

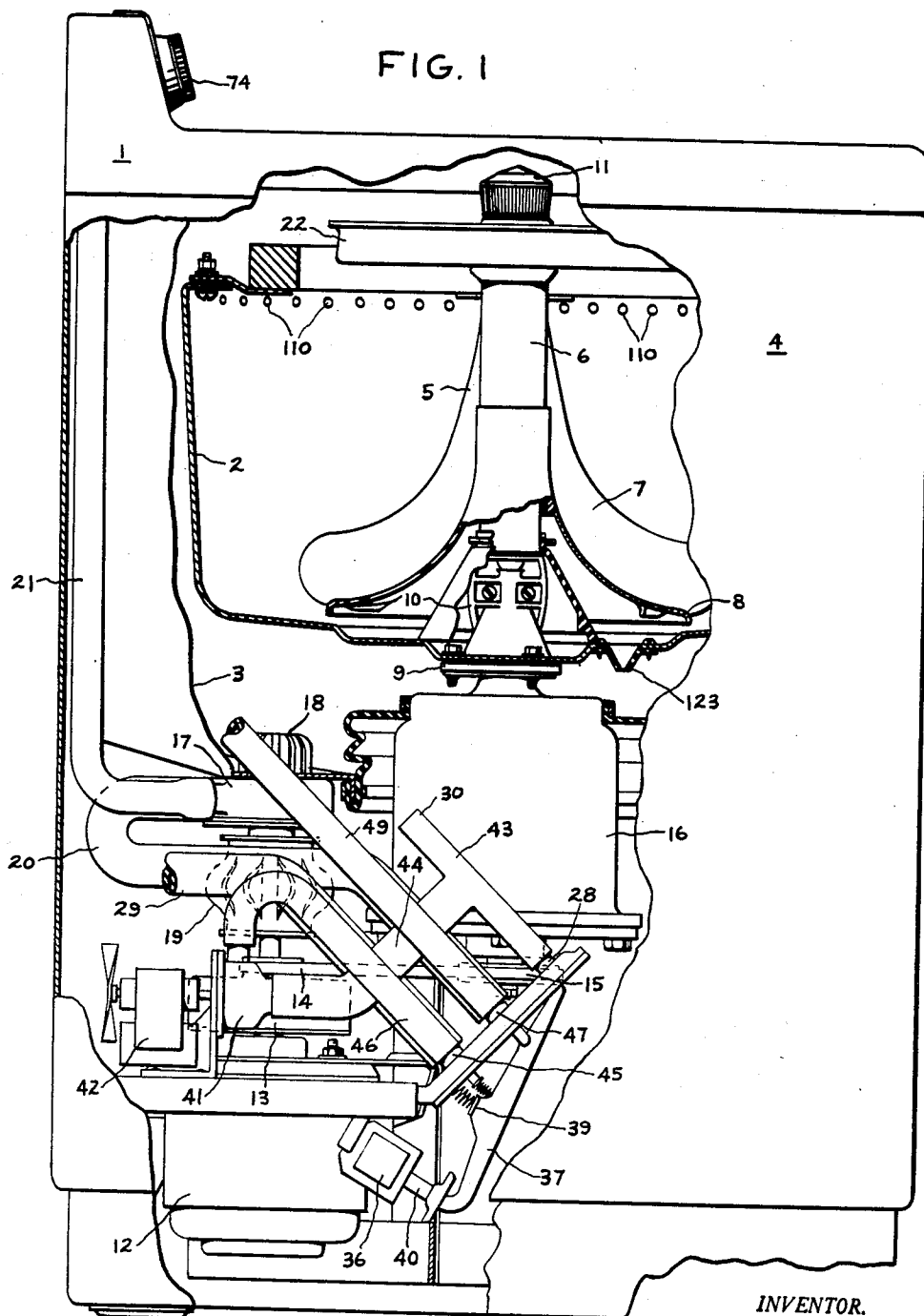
July 26, 1960

P. H. HOUSER
CONTROL SYSTEM FOR WASH WATER STORAGE
AND RE-USE SYSTEM

2,946,212

Filed July 24, 1958

3 Sheets-Sheet 1



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FIG. 2

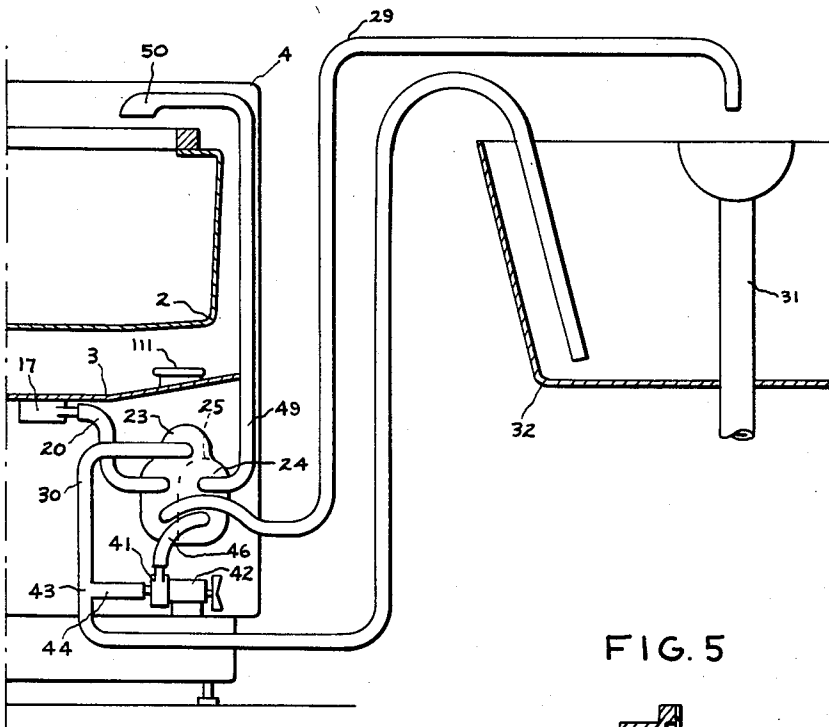


FIG. 5

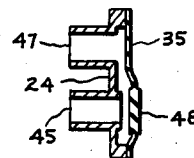


FIG. 4

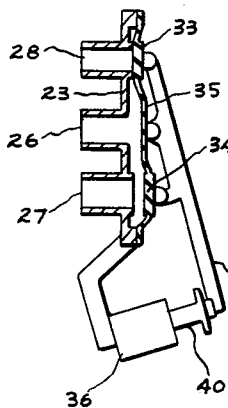
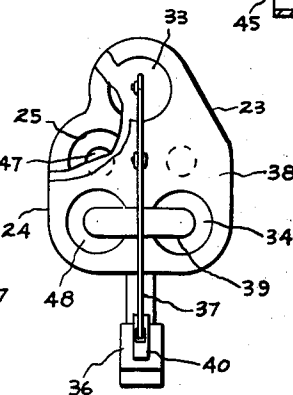


