May 3, 1960 W. H. HENSHAW, JR., ET AL 2,934,925

CONTROL ARRANGEMENT FOR CLOTHES WASHING MACHINE

Filed July 2, 1959 3 Sheets-Sheet 1

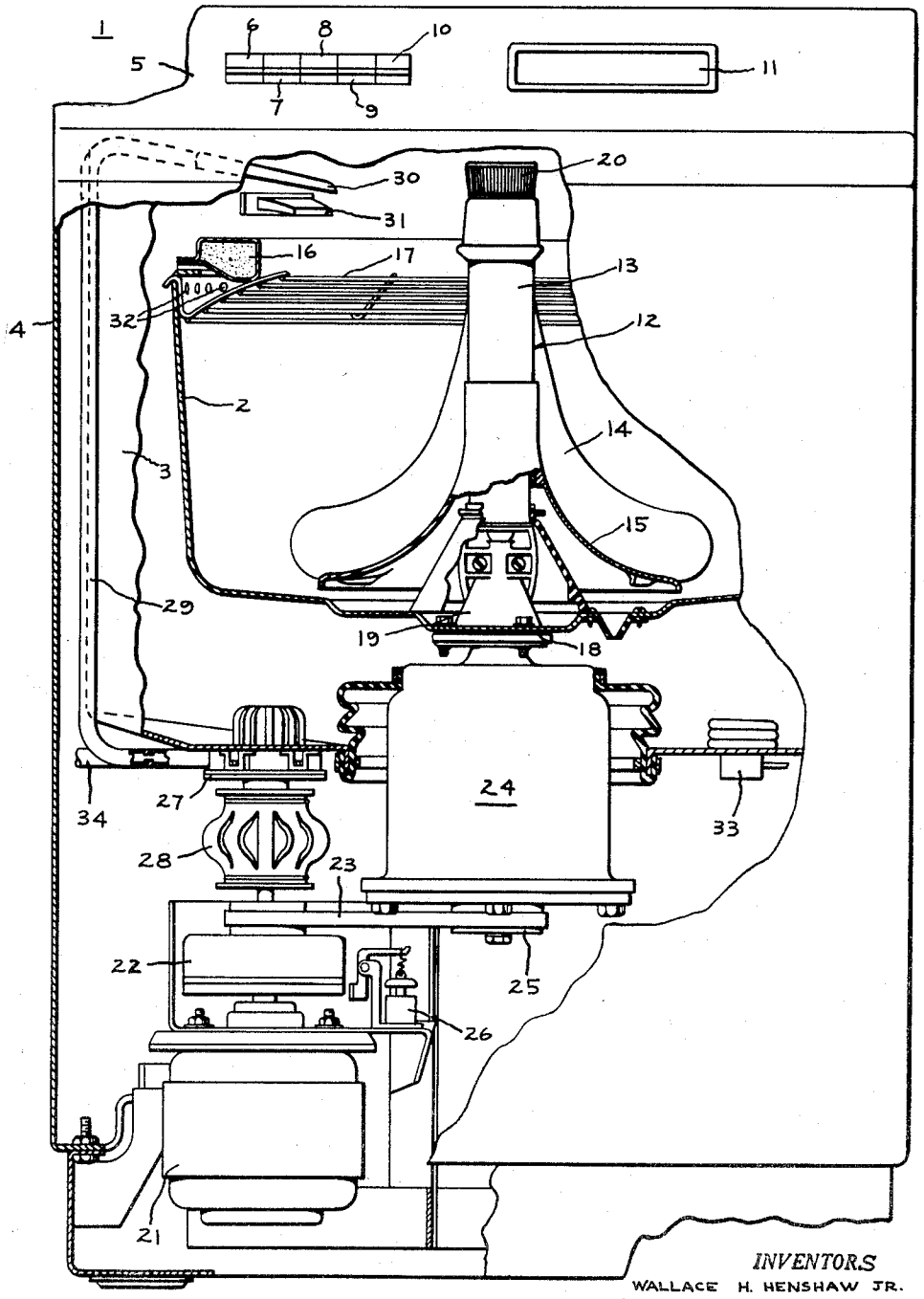


FIG. 1

INVENTORS
WALLACE H. HENSHAW JR.
& PHILIP H. HOUSER
BY
Dred P Laurence
THEIR ATTORNEY

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CONTROL ARRANGEMENT FOR CLOTHES WASHING MACHINE

Filed July 2, 1959 3 Sheets-Sheet 2

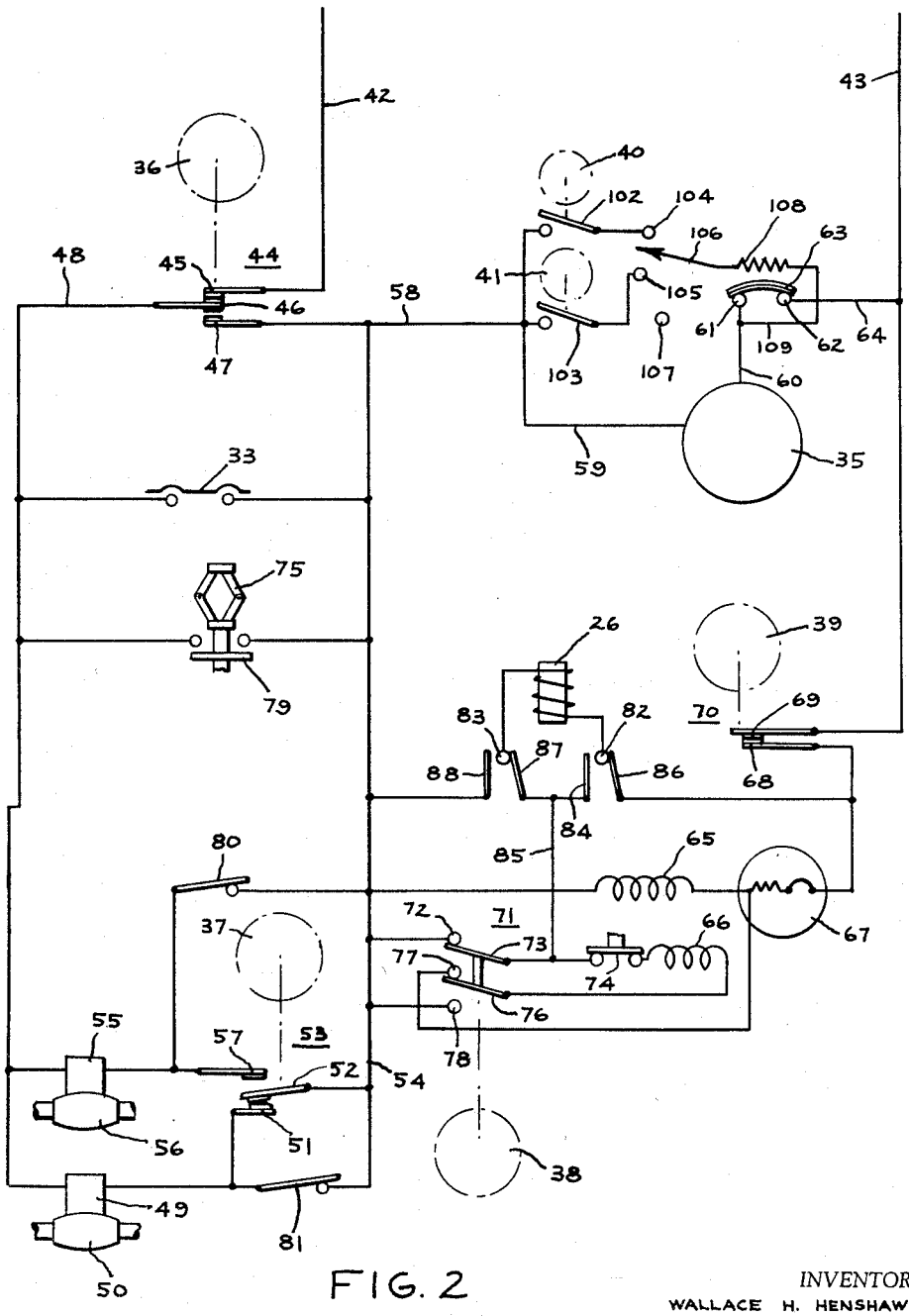


FIG. 2

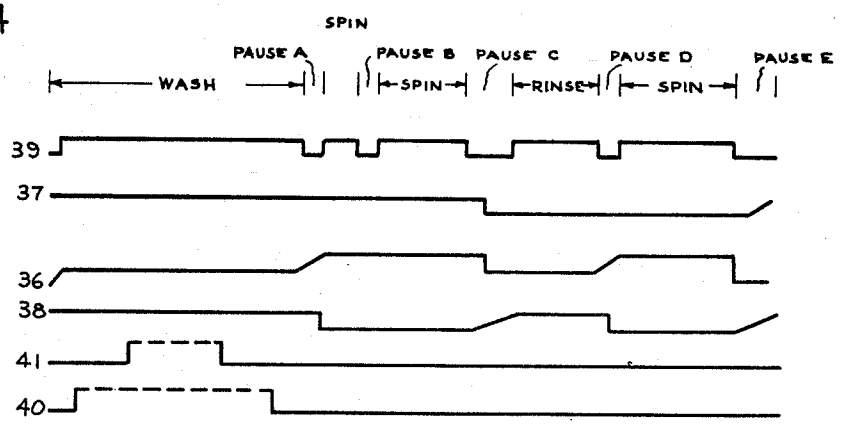
INVENTORS
WALLACE H. HENSHAW JR.
& PHILIP H. HOUSER
BY Dale P Laurence
THEIR ATTORNEY

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CONTROL ARRANGEMENT FOR CLOTHES WASHING MACHINE

