundry tub 14 is spinning at approximately 400 r.p.m. In this cool-off period the hot wire 168 contracts and cycling switch 166 again energizes the circuit, causing the motor 126 to accelerate quickly to 500 r.p.m. This cycling action pulses the motor 126 between 400 and 500 r.p.m. to effect an average spin speed of approximately 450 r.p.m. It should be noted that the inertia of the spinning tub 14 acts as a flywheel in smoothing out this cyclical operation. It should be equally obvious that any desired low speed spin may be obtained merely by the proper sizing of the shunt 170. For instance, a lower resistance for shunt 170 would cause the motor 126 to accelerate for a longer period, for example, to a point 198 on the graph, at which point the relay switches 164 and 166 would have interrupted the circuit to initiate the cycling action for the motor. With a lower resistance 170, therefore, a higher average low spin speed is obtainable. It is within the purview of this invention to give the operator an infinite speed selection for the spin cycle by including a variable resistance for the shunt 170. However, for practical use a fixed resistance has been found successful to give a predetermined low speed spin.

FIG. 9 is illustrative of a circuit combining the foregoing novel approaches to variable spin and agitation speeds for clothes washers. The circuitry of FIG. 9 is applicable to the washing machine 120 of FIG. 4 and to the agitate and spinning mechanism 122, best taught in the patents to Clark. Those portions of the washing machine control circuit directed to dispensing and water flow control, have been omitted. Only that circuitry

necessary for operating a multiple speed agitation and a multiple speed spin, have been included. Let us assume, now, that an operator has selected low speed agitation and high speed spin. The dial 36 is positioned to place the switch 80 on the transformer 38 to place a reduced voltage across the motor 126. In accordance with conventional design, the pushing-in of dial 34 closes the On/Off switch 140. This completes a circuit to energize the timer motor 82 which acts to sequentially position the timer actuated switches 84, 85, 144, 145. During the agitation portion of the washing cycle the cam actuated switches 84, 85 are closed and the cam actuated switches 144, 145 are open. During the agitation cycle, the motor 126 is thus energized in accordance with the disclosure hereinbefore in connection with FIGS. 2 and 3. As the timer motor 82 progresses, the agitation cycle will be interrupted with the opening of timer switches 84 and 85. At the initiation of the spin cycle, the timer switches 144 and 145 will be closed and the motor 126 will again be energized in accordance with the speed selection on switch 134. With the switch 134 set for high speed spin operation, the motor 126 will be energized from L₁, On/Off switch 140, line 202, lid switch 142, cam actuated switch 145, line 204, selector switch blade 150, line 178, line 206, timer switch blade 144, line 208, line 210, motor 126, relay switch blade 70, line 212 to L₂. This motor operation will continue so long as timer switches 144 and 145 are closed. At the same time, the solenoid 130 is energized to adapt the agitate and spin mechanism 122 for a spin operation whenever the spin switches 144 and 145 energize the spin circuit. A low speed spin selection on switch 134, in accordance with dial 132, has been set forth previously in connection with FIGS. 5, 6, 7 and 8 and need not be reemphasized at this point.

It should now be obvious that a novel washing machine control circuit has been provided wherein multiple speed operation is effected through a conventional single-speed motor. Also, an automatic electrical control has been set forth wherein the motor is automatically conditioned to meet a varying washing machine load. Furthermore, a speed sensitive device has been utilized to sense a changed load situation during agitation, and a current sensitive device to sense the motor current flow during the spin portion of the wash cycle. This electrical approach to switching a washing machine motor in accordance with the user's operational speed desire and the load situations within the appliance is believed to present an advance in the art which will simplify and improve washing machine control circuitry.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a washing machine having a tub, means for spinning said tub, said means including a spin mechanism and a motor connected directly to said mechanism and adapted to multi-speed operation and a control circuit, said motor having a plurality of windings and centrifugally actuated means for deenergizing one of said windings, said circuit including means for initiating a spin cycle by energizing said windings for high speed, high torque operation to bring the spin speed up to a predetermined value, and means for automatically selectively controlling said windings for low speed, high torque operation at a delayed time after initiation of said spin cycle.

2. In a laundry appliance having a container, means for rotating said container, said means including a single speed motor adapted for multi-speed operation and a control circuit, said circuit including means for initiating a rotation by energizing said motor for high speed, high torque operation to bring the rotating speed up to a predetermined value, and means operative at a delayed time after initiation for current sensitively energizing and deenergizing said motor for low speed.

3. In a control circuit for a washing machine fabric retaining tub having an agitate and spinning mechanism for agitating said fabric and spinning said tub and a motor connected directly to said mechanism and having a plurality of windings adapted to operate under a plurality of load conditions in accordance with the amount and type of fabrics in said tub, means for energizing said motor for one of said load conditions, and means operative in response to another of said load conditions automatically selectively to energize and deenergize said windings to operate under another of said load conditions.

4. In a washing machine having agitate and spin portions adapted for multi-speed operation, means for actuating one of said portions, said means including an actuating mechanism, a motor connected directly to said actuating mechanism and a control circuit, said motor having a plurality of operating speeds, said control circuit including a timer switch, a speed selector switch and a current sensitive switch in series electrical flow relationship with said motor, said timer switch operating to initiate an actuation of one of said portions, said speed selector switch preset to energize said motor for one of said operating speeds and said current sensitive switch, at a delayed time after initiation of said actuation, selectively energizing and deenergizing said motor for another of said operating speeds.