FIG. 3



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FIG. 6

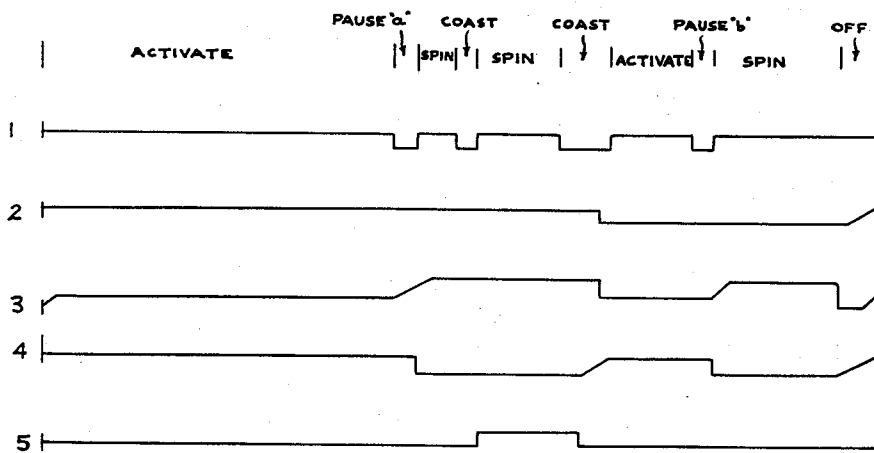
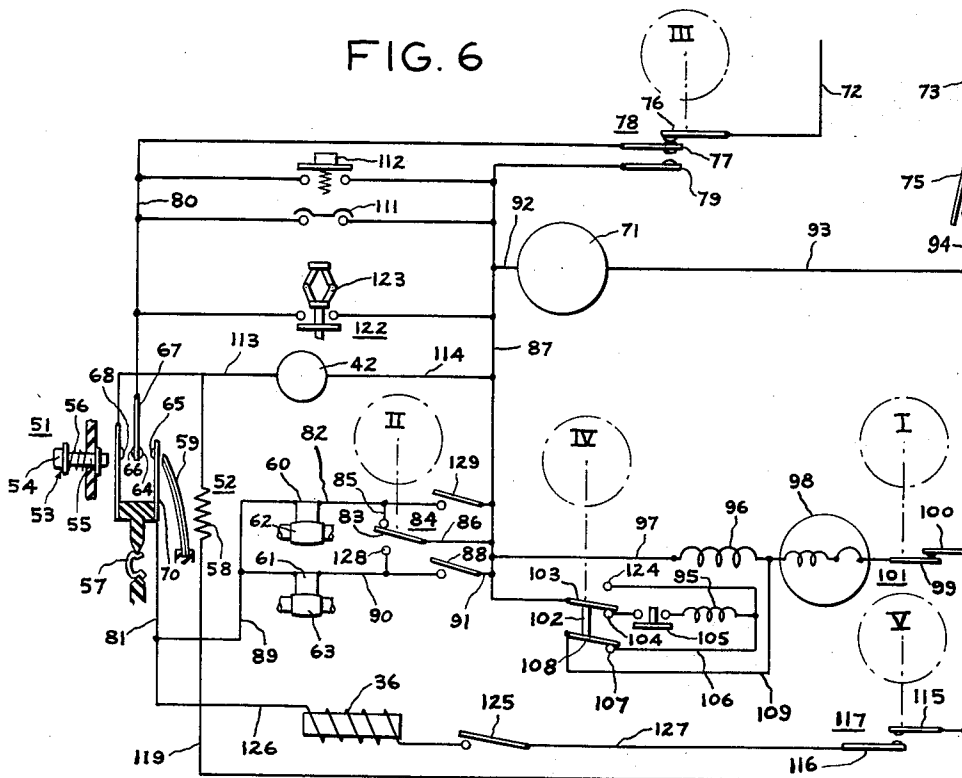


FIG. 7

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CONTROL SYSTEM FOR WASH WATER STORAGE AND RE-USE SYSTEM

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Filed July 24, 1958; Ser. No. 750,653

5 Claims. (Cl. 68—12)

My invention relates to automatic washing machines and more particularly to such machines including a wash water storage and reuse system for storing the wash water after the washing operation and then returning it to the machine for use in a subsequent operation.

By means of a wash water storage and re-use system, commonly called a "suds saver" system, the hot sudsy wash water used in the washing step of an automatic clothes washing machine may be passed into a suitable storage reservoir after the washing step is completed rather than being discharged to the drain. The sudsy water is retained in the reservoir until the washing machine completes its cycle of operation, rinsing and drying the clothes, and the clothes are taken out of the machine. Then when another load of dirty clothes is placed in the machine, the system is effective to return the sudsy water from the reservoir to the washing container for washing the second load of clothes. This re-use of the sudsy water, of course, provides appreciable savings in both hot water and detergent.

To pass the wash water to the reservoir for storage, the storage and re-use systems ordinarily utilize the drain pump of the washing machine. Suitable conduits and valve means are connected to the drain pump whereby the wash water may be conducted to the reservoir as the pump empties the machine. The drain pump cannot, however, ordinarily be used to return the water from the reservoir to the machine, and therefore a separate return pump is provided for that purpose. The return pump is arranged with its inlet connected to the storage reservoir and with its outlet connected to the washing container of the machine, and upon its operation it is effective to withdraw the stored water from the reservoir and pass it back into the washing container.

It is a primary object of my invention to provide a new and improved electrical control system for washing machines including a wash water and storage and re-use system, whereby after initially setting the return pump in operation, the operator may then leave the machine and it will automatically proceed into its cycle of operation after a predetermined period of time which may be of such duration that all the stored liquid can be returned to the washing container.

It is another object of my invention to provide a control system including time delay means for automatically controlling both the return pump and electrically controlled valve means connected to the water supply whereby the pump is locked in and concurrently the valve means is closed for a predetermined period of time in order that the stored liquid may be returned to the washing container.

