

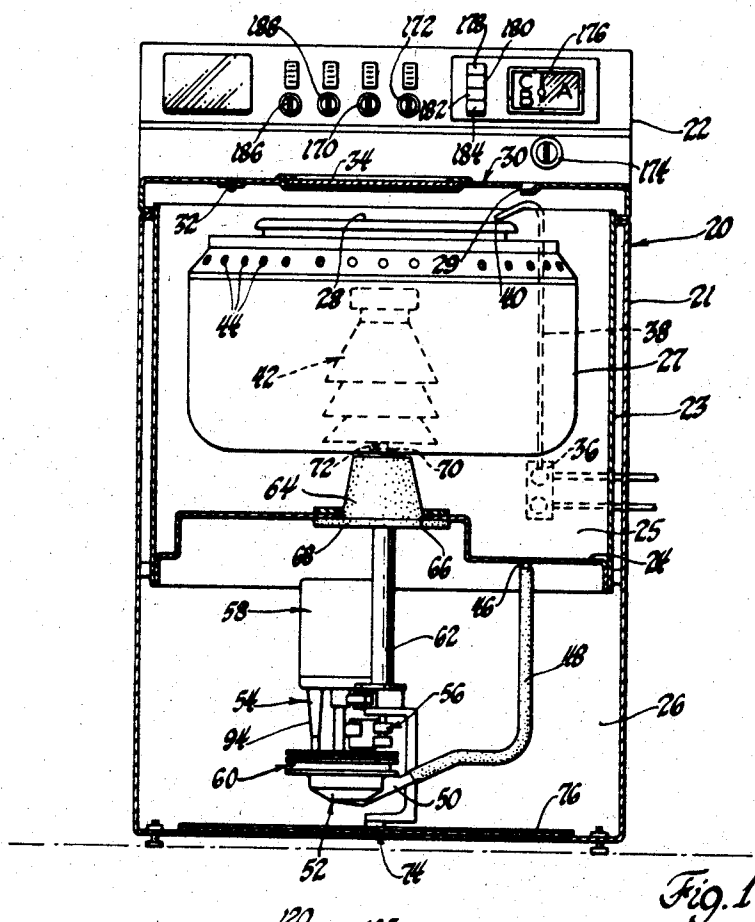
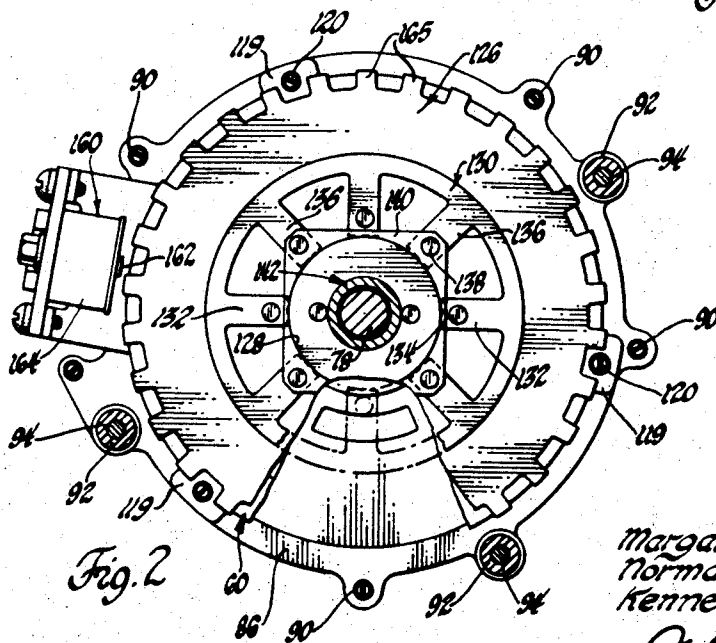
Oct. 1, 1968

M. J. ANDREW ET AL  
AUTOMATIC CLOTHES WASHING APPARATUS WITH  
IMPROVED AGITATION CONTROL

3,403,538

Filed Sept. 26, 1966

4 Sheets-Sheet 1



INVENTORS  
Margaret J. Andrew  
Norman J. Bullock, Jr.  
Kenneth O. Sisson  
J. C. Evans  
ATTORNEY

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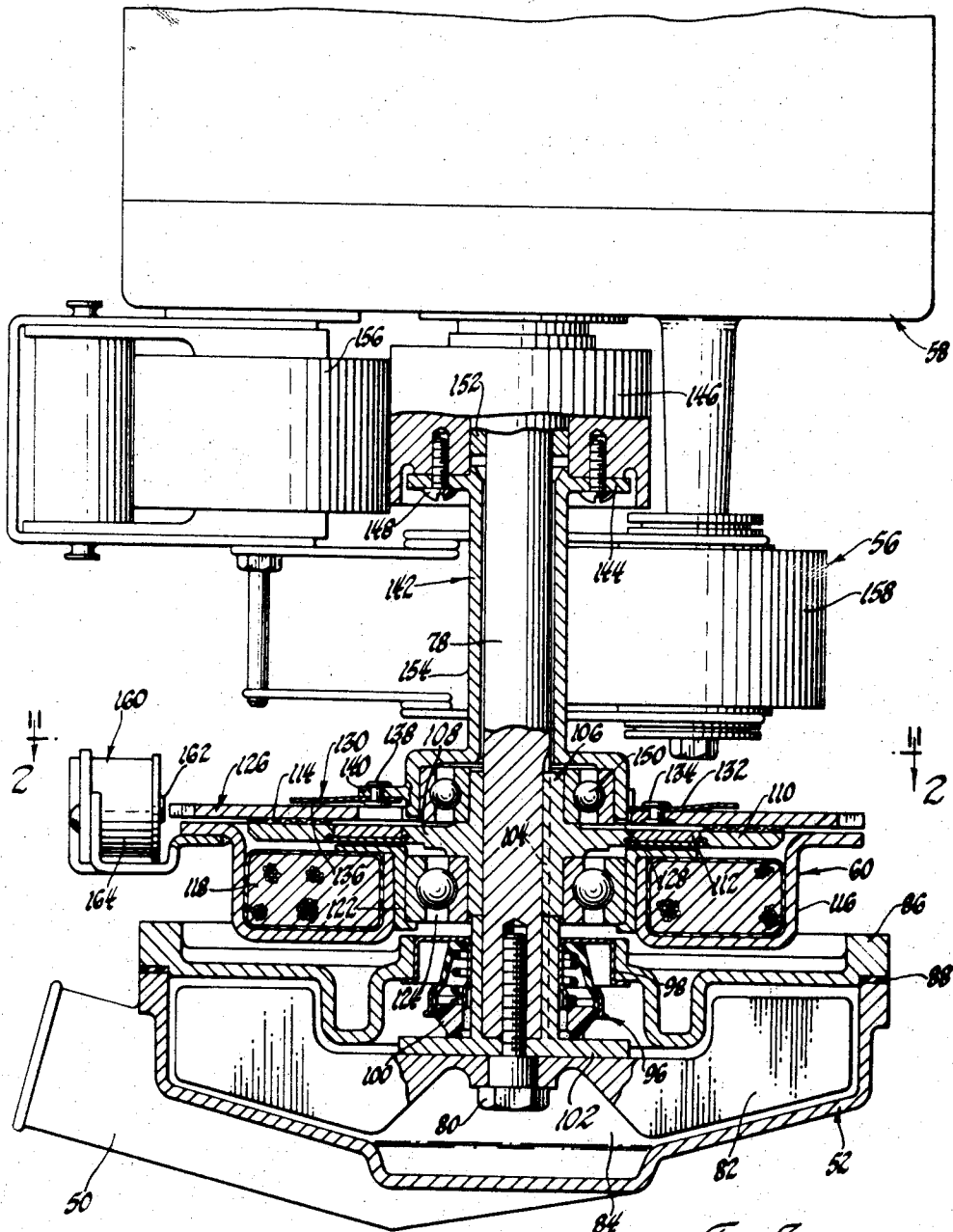


