Jan. 8, 1963 J. D. SEAL 3,072,129

DISHWASHING APPARATUS

Filed Dec. 26, 1961

FIG. 1

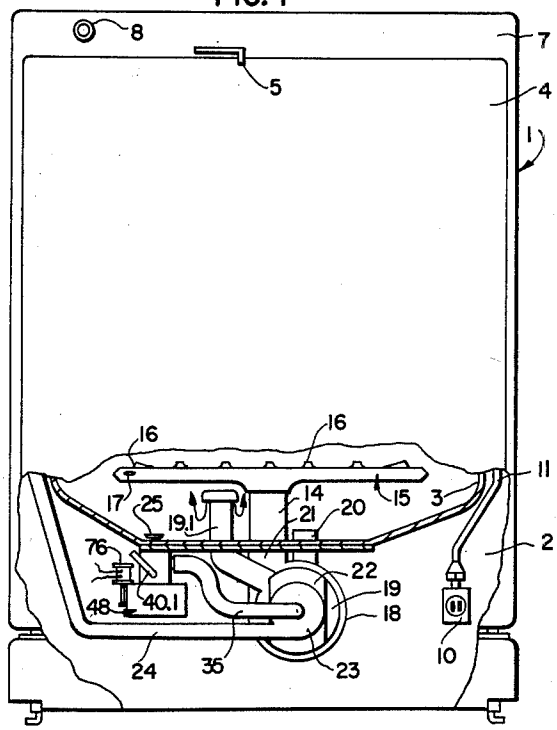


FIG. 3

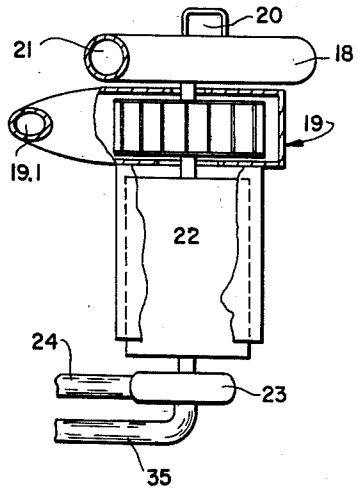
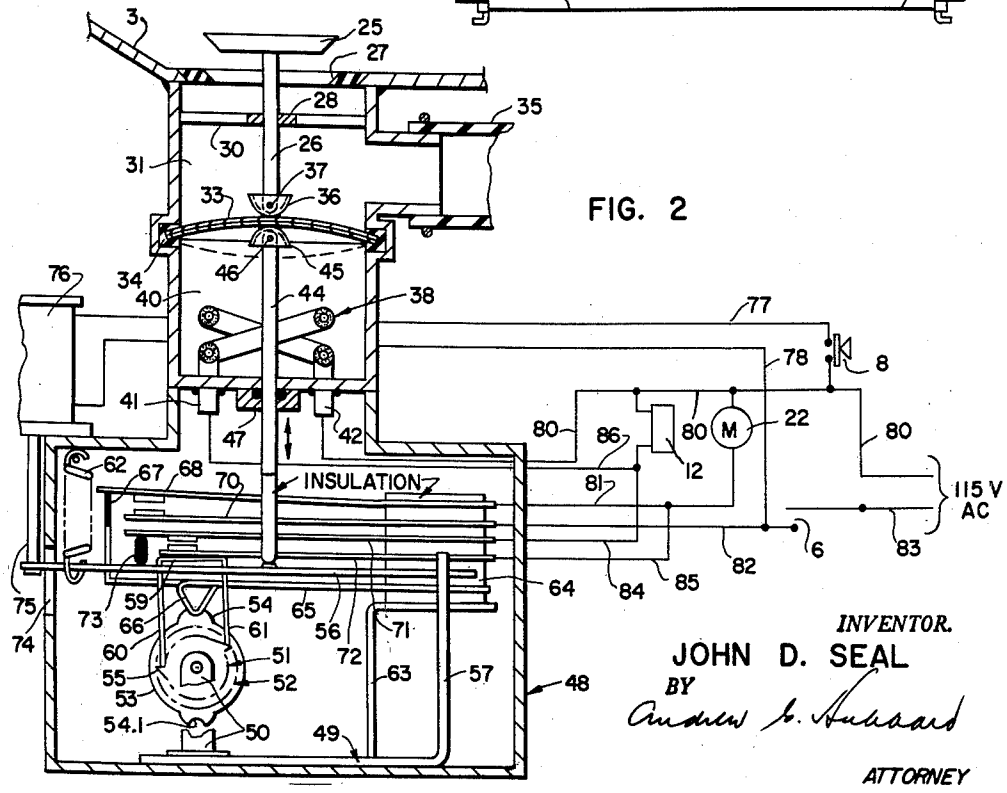