A further object of my invention is to provide a control system of the type which is effective to energize electrically controlled valve means connected to a water supply concurrently as the return pump is de-energized, thereby to supply automatically and immediately any make-up water needed in addition to the stored liquid to fill the washing container.

In carrying out my invention I provide a washing machine which includes a wash water storage and return system. This system is arranged for storing the wash water drained from the machine after the washing operation in a suitable storage reservoir, and for then returning the water to the machine for use in a subsequent washing operation. In order to return the stored liquid to the machine, the system includes an electrically controlled return pump, and by my invention an improved control of this pump is provided. My improved control means for the return pump include a manually-operated switch for initiating the operation of the return pump and a time delay means which concurrently energized with the return pump by means of the manually-operated switch. The return pump, when energized in its operated position, returns the water from the storage reservoir to the machine. After a predetermined period of time, which may be long enough to exhaust the reservoir, the time delay means returns the manually-operated switch to its initial position and the return pump is thereupon immediately de-energized. With this arrangement the operator is freed from attendance on the machine, and in addition the return pump is caused to run only as long as is desired.

By a further aspect of my invention the manually operated switch may also be advantageously employed to control the water inlet valve means of the machine connected to the household water supply. Specifically the switch is so arranged that it normally closes the valve means circuit but opens that circuit whenever it closes the time delay means and the return pump circuits. Thus the valve means cannot be energized to supply fresh water while the return pump is returning the stored liquid to the machine, but once the return pump ceases to operate, as determined by the time delay means, the valve means circuit is automatically and immediately closed. This allows the valve means to supply and make-up liquid needed in addition to the stored liquid to fill the washing machine to the desired level.

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 wash water storage and re-use system suitable for control by my new and improved control system, the view being partially broken away and partially in section to show details;

Fig. 2 is a schematic showing of the storage and re-use system;

Fig. 3 is a plan view of the valve means incorporated within the storage and re-use system, the valve means including both a two-way valve and a shut-off valve within the same casing;

Fig. 4 is a schematic cross sectional view of the two-way valve;

Fig. 5 is a schematic cross sectional view of the shut-off valve;

Fig. 6 is a schematic diagram of a preferred embodiment of my new and improved control system; and

Fig. 7 is a cam chart showing in extended form the surfaces of the various timer-driven cams included in the control system of Fig. 6, thereby to illustrate the sequence of operation of the switches controlled by the cams.

Referring now to Fig. 1, I have shown therein an agitator type clothes washing machine 1 which is provided with a wash water storage and re-use system suitable for

control by my new and improved control system. This control system will be explained hereinafter in detail. The machine 1 includes a clothes basket 2 which is disposed within an outer imperforate tub or casing 3. The tub 3 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 of radially extending vanes 7. The agitator is further provided with an outwardly and downwardly flared skirt 8 to which the vanes 7 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 (not shown) 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 11 at the top of the center post. During the cycle of operation of the machine, the agitator 5 is first oscillated back and forth within the basket 2 to wash the clothes therein. Then, after a predetermined period of this washing action, the basket is rotated at high speed to extract centrifugally the washing liquid and discharge it into the outer tub 3. Following this extraction operation a supply of clean liquid is introduced into the wash basket for rinsing the clothes, and the agitator is again oscillated. Finally, the wash basket is once more rotated at high speed to extract the rinse water and discharge it into the outer tub. Preferably the first extraction operation following the washing operation is divided into two separate stages of basket rotation separated by a pause during which the basket does not rotate. The provision of this pause, it has been found, aids greatly in avoiding suds locking of the basket.

The basket 2 and the agitator 5 may be driven by any suitable means since their drive means form no part of the present invention. However, by way of example, I have shown them as driven from a reversible motor 12. The motor 12 drives the basket and agitator through a drive including a clutch 13 which is mounted on the motor shaft. Clutch 13 allows the motor to start without load and then pick up the load as it comes up to speed. The clutch is connected by a suitable belt 14 to the input pulley 15 of a transmission assembly 16, and it is effective to drive the pulley 15 in both directions of motor rotation. Thus depending upon the direction of the motor rotation the input pulley of the transmission is driven in opposite directions.

The transmission 16 is so arranged that it supports and drives both the agitator drive shaft and the basket mounting hub 10. When the pulley 15 is driven in one direction by the clutch 13, the transmission causes the agitator 5 to oscillate within the basket 2. Conversely, when the pulley 15 is driven in the opposite direction, the transmission drives the wash basket at high speed for centrifugal extraction. Thus, the operation carried out, i.e., agitation or centrifugal extraction, is controlled by the direction of rotation of the drive motor, agitation occurring when the motor turns in one direction and centrifugal extraction occurring when it turns in the other direction. Although the drive mechanism forms no part of the present invention, reference is made to the application of James R. Hubbard et al., 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.

In order to drain or empty the machine during the centrifugal extraction operation, there is provided a pump 17 which is secured to the bottom wall of the tub 3 and which withdraws liquid from the tub through a suitable baffle assembly 18. The liquid in the basket 2 is, of course, discharged into the tub 3 during the extraction operations as a result of the centrifugal force created by

the basket rotation, and thus it, as well as any liquid originally in the tub, is drained from the machine by the pump 17. The pump 17 is driven by the motor 12 through a flexible coupling 19 and during the centrifugal extraction operation it discharges into a hose or conduit 20 which leads to valve means forming part of the wash water storage and re-use system. Any suitable drain pump may be used, but in the illustrated machine there is shown a bi-directional pump which discharges into one of two outlets depending upon the direction of pump rotation. A directional pump of this type is described in detail and claimed in the application of John Bochan, S. N. 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 the bi-directional pump 17 discharges through its one outlet into the hose 20 for either storing the liquid or discharging it to a drain. However, during the washing and rinsing operations the pump discharges into a second outlet which is connected to a hose 21. This hose 21 leads to a nozzle (not shown) which discharges into a filter 22 mounted on the center post of the agitator 5. The hose 21 and filter 22 so combined with the bi-directional pump form a recirculation system for continuously cleaning and filtering the wash liquid during the washing operation. In summary with regard to the pump 17, it will thus be understood that due to the change in the direction of rotation of the pump, the liquid in the tub 3 is discharged to the discharge hose 20 during the extraction operations, but is continuously recirculated through the recirculation hose 21 during the washing and rinsing operations.