Fig. 3

INVENTORS  
Margaret J. Andrew  
Norman J. Bullock, &  
Kenneth O. Sisson  
J. C. Evans  
ATTORNEY

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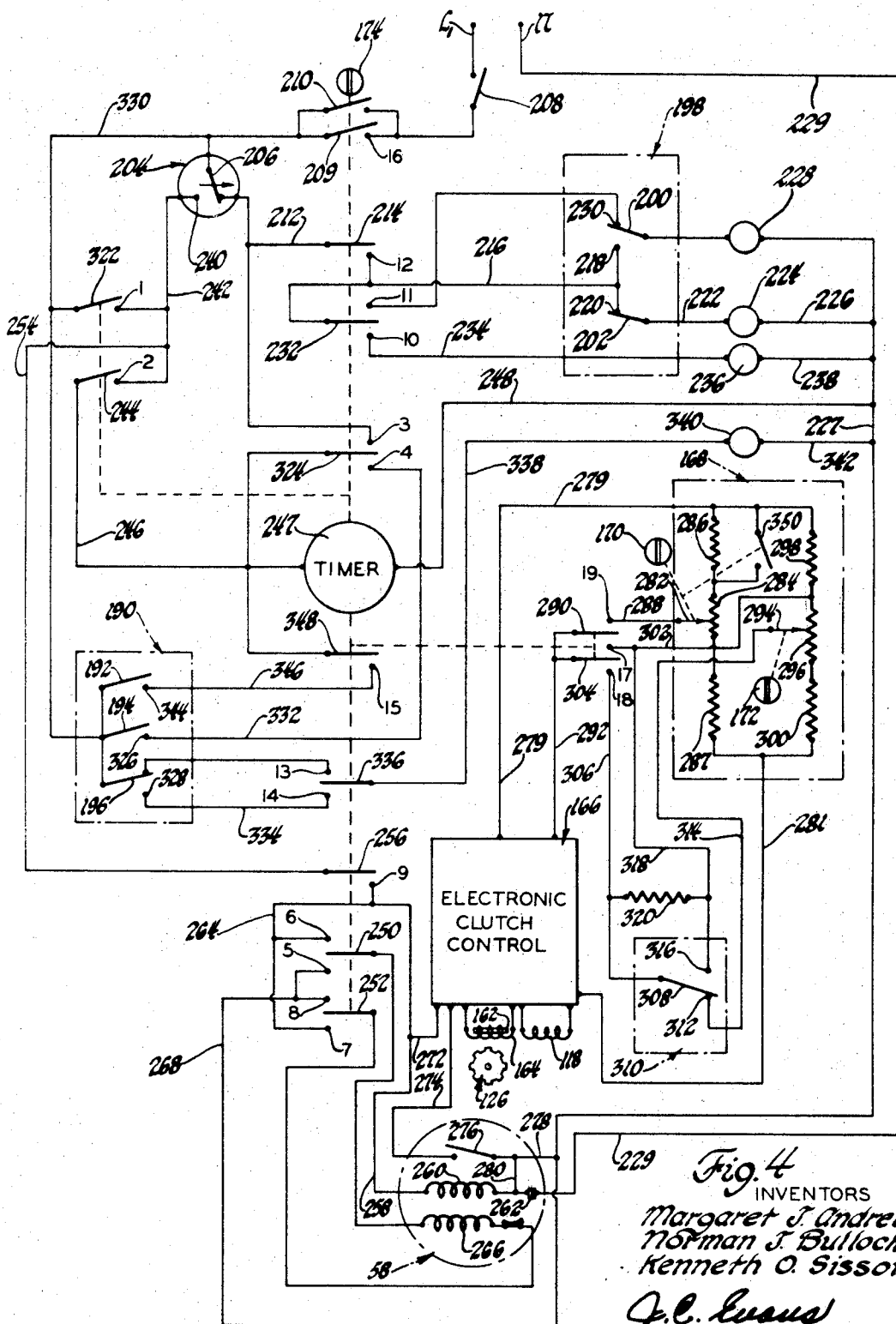


Fig. 4  
INVENTORS  
Margaret J. Andrew  
Norman J. Bullock  
Kenneth O. Sisson  
J. C. Evans  
ATTORNEY

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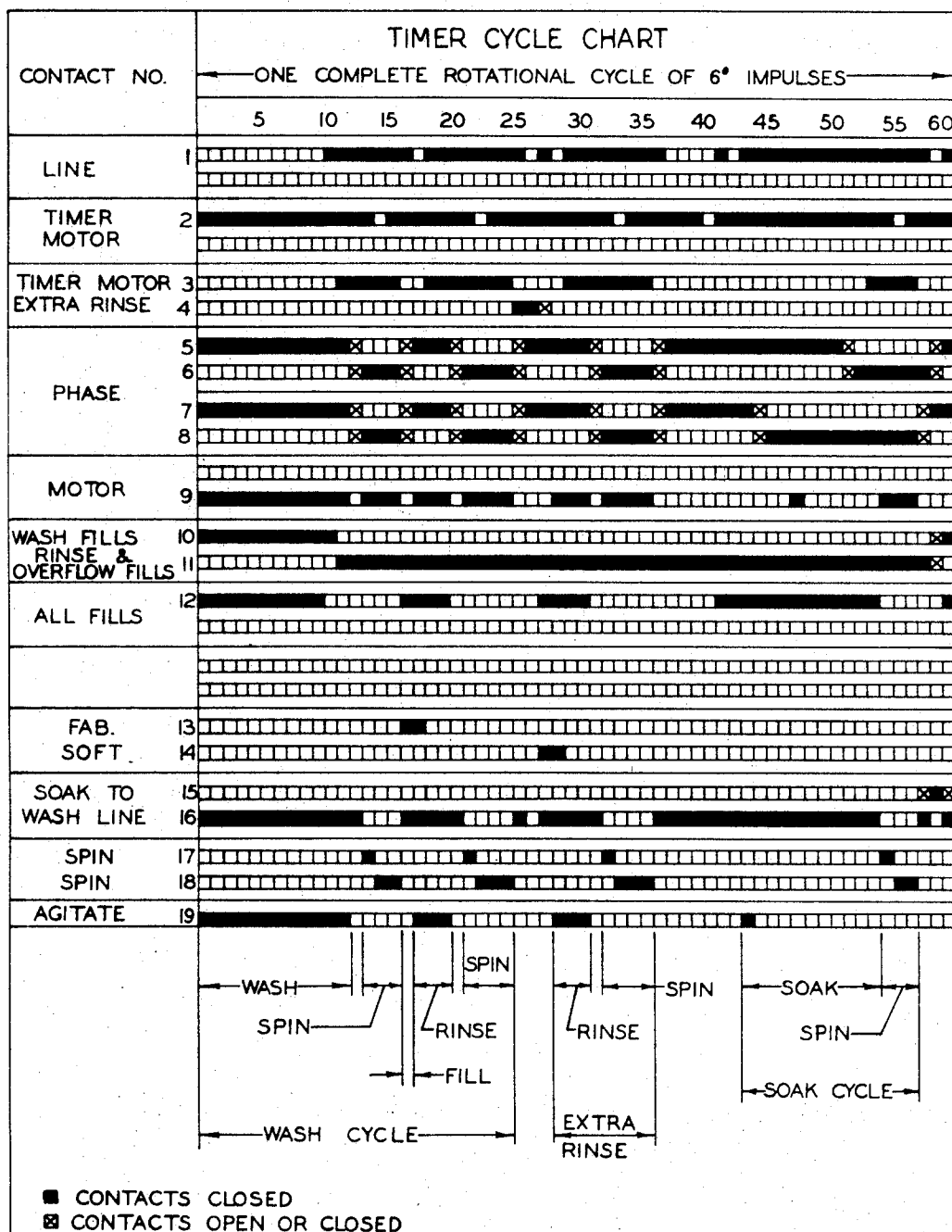