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FIG. 4



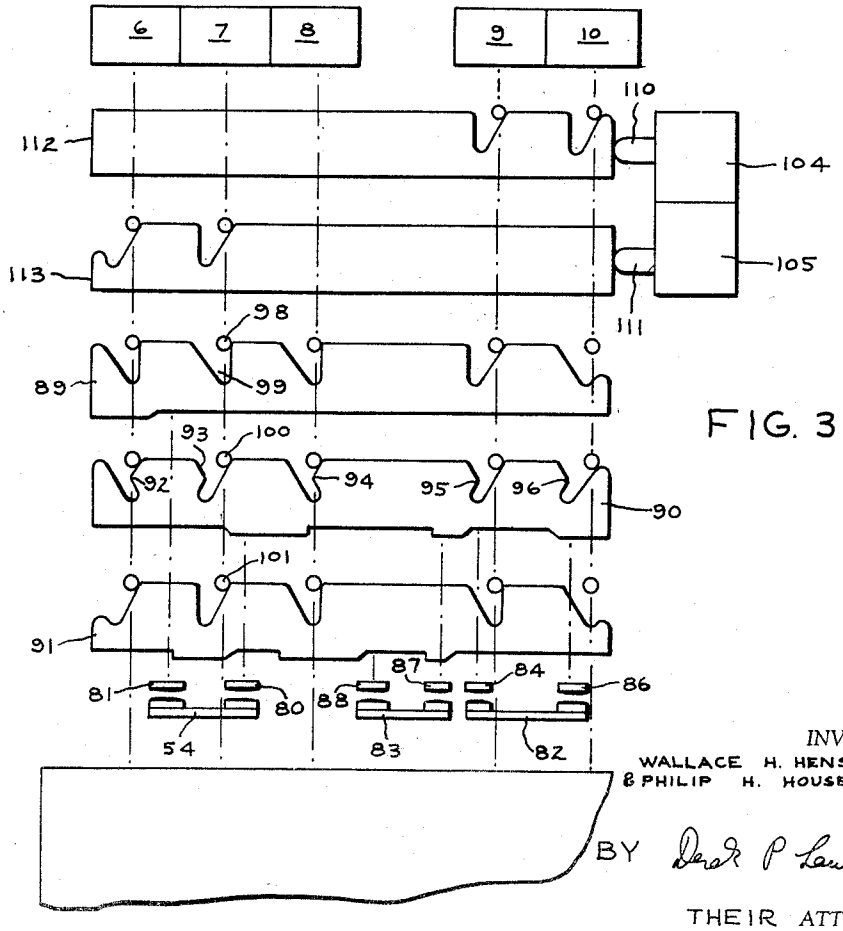


FIG. 3

INVENTORS
WALLACE H. HENSHAW JR.
& PHILIP H. HOUSER

BY Dean P. Lawrence

THEIR ATTORNEY

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CONTROL ARRANGEMENT FOR CLOTHES WASHING MACHINE

Wallace H. Henshaw, Jr., and Philip H. Houser, Louisville, Ky., assignors to General Electric Company, a corporation of New York

Application July 2, 1959, Serial No. 824,549

6 Claims. (Cl. 68—12)

This invention relates to automatic clothes washing machines, and more particularly to apparatus in such machines for providing a plurality of alternative washing sequences each selectable by a single manual operation.