5. In an appliance having a wash portion adapted for multi-speed operation, means for actuating said portion throughout a plurality of load conditions, said means including a motor connected directly to said actuating means and adapted for multi-speed operation and a control circuit, said circuit including means for initiating an actuation for one of said load conditions by energizing said motor for high speed, high torque operation to bring the actuation speed up to a predetermined value, a speed selector switch and means for centrifugally connecting said motor in series with said speed selector switch for low speed, low torque operation at a delayed time after initiation of said actuation, said last named means adapted to reconnect said motor for high torque operation in response to another of said load conditions.

6. In a washing machine having a tub and an agitator, means for agitating said agitator and spinning said tub, said means including an agitate and spin mechanism, a motor directly connected to said mechanism and having a plurality of windings and an electrical control circuit, said circuit including an agitate circuit portion and a spin circuit portion, said agitate portion including a first timer switch, an agitate speed selector means in series with said timer switch and selectively in series with said motor, and a speed sensitive switch means in series with said timer switch and one of said windings, said spin portion including a second timer switch, a spin speed selector switch and a motor current sensitive switch in series electrical flow relationship with said motor, and means selectively operating said timer switches to energize said motor for one speed through one of said portions, said speed sensitive switch means, at a delayed time after the energization of said agitate portion, deenergizing said one of said windings and placing said agitate speed selector switch in series with another of said windings to energize said motor for another speed, and said current sensitive switch, at a delayed time after the energization of said spin portion, selectively energizing and deenergizing said motor for another speed.

7. In a washing machine having a tub and an agitator, means for agitating said agitator and spinning said tub, said means including a motor having first and second windings and an electrical control circuit, said circuit including an agitate circuit portion and a spin circuit portion, said agitate portion including a first set of timer switches, a manually presettable agitate speed selector switch selectively in series with said second winding and one of said first set of timer switches, and an automatically centrifugally actuated switch means in se-

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ries with said first winding and one of said first set of timer switches, said spin portion including a second set of timer switches, a manually presettable spin speed selector switch and a hot wire relay in series electrical flow relationship with said motor, and means selectively operating said timer switches to energize said motor for one speed through one of said portions, said centrifugally actuated switch means, at a delayed time after the energization of said agitate portion, selectively deenergizing said first winding and placing said agitate speed selector switch in series with said second winding to obtain a reduced agitate speed, and said hot wire relay, at a delayed time after the energization of said spin portion, selectively energizing and deenergizing said motor to obtain a reduced spin speed.

8. In a washing machine having a tub and an agitator, means for agitating said agitator and spinning said tub, said means including a motor having first and second windings and an electrical control circuit, said circuit including an agitate circuit portion and a spin circuit portion, said agitate portion including a first set of timer switches, a manually presettable agitate speed selector switch selectively in series with said second winding and one of said first set of timer switches, and an automatically centrifugally actuated switch means in series with said first winding and one of said first set of timer switches, said spin portion including a second set of timer switches, a manually presettable spin speed selector switch and a hot wire relay in series electrical flow relationship with said motor, and means selectively operating said timer switches to energize said motor for one speed through one of said portions, said centrifugally actuated switch means, at a delayed time after the energization of said agitate portion, selectively shifting from a position wherein said first winding is energized to a position wherein said first winding is deenergized and said agitate speed selector switch is placed in series with said second winding to obtain a reduced agitate speed, and said hot wire relay, at a delayed time after the energization of said spin portion, selectively energizing and deenergizing said motor to obtain a reduced spin speed.

9. In a washing machine having a tub and agitator, means for agitating said agitator and spinning said tub, said means including an agitate and spin mechanism, a motor connected to said mechanism and having a plurality of windings and an electrical control circuit, said circuit including an agitate circuit portion and a spin circuit portion, said agitate portion including a first timer switch, an agitate speed selector means in series with said timer switch and selectively in series with said motor, and a speed sensitive switch means in series with said timer switch and one of said windings, said spin por-

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tion including a second timer switch, a spin speed selector switch and a current sensitive switch in series electrical flow relationship with said motor, and means selectively operating said timer switches to energize said motor for one speed through one of said portions, said speed sensitive switch means, at a delayed time after the energization of said agitate portion, deenergizing said at least one of said windings and placing said agitate speed selector switch in series with another of said windings to energize said motor for another speed, and said current sensitive switch, at a delayed time after the energization of said spin portion, selectively energizing and deenergizing said motor for another speed.

10. In a washing machine having an agitator, means for agitating said agitator, said means including an agitate mechanism, a motor directly connected to said mechanism and having a plurality of windings and an electrical control circuit, said circuit including a timer switch, an agitate speed selector means in series with said timer switch and selectively in series with said motor, and a speed sensitive switch means in series with said timer switch and one of said windings, and means selectively operating said timer switch to energize said motor for one speed, said speed sensitive switch means, at a delayed time after the energization of said agitating means, deenergizing said one of said windings and placing said agitate speed selector switch in series with another of said windings to energize said motor for another speed.

11. In a washing machine having a tub, means for spinning said tub, said means including a spin mechanism, a motor directly connected to said mechanism and having a plurality of windings and an electrical control circuit, said circuit including a timer switch, a spin speed selector switch and a current sensitive switch in series electrical flow relationship with said motor, and means selectively operating said timer switch to energize said motor for one speed, and said current sensitive switch, at a delayed time after the energization of said spinning means, selectively energizing and deenergizing said motor for another speed.

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