Fig. 5

INVENTORS  
Margaret J. Andrew  
Norman J. Bullock, &  
Kenneth O. Sisson  
J. C. Evans  
ATTORNEY

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3,403,538

## AUTOMATIC CLOTHES WASHING APPARATUS WITH IMPROVED AGITATION CONTROL

Margaret J. Andrew, Norman J. Bullock, and Kenneth J. Sisson, Dayton, Ohio, assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware  
Filed Sept. 26, 1966, Ser. No. 581,805  
14 Claims. (Cl. 68—12)

### ABSTRACT OF THE DISCLOSURE

In preferred form, an automatically controlled domestic washing apparatus having a spin tub and an agitator, a system for operating the tub and agitator including a reversible electric motor and a power transmission including a magnetic slip clutch between the motor and the transmission, a control system for conditioning the electric motor and the slip clutch to produce different washer operating cycles, the control means including a sequence time controller, an electronic control module and a pre-settable selector control that are interrelated and operated to produce either a soak-wash or agitating wash during the same predetermined number of timer controlled impulses of a given part of the operating cycle.

This invention is directed to automatically controlled domestic washing apparatus and more particularly, to clothes washing apparatus having pulsator means for surging cleaning fluid through articles for removing soil therefrom.

In the operation of automatic clothes washing apparatus of the type including a pulsator or agitator for surging cleaning fluid through articles being processed, it is desirable to control the operation of the pulsator to produce a range of cleaning effects suited for the different types of articles.

An example of an automatic clothes washing apparatus including means for variably controlling the cleaning action of a pulsator therein is set forth in the United States Patent No. 3,152,463 to Sones et al. In this system, during a predetermined washing cycle of operation, a user control is present for varying the rate of pulsation of clothes agitating means to process different types of articles made of different kinds of fabrics. However, in this system, during the washing cycle of operation, there is always a predetermined minimal level of agitation present that can cause shrinkage, matting or wear in certain normally handwashable articles such as sheer hose, lingerie, wool fabrics, sweaters, and the like.

An object of the present invention, therefore, is to improve an automatic clothes washer apparatus including a timer driven sequence controller operative to condition operating means in the machine for carrying out automatically sequenced agitation and spin phases of operation and wherein pre-settable user control means are selectively operative in conjunction with the timer sequence controller to condition said operating means to produce a "soak wash" operation during a normal agitation phase in the automatic control sequence.

A further object of the present invention is to improve automatic washing apparatus including means for agitating articles to be cleaned, means for extracting fluid therefrom and sequential control means for establishing an automatic control sequence of operation including a series of washing and fluid extracting phases by the provision of means associated with the sequential control means for preventing agitation of articles by said pulsator during at

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least one of the agitate washing phases in the automatically controlled sequence of operation.

Another object of the present invention is to improve clothes washing apparatus of the type including a container adapted to receive articles, pulsator means for surging fluid through the articles in the container and means to extract fluid from the articles and wherein the pulsator and fluid extraction means are operated by energizable prime mover means by the provision of sequence control means for sequentially operating said pulsator means and fluid extraction means through an automatically advanced cycle of operation including a wash phase followed by a first fluid extraction phase and a subsequent rinse phase followed by a final fluid extraction phase of operation wherein during both the wash and rinse phases the pulsator means is normally operative to surge fluid through the articles being cleaned and by the further provision of pre-settable user control means operatively associated with said sequence control means to selectively prevent pulsator agitation of articles in the container so as to produce a "soak wash" action thereon during a normal wash phase of operation.

Still another object of the present invention is to improve domestic washing apparatus of the type including means for automatically directing cleaning fluid into contact with articles to be cleaned, and operating means including means for agitating the articles in the presence of the cleaning fluid and means for extracting the cleaning fluid therefrom by the provision of sequence control means normally operative to automatically condition said fluid supply means and operating means to produce a series of operations including a wash phase, a fluid extracting phase, and a subsequent refilling or rinse phase of operation and wherein the sequence control means includes user selector means for selectively conditioning said operating means during the automatically controlled sequence of operation to produce clothes agitation or soaking during the same wash phase in the automatically controlled sequence.

Yet another object of the present invention is to improve article cleaning apparatus by the provision of a pulsator speed control system including a pulsator, means for driving the pulsator at variable speeds and user control means for conditioning the drive means to one of a plurality of speeds of operation and wherein transparent door closure means are included for directly viewing the pulsator in the clothes washing apparatus whereby the user can visually set a given pulsating action.

Still another object of the present invention is to improve an infinite speed clothes washer of the type including variable speed drive means for maintaining a predetermined agitation action during a washing phase of operation and a predetermined spin speed during a fluid extraction phase of operation in the washer and wherein the variable speed drive means is maintained at a predetermined output speed norm by control means including pre-settable user agitate and spin speed controllers by the provision of sequence control means associated with the speed controller operative to condition the variable speed drive means to selectively operate the agitate and spin means through an automatically controlled cycle of operation and wherein pre-settable selector means are present to condition the variable speed drive means to prevent agitation during a washing in the automatically controlled cycle.

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

In the drawings:

FIGURE 1 is a view in vertical section of an automatic clothes washing apparatus including the present invention;

FIGURE 2 is a view in horizontal section taken along the line 2—2 of FIGURE 3;

FIGURE 3 is an enlarged fragmentary view, partially in section and partially in elevation of a drive mechanism in the washer of FIGURE 1;

FIGURE 4 is a diagrammatic view of an electrical control circuit of the present invention;

FIGURE 5 is a timer cycle chart showing the operative phases of the washer of the present invention.

Referring now to FIGURE 1, a clothes washer 20 is illustrated including an outer casing 21 having a rearwardly located upper control panel 22 thereon. Within the outer casing 21 is located a cylindrical water container 23 having a bottom bulkhead 24 that separates a water collection space 25 from a lower mechanism compartment 26. Within the water collection space 25 is located a rotatable clothes containing spin tub 27 which has a top opening 28 therein located in alignment with a top loading port 29 in the outer casing 21 that is closed by a door 30 pivotally mounted at 32 for movement upwardly of the top of the outer casing 21. The door 30 further includes a transparent window 34 therein that serves when the door 30 is closed as a means for viewing the action of clothes suds, and cleaning fluid in the interior of the spin tub 27 during the operation of the washer 20.