Automatic clothes washing machines customarily proceed through a sequence of operations in order to wash, rinse and dry the clothes. The sequence ordinarily includes a washing operation, a first extraction operation in which the wash water is removed from the clothes, a rinsing operation in which the clothes are rinsed in clean water, and a final extraction operation in which the rinse water is removed from the clothes. Depending upon the type of machine, this sequence may vary; for example, some machines include a two-stage initial extraction operation in order to avoid "suds locking" of the basket, and other machines include a spray rinse in addition to the customary submersion rinse. However, the general sequence of washing, rinsing and extracting is used in almost all automatic washing machines. While, in a broad sense, this sequence is suitable for the washing of almost all clothes, the many different types of fabrics now used in the manufacture of clothes have resulted in the need for variations within each of the steps. For instance, during washing it may be desirable to have various water temperatures depending upon whether the clothes load is made up of fabrics formed of synthetic or natural fibers, and whether the coloring matter used on the fabrics in colorfast in hot water or not. Also during the washing operation, the agitation speed, in the many machines which provides some type of mechanical agitator, may preferably be relatively high for sturdy fabrics (particularly those which become highly soiled such as working clothes) but relatively slow for more delicate fabrics.

The same general considerations are present during rinse: for many types of loads a warm rinse will be preferable and for many other types of loads a cold rinse will be preferable. Also during rinse, the agitation speed should be substantially the same as that provided during the washing step, either fast or slow depending upon the fabrics.

When it comes to the operation of centrifugally extracting liquid from the clothes, a relatively high speed spin operation may be desirable if the clothes are of the type which have a substantial tendency to retain water, whereas if the clothes are relatively delicate, or wrinkle easily, relatively low speed spins may be preferable.

Originally, the selection of these variable operations was left entirely to the operator, with manual controls being provided for each individual variable. However, because the operator frequently did not have access to scientifically obtained information as to the optimum water temperatures, wash speed, and spin speed for a given clothes load, the selections were frequently not those which would provide optimum washing results. Consequently, the next step was to provide manual controls where a single manual operation was required for each type of clothes load, and connections were provided

within the machine for automatically selecting the best combination of variables for the particular type of fabric.

It will be recognized that the variables, that is, the operation modifications which have been described hereabove are of the variety which involve simply operation of the switches to predetermined circuit controlling positions prior to start of a sequence, without any other complicating factors being involved. In other words, timing of the various steps (wash, rinse, extraction) as performed by the conventionally provided timer motor was unaffected by the single manual setting of the above discussed variables. However, just as with the other factors such as temperature and speed, the optimum length of the wash time varies and can be scientifically ascertained with respect to any given type of clothes load. It is therefore most desirable to cause the length of wash time to be selected automatically at the same time as the other variables in the cycle by the same single manual operation. Due to the fact that operation of the timing arrangement itself must be modified in order for variable wash time to be achieved, the provision of different automatically selected wash times is a somewhat more complex matter than the provision of the other variables. Since even the simpler controls for automatically preselecting all the variables by a single manual operation are relatively expensive, it is important to prevent any further substantial increase in the cost of the washing machine and to keep to a minimum the number of additional components required to automatically provide the proper wash time in response to a single manual operation.

It is therefore an object of my invention to provide a washing machine wherein a single manual operation preselects the different modifications required for optimum washing of the clothes load, including the optimum washing time for each type of load.

A further object of my invention is to achieve this goal by removing control of the cycle from the conventional timer motor for a period determined by a thermally responsive device which opens the timer motor circuit at a predetermined high temperature and keeps it open until a predetermined low temperature is reached.

In one aspect of my invention I provide a washing machine which has the desired number of different washing sequences which will normally each include a wash step, a rinse step, and one or more liquid extraction steps. These steps are provided by conventional electrically controlled components with the components in turn being controlled by suitable switch means. The timer motor controls at least part of the switch means and operates it at predetermined times in a predetermined manner so as to provide steps of a predetermined duration. At least a portion of the switch means is also controllable by means manually operable to several positions each corresponding to a particular washing sequence. Different washing sequences at the different positions of the manual means are provided by virtue of the fact that a different controlling effect on the switch means is provided at each position.

Together with the relatively conventional structure described above I provide an arrangement for varying the duration of at least one of the steps, preferably, the washing step, by preventing the timer motor from operating during that step for a selectable predetermined length of time. The duration varying means includes, besides the timing motor and an appropriate first circuit for energizing the motor, normally closed contact means which are in series with the motor. The position of the contact means is controlled by thermally responsive means, and electric heating means are provided to cause the thermally responsive means to open the contact means upon energization of the heating means for a predeter-

mined length of time. The heating means is also positioned in series with the contact means, but in a second circuit which is in parallel with the motor energizing circuit. This second circuit also includes a switch controlled by the timer motor and connected in series with the heating means; the switch is closed for a predetermined period of motor operation during the step which is to be lengthened. A manually presettable switch construction is provided in the second circuit in series with the heating means and with the timer controlled switch. By means of this manually presettable switch, the second circuit may either be closed subject to operation of the timer controlled switch or else opened regardless of the position of the timer controlled switch.

When the heating means is energized by completion of the second circuit, it causes the thermally responsive means to open the contact means which, of course, opens both the first and second circuits. These circuits remain open then until the thermally responsive means cools down enough for the contact means to close. This sequence continues for as long as the timer operated switch and the manually presettable switch retain the second circuit operative to energize the heater. The fact that the timer motor is stopped each time the contact means opens until the thermally responsive means cools down lengthens the time of the sequential operation to an extent dependent on the duration of closure of the timer controlled switch.

By thus causing the thermally responsive means and the heating means to preclude the function of the timer motor for a variable period determined by the characteristics of the thermally responsive means, the heating means, and the length of time the timer operated switch is closed, an economical, simple and reliable method of varying the duration of any step of the sequential operation and of tying the wash time selection in with the other variables is achieved.