FIG. 2



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DISHWASHING APPARATUS

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This invention relates to dishwashing apparatus of the type in which the articles to be washed are automatically subjected to a plurality of washing and rinsing operations; and in particular, to dishwashing apparatus in which a heat motor mechanism is used to cycle a drain valve and the total number of washing and rinsing operations is established by a stepping switch operatively associated with the heat motor.

An object of the present invention is to control the washing and rinsing operations of a dishwasher by means of a heat motor and stepping switch in lieu of the conventional time clock operated switching mechanism.

In presently known automatic dishwashers for domestic service, it is customary to use an electric motor which powers a wash water circulation pump and a waste water discharge pump. In such dishwashers it is the practice to eliminate drainage valves by utilizing a discharge pump which is direction sensitive. Such a pump has little or no pumping effect when it is rotated in the direction of rotation of the wash water circulation pump, but is an efficient pumping mechanism when it is driven in the opposite direction. Therefore, since it is necessary in such dishwashers to stop and then reverse the direction of operation of the main drive motor, it is the practice to use a motor of the split-phase induction type, for such motors are easily reversible and have the high starting torque which is necessary for the starting loads to which it is subjected. It is well known that such motors are relatively expensive, and the cost of the motor is not compatible with the ever-growing pressure to reduce manufacturing costs.

In carrying out the objectives of the present invention I am able to reduce manufacturing costs by utilizing a mechanism which is less expensive than the conventional time-cycle mechanism, and by using a low cost shaded pole motor. To allow for the low starting torque of such a motor, I start the motor under substantially no-load, and continue it in operation without interruption, throughout the full sequence of washing and rinsing functions of the dishwasher. I utilize a simple drain valve mechanism in association with a stepping switch which is operated through a predetermined number of steps—each step representing a drain valve operation—and then interrupts the motor circuit to signify the end of the final rinsing operation. I operate the drain valve and time its operation by means of a heat motor which may, for example, comprise a bimetal disc adapted to flex from one position to another when being heated or cooled. It is a simple matter to arrange this heat motor to be electrically heated continuously throughout the total washing and rinsing time; by means of a heat sink I can quite accurately time the duration of the closed valve condition, and by placing the heat motor at a location in which the waste water discharge from the tub serves as a cooling medium, I can quickly chill the heat motor to the extent necessary for it to flex to return the valve to closed position. It has been established, for example, that within quite acceptable commercial tolerances the valve can be closed for five minutes and opened for one minute merely by the rate of heat absorption and dissipation to which the heat motor is subjected. The discharge valve is of the disc type, and I use the axial movement of the valve stem to operate a stepping switch, which after tolling a predetermined number of valve operations, terminates the operation of the dishwasher.

Other features and advantages will be understood from the following detailed description of a presently preferred embodiment of the invention, read in connection with the accompanying drawings in which:

FIG. 1 is a front elevation of a dishwasher embodying the invention, with the lower portion in section to indicate the arrangement of the operating mechanism;

FIG. 2 is a sectional elevation of the valve and stepping switch organization of FIG. 1, additionally schematically showing the control circuit; and

FIG. 3 is a somewhat schematic view of the pumping mechanism.