The washer 20 includes a water supply system having a hot and cold water solenoid operated mixing valve 36 connected to a household water supply and to a supply conduit 38 which terminates in a chute 40 overlying the opening 28 into the spin tub 27. Within the spin tub 27 is located an agitator or pulsator 42 that is adapted to be reciprocated vertically to circulate or surge the water admitted by the water supply conduit 38. Thus, clothes or other articles placed within the tub 27 are washed as the agitator 42 forces surging toroidal currents of washing fluid and detergent through the fabric of the material. Following a predetermined period wherein the agitator 42 is operated, the spin tub 27 is rotated about its axis whereby washing fluid therein is centrifugally extracted through ports 44 to be discharged into the water collecting space 25 from whence it is drained through an outlet fitting 46 connected to a drain conduit 48 that supplies the inlet 50 of a drain pump 52 having the outlet thereof connected to a household drain or the like exteriorly of the cabinet 21.

In the illustrated arrangement, the agitator 42 and spin tub 27 are operated through the agitation and fluid extraction phases of operation by a drive mechanism 54 which is of a type more specifically set forth in copending United States application Ser. No. 511,194, filed Dec. 2, 1966, by Brucken et al., now Patent No. 3,328,983. The mechanism 54 includes a friction roller drive assembly 56 driven by a reversible electric motor 58 through a magnetically operated slip clutch 60. More particularly, in the illustrated arrangement, the roller drive assembly 56 includes a vertically oriented shaft housing 62 that is connected at an upper end to an inverted resilient cup-shaped support member 64 supported on the bulkhead 24 around an opening 66 therethrough which is sealed against water leakage by a suitable annular gasket 68. The shaft housing 62 encloses a tubular spin shaft 70 which is secured to the base of the spin tub 27. Directed co-axially within the spin shaft 70 is located an agitator shaft 72 that is secured to the agitator 42 for producing vertical reciprocation thereof. In order to damp excessive gyrating movement of the lower end of the drive mechanism 54, a snubber device 74 of a type more specifically set forth in copending application Ser. No. 430,266, filed Feb. 4, 1965, is supported between the drive mechanism 54 and the base 76 of the outer cabinet 21 to produce a predetermined degree of frictional restraint therebetween.

Referring now to FIGURE 3, a portion of the drive mechanism 54 is illustrated including the lower part of the reversible electric motor 58. The motor 58 in one working embodiment is a  $\frac{1}{3}$  horsepower split phase four pole unit with a built-in automatic reset type thermal overload protector. The motor 58 has a depending drive shaft 78 which is connected by a bolt 80 at its lower end to an impeller 82 located within a pumping chamber 84 of the drain pump 52. The pump 52 has a cover plate 86 secured thereon which is sealed at its outer periphery by an annular seal ring 88 supported on the upper peripheral edge of the housing of the pump 52 that forms a pumping chamber 84. In the illustrated arrangement, the cover 86 is secured to the pump housing by a plurality of screws 90 and the pump is suspended from the base of the motor 58 by upwardly directed posts 92 secured to the pump housing by elongated screws 94 as best seen in FIGURES 1 and 2. The pump cover 86 is sealed at the shaft opening therethrough by a pump seal assembly 96 secured to the top 86 in the opening therethrough by an inverted cup-shaped retainer member 98 so as to locate a sealing face 100 in sealing engagement with a rotatable sealing member 102 secured to the end of the shaft 78 by a key member 104.

The key member 104 also secures a bearing retaining hub 106 of a clutch driver 108 in the magnetic slip clutch assembly 60 to the shaft 78 whereby torque is supplied from the motor 58 to the slip clutch 60. The clutch driver 108 has a radially outwardly directed plate portion 110 in which are located a plurality of circumferentially spaced insert members or pads 112 of a suitable magnetic material. On the outer periphery of the driver plate 110 is bonded a friction liner member 114 of a suitable frictional material such as cork. Below the clutch driver plate 108 is located a coil housing 116 in which is located a coil winding 118 of the slip clutch 60. The housing 116, as best seen in FIGURE 2, has a plurality of circumferentially spaced radially outwardly directed tabs 119 thereon which are secured to upwardly directed posts 120 on the pump cover 86. The coil 118 is held in place in the coil housing by a retainer member 122 that forms a seat for a lower ball-bearing assembly 124 that guides the lower end of the drive shaft 78 for rotation with respect to the pump cover 86.

The magnetic clutch assembly 60 further includes a driven plate 126 that overlies the friction lining 114 on the clutch driver 108. The driven plate 126 has a central opening 128 therethrough about which a clutch spring 130 is disposed. As best seen in FIGURE 2, the clutch spring 130 includes a first plurality of radially inwardly directed fingers 132 that are secured by suitable fastening means such as rivets 134 to the inner periphery of the driven clutch ring 126. The spring member 130 also includes a plurality of circumferentially spaced radially inwardly directed fingers 136 that are secured by suitable fastening means such as rivets 138 to a peripheral flange 140 on the end of an elongated tubular drive member 142 through which the drive shaft 78 is directed as best seen in FIGURE 3.

The upper end of the drive member 142 has a flange 144 thereon that is fastened to a spin drive cylinder 146 by suitable means such as screws 148. The lower end of the drive member 142 encloses a ball bearing assembly 150 that guides the driver 142 for relative rotation with respect to the drive shaft 78. In the illustrated arrangement, the ball bearing assembly 150 is supported by the hub 106 of the clutch driver 108. The upper end of the drive shaft 78 is rotatably guided by a bushing 152 located centrally of an opening through the spin cylinder 146.

In the illustrated arrangement, when the coil 118 is energized, a magnetic circuit is completed through the coil housing 116, the coil retainer 122, the magnetic inserts 112, the driven plate 126 of the clutch 60, thence back to the coil housing 116. Depending upon the level

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of energization of the clutch 118, the magnetic circuit will produce a greater or lesser attraction of the driven clutch plate 126 toward the clutch drive plate 108 whereby the driven plate 126 of the clutch will be moved axially along the shaft 78 against a restoring force present in the clutch spring 130. The driven plate 126 is thereby located in frictional engagement with the liner 114 on the clutch driver 108 whereby torque from the drive shaft 78 will be transferred to the drive member 142 and the spin cylinder 146 of the friction roller drive mechanism 56.

As is more specifically pointed out in the copending Brucken et al. patent application Ser. No. 511,194, the friction roller mechanism 56 includes in addition to the spin cylinder 146 a small diameter surface 154 on the drive member 142. In the same general plane as the spin cylinder 146 is located, a self-energizing spin roller or idler 156 that is operative depending upon the direction of rotation of the reversible motor 58 to frictionally engage the spin cylinder 146 and a spin wheel assembly of the friction roller drive mechanism 56 whereby the spin shaft 70 will be rotated to carry out a predetermined rotation of the spin tub 27 for extracting fluid therefrom during a spin phase of operation of the machine. Likewise, a small diameter portion 154 is located adjacent an agitate roller or idler 158 which is self-energizing upon a predetermined direction of rotation of the shaft 78 to frictionally engage an agitate wheel assembly of the friction roller drive mechanism 56 to transfer torque from the driver 142 to cause vertical reciprocal movement of the agitate shaft 72 for vertically reciprocating the agitator 42 within the spin tub 27 during a predetermined washing phase of operation. For purposes of the present invention, the above description of the friction roller drive mechanism 56 should suffice, however, for a better understanding of a mechanism of this type reference may be had to the above mentioned copending Brucken application.