Connected to the hose 20 is a wash water storage and re-use system whereby the liquid discharged from the tub 3 during the first centrifugal extraction operation following the washing operation either may be discharged to a suitable drain, or else may be stored in a set tub or other reservoir while the machine completes its cycle of operation and then be returned to the machine for use in another washing operation. The arrangement of this storage and re-use system, including its conduits, valves and pump means, is fully described and claimed in my co-pending application S.N. 626,702, filed December 6, 1956, and assigned to the same assignee as the present invention, and it comprises one suitable storage and re-use system with which my new and improved control system may be employed. In order to control the disposition of the liquid being emptied from the tub, the storage and return system includes valve means in the form of a two-way valve 23. The valve 23, as shown, is incorporated within the same casing as a completely separate shut-off valve 24, whose purpose will be explained hereinafter, and the valves are separated from each other by means of an interior wall 25 of the valve casing (Fig. 3). The two-way valve 23 includes a central inlet port 26 which is connected to the discharge hose 20 of the tub and two separate outlet ports 27 and 28 which are connected respectively to a drain hose 29 and a storage hose 30. Both of the hoses or conduits 29 and 30 extend out of the casing 4 of the washing machine and as may best be seen in Fig. 2 the drain hose 29 has its discharge end adapted for emptying into a drain 31 which leads directly to the household waste line. The storage hose 30 on the other hand has its outer end adapted for communication with, or more accurately disposed within, a suitable storage reservoir 32 which is here shown as a common household set tub. It will thus be seen that if the flow is discharged from the valve 23 to the drain hose 29 it will be emptied into the drain 31 and the household waste line. Conversely, if it is passed outwardly to the hose 30 it will be discharged into the reservoir or tub 32 for storage.

In order to control which of the hoses 29 or 30 carries the flow; i.e. in order to control whether the liquid is

emptied to the drain or stored, the valve 23 includes a pair of valve disks 33 and 34 which are formed as part of a flexible diaphragm 35. The valve disks 33 and 34 are actuated by means of a solenoid 36 through a pivoted control member or lever 37. The control lever 37 is pivoted intermediate its ends to the cover plate 38 of the valve casing, and on one side of the pivot is attached to the valve disk 33 and on the other side of the pivot is attached to the valve disk 34. The connection to the disk 34 is made through a suitable cross arm 39, as shown. When the solenoid 36 is de-energized, its armature 40 and the lever 37 assume the position illustrated in Fig. 4 wherein the port 27 leading to the drain hose is open and the port 28 leading to the storage hose is closed by the valve disk 33. Conversely, when the solenoid 36 is energized, the armature 40 is pulled inwardly and the lever 37 is pivoted so that the disk 34 closes the port 27 leading to the drain hose and the disk 33 is moved away from the port 28 so as to open communication with the storage hose. In other words in the de-energized position of the solenoid 36 communication is provided between the inlet port 26 and the drain port 27, whereas when the solenoid is energized, communication is provided between the inlet port 26 and the storage port 28. Thus if it is desired to store the wash water, the solenoid 36 is energized during the centrifugal extraction operation following the washing operation. However, if it is not desired to store the wash water, then the solenoid is left de-energized and the water is passed to the drain through the port 27 and the hose 29.

In order to return the stored water from the reservoir or tub 32 when it is desired to re-use it for washing another load of clothes, there is provided within the system a return pump 41 which is driven by means of a separate, electric motor 42. The intake of the return pump 41 is connected to the storage hose 30 at a point 43 intermediate its ends by means of a relatively short circuit or hose 44, and the outlet of the pump is connected to the inlet port 45 of the shut-off valve 24 by means of another relatively short conduit or hose 46. Thus it will be seen that when the return pump 41 is operated, it is effective to withdraw the stored liquid from the tub 32 through the outer portion of the storage hose 30 and the hose 44 and discharge it through the hose 46 to the inlet port 45 of the shut-off valve 24.

The valve 24 is provided with a single outlet port 47 and communication between the inlet port 45 and the outlet port 47 is controlled by means of a valve disk 48 adapted to seat on the inner end of the inlet port. The valve disk 48 is formed as a part of the same diaphragm 85 as are the valve disks of the two-way valve 23, and it is actuated by means of the same solenoid 36 and connected lever 37. The valve disk 48 is specifically actuated to the lever 37 by the same cross bar 39 as the valve disk 34. When the solenoid is in its illustrated or de-energized position, the valve disk 48, as shown, is lifted off the inlet 45 so that the inlet 45 and the outlet 47 of the shut-off valve are in open communication. However, when the solenoid 36 is energized, the valve disk 48 is then moved inwardly to seat on the inlet 45 and close off the communication between the inlet and the outlet. This, of course, closes the valve 24 completely.

The outlet 47 of the shut-off valve 24 is connected to a return hose 49 which is adapted to discharge into the basket 2. Specifically, the hose or conduit 49 extends upwardly within the casing of the machine 1 to a point above the wash basket 2, and at its upper end is provided with a discharge nozzle 50 which discharges the stored liquid into the basket 2 through the open top thereof. In summary, the conduit system for returning the stored liquid from the reservoir 32 to the wash basket 2 thus comprises the outer portion of the hose 30 and the hose 44 from the reservoir to the return pump 41. From the pump 41 the stored liquid then passes through the hose

46, the shut-off valve 24, and the hose 49 and its nozzle 50 into the wash basket.

My invention is particularly directed to an improved control arrangement for controlling the operation of the return pump 41. This arrangement includes a switch, generally indicated at 51 (Fig. 6), and a time delay means, preferably of the thermal type as generally indicated at 52, which are effective to lock in the return pump for a predetermined time until the pump has emptied the reservoir 32. Thereafter the return pump is de-energized, or more specifically, its drive motor 42 is de-energized and simultaneously conditions other electrical components of the machine so that the machine automatically proceeds into its normal operation. The manner in which this arrangement is connected in the control system to effect the desired result is fully explained hereinafter.

In my preferred embodiment, the switch 51, as shown in Fig. 6, comprises a manually operated actuator assembly 53 composed of a button 54, a plunger unit or actuator member 55, and a spring 56 which biases the assembly 53 outwardly. Switch 51 is a double snap acting type with an overcenter spring 57 providing the double snap action. Before actuation, switch 51 occupies a first or normal position. However, when it is desired to operate the re-use system, the switch is actuated by the machine operator when the actuator assembly 53 is pushed. At that time the switch is moved to a second position and the time delay means 52 is simultaneously set into operation. The time delay means, as shown in this preferred embodiment, comprises a heating element 58 cooperatively positioned with a bimetal member 59.

