

Oct. 11, 1960

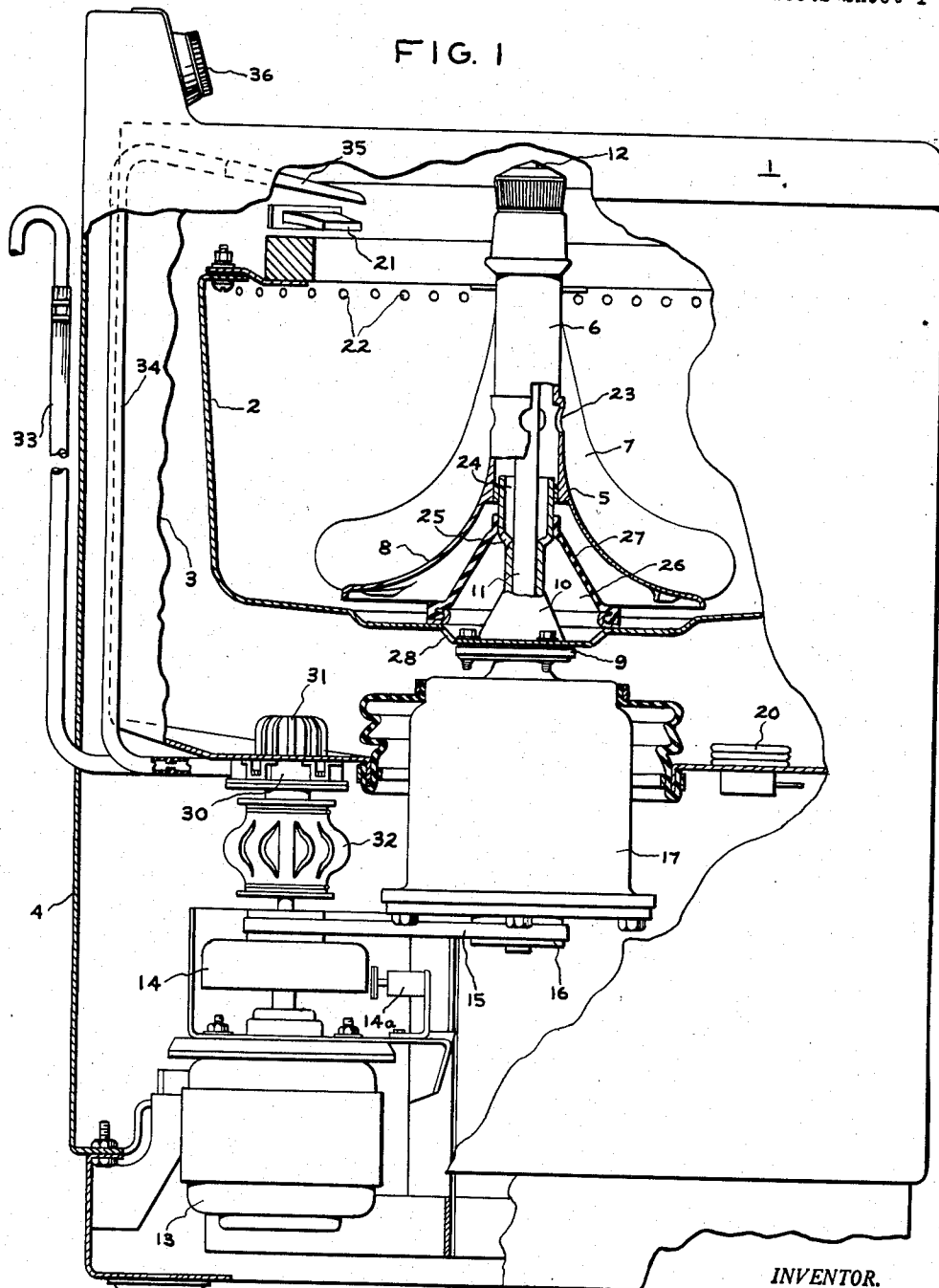
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2,955,448

CLOTHES WASHER WITH AN IMPROVED WATER LEVEL CONTROL SYSTEM

Filed Feb. 10, 1958

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

FIG. 2

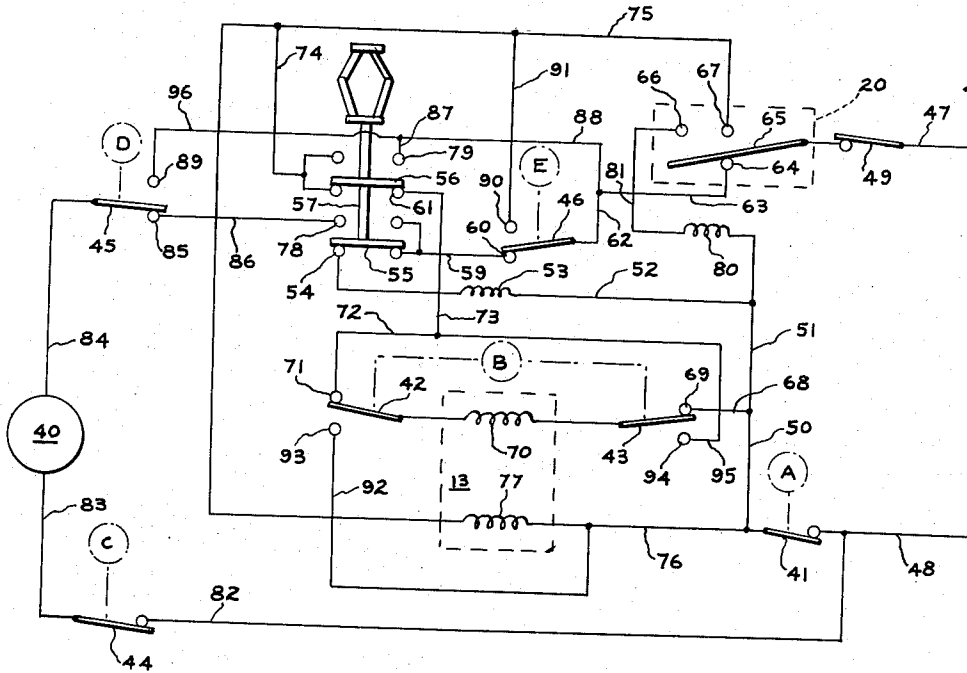
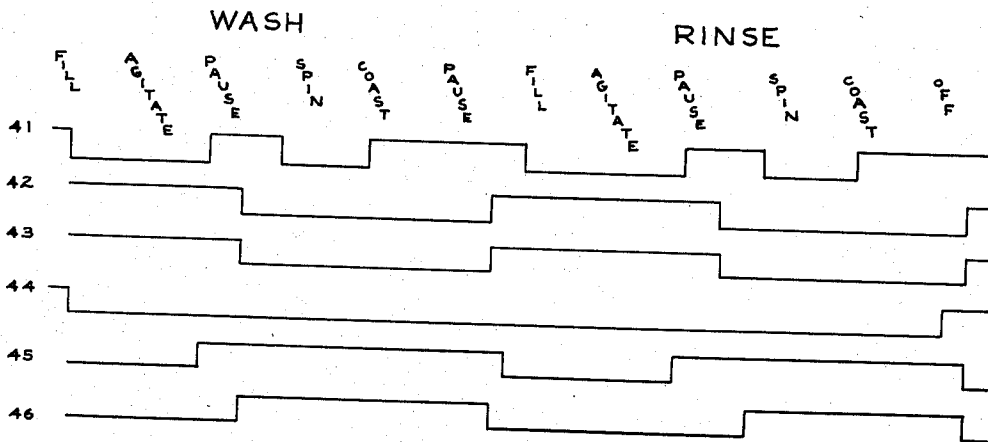