In accordance with certain principles of the present invention, the coil 118 of the magnetic slip clutch 60 is connected to a direct current source for producing the magnetic field through the coil housing and the driven plate whereby the driven plate 126 is pulled against the clutch facing on the clutch driver 108 with a pressure which is proportional to the current in the coil. In the illustrated arrangement, means are associated with this power supply to the clutch 118 whereby the output torque and speed of the driven plate 126 and thence the drive member 142 can be varied by increasing or decreasing the current in the coil 118. Thus, the speed of the agitator 42 and spin tub 27 can be controlled infinitely between a predetermined lower and upper limit in a manner to be discussed.

In the illustrated arrangement, the output speed of the driven clutch plate 126 is measured by an output speed sensor 160 which is representatively shown as being a tachometer generator including a permanent magnetic core 162 and a coil 164. The outer periphery of the driven plate 126 has a plurality of circumferentially spaced teeth 165 thereon that are passed in close spaced relationship with the permanent magnet core 162 of the speed sensor 160. This produces a change in the reluctance of the core 162 whereby a voltage is induced in the coil 164. The coil 164 thereby has a predetermined electrical signal produced therein which is proportional to the output speed of the clutch assembly 60. This variable speed signal is directed to an electronic clutch control module 166 to be discussed. In addition to the control signal produced by the speed sensor 160, the control module 166 has a plurality of reference speed control signals directed thereto from a pre-settable speed controller 168 which includes an agitate speed control knob 170 and a spin speed control knob 172 on the control panel 22.

The electronic control module 166, as will be discussed, compares the signal from the output speed sensor 160 with the preset control signal from the user control 168 to establish a predetermined direct current power supply to the coil 118 of the magnetic slip clutch 60 to either

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hold or vary the output speed of the magnetic slip clutch 60 so as to produce an agitation pulsing rate or spin tub speed as preselected by the control knobs 170, 172. The electronic control module 166 is continually operative to correct or vary the power supply to the variable speed clutch coil 118 throughout the operation of the clothes washer 20 so as to maintain the speeds of agitate and spin tub operations as preset by the knobs 170, 172.

In accordance with certain principles of the present invention, the electronic control module 166 and user control 168 are operatively associated with a sequence controller for the mechanism 20 that includes a presettable cycle selector knob 174 on the control panel 22 which positions an indicator 176 with respect to suitable indicia on the control panel plate indicating the selection of a predetermined cycle of operation of the washer 20. In the illustrated arrangement, when the dial 176 is located in the region A, the sequence controller is conditioned in a particular phase of a wash cycle as set forth in a timer cycle chart of FIGURE 5. When the dial 176 is located in a region B, the sequence controller is operative in an extra rinse cycle of operation; when the dial 176 is in a region C, the sequence controller is operative to condition the machine for a soak cycle as set forth in FIGURE 5.

Additionally, the illustrated sequence controller can be modified for different types of fabrics by positioning option control buttons on the control panel 22 including a normal wash cycle button 178, a wash and wear fabric selector button 180, a soak and extra rinse option button 182, and an extra rinse button 184. Additionally, the control panel 22 includes a water temperature selector knob 186 and a water level selector knob 188. In the case of each of the control knobs 170, 172, 186, 188 an indicator is associated therewith movable with respect to suitable indicia on the control knob 14 to indicate the selection of a given machine operating condition.

The option control buttons are associated with an option selector switch assembly 190 best seen in FIGURE 4 as including a plurality of movable switch plates 192, 194, 196. The water temperature selector knob 188 is associated with a water temperature selector switch 198 that includes movable switch blades 200, 202. The water level selector knob 186 is associated with an adjustable pressure switch assembly 204 including a movable switch blade 206.

In the illustrated arrangement, the sequence controller as seen in the circuit diagram of FIGURE 4 includes contacts 1 through 19 operatively located with respect to a plurality of cam operated movable switch blades to be opened and closed in accordance with the timer cycle chart of FIGURE 5 to produce a wash cycle of operation including a wash phase wherein the agitator 42 is reciprocated vertically within the spin tub 27; a dwell period for reversal of the phase switches to produce reverse operation of the motor 58; a subsequent spin phase of operation wherein the motor 58 is conditioned to cause the spin shaft 70 to drive the spin tub 27 so as to extract fluid therefrom; a subsequent fill period followed by a rinse and a final spin phase of operation. The sequence controller is also operative as noted in FIGURE 5 to produce an extra rinse cycle of operation wherein additional fill water is directed into the spin tub and the agitator is reciprocated therein following which there is a dwell period for motor reversal followed by a centrifugal extracting spin phase of operation. The controller further includes a soak cycle as noted wherein the spin tub is filled with water and articles are allowed to soak in the water without operating the agitator 42 immediately following which time the machine is operated through a centrifugal extraction or spin phase of operation.

To better explain certain aspects of the present invention, a brief summary of the operation of the machine under the control of the circuit in FIGURE 4 is desirable. Assuming that the sequence control knob 174 has been

located to position the indicator dial 176 in the wash cycle region A and more specifically at the beginning of the wash cycle and that clothes have been loaded in the spin tub 27, the lid 30 is closed and the control knob 174 pushed inwardly. A fill energization circuit thereby is completed from wire L<sub>1</sub> through a closed push-pull switch 208 operated by the knob 174 thence through a closed lid switch 210, the adjustable pressure switch 204 thence through a conductor 212 to a movable switch blade 214 which is in electrical engagement with the contact 12 which is electrically connected to a conductor 216 that is electrically connected to contacts 218, 220 in the water selector switch 198. If it is desired to obtain a hot water fill, the movable switch blades 200, 202 of the selector switch 198 are positioned as shown in FIGURE 4. This completes a circuit through conductor 222 to one side of a hot water solenoid coil 224 which has the opposite side thereof connected by conductors 226, 227 to motor 58 thence through conductor 229 to a wire N of the 115 volt power source. With selector valve 198 conditioned for a hot water fill, a cold water solenoid 228 is maintained de-energized. If desired, a warm water fill can be obtained merely by moving the switch blade 200 out of electrical contact with an overflow fill contact 230 of the water temperature selector switch 198 into electrical contact with the cold water wash fill contact 218. Also in the illustrated circuitry, the sequence controller includes a movable switch blade 232 that is engageable with the wash fill contact 10 to complete a circuit through conductor 234 to one side of a detergent dispenser solenoid 236 having the opposite side thereof connected by a conductor 238 thence through conductor 227 to the electric motor 58 and conductor 229 to wire N.

Following the fill cycle of operation, the pressure responsive fill switch 204 has switch blade 206 thereof moved to a back contact 240 to complete a timer motor energization circuit from wire L<sub>1</sub> through push-pull switch 208, contact 16 of the sequence controller thence through a closed, movable switch blade 209 thereof and the pressure responsive switch 204 to a conductor 242 connected to the timer control contact 2 which is in electrical engagement with a closed movable switch blade 244 of the controller thence through a conductor 246 to one side of a timer motor 247 of the controller which has the opposite side thereof connected to a conductor 248 that is in turn electrically connected to conductors 227, and 229 back to wire N. With the sequence control knob 174 located at the beginning of the wash cycle of operation, the controller has movable switch blades 250, 252, of a phase switch positioned in electrical contact with contacts 5 and 7, whereby the motor 58 is conditioned for rotation in a direction to cause the agitator shaft 72 to reciprocate the agitator 42 within the spin tub 27. More particularly, following the fill period, the circuit includes a motor energization circuit from wire L<sub>1</sub> through the push-pull switch 208, the switch blade 209, thence to the switch blade of the pressure responsive fill switch 204 that engages contact 240, through conductor 242, a conductor 254, and a movable switch blade 256 of the controller that engages a motor energization contact 9. The contact 9 is connected to a conductor 258 that electrically connects to one side of a run winding 260 of the motor 58 which, has an overload protector 262 connected to its opposite side which in turn is electrically connected to the conductor 229 thence to wire N. The motor contact 9 is also connected to a conductor 264 which is electrically connected to phase contacts 6 and 7 which connect through the movable switch blades 250, 252 to opposite sides of a phase winding 266 of the motor 58 to determine the direction of rotation of the motor 58. Likewise, movable switch blades 250, 252 are movable into electrical engagement with phase contacts 5, 8 which are electrically connected by a conductor 268 to conductor 227 thence through the motor 58 and the motor protector 262 to conductor 229 thence to wire N. At the start of the wash cycle, the mov-

able switch blades 250, 252 electrically engage the phase contacts 5 and 7 so the motor 58 is conditioned to drive the output shaft 78 in a counter-clockwise direction whereby the roller drive mechanism 56 through the drive coupling magnetic slip clutch 60 will operate the agitate shaft 72 for vertical reciprocation to produce agitating action within the spin tub 27 by the agitator 42.