In order to provide both for the lock-in control of the return pump and for the automatic operation of the machine 1 after a predetermined time, the lock-in switch 51 is so arranged that it controls several different circuits. First of all it controls a circuit for operating the return pump; i.e., a circuit for operating the return pump motor 42; secondly it controls a circuit for energizing the time delay means; and thirdly, it controls a circuit for energizing the operating solenoids 60 and 61 of the hot and cold water valves 62 and 63 (Fig. 6). The switch 51 is so arranged that the first two circuits are closed simultaneously while the third circuit is open and conversely, when the third circuit is closed, the first two circuits remain open. More specifically, it is arranged so that in its normal position it closes the circuit for the valve solenoids whereas in its operated or second position, it closes the circuits for the return pump and time delay means.

To provide this action the switch 51 is preferably provided with a normally closed set of contacts connected in the valve means circuit, and a normally open set of contacts connected in the return pump circuit and in the time delay means circuit. Referring to Fig. 6, the stationary contact 64 and the movable switch contact 65 constitute the normally closed set of contacts; the normally open set of contacts consists of stationary contact 66 connected to the same contact arm 67 as contact 64, and movable switch contact 68. When the contacts 64, 65 are connected, they are in series in relation to the valve circuit; when the contacts 66 and 68 are connected, they are in series both with pump 42 and heater 58. Therefore, when the return pump 42 is in operation, the thermal time delay heater 58 will be energized, supplying heat to the heat sensitive bimetallic element 59. After a predetermined time, element 59 will bend, engage movable member 70 of switch 51, and return the switch contacts to their normal position. At this time, both the return pump and thermal time delay heater circuits will be disconnected. Since the two sets of contacts 64, 65 and 66, 68 are connected respectively in series relation in the valve and return pump circuits, as will be explained in detail hereinafter, the valve means cannot be energized while the return pump is locked in by switch 51. Thus, no

fresh water is introduced into the machine so long as the return flow continues. However, once the switch 51 is returned by the time delay means from its operated position, wherein the contacts 66, 68 are closed, to its normal position, wherein the contacts 64, 65 are closed, after a predetermined time it is apparent that the valve means circuit will be closed. This occurs at the desired time, after the reservoir 32 is drained, in response to the functioning of the time delay means.

Referring still to Fig. 6, I have shown therein a preferred embodiment of my new and improved control system for controlling the various electrical components of the machine 1, this system including the switch 51 for controlling the return pump, thermal time delay means 52, and the water valve solenoids. In order to control the sequence of operation of the machine 1, the system includes a timer motor 71 which drives a plurality of cams I, II, III, IV, and V. These cams, during their rotation by the timer, actuate various switches so as to cause the machine to progress through a preferred cycle of operation, first, washing the clothes, next extracting the wash water from them, then rinsing the clothes in clean water and finally extracting the rinse water from the clothes. The electrical circuit as a whole is energized from a two-wire power supply 72, 73 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. 6 is shown in its condition just after the timer has been rotated manually into the wash range for placing the machine originally in operation. A manual control dial 74 (see Fig. 1) is provided on the timer shaft to permit this or any other desired setting or the timer at the discretion of the operator. With the timer set in the wash range or step, the operator then need only close a manually operable switch 75 to place the machine in operation. One preferred manner of manually controlling the switch 75 is to arrange the timer control shaft so that it is axially movable, and mount the switch for actuation by axial movement of the shaft.

To explain the valve means circuit for introducing fresh water into the machine, commencing with the supply line 72 the circuit extends through the contacts 76, 77 of a switch 78 which is controlled by the cam III. As shown, the contacts 76 and 77 are closed together by the cam III when the timer is in the "wash" portion of the cycle. It will be noted, incidentally, that the switch 78 further includes another contact 79 and that the cam III can maintain the switch contacts in three different conditions, i.e., no engagement at all between the contacts at the lowest level of the cam, contacts 76 and 77 engaged at the intermediate level of the cam, and all three contacts 76, 77 and 79 engaged at the high level of the cam. From the contact 77 the water supply circuit extends through a conductor 80 to contact arm 67 and contact 64 of switch 51. As previously discussed, switch 51 is in its normal position, has contacts 64, 65 closed. From the closed contacts 64, 65 the circuit extends through conductor 81 to the hot water solenoid 60. From solenoid 60 the circuit continues through conductor 82 to a movable cam or contact 83 of switch 84 which is controlled by cam II. With the timer in the wash range, the contact 83 is connected with contact 85 and from that contact the circuit extends through a conductor 86 to another conductor 87.

If it is desired to supply warm water to the basket 2 rather than hot water, then a manually actuated switch 88 is closed. This closes a circuit energizing the solenoid 61 of the cold water valve 63 in parallel with the hot water solenoid 60, whereby both hot and cold water, i.e., warm water, are supplied to the basket. The closing of the switch 88 specifically energizes the cold water solenoid 61 between conductor 81, and conductor 87 through additional conductors 89, 90 and 91.

From the conductor 87 the valve circuit continues through a conductor 92 to the timer motor 71 and thence

through conductors 93 and 94 and the switch 75 back to the other side 73 of the power supply. From the conductor 87 the circuit also extends back to the supply line 73 through an alternate path including both the start winding 95 and the main winding 96 of the drive motor 12. Specifically the valve circuit extends to the one side of the main winding 96 through a conductor 97 and continues from the other side of the winding to the conductor 94 and the power supply through a motor protective device 98 and the contacts 99, 100 of a switch 101 controlled by the cam I. The contacts 99, 100 are, as indicated closed when the timer is in the wash portion of the cycle. The start winding 95 is connected in the circuit by means of a double pole, double throw motor reversing switch 102 which is controlled by the cam IV. From the conductor 87 the circuit extends to the start winding through contacts 103, 104 of this switch and the contacts of a motor operated, centrifugal switch 105 which is closed when the motor is inoperative. From the other side of the start winding 95 the circuit is completed through a conductor 106, the contacts 107 and 108 of the motor reversing switch 102 and a conductor 109 to the motor protective device 98. From the motor protective device the circuit extends in the same manner as the circuit for the main winding 96 through the contacts 99 and 100 of the switch 101, the conductor 94 and the manually operated switch 75 to the power supply line 73.

