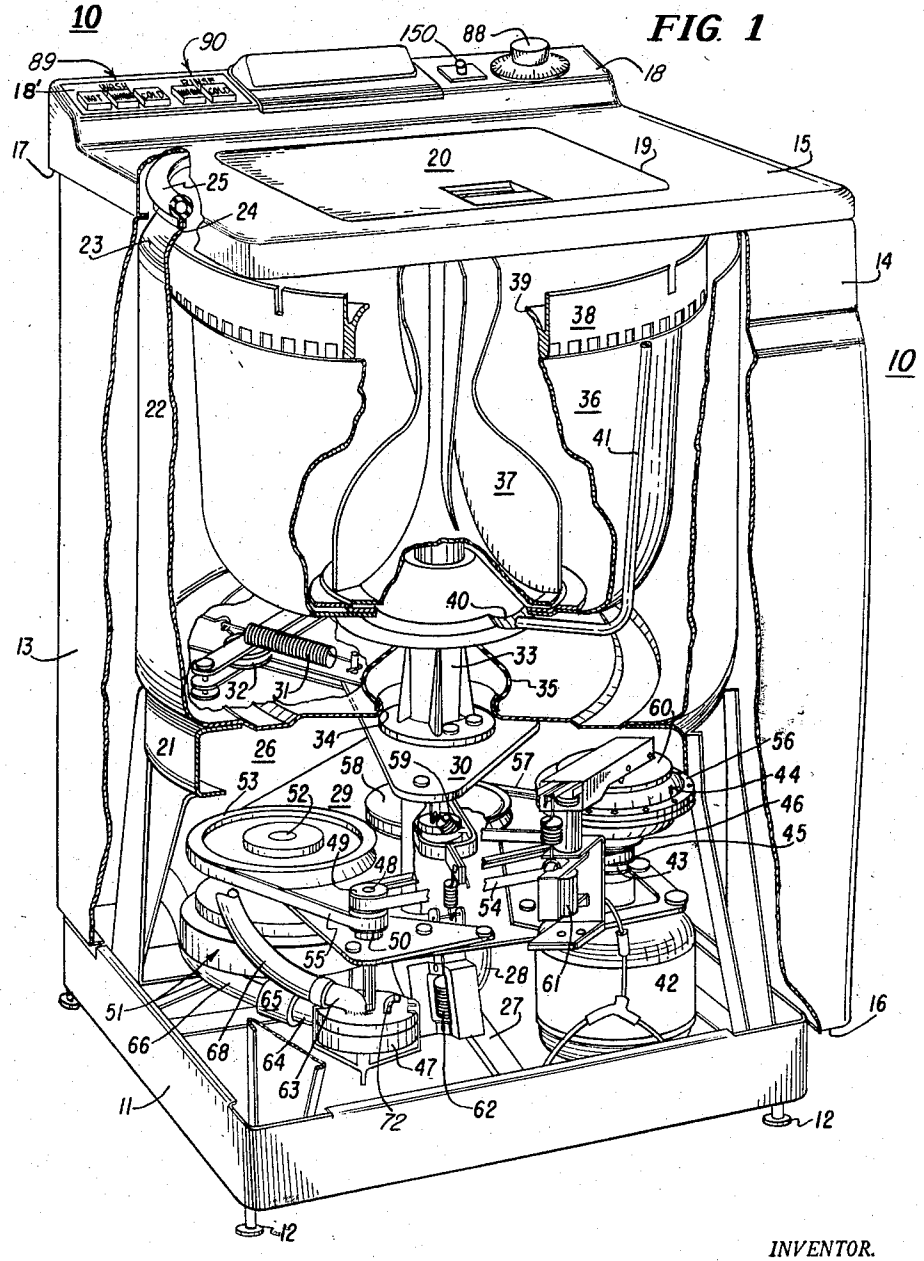
May 12, 1959 V. RE 2,885,876

CONTROL CIRCUITS FOR AUTOMATIC CLOTHES WASHING MACHINES

Filed Jan. 13, 1956 3 Sheets-Sheet 1

FIG. 1



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CONTROL CIRCUITS FOR AUTOMATIC CLOTHES WASHING MACHINES

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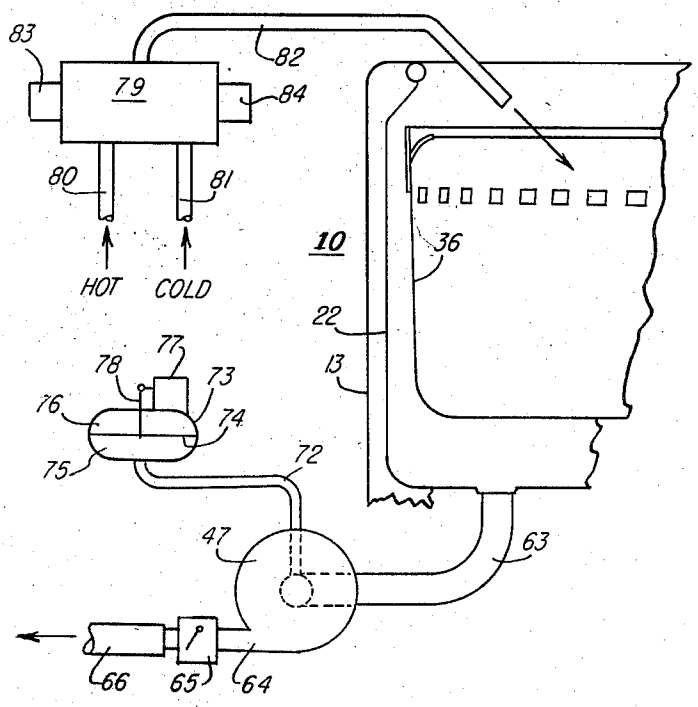


Fig 2

Fig 4

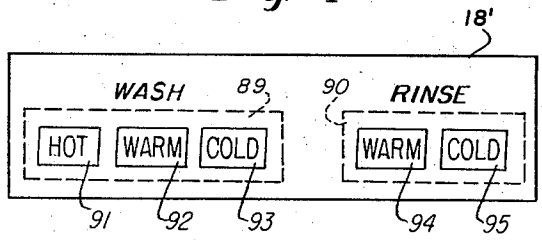
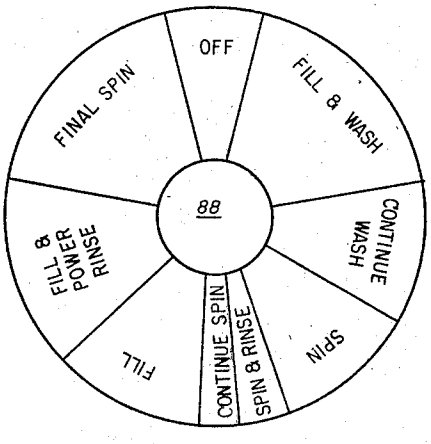