Referring to FIG. 1, a dishwasher **1** comprises a cabinet **2** within which is secured a tub **3** to accommodate dishes and other articles to be washed. It will be understood that the cabinet and the tub are conventional in that the tub has an open front, affording access for loading the dishes on racks (not shown) supported therein, and the cabinet has a door **4** hinged at its bottom (not shown) whereby the door may be swung between its illustrated closed position and a horizontal open position. Said door is arranged to be latched closed by the latch **5** which may embody an electric switch **6** (FIG. 2). This latch and switch combination may be of the type disclosed in U.S. Patent 3,005,065, which issued to D. A. Jellies on October 17, 1961, and is assigned to my assignee herein. In such a latch the switch is closed when the latch is made home and opened when the latch is operated to free the door for opening. An upper panel **7** in the cabinet may accommodate a momentary contact pushbutton switch **8** to initiate operation of the dishwasher as later described.

A solenoid operated valve **10** is arranged for connection to the hot water supply piping (not shown) of the building and its discharge tube **11** terminates in a fitting (not shown) through which water is passed into the tub. This arrangement is in all respects conventional. In the wiring diagram portion of FIG. 2, the valve solenoid is identified by reference character **12**.

The dishwashing and rinsing mechanism may be as shown in application Serial No. 145,224, in which I am an applicant jointly with D. A. Jellies, said application being assigned to my assignee herein. In brief, a standpipe **14** serves as a supply pipe for the water distribution rotor **15** which is rotatably mounted thereon; said rotor has any appropriate number of discharge orifices **16** and side-discharge reaction orifices **17**. As is well known in the art, when water under pressure is supplied to the rotor **15**, the reaction forces of water issuing from the orifices **17** cause the rotor to spin quite rapidly, and thus the sprays or jets issuing from the orifices **16** have wide coverage. These latter orifices are arranged to discharge against the dishes and other ware (not shown) within the tub.

The water is recirculated within the tub, and I provide a conventional centrifugal pump **18** which receives water through a preferably screened inlet fitting **20** in the bottom of the tub and discharges it through the outlet conduit **21** connected directly to the standpipe **14**. Fitting **20** extends above the bottom of the tub so that during the operation of the washer there is a volume of water in the bottom. The pump **18** is directly mounted on the shaft of the motor **22**. This motor may be of the shaded pole type as previously noted. Such motors generate substantial heat during operation and are air-cooled by means of a fan **19** on the motor shaft, said fan discharging heated air into the tub **3** through a conduit **19.1**. To evacuate spent washing and rinsing liquid I provide a centrifugal pump **23** also mounted on the shaft of the motor **22**. A discharge conduit **24** extends to a point of discharge into a plumbing waste line (not shown) as is well understood.

In view of the fact that the wash water circulation pump 18 and the waste water discharge pump 23 are powered by the same motor, and are thus operating concurrently, means must be provided to time the discharge of water from the tub into the pump 23, and attention is now directed to FIG. 2 which illustrates a valving system embodying a preferred form of the present invention.

The valve is of the disc type, comprising a disc 25 mounted on a stem 26 for axial movement relative to any suitable valve seat 27 defining a drainage opening at the bottom of the tub 3. The valve stem is guided for movement by way of the hub 28 of a spider 30 fixed within the cylindrical portion of a drainage fitting 31. Appropriately mounted within a shoulder extending about the said cylindrical portion of the fitting 31 is a heat motor 33, which in the illustrated embodiment is a bimetal disc having its rim seated within a sealing ring 34 of neoprene or other elastomer resistant to attack or deterioration in contact with glycerine. The heat motor forms the bottom wall of said drainage fitting, from which a conduit 35 communicates with the inlet of pump 23. The laminations of the heat motor will be arranged to assume a shape the inverse of that illustrated in FIG. 2, when the bimetal is cool. In other words, when the bimetal is cool, it will flex to establish the valve in closed position. Preferably, the valve seats before the disc is fully in its cool position, whereupon there is an inherent spring bias tending to hold the vave closed.