With the timer motor 71 and the start and main windings 95 and 96 of the drive motor being connected in parallel branches, a much lower impedance is presented in the circuit by the motors than is presented by the valve solenoid 60. As a result the greater portion of the supply voltage is taken up across the solenoid 60 and relatively little across the timer and drive motors. This has the result that the solenoid 60 is energized to open the valve 61 to admit hot water to the machine but the timer and drive motors remain inactive. If switch 88 is closed, solenoid 61 will be energized too so that cold water is also introduced to provide a warm water fill, solenoids 60 and 61 even when connected in parallel still presenting a much higher impedance than the parallel connected timer and drive motors.

With the hot water valve or both valves open, water is introduced into the wash basket 2 to fill it until such time as the water reaches the level of the overflow apertures 110 provided at the upper end of the basket side wall (Fig. 1). When the water reaches this level it then overflows through these apertures 110 into the tub 3 forming a pool of water in the tub. Filling of the tub continues for a short time until a water level responsive switch 111 (Fig. 2) in the bottom of the tub is closed. The switch 111, as shown in Fig. 6, is connected directly between the conductors 80 and 87 and when it is closed these conductors are thereby shorted together. This shorts out the water valve solenoid or solenoids and connects the timer motor and the drive motor directly between the conductors 80 and 94. Both the timer motor and the drive motor are thereby placed in operation to commence the washing operation of the machine. It will be noted that the circuit in addition to the water level responsive switch 111 also includes a manually operable, "water saver" switch 112 by means of which the conductors 80 and 87 may be shorted together by the operator at any time. This normally open, water save switch provides for terminating the filling operation and starting the timer and drive motors 71 and 12 when less than a full load of water has been introduced into basket 2.

Digressing from the operation of the machine which takes place upon the energizing of the timer and drive motors, now let it be assumed that the operator, rather than wishing to fill the machine with fresh water, wishes to use water previously stored in the tank 32 to fill the machine. In that case she would manually actuate switch 51 from its normal position to its operated posi-

tion by pushing button 54 after she had set the timer in the wash range and closed switch 75. Switch 51, as shown, is connected in series circuit relation with the drive motor 42 of the return pump between conductors 80 and 87, specifically through contacts 66 and 68 and conductors 113 and 114, so that the closing of contacts 66 and 68 thereby places power on the return pump motor. The motor 42 is of appreciably greater impedance than the parallel connection of the drive motor 12 and the timer motor 71, and thereby the voltage drop across it when contacts 66 and 68 are closed is relatively great as compared to the drop across the timer and drive motors. Thus motor 42 and thereby return pump 41 itself are placed in operation by closing contacts 66 and 68. The return pump immediately begins to withdraw the stored water from the set reservoir 32 through the hoses 30 and 44 and pass it into the basket through the hose 46, the open valve 24 and the return hose 49. The shutoff valve 24 is positively maintained open during this period because cam V holds disengaged the contacts 115 and 116 of a switch 117 which is connected serially in the energizing circuit for valve solenoid 36. This removes all power from the solenoid 36 and thereby the shut-off valve assumes and remains in its open position.

As pointed out previously, the manual operation of the switch 51 not only energizes the return pump circuit, but also energizes the thermal time delay means circuit. Specifically, the closing of contacts 66 and 68 completes the circuit from conductor 80 to conductor 94 through the closed contacts 66 and 68, resistance heater 58 of the time delay means 52, and conductor 119. The energized heater 58 is positioned in the area of bimetallic element 59. Element 59 is in turn positioned so that, as heat is applied to it, it will bend toward movable member 70 of switch 51. The return pump continues to withdraw the stored liquid from the reservoir 32, with the valve solenoids 60 and 61 de-energized, until element 59 contacts movable member 70, causing it to snap from its operated position to its normal position, opening contacts 66 and 68, while closing contacts 64 and 65. At the time switch 51 is returned to its normal position, power is removed from the return pump motor 42 and heater 58 circuits and power is supplied again to the circuit for the water valve solenoid or solenoids. The water valves thereby automatically introduce any make-up water necessary to complete the filling of the tub. After the heat is removed from the area surrounding the bimetallic element 59, the element cools and resumes the position it occupied prior to the application of heat. Thus it will be seen that my new and improved control system through its inclusion of lock-in switch 51 and time delay means 52 not only automatically shuts off the return pump when all the stored liquid is returned from the reservoir, if desired, but also automatically actuates the water valves 62 and 63 so that any make-up liquid necessary is added to the wash basket. The filling of the tub with the make-up liquid is, of course, terminated just as when all fresh water is added, by the water level switch 111 being closed when the machine is filled to the desired level. It will be noted also that just as when the basket 2 is being completely filled with fresh water, the water saver switch 112 may be used to terminate the filling of the basket at any time. Since the return pump motor 42 is energized between the conductors 80 and 87, the closing of the switch 112 is equally effective to short out the return pump motor as the water valve solenoids 60 and 61.

A further feature of the system which will be noted is that since the return pump 41 is placed in operation only when the operator depresses the switch 51, she may, if she wishes, allow the machine to be filled partially with fresh water before she begins to return the stored water. For example, she may at times wish to introduce a partial load of fresh hot water to heat up the stored water to a desired washing level. In that case she allows the fresh

water valve 62 to fill the machine for a period before she depresses the switch 51. The water valve of course commences operation as soon as the timer is set in the wash range and the switch 75 is closed. With the wash basket partially filled with fresh hot water before the return flow from the storage reservoir is started, it is likely that the wash basket 2 will be filled before the storage reservoir is drained by the return pump. The water level switch 111, however, in this instance terminates the filling and prevents over-flowing of the machine just as if the water valves were energized. Specifically, the switch 111 is closed as soon as a small amount of liquid is overflowed into the tub 3, and its closing shorts out the return pump motor 41 so that the return flow ceases. Additionally, its closing places the timer motor 71 and drive motor 12 in operation so that the machine begins its washing operation.

Once either of the switches 111 or 112 is closed, both the timer motor and the drive motor are then energized with full line voltage as mentioned above, and they thereby both commence operation. Initially both the main winding 96 and the start winding 95 of the drive motor 12 are energized, but as soon as the motor comes up to speed the centrifugal switch 105 opens so as to remove the start winding from the circuit.

With the motor reversing switch 102 in the position shown in Fig. 6, the polarity of the start winding is such that the motor 12 rotates in the direction for causing operation of the agitator. In other words, once the filling of the machine is completed, the motor drives the agitator with an oscillatory motion about its axis with the spin basket 2 remaining relatively stationary. Besides opening the switch 105, the operation of the main drive motor also causes the closing of a normally open, motor operated, centrifugal switch 122 which is connected between the conductors 80 and 87. The closing of this switch 122 results in the power being kept on the timer and drive motors even if the level of water in the tub should decrease below that necessary to keep the switch 111 closed. The centrifugal switches 105 and 122 are preferably both operated from the same centrifugal mechanism 123 driven by the drive motor 12.