Fig 5



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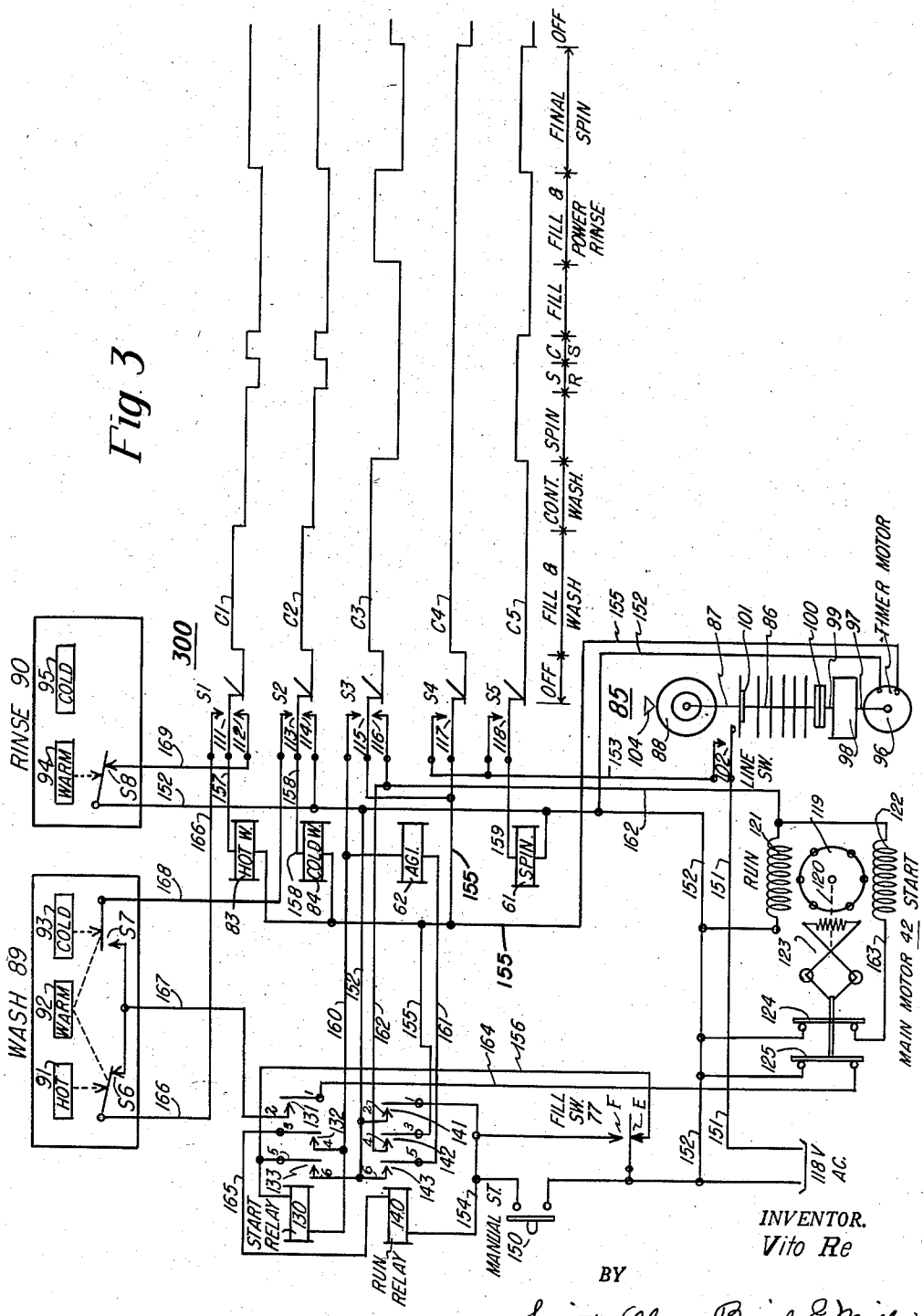
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CONTROL CIRCUITS FOR AUTOMATIC CLOTHES WASHING MACHINES

Filed Jan. 13, 1956 3 Sheets-Sheet 3

Fig. 3



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2,885,876

CONTROL CIRCUITS FOR AUTOMATIC CLOTHES WASHING MACHINES

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Application January 13, 1956, Serial No. 558,986

9 Claims. (Cl. 68—12)

The present invention relates to control circuits for automatic clothes washing machines; and it is the general object of the invention to provide such a control circuit incorporating an improved arrangement for governing the filling of the tub with water to be used in the washing step and then for governing the operation of the agitator to carry out the washing step.

Another object of the invention is to provide in a clothes washing machine, a control circuit of the character noted that incorporates an improved relay arrangement for the purposes mentioned, and including a start relay and a run relay that positively responds respectively to empty and to full conditions of the tub and cooperate to control the supply of water thereto.

A further object of the invention is to provide in a clothes washing machine, a control circuit of the character noted that is of improved and simplified connection and arrangement, whereby the machine is positive and reliable in operation.

Further features of the invention pertain to the particular arrangement of the elements of the electric control circuit for the clothes washing machine, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

Figure 1 is a front perspective view, partly broken away, of an automatic clothes washing machine of the spin tub type incorporating an electric control circuit embodying the present invention;

Fig. 2 is a fragmentary diagrammatic view of a portion of the clothes washing machine shown in Fig. 1, illustrating the relationship between the spin tub and the water supply system therefor and the relationship between the casing enclosing the spin tub and the drain system therefor;

Fig. 3 is a combination circuit diagram and program schedule of the electric control circuit incorporated in the clothes washing machine shown in Fig. 1 and embodying the present invention;

Fig. 4 is an enlarged plan view of the cover plate for the wash pushbutton switch and the rinse pushbutton switch incorporated in the electric control circuit of Fig. 3; and

Fig. 5 is an enlarged plan view of the manually operable control knob or dial for the program selector switch incorporated in the electric control circuit of Fig. 3.

Referring now to Fig. 1 of the drawings, the clothes washing machine 10 there illustrated is of the spin tub type and of the general construction and arrangement of that disclosed in U.S. Patent No. 2,723,737, granted on November 15, 1955 to Kemper M. Hammell and John D. Warhus. More particularly, the machine 10 comprises a substantially rectangular base 11 that is supported upon independently adjustable feet 12 arranged

to engage the floor or other supporting surface. A housing 13 is removably carried by the base 11 and includes rear and side walls defining both a front opening and a top opening; a front wall 14 is removably carried by the front of the housing 13 in order to close the front opening mentioned; and a top wall 15 is removably carried by the top of the housing 13 in order to close the top opening mentioned. The lower portions of the rear and side walls of the housing 13 join the upper portions of the rear and sides of the base 11; while the lower portion of the front wall 14 joins the upper portion of the front of the base 11 so as to provide a toe-receiving recess 16 disposed below and rearwardly of the front wall 14 and forwardly of the front of the base 11. The sides of the front wall 14 are disposed substantially flush with the side walls of the housing 13. The sides of the top wall 15 are disposed substantially flush with the side walls of the housing 13; and the front of the top wall 15 is disposed substantially flush with the upper portion of the front wall 14. The top wall 15 projects rearwardly from the rear wall of the housing 13 in order to provide an upstanding space 17 disposed below the rear of the top wall 15 and behind the rear wall of the housing 13; which upstanding space 17 is adapted to receive plumbing connections, not shown. More specifically, the rear of the top wall 15 terminates in an upwardly directed backsplash 18 that projects over the top of the upstanding space 17; and a substantially centrally disposed top opening 19 is provided in the top wall 15 in order to render the interior of the housing 13 accessible from the exterior. A door 20 is provided for the purpose of selectively closing the top opening 19, the rear edge of the door 20 being hinged to the top of the wall 15 and movable toward and away from the backsplash 18 into respective open and closed positions with respect to the top opening 19.

Upstanding supporting structure 21 is arranged in the lower portion of the housing 13 and carried by the base 11; which supporting structure 21 carries an upstanding substantially cylindrical casing or drain tub 22 arranged in the upper portion of the housing 13. The drain tub 22 is provided with an inwardly directed annular marginal throat 23 that terminates in a top opening 24 disposed below the top wall 15; and the top edge of the throat 23 carries a substantially annular sealing gasket 25 surrounding the top opening 24 and engaging the lower surface of the top wall 15 for the purpose of sealing the top opening 24 in the drain tub 22 to the top wall 15, the bottom wall of the drain tub 22 being spaced above the base 11 to define a machinery compartment 26 arranged in the lower portion of the housing 13. The base 11 carries additional supporting structure 27 upon which the principal machinery disposed in the machinery compartment 26 is mounted. Specifically, an upstanding support 28 is pivotally mounted at the lower end thereof upon the structure 27, which upstanding support 28 comprises, among other structure, two vertically spaced-apart plates 29 and 30 arranged substantially centrally in the machinery compartment 26. The plate 30 is operatively connected to the upstanding structure 21 by a plurality of resilient springs 31 and associated snubber devices 32; whereby the upstanding support 28 is normally centered along a substantially central vertical axis, but is capable of gyratory movement about its pivotal mounting upon the structure 27. The plate 30 carries an upstanding bearing bracket 33 that projects through a substantially centrally disposed opening 34 provided in the bottom wall of the drain tub 22, which bracket 33 is sealed to the portion of the bottom wall of the drain tub 22 surrounding the opening 34 by an arrangement including an upstanding flexible boot 35 formed of rubber, or the like.