The subject matter which we regard as our invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention itself, however, both as to its organization and method of operation, may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a front elevational view of a clothes washing machine including my invention, the view being partially broken away and partially in section in order to illustrate details;

Figure 2 is a schematic diagram of an electrical control circuit suitable for use in the machine of Figure 1 and including my improved control arrangement;

Figure 3 is a schematic illustration of conventional manually operable switching means which may be used for achieving the desired connections in the circuit of Figure 2; and

Figure 4 is a chart of the developed surfaces of the timer operated cams of Figure 2 illustrating the sequence of closing of the timer controlled switches shown in Figure 2.

Referring now to Figure 1, I have shown therein an agitator type washing machine 1 which includes a clothes basket 2 disposed within an outer imperforate tub or casing 3. Tub 3 in turn is mounted within an outer appearance cabinet 4 which includes a control panel 5. A plurality of manually operable members 6, 7, 8, 9 and 10 are provided on the control panel 5 which also may include a suitable indicator portion 11 for indicating to the operator the particular step being provided at any given instant during the washing sequence. At the center of wash basket 2 there is positioned a vertical axis agitator 12 which includes a center post 13 and a plurality of radially extending vanes 14. The agitator is further provided with an outwardly and downwardly flared skirt 15 to which the vanes are joined at their lower ends. Skirt 15 extends to a position in proximity

to the bottom of the basket 2 and covers a substantial portion thereof. Adjacent the top of the basket there is provided a conventional balance ring 16 and a suitable clothes retaining member 17.

Both the basket 2 and the agitator 12 are rotatably mounted. Specifically, basket 2 is mounted on a flange 18 of a rotatable hub 19 and agitator 12 is mounted on a shaft (not shown) which extends upwardly through hub 19 and center post 13. The agitator is secured to this shaft by means of an internally threaded nut or cap 20 at the top of the center post.

Basket 2 and agitator 12 are driven by any suitable means. By way of example, we have shown them driven by a reversible motor 21 which operates through a drive including a bidirectional clutch 22 mounted on the motor shaft. Clutch 22 allows the motor to start without load and then picks up the load as it comes up to speed. A suitable belt 23 transmits power to a transmission assembly 24 through a pulley 25. Thus, depending upon the direction of motor rotation pulley 25 of transmission 24 is driven in opposite directions. The transmission clutch 22 is also a two-speed clutch, and a solenoid member 26 is provided in order to achieve the two-speed operation. Specifically, in the illustrated machine, when solenoid 26 is de-energized clutch 22 provides a direct drive between motor 21 and pulley 25, and when solenoid 26 is energized clutch 22 provides a reduced speed drive to pulley 25. A two-speed clutch of this type, particularly suited for use in the illustrated machine, is described in detail and claimed in the copending application of John Bochan, Serial No. 627,817 filed December 12, 1956, now Patent No. 2,869,699 and assigned to General Electric Company, assignee of the present invention.

Transmission 24 is so arranged that it supports and drives both the agitator drive shaft and the basket mounting hub 19. When motor 21 is rotated in one direction the transmission causes the agitator 12 to oscillate within basket 2. Conversely, when motor 21 is driven in the opposite direction, the transmission drives basket 2 and agitator 12 together at high speed for centrifugal liquid extraction. While the drive mechanism forms no part of the present invention, reference is made to Patent 2,844,225 issued to James R. Hubbard et al. on July 22, 1958 and assigned to General Electric Company, assignee of the present invention. That patent discloses in detail the structural characteristics of a transmission assembly suitable for use in the illustrated machine.

In addition to driving transmission 24, motor 21 also drives a pump 27 through a flexible coupling 28 which connects the motor shaft and the pump shaft. During washing and rinsing steps, pump 27 discharges into a conduit 29 which leads to a nozzle 30 positioned over basket 2 so that liquid may be recirculated through a suitable filtering system (not shown) in order to clean and filter it during the washing operation.

Then, when water is introduced through an appropriate conduit, such as that shown at 31, water rises in basket 2 until it reaches the level of overflow apertures 32 provided around the upper periphery of the basket. The water then overflows through the apertures 32 into tub 3 forming a pool of water at the bottom of the tub until a level responsive switch 3 is closed. As will be further explained below, this starts the operation of motor 21 to effect oscillation of agitator 12 and operation of pump 27 to recirculate water from tub 3 through conduit 29 back into the basket, whence it overflows through openings 32 into the tub again.

At the end of the washing and rinsing portions of the cycle, and in response to a reverse direction of rotation of motor 21, pump 27 discharges into a conduit 34 which is connected for discharge to a stationary tub or drain line so that the pump is then effective to drain tub 3. Any suitable pump may be used for recirculating and draining purposes; one such pump is described in full detail and claimed in copending application Serial No. 468,-

460 filed November 12, 1954 by John Bochan, now Patent No. 2,883,843 and owned by the General Electric Company.

Referring now to Figure 2, there is shown an electrical control system for machine 1. It will be understood that present-day washers include various controls such as control panel lights, water savers, etc., which do not relate in any way to the present invention, and that to some extent these have been omitted for the sake of simplicity and ease of understanding. In order to control the sequence of operation of washing machine 1, the circuit includes a high impedance timer motor 35 which drives a plurality of cams 36, 37, 38, 39, 40 and 41. These cams, during their rotation by the timer motor, actuate various switches (as will be described) so as to cause the machine to pass through an appropriate cycle of operations, first 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 circuit as a whole is energized from a power supply (not shown) through a pair of conductors 42 and 43. To initiate a particular washing sequence, any one of the manual control members 6–10 is depressed. Depression of any one of these moves cams 36—41 by any appropriate conventional mechanism (not shown) to the position for starting a cycle.

Cam 36 controls a switch 44 which includes contacts 45, 46, and 47. When the cam 36 has assumed a position where all three contacts are separated, machine 1 is then disconnected from the power source and is inoperative. When operation of machine 1 is initiated by pressing down one of members 6—10, switch 44 is controlled by cam 36 so that contacts 45 and 46 are engaged. Thus, power is provided to the control circuit of the machine from conductor 42 through contacts 45 and 46.