The heat motor is operatively associated with the valve stem by any suitable means; for example, the stem may seat within a cup 36 fixed to the bimetal, being secured thereto by a pin 37 extending through the cup and stem. When the heat motor moves from a concave position to that illustrated in FIG. 2, the pin 37 will lift the valve stem; when it returns, the pin 37 will seat the valve. It will be understood that the heat motor operates in either direction with a snap action; heat motors of this type are readily available commercially and may be obtained to respond to temperature conditions within the requirements of the present duty.

Heat energy for the heat motor may be supplied by means of a resistance heating element 38 disposed in a chamber 40 comprising a lower portion of the drainage fitting 31. Heating element 38 is advantageously of the familiar metal-sheathed resistance type such as disclosed in Oakley U.S. Patent 2,546,315, granted March 27, 1951, for "Electric Heater." Such heating elements have a tubular sheath of corrosion-resistant steel or equivalent within which is a resistance element embedded in a highly compacted mass of a heat conducting, electrically insulating material such as magnesium oxide. In the schematic showing of FIG. 2, the terminal portions 41, 42, of the heater extend through the bottom wall of the compartment 40 and are welded or otherwise permanently secured thereto in fluid-tight relation.

The chamber 40 is sized to contain about 4 ounces of a heat transfer material which will conduct heat from the heating element 38 to the bimetal disc 33. Preferably, the heat transfer material has a boiling point considerably above the boiling point of water, is somewhat heavier than water, and has a relatively low specific heat. A suitable material, therefore, is glycerine, which boils at 290° C., has a specific heat of .6, and a density of 1.26.

For reasons later appearing, I wish to have the heat motor operate from concave to convex position—that is, from valve closing to valve opening position—in about five minutes, and wish to have the disc go from concave to convex at 240° F., and return to concave at about 140° F. Assuming that prior to the operation of the dishwater it has been standing in a normally heated room, it can be postulated that the glycerine will be at a temperature of 70° F. For the first operation of the valve from closed to open position, therefore, it will be necessary to increase the glycerine temperature from 70° to 240° F. During the dishwasher operation, however, the glycerine will be at about 140° F., and this temperature will be used to calculate the necessary heat capacity of heater 38. To raise 4 ounces of glycerine 100° F., assuming the specific heat of glycerine to be .6, requires $.25 \times 100 \times .6$, or 15 B.t.u. To accomplish this heating effort over a five minute period indicates the introduction of 3 B.t.u. per minute. Heat losses from the chamber 40 and other heat losses may be as much as fifty percent, indicating that the thermal output of the element 41 should be of the order of 4.5 B.t.u. per minute. At the commencement of operation of the dishwasher, when the glycerine is at a temperature which may be at least as low as 70° F., a heat output of 4.5 B.t.u. per minute will necessarily require a longer period before the valve will open. The advantage of this initially longer period will later be evident.

To maintain the chamber 40 in flooded condition with the glycerine in contact with the heat motor 33, I provide a short riser 40.1 (FIG. 1) extending to any appropriate height. The riser may be equipped with any suitable capping device (not shown) to maintain the glycerine under atmospheric pressure so as to provide for free rise and fall as the heat motor inverts its operating position.

The heat motor is operatively associated with a stepping switch by means of which the total of washing and rinsing operations is established. This association is by way of a rod 44 fixed to the motor 33 by the cup 45 and pin 46. The rod extends through a suitable gland 47 in the base of chamber 40. The switch is in a housing 48 affixed beneath the chamber 40 and comprises a ratcheting device and a bank of leaf-spring switches to be operated thereby. For example, a bracket structure 49 has suitable upstanding bearing elements 50 supporting a ratchet 51 and an integral cam 52, said ratchet and cam being formed of nylon or other electrical insulation material. The cam 52 has a cylindrical body portion 53 and two diametrically opposite lobes 54, 54.1; the ratchet 51 has a plurality of ratchet teeth 55 sufficient to rotate the cam through 180° in a number of steps corresponding to the desired total of washing and rinsing operations.