An upstanding spin tub 36 is arranged within the drain tub 22 and supported by a tub sleeve, not shown, that is mounted in the bearing bracket 33 for rotation about a substantially vertical axis; and an upstanding agitator 37 is arranged within the spin tub 36 and supported by an agitator shaft, not shown, that is mounted in the tub sleeve for oscillation about the substantially vertical axis mentioned. The spin tub 36 is provided with an upwardly and outwardly flared side wall that terminates in an open top disposed below the top wall 15 and arranged in substantial alignment with the top openings 19 and 24; whereby the interior of the spin tub 36 is readily accessible from the exterior through the top openings 19 and 24 when the associated door 20 occupies its open position. The top rim of the spin tub 36 carries an annular balance ring 38 that is provided with an inwardly directed annular clothes retaining flange 39. Also the bottom wall of the spin tub 36 is provided with an annular sediment trap 40 disposed below the base of the agitator 37, the sediment trap 40 communicating with the interior of the drain tub 22 by an arrangement including two upstanding drain conduits 41 disposed substantially diametrically opposite each other and carried by the spin tub 36.

An electric drive motor 42 is mounted upon the plate 29 and provided with an upwardly directed operating shaft 43, upon the upper end of which there is mounted a combination clutch and brake and fluid drive unit 44 that includes two independently rotatable pulleys 45 and 46. Also a drain pump 47 is mounted upon the plate 29 and provided with an upwardly directed operating shaft 48, upon the upper end of which are mounted two pulleys 49 and 50. Further, a motion-translating mechanism 51 is mounted upon the plate 29 and provided with an upwardly directed drive shaft 52, upon the upper end of which there is mounted a pulley 53.

The pulley 45 of the unit 44 is directly belted by a flexible V-belt 54 to the pulley 49 that is carried by the operating shaft 48 of the drain pump 47; and the pulley 50 that is carried by the operating shaft 48 of the drain pump 47 is directly belted by a V-belt 55 to the pulley 53 that is carried by the drive shaft 52 of the motion-translating mechanism 51. The unit 44 comprises a housing 56 that carries the pulley 46, and the pulley 46 is directly belted by a flexible V-belt 57 to a pulley 58 that is carried by the tub sleeve, not shown, that is supported within the bearing bracket 33 and directly connected to the spin tub 36. Moreover, the motion-translating mechanism 51 includes a driven shaft, not shown, that is selectively connectible by a clutch mechanism 59 to the agitator shaft, not shown, that is arranged in the tub sleeve mentioned and directly connected to the agitator 37. Also in the unit 44, the upper surface of the housing 56 constitutes a brake surface that cooperates with a brake shoe 60; and further the unit 44 comprises an operating member that is adapted to be selectively governed for clutch control purposes by an associated electromagnet 61. Further, the clutch mechanism 59 is adapted to be selectively governed for clutch control purposes by an associated electromagnet 62. The drain pump 47 is provided with an inlet connection 63 that communicates with the lower portion of the drain tub 22, in a manner more fully explained hereinafter, and an outlet connection 64 including a check valve 65 and communicating with a discharge conduit 66 projecting through the rear wall of the housing 13, the discharge conduit 66 communicating with drain plumbing, not shown.

As indicated in Figs. 1 and 2, the drain pump 47 is provided with an air chamber that is connected via a tube 72 to a casing 73 disposed above the drain pump 47 and arranged in the machinery compartment 26; which casing 73 is divided by a diaphragm 74 into lower and upper chambers 75 and 76; the lower chamber 75 communicates with the upper end of the tube 72; and the upper chamber 76 communicates with the atmosphere. Finally, the casing 73 carries a control or fill switch 77 that is provided with an operating arm 78 that, in turn, is operatively connected to the diaphragm 74; all for a purpose more fully explained hereinafter.

Further, the machine 10 comprises a water supply system including valve mechanism 79 provided with a hot water inlet conduit 80, a cold water inlet conduit 81, and an outlet conduit 82 that communicates with the spin tub 36. The valve mechanism 79 is of the solenoid controlled type including a hot water solenoid 83 and a cold water solenoid 84. It will be understood that the valve mechanism 79 normally closes the inlet conduits 80 and 81, the hot water solenoid 83 being operative to open the hot water inlet conduit 80, and the cold water solenoid 84 being operative to open the cold water conduit 81. Thus: when the hot water solenoid 83 is energized alone, hot water is delivered to the outlet conduit 82; and when the cold water solenoid 84 is energized alone, cold water is delivered to the outlet conduit 82. Of course, when both of the solenoids 83 and 84 are energized, the hot water and the cold water are mixed and warm water is delivered to the outlet conduit 82.

Referring now to Fig. 3 of the drawings, the electric control circuit 300 for the machine 10, there illustrated and embodying the features of the present invention, comprises, in addition to the hot water solenoid 83, the cold water solenoid 84, the spin solenoid 61, the agitate solenoid 62, the main drive motor 42, and the control switch 77, a program selector switch 85 that comprises an upstanding rotatably mounted operating shaft 86 carrying five insulating control cams C1 to C5, inclusive, that respectively govern five sets of switch springs S1 to S5, inclusive. The selector switch 85 is arranged in the housing 13 below the backsplash 18 and adjacent to the junction between the rear wall and the right-hand side wall of the housing 13, and further comprises an upstanding control shaft 87 that projects through an opening, not shown, provided in the backsplash 18, the upper end of the control shaft 87 carrying a rotary control knob or dial 88, as shown in Fig. 1, the construction of the knob 88 being shown in detail in Fig. 5. Also the control circuit 300 comprises a wash preselect switch 89 and a rinse preselect switch 90 that are arranged adjacent to each other within the housing 13 below the backsplash 18 and adjacent to the junction between the rear wall and the left-hand side wall of the housing 13, the preselect switches 89 and 90 being of the pushbutton type and provided with pushbuttons projecting through corresponding openings, not shown, provided in the backsplash 18, the upper ends of the pushbuttons mentioned also projecting through holes provided in a cover plate 18' carried adjacent to the left-hand side of the backsplash 18, as shown in Fig. 1, the construction of the cover plate 18' being shown in detail in Fig. 4.

Both the wash preselect switch 89 and the rinse preselect switch 90 are of the pushbutton type disclosed in U.S. Patent No. 2,431,904, granted on December 2, 1947 to John L. Andrews. More particularly, the switch 89 comprises three individual interlocked pushbuttons 91, 92 and 93 respectively constituting hot, warm and cold pushbuttons and two cooperating sets of switch springs S6 and S7. In the arrangement, the set of switch springs S6 is normally biased into its open position but may be operated into its closed position by operation of either of the pushbuttons 91 or 92; and the set of switch springs S7 is normally biased into its open position but may be operated into its closed position by operation of either of the pushbuttons 92 or 93. Moreover, operation of any one of the pushbuttons 91, 92 or 93 effects the return of the last operated one of the pushbuttons, whereby one of the pushbuttons 91, 92 or 93 always occupies its operated position, the hot pushbutton 91 being illustrated in its operated position in Fig. 3. Similarly, the switch 90 comprises two individual interlocked pushbuttons 94 and 95 respectively constituting warm and cold

pushbuttons and a single cooperating set of switch springs S8. In the arrangement, the set of switch springs S8 is biased into its open position but may be operated into its closed position by operation of the pushbutton 94. Moreover, operation of either one of the pushbuttons 94 or 95 effects the return of the other one of the pushbuttons; whereby one of the pushbuttons 94 or 95 always occupies its operated position, the warm pushbutton 94 being illustrated in its operated position in Fig. 3.