From contact 46, the circuit extends through a conductor 48 to the control solenoid 49 of a hot water valve 50, and then through contacts 51 and 52 of a switch 53 controlled by cam 37 to conductor 54. Conductor 48 is also connected to a control solenoid 55 of a cold water valve 56 which may then be connected through contact 57 and contact 52 of switch 53 to conductor 54.

It will be observed that cam 37 moves contact 52 alternatively into engagement with contact 51 or contact 57, so that automatic operation of either the hot or cold water valve is provided. From conductor 54 the energizing circuit continues through conductors 58 and 59 to timer motor 35 and then through a conductor 60 to contacts 61 and 62 which are connected together under the control of a thermally responsive device in the form of bridging bimetallic member 63. The circuit then proceeds through conductor 64 back to conductor 43.

Also, from conductor 54, a path in parallel with the timer motor is provided which includes main winding 65 and start winding 66 of motor 21. More specifically, the circuit extends from conductor 54 through main winding 65, motor protective device 67, and the contacts 68 and 69 of a switch 70 controlled by cam 39, back to conductor 43. The start winding 66 is connected in the circuit in parallel with the main winding 65 by means of a double pole double throw motor reversing switch 71 controlled by cam 38. From conductor 54 the circuit extends through contact 72 and 73 of switch 71, and then through the contact 74 of a motor operated centrifugal switch 75 which is closed when the motor is at rest or rotating below a predetermined speed. The circuit then continues through the start winding 66 itself, contacts 76 and 77 of switch 71, then to protective device 67 and along the same path as the main winding circuit.

It will be observed that when contacts 73 and 76 are moved by cam 38 to engage contacts 77 and 78 respectively, the polarity of the start winding is reversed since the circuit from conductor 54 then proceeds through contact 76, start winding 66, centrifugal switch contact 74, and contacts 73 and 77 to protective device 67.

When the main and start windings 65 and 66 of motor 21 are connected in parallel as described, and are in series with the valve solenoids 49 and 55, a much lower impedance is presented in the circuit by the motor 21 than is presented by the valve solenoids. As a result, the greater portion of the supply voltage is taken up across the solenoids and relatively little is across the motor. This causes whichever of the solenoids is connected in the circuit to be energized sufficiently to open its associated water valve. As a result, water at a suitable temperature is admitted to the machine through conduit 31, motors 21 and 35 remaining inactive.

This action continues, with the circuitry thus arranged, so that the water pours into basket 2 and fills it to the level of the overflow apertures 32. The water then overflows through the apertures into tub 3 forming a pool of water in the bottom of the tub until water level responsive switch 33 is closed. This switch is connected directly between conductors 48 and 54, so that when it closes it shorts them together and removes substantially all power from across the solenoids. This then connects timer motor 35 and drive motor 21 directly between conductors 42 and 43, and both motors then start in operation.

When motor 21 comes up to speed, centrifugal switch 75 opens contact 74 so as to remove start winding 66 from the circuit. At the same time, the centrifugal switch closes a contact 79 which keeps the solenoids shorted out regardless of whether the water pressure keeping switch 33 closed is subsequently depleted by the water recirculating action previously described. When the reversing switch 71 is in the position shown in Figure 2, the polarity of start winding 66 is such that motor 21 rotates in the direction for causing operation of agitator 12, while in the reverse connection the motor rotates in the direction to cause rotation of the basket and agitator together.

When contacts 68 and 69 of switch 70 are opened by cam 39, once motors 21 and 35 have started in operation, motor 21 ceases to operate while motor 35 continues to operate. When this occurs, the impedance of motor 35 is much greater than that of the valve solenoids so that it takes up most of the supply of voltage and continues in operation, leaving so little voltage across the solenoids that they do not operate their respective valves. With motor 21 stopped, reversal of switch 71 is then effective to cause the motor to rotate in the opposite direction from that previously provided once the motor 21 starts again. In order to energize motor 21 independently of the water level switch and the valve solenoid during reverse rotation of the motor (to provide spin), cam 36 causes all three contacts 45, 46 and 47 of switch 44 to be closed during the extraction, or spin, steps so that power is supplied through contact 47 and conductor 54 to the motors directly rather than through the water level switch and the valve solenoids.

Operation of cams 36 through 39 by timer motor 35 to actuate switches 44, 53, 71 and 70 in a predetermined sequence effects a basic washing operation by causing provision of a washing step, a rinsing step, and suitable extraction steps after the washing and rinsing steps.

However, as explained above, for optimum results the variety of modern fabrics requires different sequences insofar as water temperatures, agitation and spin speeds, and wash time are concerned. For the wash step it will be recognized that, while hot water is desirable for some types of clothes loads, such as colorfast cottons, there are other types of loads such as non-colorfast cottons and synthetic fabrics which may better be washed in warm water. In order to provide this choice a manually operated switch 80 is provided which in effect connects cold water solenoid 55 to conductor 54 independently of switch 53. When switch 80 is closed, the cold water solenoid will be energized at the same time as the hot water solenoid even if switch 52 is in the position where contacts 51 and 52 are together to select hot water. Consequently, warm water will be provided through the con-

duit 31. Conversely, when switch 80 is open and switch 53 is in the position connecting contacts 51 and 52, only the hot water solenoid can be energized and hot water will be supplied.

A second variable factor which has been described is the necessity for a cold water rinse at times and warm water rinse at other times. In order to provide this selection, a second switch 81 is provided which in effect connects hot water solenoid 49 to conductor 54 independently of switch 53. In other words, even if switch 53 is in the position where contacts 52 and 57 are engaged, the hot water solenoid will be energized at the same time as the cold water solenoid so that warm water will flow when the solenoids are energized. By the same token, if switch 81 is left open, then when contacts 52 and 57 are in engagement only the cold water solenoid 55 will be energized and cold water will flow.

A third operation of the machine which is preferably variable in order to obtain maximum washing effectiveness with different types of loads is the speed of the agitator mechanism in its oscillating movement during the washing and rinsing steps. A fourth important variable is the spin speed, which, for certain types of loads which tend to retain a lot of water, should be high, and for certain other types of loads which are of delicate material and tend to wrinkle easily should be low. As stated above, solenoid member 26 is provided in connection with clutch 22 in order to achieve the two output speeds of the clutch to provide for high and low speed agitation and high and low speed spin operations. Switch member 82 controls the agitation speed and switch member 83 controls the spin speed. When switch member 82 is connected to contact 84 and conductor 85, solenoid 26 is not energized during agitation and consequently a high speed agitation is provided; if switch member 82 engages contact 86 and conductor 43 the solenoid is energized during agitation and a low speed agitation is provided. In the same manner, connection of switch 83 with contact 87 precludes energization of solenoid 26 during spin and a high spin speed is provided, while connecting switch 83 to contact 88 causes energization of solenoid 26 during spin and a low spin speed is provided.