Associated with the motor energization circuit 58 is the electronic control module 166 of a type more specifically set forth in the above mentioned copending Brucken application. The power supply for the electronic control module is directed from a conductor 272 connected to conductor 258 and a conductor 274 that is electrically connected to one side of a speed responsive centrifugal switch 276 having the opposite side thereof electrically connected by a conductor 278 to an internal crossover conductor 280 in the motor 58 through the overload protector 262 thence to conductor 229 and wire N. By virtue of this arrangement, until the motor 58 reaches a predetermined percentage of its operating speed, the electronic control module 166 will be de-energized whereby the coil 118 of the magnetic slip clutch 60 will have no DC power component directed therethrough whereby the driven plate 126 of the clutch 60 will not be attracted into frictional driving engagement with the liner 114 on the drive plate 108 whereby the torque from the motor shaft 78 will not be transferred into the roller drive mechanism 56. Once the motor has reached the predetermined percentage of its operating speed, the switch 276 will close to energize the electronic control module 270 and operate clutch 60.

As illustrated in FIGURE 4, in addition to the power supply circuit of conductors 272, 274, the electronic control module includes means as best described in the aforementioned Brucken et al. application to produce a control potential across conductors 279, 281 that are connected to the user speed control circuit 168 that is operated by positioning the agitate control knob 170 and the spin speed control knob 172 on the control panel 22. More particularly, at the start of a wash cycle of operation, the control knob 170 positions a movable contact carrying arm 282 of an agitate speed potentiometer with respect to a resistance 284 which in conjunction with a voltage level determining resistances 286, 287 will establish a predetermined agitate control voltage at the agitate contact 19 which is electrically connected to the contact carrying arm 282 by a conductor 288. The sequence controller has a movable switch blade 290 thereof positioned in electrical engagement with the contact 19 so as to direct the agitate speed control potential through a conductor 292 into the electronic control module 166 for comparison with the speed pick-up signal generated in the coil 164 of the speed sensor assembly 160. The comparison of the control potential with the speed signal will produce a DC potential across the coil 118 to provide a predetermined coupling of the drive motor 58 to the friction roller drive mechanism 56 through clutch 60. The electronic control module 166 will continually vary the energization of the coil 118 to maintain an agitate action corresponding to a predetermined setting of the agitate speed control knob 170 during the wash cycle of operation when the agitate contact 19 is closed as noted on the timer cycle chart.

During the wash cycle following a wash phase wherein the agitator 42 is operative, the motor contact 9 is opened at the 13th pulse of the timer mechanism driven by timer motor 247 whereby the motor 58 is momentarily de-energized. During this period, the motor slows down and movable phase contacts 250, 252 are positioned in engagement with phase contacts 6 and 8 to reverse the polarity of the phase winding 266 whereby the motor 58 will be operated to cause the shaft 78 thereof to rotate in a clock-wise direction whereby the roller mechanism 56 will be conditioned to cause the spin shaft 70 to rotate the spin tub 27. With reference to the user control 168 dur-

ing the spin phases of the wash cycle, the speed of operation will be established by positioning the spin speed control knob 172 to position a movable contact carrying arm 294 of a spin speed potentiometer with respect to a resistance 296 thereof that cooperates with resistances 298, 300 to utilize the potential across the conductors 279, 281 so as to establish a predetermined control voltage at spin contact 18. In addition to the control potential at spin contact 18, a constant control potential is maintained at spin contact 17 which is electrically connected by a conductor 302 between resistance 300 and the lowest speed setting on the resistance 296 of the spin speed potentiometer 296. It will be noted with references to FIGURE 5, that at the beginning of each spin phase of operation in the wash cycle, the sequence controller will position a movable switch blade 304 thereof in electrical engagement with the contact 17. By virtue of this provision, during initial acceleration of the spin tub 27 through its critical speed of operation which occurs in the range of 125 to 130 r.p.m. in the illustrated machine, a spin speed control voltage is directed through the conductor 292 to the electronic control module 270 that will limit the energization of the clutch coil 118 produce an output speed from the roller drive mechanism 56 to the spin tub 27 to prevent a speed of operation of the spin tub 27 in excess of 300 r.p.m. Following the first timer impulse in each spin phase of operation of the wash cycle, the movable switch blade 304 is moved into electrical engagement with spin contact 18 which is electrically connected by a conductor 306 to a movable switch blade 308 of an unbalance sensing switch 310. The unbalance switch 310 includes a contact 312 that is in electrical engagement with the movable switch blade 308 when there is no unbalance present in the spin tub 27 and the contact 312 in turn is electrically connected by a conductor 314 to the contact carrying arm 294 of the speed control potentiometer. The unbalance switch 310 further includes a contact 316 that is electrically engaged by the movable switch blade 308 when there is a predetermined degree of unbalance in the spin tub 27. The contact 316 is in turn electrically connected by a conductor 318 to conductor 302. In the illustrated arrangement, the conductors 306, 318 are bridged by a 10,000 ohm resistance 320 for reasons to be discussed.

By virtue of the above described spin speed control circuitry, when the timer advances to a spin phase of operation in the wash cycle, the movable contact 290 will open from the agitate contact 19 and the movable switch blade 304 will be positioned for one timer impulse in electrical engagement with the contact 17 whereby the predetermined control potential of the spin circuitry is directed into the electronic control module 166 so as to maintain energization of the coil 118 to prevent rotation of the spin tub 27 above 300 r.p.m. Following the first timer impulse, the movable switch blade 304 is moved into electrical engagement with the spin contact 18 whereby the control potential established by the spin speed control knob 172 will be directed into the electronic control module 166 through the conductor 292 so as to establish a control of the energization of the coil 118 to operate the spin shaft 70 so as to rotate the spin tub 27 between 300 and 1,000 r.p.m. depending upon the position of the control knob 172.

In cases where there is unbalanced loading of articles in the spin tub 27 as it attempts to pass through the critical speed of operation, a substantial gyratory movement thereof will occur so as to condition the unbalance switch 310 to move the switch blade 308 thereof into electrical engagement with contact 316. This prevents the slip clutch coil 118 from being energized to produce a speed output to the spin shaft 70 capable of rotating the spin tube in excess of 300 r.p.m. In the illustrated arrangement, it has been found that by so limiting the upper speed limit under unbalance load conditions, the transfer of vibrations to the outer casing 21 of the machine will be

maintained at a level to maintain a stable machine operation and while the spin tub 27 will be driven during the spin phases of the washing cycle at a lower speed limit some effective fluid extraction will occur therefrom. In cases where the unbalance corrects itself, the unbalance switch 310 will have the movable switch blade 308 thereof moved into electrical engagement with the contact 312 whereby the spin speed control signal from the potentiometer arm 294 will be directed into the electronic control module so as to produce a higher spin speed output during the spin phases of the washing cycle of operation so as to improve the extraction of fluid from the spin tub 27.