FIG. 3

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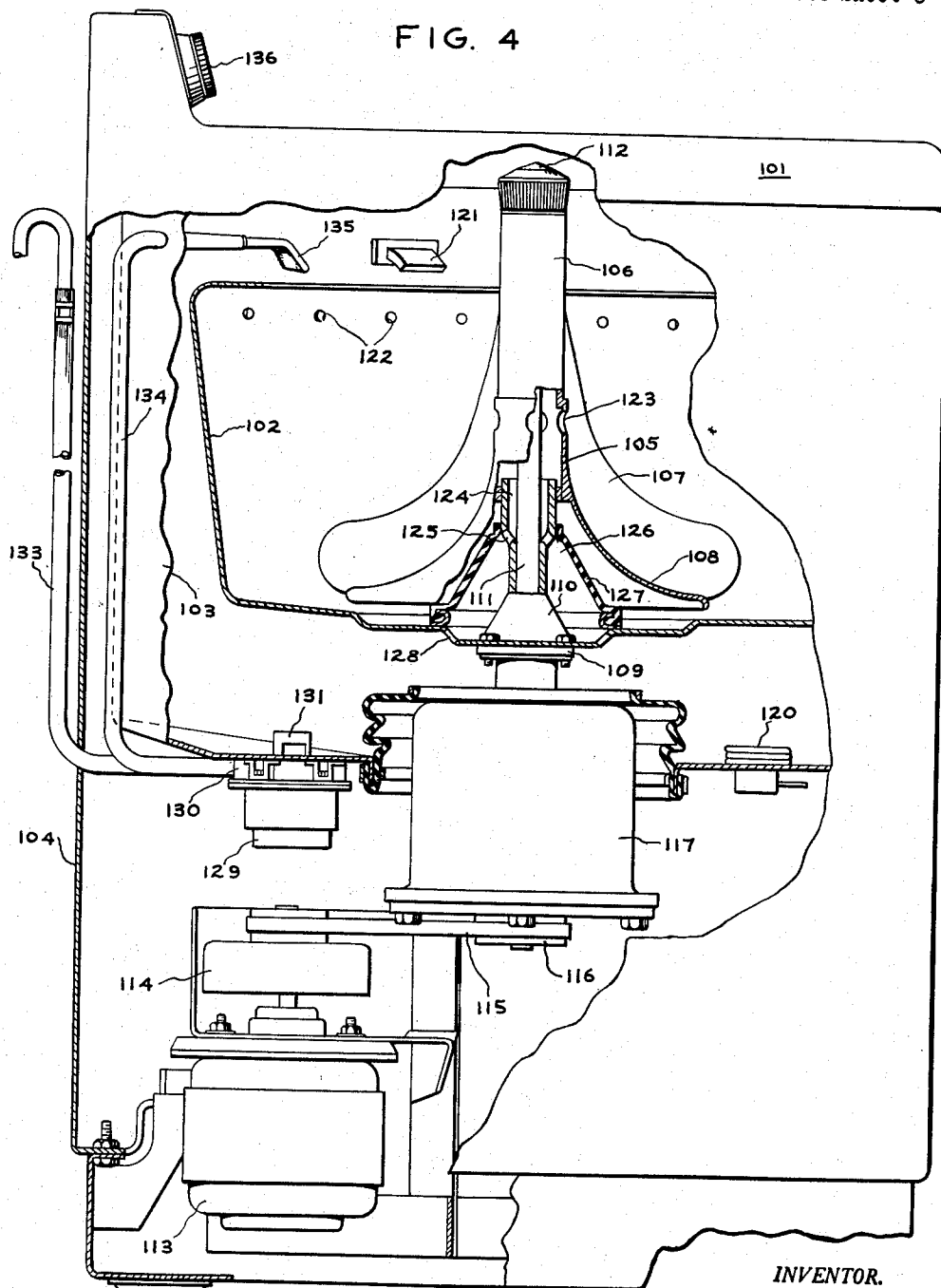
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4 Sheets-Sheet 3



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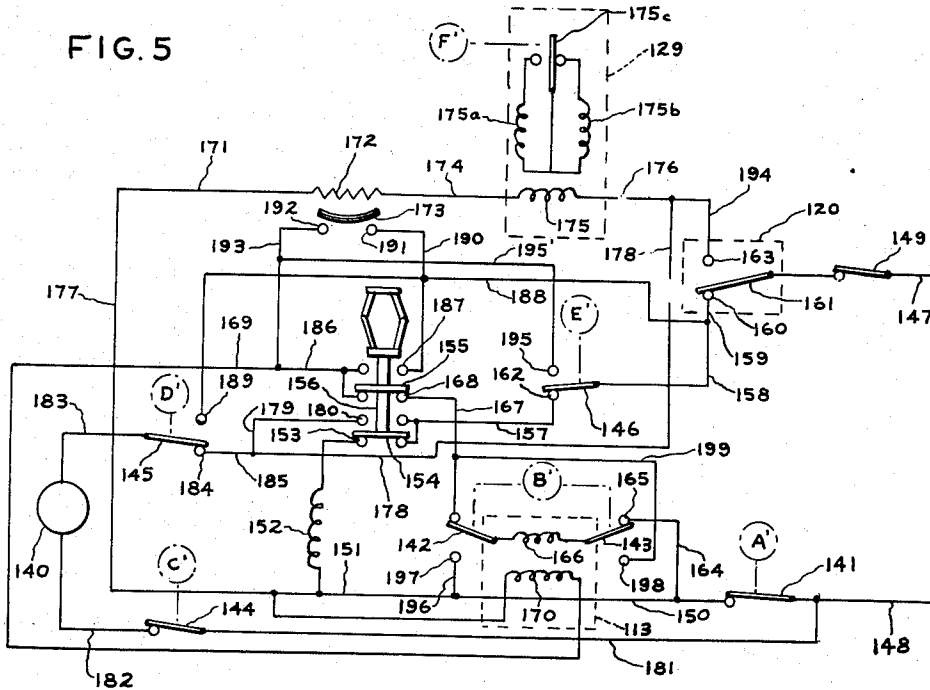
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CLOTHES WASHER WITH AN IMPROVED WATER LEVEL CONTROL SYSTEM