The precise manner in which the setting of the switches 82 and 83 controls the energization of solenoid 26 is described in substantial detail and is claimed in copending application Serial No. 627,821 of Wallace H. Henshaw, Jr. filed December 12, 1956 on a control system for automatic washing machines, assigned to the General Electric Company, owner of the present invention. Accordingly, since it forms no part of the present invention, the precise manner in which the control of solenoid 26 is achieved will not be further described herein.

Prior to describing the specific innovation we have provided in the washing machine control, the operation of the machine will be described in connection with the control circuit of Figure 2 and in connection also with Figures 1, 3 and 4. Depression of any one of buttons 6 through 10 will cause the machine to start operation of a particular sequence, each one of the buttons providing a sequence particularly suited for a particular type of clothes load. In addition, as stated above, the depression of any of the manual controls 6 through 10 sets the cam members 36, 37, 38 and 39 at the beginning of the cycle.

Consideration of the operation of cam members 40 and 41, which are also set at the beginning of the cycle by the depression of the manual members will be deferred until they are considered in connection with the specific novel arrangement of our invention.

Cam 36 at the beginning of the cycle closes contacts 45 and 46 leaving contact 47 disconnected; thus the circuit, with switches 33 and 79 open, must necessarily proceed through at least one of the valve solenoids 49 and 55. Cam 37, it will be seen from Figure 4, opens contacts 57 and 52 and closes contacts 51 and 52 so that solenoid 49 is automatically energized. At this time, solenoid 55 is energized only if switch 80 has been closed. Cam 38 is in the position shown so that contact arm 73 engages contact 72 and contact arm 76 engages contact 77. Also, contacts 68 and 69 of switch 70 are closed by cam 39.

With this arrangement of the cams, either solenoid 49 alone or both solenoids 49 and 55 are energized to provide a flow of either hot water or warm water into the basket 2. This flow continues until switch 33 is closed. When switch 33 closes, the solenoids are short circuited and an energizing circuit is completed to the main motor windings 65 and 66, and to the timer motor 35 through conductors 59 and 69 which constitute an energizing circuit therefor, so that both motors start to operate. Operation of the main motor 21 causes centrifugal switch contact 74 to open, disconnecting winding 66 so that the motor runs on winding 65 alone. Also, contact 79 is closed so that the solenoids remain short circuited out of the system even though pressure switch 33 should later open as a possible result of the recirculating action of the machine. As has been stated, the motor 21 rotates at this time in the direction appropriate to provide both recirculation by pump 27 and agitation which is either slow or fast, depending upon whether contact 82 engages contact 84 or contact 86.

This wash action continues until cam 39 opens contacts 68 and 69 to de-energize the main motor. The timer motor 35, however, continues to operate; this precludes operation of the valve solenoids even if switches 33 and 79 are both open since the timer motor is a relatively high impedance motor and does not leave sufficient potential across the solenoids for them to be energized. This provides the pause "A" shown in Figure 4; during the pause the cam 36 closes all three contacts 45, 46 and 47 together so that it automatically shorts the solenoids out of the system by connecting contact 47 to contact 45. Also, cam 38 moves switch arms 73 and 76 so that arm 73 engages contact 77 and arm 76 engages contact 78. As a result of this, when at the end of the pause cam 39 recloses contacts 68 and 69, the motor starts its rotation in the opposite direction.

With motor 21 rotating in the opposite direction, a spin action is provided at either fast or slow speed, depending upon the position of switch arm 83, and continues until contacts 68 and 69 are again opened by cam 39 to provide pause "B" which is often deemed desirable for the elimination of the "suds lock" phenomenon whereby the machine may be prevented from coming up to full spin speed if excessive suds were present during the washing operation. After pause "B" contacts 68 and 69 are again closed by cam 39 and the second half of the wash spin operation is provided in the same manner.

Contacts 68 and 69 then open to provide pause "C"; during this pause cam 36 again opens contact 47 and cam 38 returns switch 71 to its first position. In addition, cam 37 moves contact 52 from engagement with contact 51 to engagement with contact 57 so that instead of solenoid 49, solenoid 55 is energized by the timer action and solenoid 49 is dependent upon the manually set switch 81.

As a result, when contacts 68 and 69 are closed at the end of pause "C" the timer will stop its operation and the solenoids will be energized to the exclusion of the two motors as before. In this case, either cold water (if only solenoid 54 is energized) or warm water (if both solenoids are energized) will be provided to the basket until pressure switch 33 is closed when, as before, the solenoids close the valves and the two motors 21 and 35 start in operation to provide the rinse step at the same oscillation speed as the wash step.

At the end of the rinse step, cam 39 again opens con-

tacts 68 and 69 to provide pause "D" during which cam 36 again causes connection of contact 47 with contacts 45 and 46, and cam 38 reverses switch 71. As a result, when cam 39 again closes contacts 68 and 69 a spin operation will be provided to extract the rinse water from the clothes. At the end of the spin operation contacts 68 and 69 are again separated by cam 39, and then, after a final brief pause "E" of continued timer motor operation cam 36 separates all three of the contacts 45, 46 and 47 to remove power from the machine so that the cycle comes to an end. The clothes are then ready for removal from the machine.

In order to effect the desired modifications for the different types of sequences to be provided by depression of members 6—10, the depression of the members, in addition to starting the cycle, also operates a plurality of camming bars 89, 90 and 91 (Figure 3). All three bars in turn operate each of the switching members 80, 81, 84, 86, 87, and 88, a closing action by any one of the bars 89, 90 and 91 being sufficient to close a given switch member. The bars are part of a conventional switching system in which bar 90 may, as shown, be provided with curved portions 92, 93, 94, 95 and 96 so that whichever of the members 6—10 is depressed it is retained in the depressed position until bar 90 is moved by a subsequent operation of a different one of the members 6—10 to release the previously depressed button. Each button is caused to return automatically to an unactuated position by the action of the camming bars, in the conventional well known manner, when another button is depressed.