Concurrently with the operation of the agitator, the drive motor 12 also drives the pump 17 in a direction to cause flow from the tub 3 into and through the recirculation conduit 21. This results in the wash water being continuously recirculated through the wash basket during the washing operation, with lint being removed by means of the filter 22 and with sand flowing out of the basket through a soil removal nozzle 123 (Fig. 1) disposed beneath the agitator skirt 8. The washing operation continues with the movement of the agitator and the recirculation flow until such time as the timer motor reaches the region marked pause "a" in the cam chart of Fig. 7. At that point cam I opens the contacts 99, 100 of switch 101. This removes power from the drive motor 12 and thereby halts operation of the agitator 5 and the pump 17. The stopping of the motor, of course, also results in the opening of the centrifugal switch 122 which connected together the conductors 80 and 87 during the wash period. However, power is not removed from the timer motor 71 as a result of this opening since a power circuit is still completed to it from the conductor 80 through the valve solenoid 60 or both solenoids 60 and 61 if switch 88 is closed. The timer is so constructed that its impedance is much greater than that of the valve solenoids, and thus it takes up most of the supply voltage and continues in operation. The solenoids in fact assume so little of the voltage that they are not effective to open their respective valves 62 and 63.

To point out positively at one place the impedance relationships between the valve solenoids 60 and 61, the timer motor 71 and the drive motor 12, it will be understood that when the drive motor and the timer motor

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are connected in parallel branches in series with the valve solenoids, then the solenoids are operated, but when the drive motor is removed from the circuit and only the timer motor is connected in series with the solenoids, then the timer motor is operated and the solenoids are not. This latter condition exists during pause "a."

As the timer continues to run during pause "a," the cam IV causes operation of the motor reversing switch arms or contacts 103, 108 from their illustrated position where they engage the contacts 104, 107 respectively to a second position wherein the arm 103 engages a contact 124 and the arm 108 engages the contact 104. This has the effect of reversing the polarity of the start winding 95 when power is again applied to it.

When the timer runs to the end of pause "a," the cam III first closes together all three contacts 76, 77 and 79 of switch 78 and then the cam I again closes the contacts 99, 100 of the switch 101. This places power on both the main winding 96 and the start winding 95 of the drive motor between conductors 87 and 94. However, since the polarity of the start winding 95 is now reversed, the motor begins to rotate in the reverse direction from that in which it rotated during the wash period. This has the result that the wash basket 2 is now driven at high speed for extracting the wash water from the clothes. Further the pump 17 now discharges into the discharge hose or conduit 20 rather than into the recirculation conduit 21.

As the water is discharged from the tub 3 through the drain pump 17 and the hose 20, it may, by means of the storage and re-use system, either be stored in the reservoir 32 or discharged into the drain 31 at the option of the operator. During pause "a" prior to the start of the spin period, the cam V closes the contacts 115, 116 of the switch 117. This has the effect of readying the solenoid 36 for energization if the operator of the machine closes a manual "save suds" switch 125. Assuming that the operator does close the switch 125, the solenoid 36 is then energized between the supply conductors 72, 73 during the spin period. From the conductor 72 the energizing circuit extends to solenoid 36 through the contacts 76, 77 of switch 78, conductor 80, through contacts 64, 65 of switch 51, and the conductors 81 and 126. From the other side of the solenoid the circuit is completed through the manually operated switch 125, the conductor 127, the contacts 115, 116 of switch 117, the conductor 94 and the switch 75 to the power supply line 73. With the solenoid 36 energized by this circuit, the valve disk 34 is seated on the drain port 27 of the two-way valve 23, and the valve disk 31 is moved out of engagement with the storage port 28. As a result the water entering the valve 23 through the intake port 26 is discharged into the storage hose 30 and conducted through it into the set reservoir 32. There is, of course, no loss of flow through the return pump 41 and its connected hoses since the shut-off valve 24 is closed whenever the solenoid 36 is energized. In other words the valve disk 48 is seated on the port 45.

Alternatively if the operator should not wish to save the wash water but rather to direct it to the drain 31, she does not close the switch 125. The switch 125 incidentally may be closed any time before the machine is set in operation or any time during the wash period. If the switch 125 is not closed, the solenoid 36 will not be energized and thereby the valves 23 and 24 are not operated to their storage positions. Rather they are left in their illustrated position wherein the intake and drain ports 26 and 28 of the valve 23 are in open communication, so that the flow thereby passes through the drain hose 29 to the drain 31.

The rotation of the spin basket and the draining or storing of the wash liquid continues until the timer reaches the first coast period, the timer of course being energized concurrently with the drive motor between the conductors 87 and 94 during the spin period. When the coast

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period is reached, at that time the cam I opens the contacts 99, 100 of switch 101 for a brief period. This removes power from the drive motor 12 and allows the basket 2 to coast toward a stop. It has been found that this interruption of the spin period is very effective in avoiding suds locking of the basket. The positions of the other cam operated switches are not changed at this point of the machine operation so that the timer motor continues to run during this first coast period.

At the end of the first coast period the cam I again closes the contacts 99, 100 of switch 101. This places power once more on the drive motor 12 and it again begins to drive the wash basket and the drain pump. As this second portion of the wash spin period proceeds, the water discharged from the tub 3 is either stored or passes to the drain 31 as before depending upon how the operator has set the switch 125.

The spin period with the saving or draining of the wash water continues until such time as the second coast period is reached. At that time the cam I opens the contacts 99, 100 and removes power from the drive motor. The driving force is thereby removed from the wash basket 2 and it begins to coast to a stop. As the coast period continues, the cam II operates the switch arm 83 of switch 84 so that it no longer engages contact 85 but rather is brought into engagement with a contact 128. Also, cam III disengages the contacts 77 and 79 of switch 78 so that only contacts 76 and 77 remain in engagement. The operation of these switches, however, does not remove power from the timer motor 71 since it is now energized through the solenoid 61 of the cold water valve 63. Specifically, once the contacts 77 and 79 are disengaged, the circuit for the timer motor then extends through contacts 76, 77 of switch 78, conductor 80, contacts 64 and 65 of switch 51, conductors 81 and 89, the cold water solenoid 61, conductor 90, contact 128 and switch arm 83 of switch 84, and the conductors 87 and 92 to the timer motor. The circuit is completed from the other side of the timer motor through the conductors 93 and 94 and the manually operated switch 75 as before. As mentioned above the impedance of the timer motor 71 is considerably greater than that of the valve solenoid 61 whereby the timer motor continues to run but there is not enough of a voltage drop across the solenoid 61 to cause opening of the cold water valve.