Also, the control circuit 300 comprises a source of power supply of 118 volts A.C. single-phase and a synchronous timer motor 96 that is preferably of the "Telechron" type; and a timer motor 96 is provided with an operating shaft 97 that is rotated at a constant speed and connected to escapement mechanism 98 provided with a drive shaft 99, the drive shaft 99 being connected to the lower end of the operating shaft 86 by a slip clutch 100 arranged therebetween; while the upper end of the operating shaft 86 and the lower end of the control shaft 87 are interconnected by a fixture 101 that accommodates rotary movement of the operating shaft 86 and both rotary and longitudinal sliding movements of the control shaft 87. Also the fixture 101 carries a substantially annular insulating disk that cooperates with a master or line switch 102. More particularly, the control knob 88 is capable of both rotary and longitudinal (up and down) movements with respect to the backsplash 18; whereby the rotary movement of the control knob 88 is transferred by the fixture 101 to the operating shaft 86, while the longitudinal movement of the control knob 88 causes the insulating disk carried by the control shaft 87 selectively to operate the master switch 102. Specifically, when the control knob 88 occupies its downward position, the master switch 102 is operated into its open position, and when the control knob 88 occupies its upward position, the master switch 102 is operated into its closed position. Finally, the control disk 88 cooperates with an index marker 104 carried by the adjacent portion of the backsplash 18.

In the arrangement, when the timer motor 96 is operating, the escapement mechanism 98 operates intermittently to drive the shaft 99 step by step through small arcs of revolution that are imparted through the slip clutch 100 to the operating shaft 86 and consequently to the control cams C1 to C5, inclusive. For example, the escapement mechanism 98 might rotate the operating shaft 86 through an arc of 3° at the expiration of each 45 seconds during operation of the timer motor 96.

The set of switch springs S1 comprises three individual springs providing two pairs of contacts 111 and 112; and the cooperating control cam C1 is provided with three control levels; whereby the contacts 111 are closed when the control cam C1 occupies its high level, the contacts 111 and 112 are opened when the control cam C1 occupies its medium level, and the contacts 112 are closed when the control cam C1 occupies its low level. Similarly, the set of switch springs S2 comprises three individual springs providing two pairs of contacts 113 and 114; and the cooperating control cam C2 is provided with three control levels; whereby the contacts 113 are closed when the control cam C2 occupies its high level, the contacts 113 and 114 are opened when the control cam C2 occupies its medium level, and the contacts 114 are closed when the control cam C2 occupies its low level. Similarly, the set of switch springs S3 comprises three individual springs providing two pairs of contacts 115 and 116; and the cooperating control cam C3 is provided with three control levels; whereby the contacts 115 are closed when the control cam C3 occupies its high level, the contacts 115 and 116 are opened when the control cam C3 occupies its medium level, and the contacts 116 are closed when the control cam C3 occupies its low level. The set of switch springs S4 comprises two individual springs providing a single pair of contacts 117; and the cooperating control cam C4 is provided with high and low levels respectively closing and opening the contacts 117. Similarly, the set of switch springs S5 comprises two individual springs providing a single pair of contacts 118; and the cooperating control cam C5 is provided with high and low levels respectively closing and opening the contacts 118.

In the circuit arrangement, the fill switch 77 comprises three individual switch springs providing two pairs of contacts E and F, the contacts E being closed when there is no water in the drain tub 22 and the contacts F being closed when there is water in the drain tub 22. More particularly, water in the drain tub 22 flows into the inlet connection 63 to the drain pump 47 producing a hydrostatic pressure therein, with the result that the air in the air chamber of the drain pump 47 is correspondingly compressed producing a pressure in the tube 72; whereby the diaphragm 74 in the casing 73 is operated to bring about opening of the contacts E and closing of the contacts F of the fill switch 77. The operation of the drain pump 47 to discharge the water to the exterior via the drain conduit 66 relieves the hydrostatic pressure mentioned so that the diaphragm 74 returns the fill switch 77 back into its normal position, opening the contacts F and closing the contacts E.

The main motor 42 is of the induction type provided with a rotor 119 carried by an operating shaft 120 and provided with a stator, not shown, carrying a run winding 121 and a start winding 122. The operating shaft 120 carries a speed responsive device 123 that includes two contact bridging members 124 and 125 respectively controlling two pairs of contacts. In the arrangement, when the rotor 119 is at rest or below a critical speed somewhat in excess of 50% of its normal running speed, the device 123 causes the contact bridging members 124 and 125 to close the associated pairs of contacts. On the other hand, when the rotor 119 is rotated at a speed above the critical speed mentioned, the device 123 controls the contact bridging members 124 and 125 to bring about opening of the associated pairs of contacts.

Further, the circuit arrangement comprises a start relay 130 including six individual switch springs providing three pairs of contacts 131, 132 and 133, as well as a run relay 140 including six individual switch springs providing three pairs of contacts 141, 142 and 143. Finally, the control circuit comprises a manual start switch of the pushbutton type 150 disposed below the right-hand side of the backsplash 18 and provided with an operating pushbutton projecting through a hole provided therein.

In the circuit arrangement 300, the source of power comprises two line conductors 151 and 152, the line conductor 151 being connected to one spring of the line switch 102, and the other spring of the line switch 102 being connected to a bus 153. The line conductor 152 is commonly connected to one terminal of the timer motor 96, to one contact of the manual start switch 150, to one terminal of the spin solenoid 61, to the midspring of the fill switch 77, to one terminal of the run winding 121, to the second and sixth springs of the run relay 140, to the sixth spring of the start relay 130, to one contact of the set governed by the contact bridging member 124, to one contact to the set governed by the bridging member 125, to the lower spring of the set S2, and to the upper spring of the set S8. The bus 153 is connected to the upper spring of the set S4 and to the upper spring of the set S5; while the other contact of the manual start switch 150 is connected to a conductor 154. The conductor 154 is commonly connected to the upper spring of the fill switch 77, to one terminal of the winding of the run relay 140 and to the first spring of the run relay 140. The other terminal of the timer motor 96 is connected to a conductor 155 that is commonly connected to one terminal of the hot solenoid 83, to one terminal of the cold solenoid 84, to the third spring of the run relay 140, to the lower spring of the

set S4 and to the midspring of the set S3. The lower spring of the fill switch 77 is connected to a conductor 156 that is commonly connected to one terminal of the start relay 130 and to the fifth spring of the start relay 130. The other terminal of the hot solenoid 83 is connected to a conductor 157 that is connected to the midspring of the set S1; the other terminal of the cold solenoid 84 is connected to a conductor 158 that is connected to the midspring of the set S2; and the other terminal of the spin solenoid 61 is connected to a conductor 159 that is connected to the lower spring of the set S5. One terminal of the agitate solenoid 62 is connected to a conductor 160 that is commonly connected to the fourth spring of the start relay 130, to the other terminal of the start relay 130 and to the upper spring of the set S3; while the other terminal of the agitate solenoid 62 is connected to a conductor 161 that is connected to the fifth spring of the run relay 140. The other terminal of the run winding 121 is connected to a conductor 162 that is commonly connected to the fourth spring of the run relay 140, to one terminal of the start winding 122 and to the lower spring of the set S3; while the other terminal of the start winding 122 is connected to a conductor 163 that is terminated by the other contact of the set governed by the bridging member 124. The other contact of the set governed by the bridging member 125 terminates a conductor 164 that is connected to the first spring of the start relay 130. The other terminal of the run relay 140 is connected to a conductor 165 that is connected to the third spring of the start relay 130. The upper spring of the set S6 is connected to a conductor 166 that is connected to the upper spring of the set S1; the lower spring of the set S6 is connected to the lower spring of the set S7 by a conductor 167 that is also connected to the second spring of the start relay 130; while the upper spring of the set S7 is connected to a conductor 168 that is connected to the upper spring of the set S2. Finally, the lower spring of the set S8 is connected to a conductor 169 that is connected to the lower spring of the set S1.