It will, of course, be understood that the operation of a switch member effected in accordance with the movement of the camming bars is of a predetermined nature for depression of each one of the manually operated members. For example, if member 7 should be operated it will be seen that bar 89 will remain in the position shown because member 98 (movable with button 7) will merely travel directly downwardly in groove 99; bar 90 will be moved to the right by the action of member 100 (also movable with manual member 7) and bar 91 will be moved to the right by the operation of member 101 (also movable with manual member 7).

With camming bar 89 not moved by depression of member 7, each of its switch actuating portions is in the switch open position. With bar 90 moved to the right, switching member 80, which is normally closed by this bar is permitted to move to an open position. However, the movement of bar 91 forces switch 80 back to a closed position so that switch 80 is closed by depression of member 7. In the same fashion, switch member 88 is moved to its closed position by bar 91, member 87 is moved from a closed to an open position by virtue of the movement of bar 91, switch member 84 moves from an open to a closed position because of the movement of bar 90, and switch member 86 moves from a closed to an open position by virtue of the movement of bar 90. It will thus be seen that the depression of member 7 will cause member 80 to be closed, member 81 to be opened, member 83 to be connected to member 88, and member 84 to be connected to member 82. This provides, in connection with the timer control sequence described above, warm wash water, cold rinse water, fast agitation and slow spin. This particular type of cycle has been found to be the best for sturdy synthetic materials. In the same manner, depression of each of the other members 6, 8, 9 and 10 provides a combination of factors best suited to a particular type of clothes load.

As stated above, a further desirable variable is the washing time; it should for certain types of loads be longer than for certain others. In order to achieve this I provide (Figure 2) cams 40 and 41, contacts 61 and 62, and thermally responsive member 63, as well as the following additional structure. A pair of switches 102 and 103 are respectively controlled by the cams 40 and 41, which, it

will be recalled, are driven together with the other cams by the timer motor 35. In series with switch 102 is a contact 104 and, similarly, a contact 105 is positioned in series with switch 103. A contact arm 106 is operable into engagement with contact 104 or contact 105, or, alternatively, to an open position indicated at 107. Contact arm 106 in turn is in series with electric heating means 108 in the form of a resistance element which is physically located adjacent the thermally responsive bimetallic element 63 so that when an energizing circuit is completed through the heating element it heats the bimetallic element and after a predetermined length of time (determined by the characteristics of the heating means and the thermally responsive means) the bimetallic element will deform to open contacts 61 and 62.

It will further be observed that heating element 108 is connected to conductor 43 in series with element 63 and contacts 61 and 62 through a conductor 109. Thus, in effect, the heating element 108, the contact arm 106, the contacts 104 and 105, and the switches 102 and 103, form an energizing circuit for the heating means which is in parallel with the timer motor 35 but in series with the contacts 61 and 62 controlled by the thermally responsive means 63.

Referring now to Figure 3 again, contacts 104 and 105 alternatively engageable by contact 106 are shown schematically, for purposes of illustration, as switching members with contact 104 engaging contact arm 106 when button 110 is depressed and with contact 105 engaging contact arm 106 when button 111 is depressed. It will readily be observed that switch 105 is operated by depression of either of members 6 and 7, switch 104 is closed by operation of either of buttons 9 and 10, and depression of button 8 does not serve to close either switch. It will, of course, be understood that members 110 and 111 are appropriately biased to an outward position so that they remain closed only so long as they are depressed by operating levers 112 and 113 respectively.

It will thus be seen that depression of one of the manual members 6—10, in addition to selecting the four switch positions previously described in connection with the wash water and rinse water temperatures and the spin and agitation speeds, also either closes one of the two switches 104 and 105 or else leaves them both open.

As has been stated, cams 40 and 41 are appropriately formed in order to close their switches for a predetermined period of time. Since the primary purpose of this invention is to achieve a variable washing step, the cams are preferably formed so that they close their respective switches only during the washing step, with cam 40 closing its switch 102 for a predetermined period of time and cam 41 closing its switch 103 for a different predetermined period of time. For purposes of this explanation it will be assumed that cam 40 closes its switch 102 for a period of two minutes of cam operation and that cam 41 closes its switch 103 for a period of two-thirds of a minute of cam operation. It will further be assumed that, as stated before, button 7 has been depressed so that switch 105 is closd to cause the switch 103 to be the one effectively in circuit with the heating means.

Accordingly, if an assumed total of two and a half minutes of washing is provided when the timer motor 35 operates without interruption, then the washing operation will start after the tub has been filled in response to the closing of switch 33 as explained, and the timer motor will run without interruption until the rise in cam 41 causes switch 103 to be closed. With contact arm 106 engaging contact 105 as a result of the depression of button 7, heating element 107 is then energized and causes the element 63 to be heated. During this heating period the timer motor continues to run. However, when enough heat has been supplied to element 63 by element 108 to cause the element to open and disconnect contacts 61 and 62, the timer motor stops while the washing function of the machine continues uninterrupted because of the

continued energization of motor **21**. With the stopping of motor **35**, cam **41** also ceases to rotate so that where, as will commonly be the case by design, the dwell on the cam has not been reached, switch **103** will still be closed. However, because of the opening of the bimetal, element **108** is de-energized and thus the bimetal starts to cool and after a predetermined period of time is cool enough to snap back to its position causing connection of contacts **61** and **62**.

At this point the timer motor starts to operate again and the heating element again starts to heat the bimetal. When the bimetal is sufficiently heated to snap to its open position timer motor **35** will again be stopped thereby stopping cam **41**, and element **108** will again be de-energized until the element **63** cools enough to reconnect contacts **61** and **62**. This sequence then continues until finally the timer motor drives the cam **41** around far enough so that the dwell is reached; at this point switch **103** opens to de-energize element **108** for the remainder of the washing cycle thereby to insure that bimetal element **63** remains closed and that timer motor **53** operates continuously to the end of the cycle (except as otherwise controlled during fill as explained above).