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4 Sheets-Sheet 4

FIG. 5



WASH

RINSE

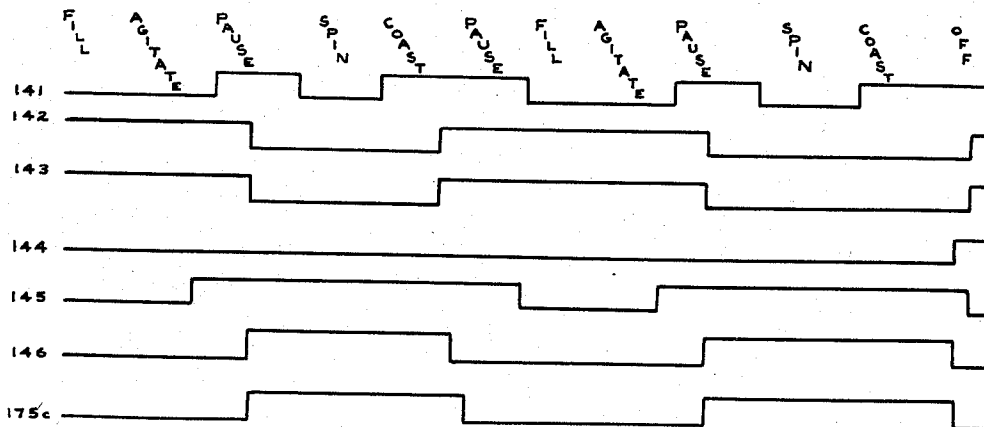


FIG. 6

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2,955,448

CLOTHES WASHER WITH AN IMPROVED WATER LEVEL CONTROL SYSTEM

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Filed Feb. 10, 1958, Ser. No. 714,214

7 Claims. (Cl. 68—12)

This invention relates to clothes washing machines of the basket type provided with an outer tub and a basket and agitator within it, wherein the clothes are washed in the basket, and wherein the water is continuously recirculated from the tub to the basket during the washing operation. The invention is especially useful in such machines wherein several operations are performed automatically, as for example in domestic clothes washers.

In domestic washers, the user frequently desires to wash a quantity, or load, of clothes which is less than the full capacity of the machine and which therefore requires less than the full amount of water. My invention is especially useful for such purposes in that it provides for a wide range of loadings without requiring the use of more water than is necessary for a given load of clothes. However, when employing an amount of water which is commensurate with a load of clothes less than the full capacity of the machine, it is important to have substantially all of the water in the clothes basket prior to the start of, and during, the washing operation rather than having part of the water in the basket and part in the tub outside the basket. Damage to the clothing, or to the machine, or to both, may occur when the agitator is operated with less than the commensurate amount of water in the basket. An advantage of the present invention is found in the arrangement whereby the agitator is operated only with the correct level of water for the selected load of clothes is present in the basket and this feature, which may be called a water level insurer feature, is inherent in the automatic operation of my improved machine.

An object of my invention is to provide an improved system for supplying water to a clothes washing machine under a water control arrangement contributing to safe and effective conservation of water, in clothes washing operations.

Another object is to provide an improved system for supplying water to the basket of clothes washing machine under a water control arrangement adapted for use where variable settings, commensurate with the load of clothes contained in the basket, are used.

A further object is to provide an improved washing machine having an arrangement for insuring the presence of the predetermined quantity of water in the clothes basket at all times during the washing stage, but without requiring a total volume of water which is greater than that necessary for the load of clothes being washed.

In carrying out my invention, I provide a clothes washing machine which includes a tub, a basket in the tub, and agitator means in the basket. Suitable water supply means feed into the basket, and, in the usual manner, a motor is provided to drive the agitator means during the washing operation. Means are provided in the basket so as to overflow a predetermined volume of water into the tub. The machine includes water level control means responsive to the water in the tub and operable to shut off the water supply when the desired volume of water has

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collected in the tub. A pump is provided to recirculate the water from the tub to the basket; the delivery rate of the pump is substantially more than the capacity of the overflow means.

The advantages of the invention are obtained by causing the pump to start operation when the desired amount of water has been delivered so that substantially all the water is put in the basket, and delaying operation of the agitator means for a predetermined period after the pump starts, i.e., until the water is in the basket.

This permits the minimum amount of water to be supplied for any given load with complete safety since agitation will not occur unless the water is in its effective washing location, i.e., in the basket.

The subject matter which I regard as my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. My invention, however, both as to organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a side elevational view of a clothes washing machine including a recirculation pump driven by the same motor which drives the agitator and basket of the machine, the view being partially broken away and partially in section to show details;

Fig. 2 is a schematic diagram of an electrical control circuit suitable for use in the machine of Fig. 1 and showing the positions occupied by the several switches at the beginning of a fill operation;

Fig. 3 is a cam chart showing in extended form the operation of the timer driven cam mechanism of Fig. 2 at various stages during the operating cycle;

Fig. 4 is a side elevational view of a similar clothes washing machine including a recirculation pump driven by a separate motor, the view likewise being partially broken away and partially in section to show details;

Fig. 5 is a schematic diagram of an electrical control circuit suitable for use in the machine of Fig. 4 and showing the positions occupied by the several switches at the beginning of a fill operation, and

Fig. 6 is a cam chart showing in extended form the operation of the timer driven cam mechanism of Fig. 5 at various stages during the operating cycle.

Referring now to Fig. 1, I have shown therein an agitator type clothes washing machine 1, which is provided with a water level insuring feature (as set forth below) by means of which the operation of the agitator is prevented until an adequate amount of water is present in the basket. The mechanical components of the machine include a clothes basket 2 which is disposed within an outer imperforate tub or casing 3. The tub is in turn mounted within an outer appearance cabinet 4. At the center of the wash basket 2 there is positioned a vertical axis agitator 5 which includes a center post 6 and a plurality extending vanes 7. The agitator is further provided with an outwardly and downwardly flared skirt 8 to which the vanes are joined at their lower ends.