In view of the foregoing general description of the clothes washing machine 10, it will be understood that the clothes may be placed within and removed from the spin tub 36 through the opening 19 provided in the top wall 15 when the door 20 occupies its open position. When operation of the main motor 42 is initiated, the operating shaft 43 thereof rotates the operating shaft 48 of the drain pump 47 through the drive connection including the belt 54, whereby the operating shaft 48 of the drain pump 47 rotates the drive shaft 52 of the motion-translating mechanism 51 through the drive connection including the belt 55. The operating drain pump 47 pumps to the exterior any water in the drain tub 22 thereby insuring that the water is removed from the inlet connection 63 so that the fill switch 77 occupies its empty position. In the arrangement, the check valve 65 prevents any water in the discharge conduit 66 from backing into the drain pump 47 so as to prevent any hydrostatic head of water in the discharge conduit 66 from creating any pressure in the air chamber of the drain pump 47. When the drive shaft 52 of the motion-translating mechanism 51 is thus rotated, the driven shaft thereof, not shown, extending to the clutch mechanism 59 is oscillated; however, the agitator 37 is not oscillated until the clutch mechanism 59 is operated into its clutched position. Also rotation of the operating shaft 43 conditions the casing 56 of the unit 44 to be rotated upon operation of the clutch mechanism incorporated therein; however, the casing 56 is not rotated until the clutch mentioned is operated into its clutched position by energization of the spin solenoid 61; and also the brake shoe 60 normally engages the brake surface provided on the casing 56 in order to insure that the spin tub 36 is not normally rotated. Further, it will be noted that by appropriate control of the hot solenoid 83 and the cold solenoid 84 the spin tub 36 may be filled with hot water or warm water or cold water, and that upon complete filling of the spin tub 36, water is overflowed therefrom into the drain tub 22 and thence into the drain connection 63 so that the hydrostatic head of water compresses the air in the air chamber of the drain pump 47 bringing about operation of the fill switch 77 from its empty position into its full position. Subsequently, after the supply of water to the spin tub 36 is arrested, the drain pump 47 discharges to the exterior the water mentioned; whereby the pressure of the air in the air chamber of the drain pump 47 is reduced so that the fill switch 77 is returned from its full position back into its empty position. In order to initiate the washing operation, the agitate solenoid 62 is energized so that the clutch mechanism 59 is operated from its declutched position into its clutched position with the result that the agitator 37 is oscillated. In order to arrest the washing operation, it is necessary only to deenergize the agitate solenoid 62, since the clutch mechanism 59 is normally biased into its declutched position. In order to initiate a water extracting operation, the spin solenoid 61 is energized so that the clutch incorporated in the unit 44 is operated from its normal declutched position into its clutched position so that the brake shoe 60 is moved from its normal position of engagement with the brake surface provided on the upper portion of the casing 56. At this time, the casing 56 is gradually accelerated through the fluid drive elements incorporated in the unit 44, whereby the tub sleeve, not shown, is rotated through the drive connection including the belt 57 effecting rotation or spinning of the spin tub 36 with the result that the water contained therein is centrifugally discharged therefrom and caught in the drain tub 22. In passing, it is noted that the principal portion of the water is discharged from the spin tub 36 through the holes arranged in the upper edge thereof and the associated balance ring 38; while the water contained in the sediment trap 40, along with any sediment therein, is discharged through the upstanding conduits 41 into the drain tub 22. In order to arrest the water extracting operation, it is only necessary to deenergize the spin solenoid 61, whereby the clutch mechanism incorporated in the unit 44 is returned back into its normal declutched position, and the brake shoe 60 is returned back into its braking position with respect to the brake surface provided on the upper portion of the casing 56. Accordingly, the brake shoe 60 dissipates the kinetic energy of the rotating spin tub 36 causing it quickly to assume its normal rest position.

Considering now the cycle of operation of the machine 10, with reference to the control circuit 300, shown in Fig. 3, after the operator places the clothes in the spin tub 36, along with the detergent, she determines whether the clothes should be washed in hot or warm or cold water and appropriately operates the wash selector 89, and determines whether the clothes should be rinsed in warm or cold water and appropriately operates the rinse selector 90. When the wash selector 89 occupies its hot position illustrated, the hot pushbutton 91 being depressed, only the set of switch springs S6 is closed and the other pushbuttons 92 and 93 are returned into their normal projected positions by the interlock mechanism, not shown. When the rinse selector 90 occupies its warm position illustrated, the warm pushbutton 94 being depressed, the set of switch springs S8 is closed, and the other pushbutton 95 is returned into its normal projected position by the interlock mechanism, not shown. Accordingly, for the purpose of the present description, it will be assumed that the clothes are to be washed in hot water and are to be rinsed in warm water, whereby the hot pushbutton 91 of the wash selector 89 is depressed and the warm pushbutton 94 of the rinse selector 90 is depressed.

The operator then rotates the control knob 88 from its off position into its variable fill and wash position, de-

pendent upon the time interval during which it is desired to wash the clothes, the time interval set by the control knob **88** being indicated by the cooperation thereof with the index marker **104**, and it may be assumed that the operator desires to wash the clothes for ten minutes in the present example. The operator then lifts the control knob **88** so that the line switch **102** is operated into its closed position connecting the line conductor **151** to the bus **153** so as to initiate the washing operation. When the control knob **88** is rotated into its fill and wash position, the control cams C1, C2, C3 and C4 operate the sets of switch springs S1, S2, S3 and S4 to effect closure of the respective contacts **111**, **113**, **115** and **117**; and when the control knob **88** is lifted, closure of the line switch **102** effects completion of the prepared circuits, as previously mentioned.

Specifically assuming that the fill switch **77** occupies its empty position, a circuit is completed for energizing the winding of the start relay **130**; which circuit extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **115**, the conductor **160**, the winding of the start relay **130**, the conductor **156** and the closed contacts E of the fill switch **77** to the line conductor **152**; whereby the start relay **130** operates closing its contacts **131**, **132** and **133**. Also a circuit is completed for operating the timer motor **96** that extends from the bus **153** via the closed contacts **117**, the conductor **155** and the winding of the timer motor **96** to the line conductor **152**; whereby the operating timer motor **96** effects step by step rotation of the operating shaft **86** through the escapement mechanism **98**, so that the control cams C1, etc., are driven step by step out of the fill and wash position toward the continued wash position thereof as time proceeds.

Upon operating the start relay **130** completes at the contacts **133** a holding circuit for energizing the winding thereof independent of the position of the fill switch **77**; which holding circuit extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **115**, the conductor **160**, the winding of the start relay **130**, the conductor **156** and the closed contacts **133** to the line conductor **152**. Also the start relay **130** prepares at the contacts **132** a circuit traced hereinafter for operating the run relay **140**; and completes at the contacts **131** a circuit for energizing the hot solenoid **83** (in the present example). The circuit for energizing the hot solenoid **83** extends from the bus **153** via the closed contacts **117**, the conductor **155**, the hot solenoid **83**, the conductor **157**, the closed contacts **111**, the conductor **166**, the closed set of switch springs S6, the conductor **167**, the closed contacts **131**, the conductor **164** and the closed contact bridging member **125** to the line conductor **152**. Accordingly, the hot solenoid **83** operates the valve mechanism **79** into its open position so that the hot-water is introduced into the spin tub **36** and subsequently overflows therefrom into the drain tub **22** and thence into the inlet connection **63** extending to the drain pump **47** so as to bring about the operation of the fill switch **77** from its empty position into its full position.