The ratchet is operated in step-by-step fashion by an escapement mechanism which includes an escapement lever 56 pivotally attached to an upright fulcrum member 57 of the bracket 49, said lever mounting an escapement device 59, having the legs 60, 61 straddling the ratchet 51 for engagement with the oppositely disposed teeth, as shown. The escapement device is mounted on the lever 56 in a manner which permits it to oscillate, and a leaf spring or the like (not shown) between the lever and the escapement device biases the device into counterclockwise rotation. Thus, when lever 56 is rotated upwardly as viewed in FIG. 2 (as by the spring 62) escapement leg 60 will snap over the ratchet tooth (not shown) immediately above the one shown; and on the downward rotation of the lever 56 the escapement leg 60 will rotate the ratchet a distance of one tooth. The leg 61 interrupts the rotation by engagement with one of the teeth on the opposite portion of the ratchet. These ratcheting arrangements are well known and widely used. The downward drive of the lever 56 takes place when the rod 44 is driven downwardly by the heat motor, for it will be noted that the rounded tip of rod 44 bears against the lever 56. Therefore, the size of the ratchet 51 as respects the angular spacing of its teeth must be related to the movement of the valve stem.

There are two sets of switches in the switch stack. One set is operated to open position by the cam lobe 54 or 54.1, but otherwise remains closed, and the other opens at each rise of the lever 56 and closes with each fall of the lever.

On a support 63 disposed rearwardly of support 57 as viewed in FIG. 2, a block 64 of insulation material supports a cam follower leaf spring 65 having a nose 66 and an upstanding end terminating in an insulating finger 67. Said finger cooperates with an extension of an upper leaf spring contact 68 mounted in block 64; a lower leaf

spring contact 70 is arranged for cooperation with contact 68 to form the first of the switch pairs. As illustrated, the engagement of the nose 66 with either of the lobes 54 or 54.1 lifts the spring contact 68 to open circuit position. When the nose rides on the cylindrical body portion 53 of the cam the inherent bias of leaf spring contact 68 brings it into circuit closing relationship with contact 70.

An upper leaf spring contact 71 and a lower leaf spring contact 72 comprise the second switch pair. An insulated finger 73 extends upwardly from lever 56, whereupon when the lever is raised, as in FIG. 2, upper contact 71 opens relative to contact 72.

In completion of the mechanical description of the stepping switch, it will be noted that an extension of lever 56 projects through a slot 74 in housing 48 and at its outer end is attached to an extremity 75 of the armature of a solenoid 76. Said solenoid is arranged to be energized by actuation of momentary contact push-button switch 8 on the cabinet panel 7; and as indicated in the schematic wiring diagram portion of FIG. 2, power can be applied to solenoid 76 only after the door latch 5 is made home and its switch 6 is closed thereby.

It will be assumed that the dishwasher has been prepared for operation and the door 4 is closed. In this circumstance the heat motor 33 will be "cold" and in its "down" position, thus closing the drain valve. The user starts the dishwasher by momentarily closing switch 8 which energizes the solenoid 76 through the conductors 77 and 78 drawing in its armature to lift the lever 56. This, of course, snaps the heat motor upwardly and cocks the escapement mechanism for rotation of the ratchet. When the pushbutton switch is released to deenergize the solenoid 76, the heat motor snaps back to its "cold" position, driving the lever 56 down against the return bias of spring 62. This completes the escapement operation and rotates the ratchet 51 and cam 52 one step. This brings the cam follower to the body portion 53 of the cam, closing switch contacts 68 and 70. Because lever 56 is in its "down" position switch contacts 71 and 72 are closed. A circuit is then completed through line conductor 80, motor 22, conductor 81, closed contacts 68, 70, and conductor 82, closed switch 6, to line conductor 83. The motor 22 starts under "no-load" conditions. The valve solenoid 12 is energizes through conductor 80, conductor 84, closed contacts 71 and 72, conductors 85 and 81, and closed contacts 68, 70, to conductors 82 and 83. The heating element 38 is energized through conductors 80 and 86, conductor 84, closed contacts 71 and 72, conductors 85 and 81, closed contacts 68 and 70, and conductors 82 and 83. Therefore, the heater element is energized in parallel with the valve solenoid.