Both the clothes basket 2 and the agitator 5 are rotatably mounted. Specifically, the basket 2 is mounted on a flange 9 of a rotatable hub 10 and the agitator 5 is mounted on a shaft 11 which extends upwardly through the hub 10 and the center post 6. The agitator is secured to the shaft by means of an internally threaded nut or cap 12 at the top of the center post. The basket 2 and the agitator 5 may be driven by any suitable means and by way of example may be driven from a reversible motor 13 having suitable starting and running windings and with a centrifugal switch for removing the starting winding from the circuit. The motor drives the basket and

agitator through the drive including a clutch 14 which is mounted on the motor shaft and which is provided with a suitable solenoid brake assembly 14a for engaging and disengaging the clutch and the motor shaft. The clutch is connected by means of a suitable belt 15 to the input pulley 16 of a transmission assembly 17 and it is effective to drive the pulley 16 in both directions of motor rotation.

The transmission 17 is so arranged that it supports and drives both the agitator drive shaft and the basket mounting hub 10. When the pulley is driven in one direction by the clutch 14, the transmission causes the agitator 5 to oscillate within the basket 2. Conversely, when the pulley 16 is driven in the opposite direction, the transmission drives the wash basket at high speed for centrifugal extraction, or spin, as later to be described. Although the drive mechanism forms no part of the present invention, reference is made to the co-pending application of James R. Hubbard, S.N. 420,594 filed April 2, 1954, now Patent No. 2,844,225 and assigned to the same assignee as the present invention. That application discloses in detail the structural characteristics of a transmission assembly suitable for use in the illustrated machine.

I provide at a lower portion of the bottom of tub 3 suitable water level control means such as a water level responsive switch 20 including a diaphragm and suitable switch contacts (to be described) which are opened and closed in response to movement of the diaphragm. Any suitable adjusting means (not shown) may be employed to vary the tripping point at which switch 20 opens and closes its contacts. By means of conventional solenoid actuated water control valves, (not shown) both washing and rinsing water is directed from a suitable source into basket 2 through a supply spout 21. Such water may thereafter pass into tub 3 through a series of apertures 22 adjacent the top of the basket 2, as when the basket is being employed in centrifugal extraction, or may pass into the tub through a series of apertures 23 in the agitator center post 6, thence into space 24 surrounding agitator shaft 11, thence through apertures 25 into space 26 within an impermeable boot 27 rotatably sealing the basket and the agitator center post, and thence through apertures 28 in the floor of the basket beneath that boot. The switch 20, as will later appear, adopts a setting which is dependent upon the amount of water collected in the bottom of the tub. In the preferred embodiment illustrated, the location of apertures 23 is such as to provide within the basket at the start a certain minimum level of water. By means of my invention, as will be shown, any range of washing load of clothing between that minimum amount and a capacity washing load may be washed simply by adjustment of the setting of switch 20, and the quantity which is commensurate with the particular load of clothing under treatment.

In order to retain the proper amount of water in the basket during agitation of the clothes, as well as to drain the machine during the centrifugal extraction operation, there is provided a pump 30 which is secured to the bottom of the tub 3 and which withdraws liquid from the tub through a suitable baffle assembly 31. The liquid in the basket 2 normally is discharged into the tub through apertures 22 during the extraction operation as a result of the centrifugal force created by the basket rotation, during the agitating operation, the liquid from basket 2 is discharged into the tub through apertures 23. The pump 30 is driven by the motor 13 through a flexible coupling 32 attached to the pump and motor shaft and during the centrifugal extraction operation it discharges into a conduit or hose 33 leading, for example, to a household drain or to a storage and re-use system. Any suitable drain pump may be used, but in the illustrated embodiment there is shown a bi-directional pump which discharges into one of two outlets depending upon the direction of pump rotation. A bi-directional pump of

this type is described in detail and claimed in the co-pending application of John Bochan, Serial No. 468,460 filed November 12, 1954, now Patent No. 2,883,843 and assigned to the same assignee as the present invention. As mentioned above, during the centrifugal extraction operation, this bi-directional pump discharges through its one outlet into the hose 33. However, during the washing operation the pump discharges into a second outlet which is connected to a re-circulation conduit such as hose 34. This hose leads to nozzle 35 which discharges into basket 2. Pump 30, moreover, has a capacitor greater than the flow capacity through apertures 23, space 24, apertures 25, space 26, and apertures 28 with the result that when the pump is operating it serves to drain substantially completely the tub 3. Thus, the hose 34 combined with the pump 30 forms a recirculation system for restoring into basket 2 during and prior to the washing and rinsing operation substantially all of the water admitted to the machine by the water valves thereof. In summary, with regard to pump 30, it will be understood that, due to the change in direction of rotation of the pump, the liquid in the tub 3 is discharged to hose 33 and led from the machine during the extraction operations, but is continuously recirculated through the recirculation hose 34 during the washing and rinsing operations.

Referring now to Figs. 2 and 3, I have shown therein an electrical control system for the machine 1 including a chart illustrating the positions occupied by the several switches of that system during the several stages of an operating cycle of the machine. In order to control the sequence of operations, the circuit includes a timer motor 40 which drives a plurality of cams A, B, C, D and E for operating the several switches 41, 42 and 43, 44, 45 and 46. These cams, during their rotation by the timer motor, actuate their respective switches, as is well known in the art, so as to cause the machine to pass through the above-mentioned cycle of operation, first washing the clothes, next extracting the wash water from them, and then rinsing the clothes with clean water and finally extracting the rinse water from the clothes. These electrical circuits as a whole are energized from a two-wire power supply 47 and 48, and the manner in which the various electrical components of the machine are connected to this power supply during the machine operation will now be explained.

The control system in Fig. 2 is shown in its condition just after the timer has been rotated manually into the wash range for placing the machine originally in operation and with the water level responsive switch 20 adjusted to a setting corresponding to a selected loading of clothes contained in basket 2. Suitable manual controls, such as manual control dial 36 (see Fig. 1) are provided on the shaft of timer 40 and in connection with switch 20 to permit this or any other desired setting of the timer and switch 20 at the discretion of the operator. It will be understood that any suitable one of many available adjustable pressure sensitive switches may be used. For this reason, in order not to obscure the explanation of the invention, the exact structure of the switch itself is not described or illustrated. With the timer set in the wash range and with the water level switch 20 adjusted to the desired loading, the operator then need only to close a manually operated switch 49 to place the machine in operation. This switch itself may be coordinated with the timer 40 for actuation therewith as, for example, by mounting the switch 49 for actuation by axial movement of the timer shaft, as is well known in the art.