When the fill switch **77** is thus operated into its full position, the prepared circuit for energizing the winding of the run relay **140** is completed, and extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **115**, the conductor **160**, the closed contacts **132**, the conductor **165**, the winding of the run relay **140**, the conductor **154** and the closed contacts F to the line conductor **152**. Accordingly, the run relay **140** is operated to close its contacts **141**, **142** and **143**. At the contacts **141**, the run relay **140** completes a holding circuit for energizing the winding thereof independently of the position of the fill switch **77**; which holding circuit extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **115**, the conductor **160**, the closed contacts **132**, the conductor **165**, the winding of the run relay **140**, the conductor **154**, and the closed contacts **141** to the line conductor **152**. At the contacts **142**, the run relay **140** completes a circuit for operating the main motor **42** which extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **142**, the conductor **162** and the run winding **121** to the line conductor **152**, and from the conductor **162** via the start winding **122**, the conductor **163** and the closed contact bridging member **124** to the line conductor **152**. Accordingly, both the run winding **121** and the start winding **122** of the main motor **42** are energized in parallel relation so that operation of the main motor **42** is initiated; when the rotor **119** is accelerated to a speed somewhat in excess of 50% of its normal running speed, the speed responsive device **123** operates the contact bridging members **124** and **125** into their open positions. Opening of the contact bridging member **124** interrupts the previously traced circuit for energizing the start winding **122** of the main motor **42**; whereby the rotor **119** is accelerated into its normal running speed by virtue of the energization of the run winding **121**. Opening of the bridging member **125** interrupts the previously traced circuit for energizing the hot solenoid **83**; whereby the valve mechanism **79** is returned back into its closed position to cut off the supply of hot water to the spin tub **36**.

Closure of the contacts **143** completes a circuit for energizing the agitate solenoid **62**; which circuit extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **115**, the conductor **160**, the agitate solenoid **62**, the conductor **161** and the closed contacts **143** to the line conductor **152**. The energized agitate solenoid **62** operates the clutch mechanism **59** into its clutched position, so that the agitator **37** is oscillated, as previously explained, by the operating main motor **42**. Also the operation of the main motor **42** effects operation of the drain pump **47** so that the water that is overflowed into the drain tub **22** is discharged to the exterior via the drain conduit **66** with the result that the fill switch **77** is operated from its full position back into its empty position.

As time proceeds, the timer motor **96** drives the operating shaft **86** of the selector switch **85** out of its fill and wash position into its continue wash position, as illustrated in Fig. 3; whereby the control cams C1 and C2 operate the sets of switch springs S1 and S2 so that the contacts **111** and **113** are opened in order to bring about the interruption of further points in the respective prepared circuits for energizing the hot solenoid **83** and the cold solenoid **84**.

Still subsequently, the timer motor **96** drives the selector switch **85** into its spin position, as illustrated in Fig. 3; whereby the control cam C3 and C5 operate the sets of switch springs S3 and S5. Specifically, the set of switch springs S3 is operated to open the contacts **115** and to close the contacts **116**; whereas the set of switch springs S5 is operated to close the contacts **118**. Opening of the contacts **115** interrupts the previously traced holding circuit for retaining operated the start relay **130**; whereby the latter relay restores to interrupt at the contacts **132** the previously traced holding circuit for retaining operated the run relay **140**; whereby the latter relay restores to interrupt at the contacts **143** the circuit for energizing the agitate solenoid **62** in order that the clutch mechanism **59** is returned back into its declutched position so as to arrest further operation of the agitator **37**. Also the run relay **140** interrupts at the contacts **142** the original circuit for operating the main motor **42**; however, at this time an alternative circuit for operating the main motor **42** is completed at the closed contacts **116** of the set of switch springs S3. The last mentioned circuit extends from the bus **153** via the closed contacts **117**, the conductor **155**, the closed contacts **116**, the conductor **162** and the run winding **121** to the line conductor **152**. Accordingly, it will be understood that the operation of the main motor

42 is continuous when the selector switch 85 is operated from its continue wash position into its spin position. At the closed contacts 118 of the set of switch springs S5, a circuit is completed for energizing the spin solenoid 61; which circuit extends from the bus 153 via the closed contacts 118, the conductor 159 and the spin solenoid 61 to the line conductor 152; whereby the unit 44 is controlled in the manner previously explained in order to effect rotation of the spin tub 36 by the drive motor 42. When the spin tub 36 is thus rotated through the fluid drive unit 44, the wash water contained therein is centrifuged therefrom and caught in the drain tub 22 from which it is pumped to the exterior by the drain pump 44. The passage of the water through the drain conduit 63 actuates the fill switch 77 from its empty position into its full position; however, without effect in the present position of the selector switch 85; and the subsequent removal of the water from the drain conduit 63 brings about the return of the fill switch 77 from its full position into its empty position; however, without effect in the present position of the selector switch 85.

As time proceeds, the selector switch 85 is driven into its spin-rinse position, as illustrated in Fig. 3, by the timer motor 96; whereby the control cams C1 and C2 operate the sets of switch springs S1 and S2 respectively to close the contacts 112 and 114. Closure of the contacts 112 completes a direct circuit for energizing the hot solenoid 83 that extends from the bus 153 via the closed contacts 117, the conductor 155, the hot solenoid 83, the conductor 157, the closed contacts 112, the conductor 169 and the closed set of switch springs S8 to the line conductor 152. Closure of the contacts 114 completes a direct circuit for energizing the cold solenoid 84 that extends from the bus 153 via the closed contacts 117, the conductor 155, the cold solenoid 84, the conductor 158, and the closed contacts 114 to the line conductor 152. Accordingly, the hot solenoid 83 and the cold solenoid 84 are operated simultaneously so that the valve mechanism 79 is controlled to bring about the supply of warm water into the spin tub 36 during spinning thereof so that the clothes are subjected to a spinning rinsing action.

Subsequently, the timer motor 96 drives the selector switch 85 into its continue spin position, as illustrated in Fig. 3; whereby the control cams C1 and C2 operate the sets of switch springs S1 and S2 to open the contacts 112 and 114 so as to bring about the deenergization of the hot solenoid 83 and the cold solenoid 84, with the result that the valve mechanism 79 is returned into its closed position cutting off the supply of warm water into the spin tub 36. Continued spinning of the spin tub 36 brings about the centrifugal discharge of all of the rinse water therefrom; whereby the same is caught in the drain tub 22 and discharged to the exterior by the drain pump 47, with the result that the fill switch 77 is again returned into its empty position, as previously explained.

Still subsequently, the selector switch 85 is driven out of its continue spin position into its fill position, as illustrated in Fig. 3; whereby the control cams C1, C2 and C5 operate the sets of switch springs S1, S2 and S5. Specifically the contacts 112 and 114 are closed; and the contacts 118 are opened. Closure of the contacts 112 and 114 brings about the energization of the hot solenoid 83 and the cold solenoid 84 respectively, in the manner previously explained; whereby warm water is again supplied into the spin tub 36 in the manner previously described. Opening of the contacts 118 interrupts the previously traced circuit for energizing the spin solenoid 61; whereby the clutch mechanism incorporated in the unit 44 is operated into its declutched position with the result that the brake shoe 60 is set in order quickly to brake the rotation of the spin tub 36.

The continued operation of the main motor 42 during the initial filling of the spin tub 36 in the fill position of the selector switch 85 insures that all of the water is removed from the drain tub 22 and the drain conduit 63, with the result that the fill switch 77 is returned back into its empty position; and still subsequently, and prior to the complete filling of the spin tub 36, the selector switch 85 is operated from its fill position into its fill and power rinse position, as illustrated in Fig. 3; whereby the control cam C3 operates the set of switch springs S3 so that the contacts 116 are opened and the contacts 115 are closed. Opening of the contacts 116 interrupts the previously traced alternative circuit for operating the main motor 42, whereby operation thereof is arrested; and closure of the contacts 115 completes the previously traced circuit for operating the start relay 130, the fill switch 77 occupying its empty position at this time. As soon as the spin tub 36 is completely filled with the warm water, it overflows in order to effect operation of the fill switch 77 into its full position, with the result that the run relay 140 is operated in the manner previously explained. Upon operating, the run relay 140 completes at the contacts 141, the holding circuit for energizing the winding thereof; completes at the contacts 142, the circuit for operating the main motor 42; and completes at the contacts 143, the circuit for energizing the agitate solenoid 62. Accordingly, operation of the main motor 42 is again initiated and the energized agitate solenoid 62 operates the clutch mechanism 59 into its closed position so that the agitator 37 is again operated. At this time, the introduction of warm water into the spin tub 36 continues by virtue of the completed direct circuits for energizing the hot solenoid 83 and the cold solenoid 84, while the agitator 37 is operated; whereby the clothes are subjected to a deep overflow rinsing operation.