Besides the switching operation performed by the cams II and III, the cam IV also operates the motor reversing switch 102 during this coast period. Specifically, it once more reverses the position of the contacts arms 103 and 108 bringing them into engagement respectively with the contacts 104 and 107. This reverses the polarity of the start winding 95 back to its original connection. The cam V also operates its contacts 115, 116 separating them so that the valve control solenoid 36 of the storage and reuse system is no longer energized.

The second coast period continues with the timer motor running until such time as the cam I closes the contacts 99 and 100 of switch 101. This connects the start and main windings of the drive motor in parallel with the timer motor 71, and thereby a relatively low impedance is presented between the conductors 87 and 94. The supply voltage thereby divides differently with the greater portion of the voltage drop now appearing across the valve solenoid 61 and a relatively low voltage drop occurring across the timer motor 71 and the windings of the drive motor 12. The timer motor immediately stops running and the solenoid 61 opens the cold water valve 63 introducing cold rinse water into the wash basket 2. If it is desired to introduce warm water rather than cold water into the basket 2 for rinsing the clothes, manual switch 129 is closed by the operator. The switch arm 83 and contact 128 of switch 84, when closed, connects the cold water solenoid 61 in parallel with the hot water solenoid 60 and thereby causes opening of the cold water valve 63 in addition to the hot water valve 62. With both valves 62 and 63 open, both hot and cold water are intro-

duced whereby the basket is filled with warm water for rinsing.

The machine continues to fill with rinse water until such time as sufficient water is overflowed into the tub 3 to close the water level switch 111, or else the water saver switch 112 is manually operated. When either of these occur, the water valve solenoid or solenoids are shorted out and the conductor 87 is connected directly to the conductor 83. This again applies line voltage to both the drive motor and the timer motor. The timer motor thereby begins to drive cams I—V and the drive motor begins to drive the agitator 5 with an oscillatory motion in the wash basket. Also, of course, the drive motor drives the pump 17 in the direction to recirculate the rinse water through the basket 2. The rinsing operation continues until the second pause, i.e., pause "b," is reached. At that time the cam I again opens the contacts 99, 100 removing power from the drive motor. The timer motor however continues to run, and during the pause, the cam IV again reverses the position of the switch arms 103 and 108 reversing the polarity of the start winding 95, and the cam III again closes all three contacts 76, 77 and 79.

At the end of the pause "b" the cam I closes the contacts 99 and 100. The drive motor is thus again energized and since the polarity of the start winding 95 is reversed, the motor then begins to rotate in the direction so as to drive the spin basket 2. The rinse water is thereby thrown out or, more accurately, centrifugally extracted from the clothes. Also, with the motor running in the centrifugal extraction direction the pump 17 is driven in a direction so that the water in the tub is discharged through the discharge hose 20. This rinse water passes through the two-way valve 23 and out of the machine through the drain hose 29 into the drain 31. Since the cam V positively opens the contacts 115, 116 during this period, the solenoid 36 cannot be energized and thereby the storage port 28 of the valve 23 is closed and the drain port 27 is open. The spin operation continues until such time as the cam III opens all of the contacts 76, 77 and 79 of the switch 78. This removes the power completely from all the components of the machine 1 and it thereby comes to a stop. The clean clothes may then be removed from the machine.

Summing up with regard to my new and improved control system it will be seen that with this system the operator has the choice of either using entirely fresh water or, if she has stored the wash liquid after a previous washing operation, of returning this stored liquid to the machine or using any combination of fresh or stored liquid. After setting either the return pump or the water inlet valve means in operation, the operator may then leave the machine and it will automatically proceed into its cycle of operation as soon as the liquid container is filled either with the stored liquid, the fresh liquid or the combination of both. In this automatic control sequence the return pump is automatically locked in to return the stored liquid from the reservoir to the washing container. The period of time that the return pump is locked-in is controlled by time delay means which is concurrently energized at the time the return pump is locked-in. After a predetermined period of time, as the time delay means and return pump are de-energized simultaneously, the water inlet valve means is concurrently operated so that any make-up liquid needed in addition to the stored liquid to fill the washing machine is automatically and immediately added.

While in accordance with the patent statutes I have described what at present is considered to be the preferred embodiment of my 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 it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. In a clothes washing machine, a rotatable water container, washing means in said container, electrically operated valve means for filling said container, means for emptying said container, means for rotating said container and for operating said washing means, manually operable sequence control means for controlling in a predetermined sequence said rotation of said container, and the operation of said washing means, said valve means and said emptying means, means for storing the liquid emptied from said container in a storage reservoir, means including an electrically operated return pump and conduit means for returning the stored liquid from said reservoir back to said container, switch means having first and second positions, manually operable means for moving said switch means from said first to said second position, electrically operated thermal time delay means effective to move said switch means from said second to said first position after a predetermined period of energization thereof, said switch means in said first position completing a circuit to said electrically operated valve means, said switch means in said second position completing a circuit to energize said return pump to return liquid from said reservoir and energizing said thermal time delay means, whereby said valve means is de-energized when said switch means is in its second position and is re-energized when said switch means is returned to its first position by said thermal time delay means to stop the return flow.

2. The apparatus defined in claim 1 wherein said thermal time delay means includes an electric resistance heater, and a bimetal element adjacent said resistance heater, said bimetal element being positioned to return said switch means from its second to its first position.

3. The apparatus defined in claim 1 wherein said switch means includes first contact means adapted to be connected to a supply source, second contact means engaged with said first contact means in said first position of said switch means and connected to said electrically operated valve means, and third contact means engaged with said first contact means in said second position of said switch means and connected both to said electrically operated pump means and said electrically operated thermal time delay means, said pump means and said time delay means being connected in parallel with each other.

4. The apparatus defined in claim 1 wherein a second manually operated switch is provided for de-energizing whichever of said return pump or said valve means is energized for manually terminating filling of said container at any time.

5. The apparatus of claim 1 wherein a liquid level switch is provided responsive to the level of liquid in said container for de-energizing whichever of said return pump or said valve means is energized when the liquid level in said container is at a predetermined level, thereby to terminate the filling of said container.

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