Water is now flowing into the dishwasher tub. After it accumulates to the top of the inlet fitting 20 it will enter the pump 18, which at that time is being driven at substantially operational speed by the motor 22. It will be obvious that at this time the motor is subjected only to the load imposed by the impellers of the fan 19 and pumps 18 and 23, and neither of these impellers is actually performing a pumping operation. The motor therefore starts under substantially "no-load" conditions. Water flowing into the pump 18 will be discharged into the rotor 15 from which it issues through the ports 16 to impinge on the dishes and the like within the tub. Water continues to flow into the tub and is recirculated during the entire washing operation. During this operation the heating element 38 is transferring heat to the heat motor 33. Because of the heat sink effect of the glycerine, as well as the capacity of the inlet fitting to absorb heat, a substantial time elapses before the heat energy transferred to the motor 33 is effective to cause it to snap to open position. When the dishwasher is cold, this time may be of the order of six to seven minutes; when the dishwasher is in operation, the time lag may be of the order of five minutes. The six to seven minute delay in the first operation is advantageous because usually water is cool as it first flows from the pipes into the dishwasher, and the cool dishes may further reduce the water temperature. The longer washing action compensates for the somewhat low water temperature.

The spring 62 draws the actuating lever 56 upwardly as the valve stem moves to its open-valve position, whereby the rod 44 cocks the ratchet for the next step. As lever 56 rises, the insulating finger 73 separates contacts 71 and 72 to deenergize the valve solenoid 12, interrupting water flow into the tub 3, and deenergizing the heater 38. This is without effect on the power supply to the motor 22, which maintains its operation by way of the closed switch springs 68, 70.

The total water inlet to the dishwasher during a washing or rinsing operation is from 12 to 14 pints. This amount of fill is established by the use of a flow-control device (not shown) in the valve 10, as well known in the art. When the valve opens, water from the dishwasher tub floods through the fitting 31 in heat transfer relation with the heat motor 33. The discharging water is at a temperature of about 140° Fahrenheit in the average domestic dishwasher, and after an interval which is sufficient to evacuate the wash water from the tub, the heat motor and the glycerine will have lost sufficient heat energy for the heat motor to restore to valve closing position. In so doing, of course, the valve stem and rod 44 are driven downwardly, completing the stepping of the ratchet. The reclosing of leaf contacts 71 and 72 reopens the inlet valve to admit water for the next washing operation, and heater 38 is reactivated. After about 5 minutes, the next valve opening occurs.

This action is repeated for the number of times necessary to accomplish the desired number of washing and rinsing operations. In the usual dishwasher cycle two washes and two rinses are considered adequate. Therefore, the fourth cycling of the heat motor will actuate the valve 25 to its closed position while ratcheting the cam 52 to cause the cam follower portion of the lever 56 to rise on the lobe 54.1. breaking the motor and solenoid valve circuit and the heating element circuit at the switch springs 68, 70.