Assuming then that switch 49 is closed and that no water is in the tub or basket, but that the selected load of clothes is in the basket, a circuit is then completed through conductor 48, closed switch 41, conductors 50 and 51, conductor 52, water valve solenoid 53 which is arranged to open the water supply to the machine when energized and to close the supply when de-energized, contact 54, the blade 55 of a centrifugal switch actuated by

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motor 13 (and having a second blade 56 connected to the first blade by an insulated mechanical linkage 57), conductor 59, contact 60, switch 46, conductors 62 and 63, contact 64 of water level switch 20, diaphragm actuated switch member 65, and return conductor 47.

Immediately upon completion of this circuit, water begins to flow into basket 2 through nozzle 21 and, after establishing the base amount of water in the basket, then begins to overflow into tub 3 through apertures 23. During the above described operation, motor 13, pump 30, and the timer 40 remain at rest.

However, as soon as the supplemental amount of water collects in tub 3 corresponding to the amount needed to actuate switch 20, the following circuits are established by the movement of the diaphragm operated switch to its position opposite that as seen in Fig. 2. As the member 65 moves to its new position, it closes on stationary contacts 66 and 67 and breaks the water supply circuit through contact 64. As this occurs, a starting circuit is made through conductors 50 and 68, contact 69, switch 43, starting winding 70, switch 42, contact 71, conductors 72 and 73, contact 61, centrifugal switch blade 56, conductors 74 and 75, contact 67, switch member 65, and conductor 47. Simultaneously, a circuit is made through conductor 76, running winding 77 of motor 13, conductor 75, contact 67, switch member 65, and conductor 47, causing motor 13 to turn and to drive pump 30 to discharge into recirculation conduit 34. Simultaneously, with the shifting of switch member 65, the circuit to the water valve solenoid 53 is broken at contact 64 and thereafter the machine operates with the amount of water already supplied, namely, the base amount and the selected supplemental amount.

As motor 13 comes up to speed, its connected centrifugal switch is shifted to cause blade 55 to bridge contact 78 and to leave contact 54, the mechanically connected blade 56 likewise bridging contact 79 and leaving contact 61.

At the same time that the motor circuits are completed, a circuit is made through conductors 50 and 51, brake coil 80 of solenoid brake assembly 14a which is arranged to hold clutch 14 against rotation while the coil is energized, conductor 81, contact 66, switch member 65, and wire 47. Thus, although the motor is running and driving the pump, no movement of the agitator occurs at this time. Since pump 30 has a capacity greater than the flow rate into the tub from the basket, in a short time substantially all of the water from the tub is restored into the basket. Thereafter, as pump 30 continues to be driven, in the same direction, a continuous recirculation occurs. In this way, pump 30 ensures that a volume of water commensurate with the load of clothing is present in the basket before the motor starts to drive the agitator for washing purposes.

When the pump has restored the supplemental amount of water into the basket 2, the pressure on switch 20 is no longer sufficient to keep it actuated, and the diaphragm switch again moves to the position seen in Fig. 2 and the machine is now ready to begin its washing operation. At this time, the centrifugal switch keeps contacts 78 and 79 bridged by blades 56 and 55, respectively, since the motor is still running. The timer 40 now begins to rotate by means of a circuit through conductor 48, conductor 82, closed switch 44, conductor 83, timer 40, conductor 84, switch 45, contact 85, conductor 86, contact 78, switch blade 55, conductor 59, switch blade 46, conductors 62 and 63, contact 64, switch member 65, and conductor 47. At this time, the automatic cycle represented by the cam chart of Fig. 3 is initiated. The circuit to the running winding of the motor is now through conductor 76, winding 77, conductor 74, switch blade 56, contact 79, conductors 87, 88 and 63, contact 64, switch member 65, and conductor 47. At the same time the circuit through the water valve solenoid 53 is broken at 54 to preclude water flow, and the circuit through the clutch

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brake solenoid 80 is broken at 66 so that clutch 14 is free to turn in its proper direction for agitation. By means of belt 15, the clutch then drives the transmission mechanism 17 which in turn drives the agitator 7.

This operation continues through the agitation step until timer 40 shifts switch 45. Upon shifting of switch 45 to bridge contact 89, a circuit for the timer independently of the centrifugal switch of the motor is established through conductor 48, conductor 82, closed switch 44, conductor 83, timer 40, conductor 84, switch blade 45, contact 89, conductors 96, 88 and 63, contact 64, switch member 65, and conductor 47. Thereafter, timer 40 while continuing to turn, opens switch 41 to begin a pause in the operating cycle.

As switch 41 opens, the circuit to the motor is interrupted and the pump and motor come to rest, thus opening the centrifugal switch and causing it again to bridge contacts 54 and 61 with its respective blades 55 and 56. As soon as this occurs, water from the basket starts to submerge the water level switch 20. Until switch 20 closes, the timer circuit is completed as before. Should the switch 20 trip to close on contacts 66 and 67, the timer circuit is changed to include conductor 48, conductor 82, closed switch 44, conductor 83, timer 40, conductor 84, switch blade 45, contact 89, conductors 96, 88 and 62, switch blade 46, contact 60, conductor 59, the centrifugal switch blade 55, contact 54, water valve solenoid 53 (which does not open the valve, however, due to relative impedances of that solenoid and of the motor driving timer 40), conductor 52, the solenoid 80 for the clutch brake, conductor 81, contact 66, switch member 65, and wire 47.

As the timer continues to rotate, it first shifts the starting winding switches 42 and 43 to the position corresponding to the opposite direction of rotation of the motor 13 suitable for spin or centrifugal extraction. At the same time, it shifts switch blade 46 to bridge contact 90.