It will readily be observed that the length of time that the washing step continues is substantially increased with this structure to an extent dependent upon the formation of the cam. Assuming, as stated above, that the cam **41** is so formed as to retain the switch **103** closed for two-thirds of a minute and assuming, for purposes of illustration only, that for element **63**

$$\frac{\text{Time closed}}{\text{Time closed}+\text{Time open}}=\frac{4}{4+15}=\frac{4}{19}$$

then the two-thirds of a minute of timer motor operation that the rise in cam **41** would normally last with continued operation is increased to

$$\frac{2}{3}\left(\frac{19}{4}\right)=\frac{38}{12}=3\tfrac{1}{6}$$

When this is added to the uninterrupted remainder of the wash time, i.e., 2½ minutes minus ⅔ minute, or 1⅚ minutes, a total wash time of $3\frac{1}{6}+1\frac{5}{6}=5$ minutes is obtained. Thus, with a basic washing period of two and a half minutes, it is possible by selecting button **7** to obtain an extended washing period of five minutes.

In the same manner if, for instance, button **9** were selected and switch **102** were closed instead of switch **103**, then cam **40** with its two minute rise would perform the same action during the washing step over a two minute period of timer motor operation as opposed to the two-thirds of a minute rise of cam **41**. Again, assuming the same characteristics for the bimetal element and heater element, that is,

$$\frac{\text{Time closed}}{\text{Time closed}+\text{Time open}}=\frac{4}{19}$$

then the period which would normally pass in two minutes if the timer motor were left to operate uninterruptedly is extended to

$$2\left(\frac{19}{4}\right)=\frac{38}{4}=9\tfrac{1}{2}$$

which when added to the remaining half minute of continued timer motor operation during the washing step gives $9\frac{1}{2}+\frac{1}{2}=10$ minutes.

Also, of course, it will be obvious that when button **8** is depressed and neither cam **40** nor cam **41** is ever effective to control energization of element **108**, the timer motor will operate without interruption during the wash step and will bring it to an end after two and one-half minutes.

After the wash step, with cams **40** and **41** as shown having no further rises, the operation of the timer motor **35** will be continuous to bring the cycle through steps of standard duration to an end. It will, however, be clear that cams **40** and **41** could be provided with appropriate rises during any of the other steps such as the first spin, the rinse, or the second spin, to vary the length of these periods as well as or instead of varying the length of the wash step. It will further be recognized that any number of different wash times may be provided by the addition of more cams, which is a relatively economical step, and that the characteristics of the heating element and of the thermally responsive element may be varied as desired.

It will be observed that by the foregoing construction, operation of any one of the manual means **6—10**, in addition to selecting the previously available variables, also provides a washing time which is tailored to the needs of the particular clothes load. It will further be observed that this is effected by means of relatively simple economically available additions to the previously provided circuit wherein the use of bimetallic elements and heating elements, which are relatively economical to purchase, keeps the additional cost to a minimum.

While in accordince with the patent statutes we have described what at present is considered to be the preferred embodiment of our 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 we therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. In a washing machine having a plurality of different selectable washing sequences including a wash step, a rinse step, and a liquid extraction step: a plurality of electrically controlled components for effecting said steps; first switch means for controlling operation of said components; timer motor means and an energizing first circuit therefor; means controlled by said timer motor means for operating at least a portion of said switch means in a predetermined order to provide wash, rinse and extraction steps of predetermined duration, said first switch means including a switch for extending the duration of the sequential operation and said controlled means including a cam controlling said extending switch, said extending switch being connected in a second circuit in parallel with said first circuit, said cam being formed to maintain said extending switch closed for a predetermined period of motor means operation, normally closed contact means in series with said first and second circuits, thermally responsive means effective to open said contact means upon sensing a predetermined amount of heat and to close said contact means when cool, electric heating means adjacent said thermally responsive means, said heating means being in said second circuit in series with said extending switch, and presettable second switch means in said second circuit in series with said heating means and said extending switch, said second switch means being presettable to selectively close said second circuit, said heating means when energized heating said thermally responsive means to open said contact means so as to open said first and second circuits until said thermally responsive means cools enough for said contact means to close, whereby the duration of the sequential operation provided by said motor is prolonged to an extent dependent upon the duration of the closure of said extending switch as controlled by said cam.

2. The apparatus defined in claim 1 wherein said cam is formed to extend said wash step only.

3. Electric timing motor means for causing a sequential operation in a machine, a first circuit for energizing said motor means, normally closed contact means in series with said first circuit, thermally responsive means effective to open said contact means upon sensing a predetermined amount of heat and to close said contact means when cool, electric heating means adjacent said thermally responsive means, said heating means being in

series with said contact means and in a second circuit in parallel with said first circuit, switch means in said second circuit in series with said heating means, and cam means driven by said motor means and controlling closing of said switch means, said cam means being formed to maintain said switch means closed for a predetermined period of motor means operation, said heating means when energized heating said thermally responsive means to open said contact means so as to open said first and second circuits until said thermally responsive means cools enough for said contact means to close, whereby the length of time of the sequential operation provided by said motor means is prolonged to an extent dependent upon the duration of closure of said switch means.

4. Electric timing motor means for causing a sequential operation in a machine, a first circuit for energizing said motor means, normally closed contact means in series with said first circuit, thermally responsive means effective to open said contact means upon sensing a predetermined amount of heat and to close said contact means when cool, electric heating means adjacent said thermally responsive means, said heating means being in series with said contact means and in a second circuit in parallel with said first circuit, first switch means in said second circuit in series with said heating means, cam means driven by said motor means and controlling closing of said first switch means, said cam means being formed to maintain said first switch means closed for a predetermined period of motor means operation, and second presettable switch means in said second circuit in series with said heating means and said first switch means,

said second switch means being presettable to selectively close said second circuit, said heating means when energized heating said thermally responsive means to open said contact means so as to open said first and second circuits until said thermally responsive means cools enough for said contact means to close, whereby the length of time of the sequential operation provided by said motor means is prolonged to an extent dependent upon the duration of closure of said first switch means.

5. The apparatus defined in claim 4 wherein said thermally responsive means is formed of a bimetallic element connected in series with said contact means.

6. The apparatus defined in claim 4 wherein said cam means includes at least two cams and said first switch means includes at least two switches connected in parallel and controlled by said cams respectively, each of said cams being formed to maintain its associated switch closed for a different predetermined period of motor means operation, said second switch means being operable to close said second circuit through any selected one of said switches of said first switch means whereby the extension of the length of time of the sequential operation is variable depending upon the selection of one of the switches of said first switch means.

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