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

I claim as my invention:

1. Dishwashing apparatus, comprising:
a tub to receive articles to be washed;
a valve for introducing water into said tub;
means for operating said valve between closed and open positions;
a pump for circulating the water content of said tub among the articles to wash the same;
a motor for operating said pump;
a circuit including switch means for energizing said motor;
a discharge conduit for evacuating water from said tub;
a valve in said discharge conduit;
motor means for operating said discharge valve between closed and open positions;
means responsive to a first opening and closing of said discharge valve to operate said first valve to open position and to close said pump motor switch means;
means for actuating said valve operating means to operate said discharge valve through a sequence of closed and open positions while maintaining said pump motor in operation;
means correlating said first and second valves to operate said first valve to closed position on opening said second valve and to open position on closing said second valve;

means for tolling the number of times said valve is operated to closed position; and

means responsive to a predetermined number of discharge valve operations to open said pump motor switch means and to close said first and second named valves.

2. Dishwashing apparatus, comprising:

a tub to receive articles to be washed;

a valve for introducing water into said tub;

electromotor means for operating said valve between closed and open positions;

a pump for circulating the water content of said tub among the articles to wash the same;

a motor for operating said pump;

a circuit including switch means for energizing said motor;

a discharge conduit for evacuating water from said tub;

a valve in said discharge conduit;

motor means for operating said discharge valve between closed and open positions;

means responsive to a first opening and closing of said discharge valve to operate said first valve to open position and to close said pump motor switch means;

means for actuating said valve operating means to operate said discharge valve through a sequence of closed and open positions while maintaining said pump motor in operation;

means for tolling the number of times said valve is operated to closed position; and

means responsive to a predetermined number of discharge valve operations to open said pump motor circuit switch to deenergize said first named valve to close the same.

3. Dishwashing apparatus, comprising:

a tub to receive articles to be washed,

a valve for introducing water into said tub;

means for operating said valve between closed and open positions;

a pump for circulating the water content of said tub among the articles to wash the same;

a motor for operating said pump;

a discharge conduit for evacuating water from said tub;

a valve in said discharge conduit;

thermally responsive means for operating said discharge valve between closed and open positions;

a heating element in heat exchange relation to said discharge valve operating means;

means for conjointly energizing said motor and said heating element;

means for operating said discharge valve through a sequence of closed and open positions while maintaining said pump motor in operation;

means for tolling the number of times said discharge valve is operated between open and closed position;

means for closing said first named valve each time said discharge valve is opened; and

means for opening said pump motor circuit switch and for deenergizing said heating element after a predetermined number of operations of said discharge valve.

4. Dishwashing apparatus, comprising:

a tub to receive articles to be washed;

means for introducing water into said tub;

a first pump for circulating the water content of said tub among the articles to wash the same;

a second pump for evacuating water from said tub;

a motor for conjointly operating said first and second pumps;

a chamber comprising an outflow passage communicating between said tub and said second pump;

valve means disposed at the inlet of said chamber to control flow of water thereinto;

means in said chamber effective at a predetermined elevated temperature to open said valve means for flow of water from said tub into and through said chamber to said second pump and effective at a predetermined lower temperature to close said valve means;

a heating element in said chamber;

means for energizing said element;

means providing a heat sink interposed between said heating element and said valve actuating means to delay the increase in temperature thereof to valve opening level;

said valve actuating means being in the path of water flow through said chamber to give up heat to said water during flow thereof to said second pump whereby the temperature of said valve actuating means is reduced to valve closing temperature; and

means effective upon an operation of said valve to closed position to terminate the operation of said motor.

5. Dishwashing apparatus, comprising:

a tub to receive articles to be washed;

means for introducing water into said tub;

a pump for circulating the water content of said tub among the articles to wash the same;

means for evacuating water from said tub;

a motor for operating said pump;

an energizing circuit for said motor;

a chamber comprising an outflow passage communicating between said tub and said water evacuation means;

valve means disposed at the inlet of said chamber to control flow of water thereinto;

a heat motor effective at a first heat energy condition to open said valve means for flow of water into and through said chamber to said evacuation means and effective at a second heat energy condition to close said valve means;

means to supply heat energy to said motor;

means providing a heat sink interposed between said heat energy supply and said heat motor to delay the attainment of said first heat energy condition;

said heat motor being arranged to give up heat to the water flowing to said water evacuation means whereby to establish the heat energy in said motor at the second condition; and

switch means responsive to movement of said valve to closed position to open said pump motor circuit and deenergize said heat energy source.