When the pause interval is completed and with the supplemental water collected in tub 3, the timer then recloses switch 41 and a circuit is made through conductor 48, switch 41, conductors 76 and 92, contact 93, switch blade 42, starting winding 70, switch blade 43, contact 94, conductors 95 and 73, contact 61, blade 56 of the centrifugal switch, conductors 74 and 75, contact 67, switch member 65 and wire 47. A circuit also is established through conductor 76, running winding 77, conductor 75, contact 67 and switch member 65. The motor thereupon begins to turn in its reverse, or spin direction. Also assuming that switch arm 65 has engaged contacts 66 and 67, a shunt circuit is established through conductors 50 and 51, solenoid 80 of the clutch brake, solenoid assembly 14a, conductor 81, contact 66 and switch member 65, thus holding the clutch 14 from turning, and preventing rotation of basket 2. Pump 30 is now driven to discharge the water in tub 3 through the conduit 33 and it is quickly removed from the tub. When it is removed to the level required for operation of the water level control switch 20, that switch shifts again to the position shown in Fig. 2, the centrifugal switch meanwhile having closed again against contacts 78 and 79. As this occurs, the shunt circuit through the clutch brake solenoid 80 is broken at 66, the clutch 14 begins to turn, and the basket 2 is spun for centrifugal extraction. Simultaneously, the timer circuit is effected through switch blade 45, contact 89, conductors 96, 88 and 63, contact 64 and switch member 65.

If the flow of water through apertures 23 is so slow relative to the timer actuated switching that switch 20 was not actuated, the spin circuit described above is completed at the same time that pumping starts; in such a case, the extraction is started a little sooner than if switch 20 has been actuated by the weight of water in the tub.

As the spin continues, the remaining or base volume of water in basket 2 is thrown outwardly through aper-

tures 22 into tub 3 and is removed by pump 30 into drain conduit 33. When this extraction is completed, the timer then reopens switch 41, opening the circuit to the motor and permitting the basket to coast and the motor and pump to come to rest and to begin a second pause step of the cycle. During this pause step, the timer resets switches 42 and 43 to the agitation direction of rotation, resets switch 45 to bridge contact 85, and having accomplished these settings, then resets switch 46 to bridge contact 60, as seen in Fig. 2.

The pause, accordingly, continues until timer 40 recloses switch 41 at which time the circuits of Fig. 2, as described for the initial filling operation, are again completed and the filling for rinsing purposes is initiated. Upon closing of switch 41, the water valve solenoid 53 is again energized and rinse water is supplied to basket 2 through nozzle 21. When this rinse water overflows to the predetermined amount into tub 3 through apertures 23, the water level control switch again shifts position as above described and the motor 13 comes up to speed and drives pump 30 again in a direction to recirculate the rinse water from the tub into the basket. When the control switch again shifts as a result of the supplemental volume of rinse water being restored to the basket, the agitation for rinsing starts, with the clutch brake being released. Following this agitation, the same cycle of pause, spin, and coast steps occur. Timer 40 then opens switch 44, at which time the circuit to the timer is interrupted and the machine comes to rest, thus completing the cycle. At this time, the operator may open switch 49, thus removing potential from the machine.

The above described machine and its operation represents one form of my invention in which a single drive motor is employed for driving the machine and pump. However, other variations may be used without departing from the invention. One such variation is shown in Figs. 4, 5 and 6 in which a washing machine 101 has a separate motor for driving the pump. As shown therein, washing machine 101, generally similar to that above described, may comprise clothes basket 102, tub 103, cabinet 104 and agitator 105 with a center post 106 and vanes 107 affixed to skirt 108. The basket may be mounted on the flange 109 of the rotatable hub 110 and the agitator may be mounted on the shaft 111 by the nut 112.

In this modification only the basket and agitator are driven by a reversible main motor 113 through the drive including the clutch 114. As in the earlier described modification, the motor 113 has suitable starting and running windings and with a centrifugal switch for removing the starting winding from the circuit. The clutch is connected by means of belt 115 to the input pulley 116 of the transmission assembly 117 and is effective to drive the pulley 116 in both directions of motor rotation. The adjustable water level responsive switch 120 is mounted at a lower portion of tub 103 and by means of conventional solenoid operated water control valves (not shown), both washing and rinsing water is directed from a suitable source into basket 102 through a spout 121. Apertures 122 are provided in the basket for use during centrifugal extraction; for overflow of the supplemental volume of water, a flow path into the tub through apertures 123, space 124, apertures 125, space 126 within boot 127 and apertures 128, is provided.

In contrast, with the arrangement of the machine of Fig. 1, a separate relatively small reversible motor 129 (such as a shaded pole motor, for instance) is provided for driving the bi-directional pump 130. This pump is directly connected to the shaft of motor 129. No solenoid actuated clutch brake is employed in this modification, the clutch 114 being free to turn when the shaft of the main motor 113 is turning.

Pump 130 draws water from tub 103 through a suitable baffle assembly 131 and during centrifugal extraction operation discharges into a hose 133 leading to a drain

or to storage for reuse. During washing and rinsing operating operation, the pump 130 discharges into the recirculation conduit 134 for restoring the water to basket 102 through nozzle 135. As in the case of the embodiment of Figs. 1-3, the capacity of pump 130 is greater than the flow rate through the flow path including the apertures 123.

Referring now particularly to Figs. 5 and 6, I have shown therein an electrical control system for the machine 101 including a chart illustrating the positions occupied by the several switches of that system during the several stages of an operating cycle of the machine. In order to control the sequence of operations, the circuit includes a timer motor 140 which drives a plurality of cams A', B', C', D', E', and F' for operating the several switches 141, 142 and 143, 144, 145, 146 and 175C. These cams, during their operation by the timer motor, actuate their respective switches so as to cause the machine to pass through the cycle of washing the clothes, next extracting the wash water from them, then rinsing the clothes with clean water, and finally extracting the rinse water from the clothes. The electrical circuits are energized from a two-wire power supply 147 and 148, and the manner in which the various electrical components of the machine 101 are connected to this power supply during the machine operation will now be explained.

The control system of Fig. 5 is shown in its condition just after the timer has been rotated manually into the wash range for placing the machine in operation and with the water level responsive switch 120 adjusted to a setting corresponding to a selected loading of clothes contained in basket 102. A manual control dial 136 (Fig. 4) may be provided in the same manner as before to permit any desired setting of the timer and switch 120 at the discretion of the operator. With the timer set in the wash range, and with the water level switch suitably adjusted, the operator then need only to close a manually operated switch 149 to place the machine in operation.

Assuming then that switch 149 is closed, that no water is in the tub or basket, and that the selected load of clothes is in the basket, a circuit is then completed through conductor 148, closed switch 141, conductors 150 and 151, water valve solenoid 152 which is arranged to open the water supply to the machine when energized and to close the supply when de-energized, contact 153, the blade 154 of a centrifugal switch actuated by motor 113 (which has a second blade 155 connected to the first blade by an insulated mechanical linkage 156), conductor 157, contact 162, switch 146, conductors 158 and 159, contact 160 of the water level switch 120, diaphragm actuated switch member 161, and return conductor 147.