A particular feature of the present arrangement is due to the fact that the electronic control module 166 of the type disclosed in the Brucken et al. application is highly responsive to operating speed changes from those set by knob 172. Thus, if there is unbalanced loading that will cause movement of the movable switch blade 308 of the unbalance switch 310 during a spin phase when spin contact 18 is closed there is a momentary removal of control potential from conductor 292 prior to engagement of the movable switch blade 308 with the contact 316 whereby the coil 118 will be de-energized so as to de-couple the motor drive shaft 78 from the roller drive mechanism 56 to produce a torque drop through spin shaft 70. The roller mechanism 56 includes a brake mechanism operative immediately upon such a torque change to operate through the spin shaft 70 to brake rotation of the spin tub 27. A mechanism of this type is more specifically set forth in United States Patent No. 3,174,596, issued Mar. 23, 1965, to Sisson. Rather than completely stopping the spin tub 27 upon sensing unbalance, it is desirable to maintain a residual energization of the coil 118 during the switching period of the unbalance switch 310 whereby the motor 58 will to a degree be coupled to the roller drive mechanism 56 sufficiently to prevent initiation of the built-in braking action. As a result, the resistance 320 during the switching movement of the blade 308 will direct a sufficient control potential to the electronic control module 166 to accomplish this purpose.

Following the wash or agitate phase in the wash cycle of operation and prior to a spin phase of operation the timer motor 247 positions a movable switch blade 322 thereof into electrical engagement with the line contact 1 to maintain a motor energization circuit when the water level responsive fill switch 204 is no longer positioned against the back contact 240 thereof because of the extraction of fluid from the machine during the spin phase of operation. Additionally, a timer motor energization circuit is maintained under these conditions by movement of a timer controlled switch blade 324 into electrical engagement with the timer motor contact 3.

If it is desired to operate the machine through an extra rinse cycle of operation as shown in the timer control chart, the extra rinse button 184 is depressed so as to move switch blades 194, 196 of the option control switch 190 into electrical engagement with a contact 326 for completing a timer motor energization circuit and a contact 328 for completing a fabric conditioner energization circuit.

When the extra rinse button 184 is so positioned, the circuit of FIGURE 4 will include a timer motor energization during the extra rinse cycle of operation from wire L<sub>1</sub> through push-pull switch 208, the lid switch 210, thence through a conductor 330 to movable switch blade 194 thence through a conductor 332 connected to extra rinse contact 4 which will in accordance with the schedule shown in FIGURE 5 be in engagement with movable switch blade 324 which is connected to one side of the timer motor 247 having the opposite side thereof connected by conductors 248, 227, 229 to wire N. Additionally, the extra rinse cycle option will complete a circuit from conductor 330 through the movable switch blade 196 thence through contact 328 and a conductor 334 to

fabric softener contact 14 thence through a movable switch blade 336 controlled by the timer motor 247 and associated means. As seen in FIGURE 4, the movable switch blade 336 is connected by conductor 338 to one side of a coil 340 of a fabric softener dispenser having the opposite side thereof connected by conductor 342 thence through conductors 227, 229 to wire N.

If the soak option is selected, the movable contact 192 is moved into electrical engagement with a contact 344 that is electrically connected by a conductor 346 to the soak to wash contact 15 of the controller that periodically will be in electrical engagement with a movable timer control switch blade 348 to maintain a timer motor energization circuit so as to operate the sequence controller through a soak cycle of operation followed by a wash cycle of operation as seen in FIGURE 5.

The soak to extra rinse option likewise completes a secondary timer motor energization circuit for enabling the extra rinse cycle of operation to be effectively merged with a prolonged soak cycle of operation.

It has been found that during an automatically controlled wash cycle of operation, wherein an agitation or wash phase is followed by a spin phase, and then followed by a rinse and final spin phase as noted in FIGURE 5 often, even with the infinite speed control of the agitator 42 provided by the user control 168, an amount of interaction between the agitator 42 and clothes in the spin tub 27 can cause undesirable wear, shrinkage, or the like depending upon the type of fabric being processed. In accordance with certain other principles of the present invention, the circuit of FIGURE 4 includes means for preventing torque from the motor 58 from driving the agitate shaft 72 during an agitate or wash phase of the automatically advanced wash cycle of operation and more particularly, during the first 12 timer pulses wherein the agitate contact 19 is in electrical engagement with the movable blade 290 for directing a predetermined speed establishing agitate control signal to the electronic control module 166. Thus, in the illustrated arrangement, when the agitate speed control knob 170 is moved to position the contact carrying arm 282 of the potentiometer to its lowest speed setting eventually a switch 350 will be closed to by-pass the resistance 286 and effectively produce a zero potential differential between conductor 279 and the input control conductor 292 whereby the electronic control module will be conditioned so that the coil 118 of the magnetic slip clutch 60 will be completely de-energized so that the torque from the drive shaft 78 of the motor 58 will be effectively de-coupled from the friction roller drive mechanism 56. Thus, during the wash phase of the wash cycle shown in FIGURE 5, the articles in the spin tub 27 will merely soak. However, following the wash cycle, the timer 247 will automatically advance in accordance with the program shown in FIGURE 5 to extract fluid from the articles and then refill the tub. During the rinse phase of the wash cycle, again the agitator 42 will be rendered inoperative but the wash cycle will continue through a subsequent spin phase wherein the rinse fluid is extracted again from the articles. Thus, by the provisions of the circuitry to so de-energize the slip clutch coil 118 selectively during an automatic control sequence, a user of the machine can operate the machine automatically through a wash cycle of operation with the timer motor 247 carrying out predetermined phases of operation but wherein a wash and rinse phase of operation is carried out during the wash cycle without any agitation of the clothes in the spin tub. However, the cycle will nevertheless include rinse and fluid extraction cycles whereby soil can be removed from the articles. Furthermore, this can be carried-out automatically without requiring resetting of the sequence control knob 174.

A further advantage of the illustrated machine is that the transparent port or window 34 in the lid 30 thereof allows the agitator 34 to be viewed while the agitate speed

control knob 172 is positioned. Thereby, a user of the machine is able to calibrate the action of the agitator that he believes to be best suited for a particular type of load being processed in the machine. A further feature of the present invention also relates to the lid 30. It will be noted that while there is a lid switch 210 in the motor energization circuit which is opened when the lid 30 is raised, in addition, a timer controlled switch blade 209 is arranged to periodically bypass the lid switch 210 and maintain the motor energization circuit whereby the lid 30 can be raised without de-energizing the motor circuit through all but spin phases of operation of the machine as seen at the line contact 16 of the timer cycle chart shown in FIGURE 5. This enables the washing cycle of operation to be carried out with agitation during periods where the lid might be raised as for example, when it is desired to add additional fabric conditioners to the washer during the operation thereof.