6. Dishwashing apparatus, comprising:

a tub to receive articles to be washed;

means for introducing water into said tub;

a first pump for circulating the water content of said tub among the articles to wash the same;

a second pump for evacuating water from said tub;

a motor for conjointly operating said first and second pumps;

a chamber comprising an outflow passage communicating between said tub and said second pump;

valve means disposed at the inlet of said chamber to control flow of water from said tub thereinto;

a heat motor in said chamber, said motor being effective at a first level of heat energy to open said valve means for flow of water into and through said chamber to said second pump and effective at a substantially lower second level of heat energy to close said valve means;

a source of heat energy;

means for energizing said energy source; and

means comprising a heat transfer fluid in heat exchange relation with said energy source and said heat motor to provide a heat sink to delay the increase in heat energy therein to said first level,

said heat transfer fluid heat motor being arranged to give up heat to the water flowing through said chamber whereby the heat energy in said heat motor is reduced to said second level to close said valve.

7. Dishwashing apparatus, comprising:

a tub to receive articles to be washed;

means for introducing water into said tub;
means for circulating water among the articles in said tub for washing the same;
a drainage conduit for draining water from said tub;
a valve at the entrance of said conduit;
valve actuator means including a heat motor and a shaft movable by said heat motor under one condition thereof to operate said valve to open condition and movable by said heat motor under a second condition thereof to operate said valve to closed condition;
heat transfer means operatively associated with said heat motor to establish the respective first and second conditions thereof;
means for cycling said valve between closed and open positions; and
means responsive to a predetermined number of operations of said valve to closed position to terminate the operation of said heat motor to maintain the valve in closed position.

8. Dishwashing apparatus, comprising:
a tub to receive articles to be washed;
means for introducing water into said tub;
means for circulating water among the articles in said tub for washing the same;
a drainage conduit for draining water from said tub;
a valve at the entrance of said conduit;
valve actuator means including a heat motor having a shaft movable by said heat motor under one condition thereof to operate said valve to open condition and movable by said heat motor under a second condition thereof to operate said valve to closed condition;
electric resistance means in heat transfer relation with said heat motor to establish the said first condition thereof;
means for transferring heat from said heat motor to the water draining from said tub to establish said second condition thereof;
a switch for controlling electric energy to said electric resistance means; and
a stepping mechanism actuated by said heat motor shaft to open said switch after a predetermined number of movements of said shaft.

9. Dishwashing apparatus according to claim 8, in

which said heat motor comprises a bimetallic disc self-biased to return said valve to closed position when cooled by the water passing through said conduit.

10. Dishwashing apparatus, comprising:
a tub to receive articles to be washed;
an inlet valve for introducing water into said tub;
electromotor means for operating said valve from a normally closed position to an open position;
a pump for circulating water among the articles in said pump for washing the same;
a motor for operating said pump;
a drainage conduit for draining water from said tub;
a drain valve at the entrance to said conduit;
drain valve actuator means including a heat motor and a shaft movable by said heat motor under a first heat energy condition to operate said valve to open condition and movable by said heat motor under a second heat energy condition to operate said valve to closed condition;
electric resistance means in heat transfer relation with said heat motor to produce said first heat energy condition therein;
means for effecting heat transfer from said heat motor to water in said drainage conduit to produce said second heat energy condition in said heat motor;
an electric energy circuit for conjointly energizing said inlet valve, said pump motor, and said resistance means;
switch means in said energy circuit;
means for initially closing said switch means;
a cam for operating said switch means to open position;
a ratcheting device responsive to each operation of said heat motor shaft to advance said cam toward switch-opening position, whereby after a predetermined number of said operations the energy circuit is opened to terminate operation of the components deriving energy therefrom.

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