Immediately upon closing of this circuit, water begins to flow into basket 102 through nozzle 121, and after establishing the base amount of water in the basket, then begins to overflow into tub 103 through apertures 123. During this operation the main motor 113, pump motor 129, pump 130, and timer 140, remain at rest. However, as soon as the supplemental amount of water collects in tub 103 corresponding to the amount needed to actuate switch 120, the member 161 moves to its new position in engagement with stationary contact 163 and breaks the water supply circuit through contact 160. As this circuit is broken, the water valve solenoid 152 closes the water valve and thereafter the machine operates with the amount of water already supplied, namely, the base amount plus the selected supplemental amount.

As the member 161 closes on contact 163 at the completion of the filling step, a circuit is established through the winding 175 of pump motor 129 through conductor 170 148, closed switch 141, conductors 150, 151, 177 and 171, resistance 172 of a heater switch 173, conductor 174, winding 175 of pump motor 129, conductor 176, conductor 194, contact 163, switch member 161, and conductor 147. The setting of switch 175C to complete a closed circuit through shading coil 175A causes the

pump motor to drive pump 130 in the proper direction to discharge into recirculation conduit 134 and the supplemental amount of water in tub 103 is quickly restored into basket 102. Drive motor 113 does not yet start because it is not energized, the circuit being open at switch 146 and contact 195. Timer motor 140 starts through the following circuit: conductors 148 and 181, switch 144, conductors 182, the timer motor, conductor 183, switch 145, contact 184, conductors 185, 178, and 194, contact 163, switch 161, and conductor 147.

The current through low resistance heater 172 soon actuates thermally responsive element 173 to bridge contacts 191 and 192; this, however, is without effect with switch arm 161 in its upward position.

As the water is restored into basket 102 by pump 130, switch member 161 shifts to bridge contact 160 and to break the circuit through contact 163. Motor 113 now starts rotation in the proper direction through the following circuits being completed through its windings: for main winding 170, the circuit proceeds through conductor 148, switch 141, conductors 150 and 151, winding 170, conductors 169 and 193, contact 192, element 173, contact 191, conductors 190, 188, and 159, contact 160, switch 161, and conductor 147; for start winding 166, the circuit extends through conductor 148, switch 141, conductor 164, contact 165, switch 143, winding 166, switch 142, conductor 167, contact 168, switch arm 155, conductor 186, and from conductor 193 to conductor 147 in the same manner as for the main winding. As motor 113 comes up to speed, the centrifugal switch moves switch arms 154 and 155 over to engagement with contacts 180 and 187 respectively. This breaks the circuit through solenoid 152 (which had been again completed by movement of switch blade 161 to its lower position) so rapidly that the solenoid does not receive an impulse sufficient to energize it; also, start winding 166 is disconnected at contact 168.

The circuit through the pump motor, which was very briefly broken after the last movement of blade 161 until motor 113 came up to speed, is again completed by the circuit now made through conductors 150, 151, 177 and 171, resistance 172, conductor 174, winding 175, conductors 176, 178 and 179, contact 180, switch blade 154 of the centrifugal switch in its on position, conductor 157, contact 162, switch 146, conductors 158 and 159, contact 160, switch member 161, and wire 147. The timer motor circuit, also briefly interrupted during the period from disengagement of blade 161 from contact 163 until the main motor 113 comes up to speed, is completed as follows: conductors 148 and 181, switch 144, conductor 182, timer 140, conductor 183, switch 145, and contact 184, conductors 185 and 179, contact 180, blade 154, conductor 157, contact 162, switch 146, conductors 158 and 159, contact 160, blade 161, and conductor 147.

This operation continues through the agitation step until timer 140 shifts switch 145. Upon shifting of switch 145 to bridge contact 189, a circuit for the timer independently of the centrifugal motor switch is established. Thereafter, timer 140, while continuing to turn, opens switch 141, thus completing the agitation step and initiating a pause in the operating cycle. The motors 113 and 129 come to rest during this pause, and the timer circuit is through switch 145, contact 189, conductors 188 and 158, switch 146, contact 195, conductor 195', conductor 169, winding 170, conductor 171, resistance 172, conductor 174, winding 175, conductors 176 and 194, contact 163, switch member 161, and wire 147. It will be understood that as soon as the switch 141 opened, water from the basket submerged the water level switch 120 since the pump no longer was recirculating water and thus, the switch member 161 has shifted whereby the described timer circuit through the heater switch is effective.

As the timer continues to rotate, it first shifts the starting winding switches 142 and 143 to the positions corresponding to the opposite direction of rotation of motor

113 and shifts switch 175C to put shading coil 175B in a closed circuit and provide the opposite direction of rotation for motor 129 (suitable for spin or centrifugal extraction). During these switch shiftings, the supplemental volume of water has collected in tub 103 and the apparatus is now in readiness for its next step initiated by reclosing of switch 141.

Upon reclosing of switch 141, the same circuit provided previously for pump motor 129 through contact 163 is provided once again. Pump 130 thus removes water from the tub through hose 133 until switch 120 trips again to provide engagement of blade 161 with contact 160. The pump motor runs long enough for heater 172 to cause element 173 to again bridge contacts 191 and 192. This permits the drive motor windings to be energized through contact 160 as before, the only difference being in the opposite connection of winding 166 to effect reverse rotation. As before, operation of the pump motor is briefly interrupted until motor 113 comes up to speed, and is then resumed through contact 160 by the circuit already described. The timer circuit is made directly through switch 145, contact 189, conductors 188 and 159 to contact 160.

The spin thus takes place, with the remaining or base volume of water in basket 102 being thrown outwardly through apertures 122 into tub 103 and being removed by pump 130 into drain conduit 133. When this extraction is completed, the timer then reopens switch 141, opening the circuits to the motors and permitting the basket to coast and the motors and pump to come to rest and to begin a second pause step of the cycle. During this pause step the timer resets switches 142, 143 and 175C to the agitation direction of rotation, and resets switch 145 to bridge contact 184.

The pause accordingly continues until timer 140 recloses switch 141 at which time the circuits of Fig. 5, as described for the initial filling of machine 101, are again completed and the filling for rinsing purposes is initiated. Upon closing of switch 141, the water valve solenoid 152 is again energized and clean rinse water is supplied to basket 102 through nozzle 121. When this rinse water overflows to the predetermined amount into tub 103 through apertures 123, the water level control switch 120 again shifts position as above described and the pump motor 129 again begins to turn in its recirculating direction, thus restoring the rinse water into the basket. When the control switch again shifts as a result of the supplemental volume of water being restored to the basket, the agitation for the rinsing starts. Following this agitation, the same cycle of pause, spin, and coast steps occurs until timer 140 then opens switch 144, at which time the circuit to the timer is interrupted and the machine comes to rest, thus completing the cycle. At this time, the operator may open switch 149, thus de-energizing the machine.