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 clothes washing apparatus, the combination of a container adapted to receive articles, means for directing cleaning fluid into said container, pulsator means for agitating the articles in the presence of the cleaning fluid, means including said container for extracting fluid from the articles, an electric motor, power transmission means, magnetic slip clutch means for coupling said electric motor in driving relationship with said power transmission means, said power transmission means being operated by said magnetic clutch means to transfer a predetermined amount of the output energy of said electric motor to said pulsator means and said fluid extraction means, presettable sequence control means for conditioning said electric motor means to effect a predetermined series of washing and spin phases of operation, and selector control means pre-settable independently of said sequence control means and operative in conjunction with said sequence control means to condition said magnetic clutch means to isolate said electric motor from said pulsator means during at least one of the washing phases of operation so that articles in said container are washed without agitation during said at least one washing phase of operation.

2. In the combination of claim 1, energization circuit means associated with said slip clutch means for varying the energization thereof to produce a variable washing and spin extraction action during the series of washing and spin phases of operation of the machine, said energization circuit means including said selector means and being conditionable by said selector means to produce a slip in said magnetic clutch so as to isolate said electric motor from said pulsator means during said at least one washing phase of operation.

3. In the combination of claim 1, clutch control means for producing a predetermined energization thereof, means for supplying power to said clutch control means, circuit means for directing a predetermined agitate control signal to said clutch control means and first and second spin speed control signals to said clutch control means, said circuit means for establishing said first and second spin speed signals including motion responsive switch means having a high speed and a low speed contact and a switch blade movable therebetween, said switch means responding to a predetermined gyratory movement of said container to condition said circuit means for directing said first spin speed control signal to said clutch control means for limiting energization of said clutch means to prevent rotation of said container above a first predetermined speed, said switch means being operative normally to disconnect said low spin speed signal from said clutch control means and connect said high spin speed signal thereto whereby said clutch means is normally energized for operating said container at a higher speed of rotation.

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4. In the combination of claim 1, control means for energizing said magnetic slip clutch means, first circuit means for directing a predetermined agitate control potential to said clutch control means for conditioning said clutch means to produce a predetermined agitation of articles by said pulsator means, second circuit means for establishing and directing predetermined high and low speed spin speed control signals to said clutch control means for maintaining said clutch means energized to produce first and second speeds of rotation of said container, said second circuit means in combination with said sequence control means initially connecting said low spin speed control signal to said clutch control means at the beginning of each spin phase of operation whereby said container is driven by said power transmission means through a predetermined critical speed of operation without exceeding the container speed of operation established by said low spin speed control signal.

5. In the combination claim 1, said electric motor being a reversible motor, means for energizing said electric motor including said presettable sequence control means, said presettable sequence control means including switch means for reversing rotation of said motor and means for de-energizing said motor between reverse operation thereof, said electric motor being energized throughout said series of washing and fluid extracting phases of operation except during reversal of operation thereof, means for energizing said magnetic clutch during energization of said reversible electric motor and means including said selector control means for conditioning said magnetic clutch during said at least one of said washing phases of operation wherein said magnetic clutch has a slip therein to isolate said electric motor from said pulsator means during said at least one of said wash cycles of operation.

6. In the combination of claim 2, said energization circuit means including means for establishing a first predetermined spin speed control signal to maintain said slip clutch means energized for producing a predetermined maximum rate of rotation of said container during a spin phase of operation, said energization circuit means including second circuit means for establishing a second predetermined spin speed control signal to produce a lesser rate of container rotation during the spin phase of operation, said first circuit means including means responsive to a predetermined maximum gyratory movement of said container and operative to disconnect said first control signal from said energization circuit means and to connect said second predetermined control signal in said energization circuit means for producing a reduced speed of rotation of said container.

7. In the combination of claim 3, said power transmission means including a spin shaft connected to said container for rotating said container brake means operatively connected to said spin shaft for braking said container upon a predetermined reduction in the drive torque of said spin shaft, said motion responsive switch means having a predetermined delay whereby said clutch control means momentarily is influenced by neither of said spin control signals, and means for maintaining a residual control signal to said clutch control means for maintaining said clutch means energized to prevent said predetermined reduction in the torque of said spin shaft upon switching movement of said motion responsive switch means whereby said brake means is inoperative during the switching action of said motion responsive switching means.

8. In the combination of claim 4, said second circuit means including vibration responsive switch means operative in response to a predetermined gyratory movement of said container to direct said low speed control signal to said clutch control means at subsequent phases of said spin phase of operation.

9. In the combination of claim 6, said power transmission means including a rotatable spin shaft for driving

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said container, brake means associated with said spin shaft for stopping said container in response to a predetermined reduction in the drive torque through said spin shaft, said motion responsive switch means having a predetermined delay period in switching from a high spin speed of operation to a low spin speed of operation wherein said first and second predetermined spin speed control signals are disconnected momentarily from said energization circuit means, and means for maintaining a residual spin speed control signal in said energization circuit means during said delay period to produce a predetermined drive coupling between said clutch means and said spin shaft whereby said brake means is ineffective during said delay period.

10. In a domestic washing machine, the combination of a container adapted to receive articles to be cleaned, means for directing cleaning fluid into said container, means including a movable door for access into said container, said movable door including a transparent port therein for viewing articles in said container when the door is closed, pulsator means within said container for surging cleaning fluid through articles therein, means for extracting fluid from articles in said container, operating means for driving said pulsator means at variable speeds, user control means for establishing one of the variable speeds of operation, said pulsator means being viewable through said transparent port during adjustment of said user control means whereby a desired action of said pulsator means on said clothes can be visually established.

11. In the combination of claim 10, said user control means including pre-settable means operative during a washing cycle of operation to prevent operation of said pulsator means whereby articles are soaked during the washing cycle of operation.

12. In the combination of claim 10, said user control means including presettable sequential control means for establishing a wash cycle of operation including a wash phase, a spin phase, a subsequent rinse phase, and a final spin phase, and selector control means operating in conjunction with said presettable sequence control means to produce a wash phase of operation wherein said pulsator means is operative to surge fluid through articles to be cleaned or is conditioned to be inoperative.

13. In the combination of claim 10, said operating means including an electric drive motor, power transmission means, and magnetic slip clutch means for coupling said drive motor to said power transmission means, means for conditioning said magnetic slip clutch means for varying the energy transferred from said electric motor to said transmission means, said user control means being operative to vary the energization of said magnetic slip clutch means whereby a predetermined desired energy transfer from said motor means to said transmission means is produced whereby said pulsator means is operated continuously at the present action.

14. In a clothes washing apparatus, the combination of means including pulsator means for surging cleaning fluid through articles to be cleaned, means for extracting fluid from the articles being cleaned, operating means for driving said pulsator means and said fluid extraction means, said operating means including an electric motor means, sequential control means for conditioning said electric motor means to produce operation of said pulsator means and said fluid extracting means through a wash cycle including a wash phase wherein said pulsator means is operative to surge fluid through the articles and a spin phase wherein said fluid extracting means is operative to remove fluid from the articles and a subsequent rinse phase wherein said pulsator means is operative to surge cleaning fluid through the article and a final spin phase wherein fluid is again removed, said operating means further including means for disconnecting said electric motor means from said pulsator means, and presettable selector means operative in conjunction with said pre-

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settable sequential control means to condition said disconnecting means of said operating means during the wash phase of said wash cycle to prevent operation of said pulsator means by said motor means, said disconnecting means including a magnetic slip clutch, power supply means for controlling said magnetic slip clutch to vary the transfer of energy from said motor means to said pulsator means, said presettable selector switch means being operative to condition said power supply means to maintain said slip clutch de-energized during the wash phase of operation whereby said motor means is operatively disconnected from said pulsator means.

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WILLIAM I. PRICE, *Primary Examiner.*