This overflow rinsing operation continues until the selector switch 85 is driven out of its fill and power rinse position into its final spin position, as illustrated in Fig. 3; whereupon the control cams C1, C2, C3 and C5 operate the sets of switch springs S1, S2, S3 and S5. Specifically, the sets of switch springs S1 and S2 are operated to open the contacts 112 and 114; the set of switch springs S3 is operated to open the contacts 115 and to close the contacts 116; and the set of switch springs S5 is operated to close the contacts 118. Opening of the contacts 112 and 114 effects the deenergization of the hot solenoid 83 and the cold solenoid 84, so that the valve mechanism 79 is returned into its closed position. Opening of the contacts 115 effects the restoration of the start relay 130 and the run relay 140; while closure of the contacts 116 completes the previously traced alternative circuit for operating the main motor 42. Further, the closure of the contacts 118 completes the previously traced circuit for energizing the spin solenoid 61, whereby the unit 44 is operated into its clutched position so as to bring about spinning of the spin tub 36 in the manner previously explained. Specifically, the rinse water is centrifugally discharged from the spin tub 36 into the drain tub 22 and pumped therefrom by the drain pump 47 to the exterior, whereby subsequently the fill switch 77 is returned back into its empty position in order to condition the machine 10 for another cycle of operation.

Ultimately the selector switch 85 is driven from its final spin position back into its off position, as illustrated in Fig. 3; whereby the control cams C3, C4 and C5 operate the sets of switch springs S3, S4 and S5 respectively to open the contacts 116, 117 and 118. Opening of the contacts 116 interrupts the alternative circuit for operating the main motor 42; opening of the contacts 118 interrupts the circuit for energizing the spin solenoid 61; and opening of the contacts 117 interrupts the circuit for operating the timer motor 96. Accordingly, the unit 44 is returned into its declutched position and the brake shoe is set in order quickly to arrest rotation of the spin tub 36; operation of the main motor 42 is arrested; and the operation of the timer motor 96 is arrested while the selector switch 85 occupies its off position. Accordingly, at this time the cycle of the clothes washing machine 10 is completed and the fill switch 77 occupies its empty

position so that the machine **10** is conditioned for the next cycle of operation thereof in response to rotation of the control knob **88** out of its off position into its fill and wash position, in the manner previously explained.

In view of the foregoing description of the mode of operation of the clothes washing machine **10**, when the hot pushbutton **91** of the wash selector **89** occupies its operated position and the warm pushbutton **94** of the rinse selector **90** occupies its operated position, it will be understood that the mode of operation thereof is substantially identical when any other combination of the pushbuttons of the wash selector **89** and the rinse selector **90** occupy their operated positions, as explained below. Specifically, in the event the warm pushbutton **92** occupies its depressed position parallel circuits for energizing the hot solenoid **83** and the cold solenoid **84** are completed in the fill and wash position of the selector switch **85**. The circuit for energizing the hot solenoid **83** is the same as that previously described; while the circuit for energizing the cold solenoid **84** extends from the bus **153** via the closed contacts **117**, the conductor **155**, the cold solenoid **84**, the conductor **158**, the closed contacts **113**, the conductor **168**, the closed set of switch springs S7, the conductor **167**, the closed contacts **131**, the conductor **164** and the closed bridging member **125** to the line conductor **152**. Of course, when both of the solenoids **83** and **84** are energized the valve mechanism **79** is operated to admit a mixture of hot water and cold water, and thus warm water, into the spin tub **36**. In the event the cold pushbutton **93** of the wash selector is depressed, only cold water is admitted into the spin tub **36** in the fill and wash position of the selector switch **85** since only the above-traced circuit for energizing the cold solenoid **84** is completed, with the set of switch springs S6 in its open position. When the cold pushbutton **95** of the rinse selector **90** occupies its depressed position, the set of switch springs S8 is opened, whereby only the cold solenoid **84** is energized when the selector switch **85** occupies its spin rinse position, its fill position and its fill and power rinse position.

In the foregong description of the mode of operation of the control circuit **300** for the machine **10**, it was assumed that a full volume of wash water was desired in the spintub **36** for the purpose of washing the clothes; which full volume of wash water is automatically achieved in the normal automatic operation of the control circuit by virtue of the arrangement of the fill switch **77**, as previously explained, since it is the operation of the fill switch **77** from its empty position into its full position that effects operation of the run relay **140** and the consequent initiation of operation of the main motor **42** with the result that the contact bridging member **125** interrupts one or both of the circuits for energizing the solenoids **83** and **84**. However, in the event less than a full volume of wash water is desired in the spin tub **36**, this result may be achieved manually by the operator by inspection of the quantity of wash water in the spin tub **36** with the door **20** in its open position followed by momentary operation of the manual start switch or pushbutton **150** when the operator determines that an adequate and less than full volume of wash water is in the spin tub **36**. Specifically, at any time during the filling of the spin tub **36**, when the selector switch **85** occupies its fill and wash position, and prior to the overflowing of the spin tub **36** with the wash water and the consequent operation of the fill switch **77** from its empty position into its full position, the operator may momentarily actuate the manual start pushbutton **150** completing a bridge connection between the conductor **154** and the line conductor **152** in parallel with the open F contacts of the fill switch **77**; whereby the run relay **140** is operated to bring about operation of the main motor **42** and the consequent opening of the contact bridging member **125**; all independently of the operation of the fill switch **77**. Of course, the operation of the contact bridging member **125** into its open position interrupts a common point in the circuits for energizing the solenoids **83** and **84** so as to terminate the filling of wash water into the spin tub **36**, and prior to the overflow thereof. Also operation of the run relay **140** effects energization of the agitate solenoid **62** and the consequent operation of the agitator **37** in the manner previously explained; whereby the washing operation proceeds with less than a full charge of wash water. The remainder of this cycle of operation of the circuit **300** is the same as that previously described.

In view of the foregoing, it is apparent that there has been provided in a clothes washing machine of the automatic type, a control circuit that incorporates improved facility for controlling the fill of wash water into the tub and for controlling subsequent operation of the machine in its washing cycle in order to insure proper correlation of these functions so as to prevent any possibility of damage to the clothes as a result of operation of the machine in the absence of an adequate fill of wash water in the tub thereof.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a variable wash position and a spin position, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, a manually operable member for operating said program controller from its off position into its variable wash position, means responsive to operation of said program controller into its variable wash position for operating said start relay, means responsive to operation of said start relay for operating said valve into its open position, whereby water from said system is supplied into said tub and subsequently overflowed therefrom into said casing and thence into said drain conduit in order that said control switch is operated into its full position, means responsive to operation of said control switch into its full position for operating said run relay, means responsive to operation of said run relay for initiating operation of said drive motor and for initiating operation of said agitator from said drive motor, means responsive to operation of said drive motor for operating said valve into its closed position, timing means for operating said program controller through its variable wash position and through its spin position and back into its off position, means responsive to operation of said program controller out of its variable wash position for restoring said start relay and said run relay and for arresting operation of said agitator, means responsive to operation of said program controller through its spin position for operating said drive motor independently of said run relay and for rotating said tub from said drive motor, and means responsive to opera-

tion of said program controller back into its off position for arresting operation of said drive motor.

2. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a variable wash position and a spin position, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, a manually operable member for operating said program controller from its off position into its variable wash position, means responsive to operation of said program controller into its variable wash position for operating said start relay and for operating said valve into its open position, whereby water from said system is supplied into said tub and subsequently overflowed therefrom into said casing and thence into said drain conduit in order that said control switch is operated into its full position, means controlled jointly by operation of said start relay and by operation of said control switch into its full position for operating said run relay, means responsive to operation of said run relay for initiating operation of said drive motor and for initiating operation of said agitator from said drive motor, means responsive to operation of said drive motor for operating said valve onto its closed position, timing means for operating said program controller through its variable wash position and through its spin position and back into its off position, means responsive to operation of said program controller out of its variable wash position for restoring said start relay and said run relay and for arresting operation of said agitator, means responsive to operation of said program controller through its spin position for operating said motor independently of said run relay and for rotating said tub from said drive motor, and means responsive to operation of said program controller back into its off position for arresting operation of said drive motor.

3. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a variable wash position and a spin position, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, a manually operable member for operating said program controller from its off position into its variable wash position, means governed jointly by said control switch in its empty position and by operation of said program controller into its variable wash position for operating said start relay, means responsive to operation of said start relay for completing a first holding circuit therefor and for operating said valve into its open position, whereby water from said system is supplied into said tub and subsequently overflowed therefrom into said casing and thence into said drain conduit in order that said control switch is operated into its full position, means governed jointly by said start relay in its operated position and by operation of said control switch into its full position for operating said run relay, means responsive to operation of said run relay for completing a second holding circuit therefor and for initiating operation of said drive motor and for initiating operation of said agitator from said drive motor, means responsive to operation of said drive motor for operating said valve into its closed position, timing means for operating said program controller through its variable wash position and through its spin position and back into its off position, means responsive to operation of said program controller out of its variable wash position for restoring said start relay and said run relay and for arresting operation of said agitator, means responsive to operation of said program controller through its spin position for operating said drive motor independently of said run relay and for rotating said tub from said drive motor, and means responsive to operation of said program controller back into its off position for arresting operation of said drive motor.

4. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a start position and a plurality of control positions, manually operable means for operating said program controller from its off position into its start position, timing means for operating said program controller from its start position through its control positions and back into its off position, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, means governed jointly by said control switch in its empty position and by said program controller in one of its control positions for operating said start relay, means governed jointly by said control switch in its full position and by said start relay in its operated position and by said program controller in another of its control positions for operating said run relay, means governed by said program controller in a further of its control positions for restoring both said start relay and said run relay, means responsive to operation of said start relay for operating said valve into its open position, means responsive to operation of said run relay for operating said drive motor, means responsive to operation of said drive motor for operating said valve into its closed position, means selectively governed by said program controller in still other of its control positions for selectively operating said valve between its open and closed positions independently of said start relay and said drive motor, and additional means selectively governed by said program controller in certain of its control positions for selectively

operating said agitator from said drive motor and for selectively rotating said tub from said drive motor.

5. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a start position and a plurality of control positions, manually operable means for operating said program controller from its off position into its start position, timing means for operating said program controller from its start position through its control positions and back into its off position, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, a first circuit for operating said start relay and including contacts of said control switch closed in the empty position thereof and contacts of said program controller closed in one of its control positions, a second circuit for operating said run relay and including contacts of said control switch closed in the full position thereof and contacts of said start relay closed in the operated position thereof and contacts of said program controller closed in another of its control positions, said program controller in a further of its control positions opening its contacts included in said first and second circuits to effect restoration of both said start relay and said run relay, means responsive to operation of said start relay for operating said valve into its open position, means responsive to operation of said run relay for operating said drive motor, means responsive to operation of said drive motor for operating said valve into its closed position, means selectively governed by said program controller in still other of its control positions for selectively operating said valve between its open and closed positions independently of said start relay and said drive motor, and additional means selectively governed by said program controller in certain of its control positions for selectively operating said agitator from said drive motor and for selectively rotating said tub from said drive motor.

6. The clothes washing machine control circuit combination set forth in claim 5, and further comprising a manually operable switch arranged in parallel relation with said contacts of said control switch closed in the full position thereof and included in said second circuit.

7. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub and provided with a hot water conduit and a cold water conduit, valve mechanism arranged in said water supply system and selectively operative to supply hot and warm and cold water therefrom to said tub, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising manually operable means for selectively preparing said valve mechanism to supply hot water or warm water or cold water to said tub, a program controller having an off position and a start position and a plurality of control positions, manually operably means for operating said program controller from its off position into its start position, timing means for operating said program controller from its start position through its control position and back into its off position, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, means governed jointly by said control switch in its empty position and by said program controller in one of its control positions for operating said start relay, means governed jointly by said control switch in its full position and by said start relay in its operated position and by said program controller in another of its control positions for operating said run relay, means responsive to operation of said start relay for operating said prepared valve mechanism into its open position, means responsive to operation of said run relay for operating said drive motor, means responsive to operation of said drive motor for operating said valve mechanism into its closed position, means selectively governed by said program controller in further of its control positions for selectively operating said prepared valve mechanism between its open and closed positions independently of said start relay and said drive motor, and additional means selectively governed by said program controller in certain of its control positions for selectively operating said agitator from said drive motor and for selectively rotating said tub from said drive motor.

8. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communicating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a plurality of control positions, manually operable means for initiating operation of said program controller, timing means for effecting a timed cycle of operation of said program controller through its control positions and back into its off position in response to initiation of operation thereof, a first electro-responsive device operative to effect operation of said agitator from said operating drive motor, a second electro-responsive device operative to effect rotation of said tub from said operating drive motor, a control switch having a full position and an empty position, means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch into its empty position, a start relay, a run relay, said program controller in a first of its control positions effecting operating of said start relay, a first circuit for operating said valve into its open position, means responsive to operation of said start relay for completing said first circuit, whereby water from said system is supplied into said tub and subsequently overflowed therefrom into said casing and thence into said drain conduit in order that said control switch is operated into its full position, means responsive to operation of said control switch into its full position for operating said run relay, a second circuit for operating said drive motor, a third circuit for oper-

ating said first device, means responsive to operation of said run relay for interrupting said first circuit and for completing said second and third circuits, a fourth circuit for operating said drive motor, and a fifth circuit for operating said second device, said program controller in a second of its control positions effecting restoration of said start relay and said run relay and completing said fourth and fifth circuits, and said program controller in its off position interrupting said fourth and fifth circuits.

9. In a clothes washing machine including an upstanding casing, an upstanding tub arranged in said casing and mounted for rotation, an upstanding agitator arranged in said tub and mounted for operation, a water supply system communicating with said tub, a valve arranged in said water supply system, said casing being arranged to catch excess water overflowed from said tub incident to filling thereof and water centrifuged from said tub incident to rotation thereof, a drain conduit communicating with the lower portion of said casing, a drain pump provided with an inlet connected to said drain conduit and an outlet communcating with the exterior, and a drive motor directly connected to operate said drain pump; the control circuit combination comprising a program controller having an off position and a plurality of control positions, manually operable means for initiating operation of said program controller, timing means for effecting a timed cycle of operation of said program controller through its control positions and back into its off position in response to initiation of operation thereof, a first electro-responsive device operative to effect operation of said agitator from said operating drive motor, a second electro-responsive device operative to effect rotation of said tub from said operating drive motor, a control switch having a full position and an empty position means responsive to the presence of water in said drain conduit for operating said control switch into its full position and responsive to the absence of water in said drain conduit for operating said control switch

into its empty position, a start relay, a run relay, said program controller in a first of its control positions effecting operation of said start relay, a first circuit for operating said valve into its open position, means responsive to operation of said start relay for completing said first circuit, whereby water from said system is supplied into said tub and subsequently overflowed therefrom into said casing and thence into said drain conduit in order that said control switch is operated into its full position, means responsive to operation of said control switch into its full position for operating said run relay, a second circuit for operating said drive motor, a third circuit for operating said first device, means responsive to operation of said run relay for interrupting said first circuit and for completing said second and third circuits, a fourth circuit for operating said drive motor, a fifth circuit for operating said second device, said program controller in a second of its control positions effecting restoration of said start relay and said run relay and completing said fourth and fifth circuits, a sixth circuit for operating said valve into its open position, said program controller in a third of its control positions completing said fourth and fifth and sixth circuits, said program controller in a fourth of its control positions completing said fourth and fifth circuits and interrupting said sixth circuit, and said program controller in its off position interrupting said fourth and fifth circuits.

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