From the above it will be seen that I have provided two modifications of an improved washing machine in each of which the washing operation can take place only when the basket contains an amount of water which is commensurate with the load of clothes under treatment. In accordance with both of the described electrical circuit diagrams, if, for any reason, the level of water should rise in the tub, due to accidental loss of water from the basket during the washing phase, the water level responsive switch become effective to stop the agitation and to cause the pump to restore the water into the basket before agitation can proceed further. The water level insuring factor above mentioned, is thus maintained during all conditions of the washing and rinsing operations.

While in accordance with the patent statutes I have described what at present are considered to be preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and I therefore aim, in the appended claims, to cover

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all such changes and modifications as fall within the true spirit of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A clothes washing machine comprising a tub, a basket in said tub, agitator means in said basket, water supply means feeding into said basket, a motor for driving said agitator means during washing operations, water conserving means comprising means in said basket substantially below the maximum liquid level therein for flowing water into said tub, water level control means responsive to the volume of water collected in said tub, means operated by said water level control means to shut off said water supply means upon attainment of a predetermined volume of water in said tub, a pump receiving water from said tub, conduit means leading to said basket connected to said pump, said pump recirculating water through said conduit means into said basket during the washing operation, means operated by said water level control means to control said pump to operate to pump water from said tub to said basket upon attainment of said predetermined volume of water in said tub and said pump having a delivery rate in excess of the capacity of said flow means whereby the pump supplies and maintains substantially all said water in said basket, and control means for said agitator means to delay operation of said agitator means after said pump starts operation until said basket contains substantially all of said volume of water.

2. A clothes washing machine comprising a tub, a basket in said tub, agitator means in said basket, water supply means feeding into said basket, a motor for driving said agitator means during washing operations, water conserving means comprising means in said basket substantially below the maximum liquid level therein for flowing water into said tub, water level control means movable from a first position to a second position in response to a predetermined volume of water collected in said tub, a pump receiving water from said tub, conduit means leading to said basket connected to said pump, said pump re-circulating water through said conduit means into said basket during the washing operation, means for causing operation of said pump in response to movement of said water level control means to said second position, said pump having a delivery rate in excess of the capacity of said flow means whereby said pump retains substantially all said water in said basket, means for stopping the supply of water to said basket in response to movement of said control means to said second position, said control means in said second position preventing said motor from driving said agitator means, and means for initiating operation of said agitator by said motor and continuing operation of said pump in response to movement of said control means to said first position when substantially all said water has been pumped into said basket, said control means precluding re-activation of said water supply means in response to said return to said first position.

3. A clothes washing machine comprising a tub, a basket in said tub, agitator means in said basket, water supply means feeding into said basket, water conserving means comprising means in said basket substantially below the maximum liquid level therein for flowing water into said tub, water level control means responsive to the volume of water collected in said tub, means operated by said water level control means to shut off said water supply means upon attainment of a predetermined volume of water in said tub, a pump having a delivery rate in excess of the flow capacity of said water flow means positioned to receive the water in said tub, conduit means leading to said basket connected to said pump, said pump recirculating water through said conduit means into said basket during the washing operation, a motor for selectively driving said pump, said basket, and said agitator means during washing and extraction opera-

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tions, and means for controlling the connection of said motor to said pump said basket and said agitator, said water level control means causing said connection means connecting said motor to operate said pump to restore said predetermined volume of water into said basket upon attainment of said predetermined volume in said tub, said connection control means then being operated by said water level control means to start operation of said agitation means and to continue operation of said pump, said connection control means then connecting said motor to said pump to remove water from said machine and to said basket to spin said basket for extracting liquid from clothes therein.

4. A clothes washing machine comprising a tub, a basket in said tub, agitator means in said basket, water supply means feeding into said basket, water conserving means comprising means in said basket substantially below the maximum liquid level therein for flowing water into said tub, water level control means responsive to a predetermined volume of water collected in said tub, means operated by said water level control means to shut off the supply of water upon attainment of said predetermined volume in said tub, a pump having a delivery rate in excess of the capacity of said water flow means positioned to receive the water in said tub, conduit means leading to said basket connected to said pump, drain conduit means leading out of said machine connected to said pump, a reversible motor for driving said pump, said pump selectively recirculating water from said tub into said basket for one direction of rotation of said pump motor and draining water out of said machine from said tub for the other direction of rotation, a main motor, means selectively connecting said main motor to said agitator means and to said basket during washing and extracting operations respectively, and motor control means controlling operations of said pump motor and connection of said main motor to said agitator means in said basket, said water level control means causing said motor control means to energize said pump motor in said one direction in response to the presence of a predetermined volume of water in said tub to cause said pump to recirculate water through said conduit and restore said volume of water into said basket, said water level control means being responsive to removal of said volume of water from said tub to cause said motor control means to connect said main motor to operate said agitator means, and timing control means causing said motor control means to operate said pump motor in said other direction to remove water from said machine and said main motor to rotate said basket to effect an extraction operation after a predetermined time of agitation.

5. A clothes washing machine comprising a tub, a basket in said tub, agitator means in said basket, electrically controlled water supply means for feeding water into said basket, a switch for controlling said water supply responsive to a predetermined amount of water collected in said tub by moving from a first to a second position, a pump receiving water from said tub, electric drive means for driving said agitator means and running said pump during washing operations, a timer operated control circuit including said switch said electric drive means and said water supply means control, said timer operated control circuit providing a predetermined sequence of washing operations, water conserving control means including means in said basket arranged to overflow the water supply into said tub after the establishment of a base level of water in said basket only partially filling said basket, said pump having a pumping rate greater than the overflow capacity from said basket into said tub through said overflow means, conduit means connected to said pump and leading to said basket, said pump being effective when driven to restore into said basket the water collected in said tub, said control circuit causing operation of said electric drive means to start said pump upon operation of said pressure responsive switch to said sec-

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ond position and to start to drive said agitator means thereafter when said pressure responsive switch returns to said first position whereby said agitator means operates only when said basket contains both said base level of water and substantially all of said overflow of water.

6. The combination of claim 5 wherein said drive means include a single electric motor and clutch means between said motor and said agitator means for selectively connecting said agitator means to be driven by said motor.

7. The combination of claim 5 wherein said electric drive means include a first motor to run said pump, and a second motor to drive said agitator means.

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