This invention relates to the dispensing of liquids by the controlled application of a pumping pressure thereto at predetermined times in an operating cycle. The invention is of particular application in the dispensing of liquid additives into automatic clothes washing machines.

In recent years the automatic clothes washing machine has been continually improved with the object of enabling the housewife to control the entire washing operation at the beginning of the cycle so as to permit her to leave the machine unattended after its initial setting. However, the character of many fabrics is such that certain additives, such as bleach and rinse additives, must be added into the machine tub at preselected times after initiation of the cycle.

Therefore there is need for an additive dispenser arrangement which can be set by the housewife at the beginning of the cycle, and which will automatically discharge metered quantities of the additives to the wash load at various preselected times thereafter.

Accordingly, it is an object of the present invention to provide a dispensing arrangement and control mechanism wherein different preselected quantities of a plurality of different materials can be automatically dispensed at predetermined time periods after setting of the control mechanism.

A further object of the invention is to provide a dispensing mechanism which can be economically incorporated into conventional clothes washing machines for dispensing relatively viscous liquid additives in accurately regulated quantities.

A further object of the invention is to provide a liquid dispensing mechanism wherein the quantity of liquid to be dispensed can be selected at one time and the actual dispensing operation carried out at a later time, thereby adapting the device to use in domestic clothes washing machines of the type wherein the housewife sets the machine in operation and the machine is left unattended throughout the washing-rinsing cycle.

An additional object of the invention is to provide a dispenser which dispenses various different accurately regulated quantities.

Another object of the invention is to provide a dispensing arrangement wherein a plurality of liquids may be dispensed in independently selected quantities, i.e., the quantity of each liquid being variable without affecting the quantity of another material dispensed.

A further object is to provide a dispensing arrangement which can be manufactured at relatively low cost and in a relatively small size.

An additional object is to provide a dispensing arrangement wherein the components thereof may be disposed in any of several different locations, thereby adapting the arrangement to use in any of several different conventional clothes washing machines without substantial redesign of the machine or relocation of existing mechanisms.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

FIGURE 1 is an exploded view showing one embodiment of the invention;
FIG. 2 is a top plan view of the FIG. 1 embodiment;
FIG. 3 is a view taken on line 3—3 in FIG. 2;
FIG. 4 is a sectional view taken on line 4—4 in FIG. 2;
FIG. 5 is a sectional view taken on line 5—5 in FIG. 1;
FIG. 6 is a sectional view of a pumping mechanism utilized in the FIG. 1 embodiment;
FIG. 7 is a sectional view taken through a liquid reservoir structure utilized in the FIG. 1 embodiment;
FIG. 8 is a diagrammatic view illustrating a second embodiment of the invention; and
FIG. 9 is a view taken of a zero reset mechanism which can be employed with the FIG. 1 or FIG. 8 embodiments.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phrasing or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings, and particularly FIGS. 1 and 2, there is disclosed a dispensing arrangement including a reservoir 10 for a liquid such as liquid detergent and a reservoir 12 for another liquid such as liquid rinse additive. As shown in FIG. 2, each of these reservoirs is provided with a discharge spout 16 for discharging the reservoir contents into the conventional washing machine tub 14.

In order to apply a pumping pressure to the liquid in the reservoirs 10 and 12, there is employed a pump structure generally designated by numeral 18, said pump structure being connected to the reservoirs 10 and 12 by means of the conduit 20, selector valve 22, and the branch conduits 24 and 26. Pump structure 18 is provided with an electric heater means 28 therein, the arrangement being such that when the heater means is energized the diaphragm 30 within the pump is forced upwardly by thermal expansion of the air therebelow so as to force air through the conduit 20 and into one or the other of conduits 24 and 26 as to develop a pumping pressure on the liquid in reservoir 12 or 10, thereby effecting a desired volumetric displacement of liquid therefrom.

Valve structure 22 contains a shiftable flow-control element therein which serves to direct the air pressure from conduit 20 into one or the other of conduits 24 and 26, and valve structure 22 therefore serves as a control device for determining which of the two liquid reservoirs 10 or 12 will be caused to be operated by the pump structure 18 during each particular heater energization. The purpose of this arrangement is to reduce costs by letting one pump serve for both dispensers.

The illustrated embodiment is particularly designed to be utilized in domestic clothes washing machines, and it has been previously pointed out that in operation of such machines it is desirable that at least some of the liquid additives be discharged into the washing machine tub at a predetermined time after initiation of the wash-rinse cycle by the housewife. In the illustrated embodiment the time delay between each successive dispensing operation is automatically determined by means of timer structure operating in conjunction with the electrical supply means for heater 28. Briefly the arrangement is such that the housewife can select the desired quantities of wash and rinse additives at the time she initiates the cycle; heater 28 is prevented from immediately being energized. However the timer structure goes into operation at initiation of the cycle so that at appropriate times in the cycle the heater 28 is energized to pump the correct additive into the machine.
In the illustrated embodiment the means for controlling the energization of heater 28 comprises a motor 32 having a conventional speed reducer means 34 connected therewith for driving the shaft 36 at reduced speed (as for example one-half r.p.m.). Shaft 36 is affixed to a drum 38 which carries the electrical contactor 40 on its output end. During each complete revolution of the drum 38 the contactor 40 traverses six separate contacts, numbered 42 through 47 in FIG. 4. In the illustrated embodiment these contacts are formed as part of a printed circuit on the fixed terminal board 48, the arrangement being such that as the drum 38 rotates, a circuit is completed across the heater structure 28 a number of times, the number of such circuit-completions being determined by the adjusted positions of the manually actuable control knobs 50 and 52. Control knob 50 serves as a device for selecting the volume of liquid detergent dispensed from reservoir 10, and control knob 52 serves as a device for selecting the quantity of rinse additive dispensed from reservoir 12.

Knob 50 carries a contact bridging element 54, and knob element 52 carries a bridging element 56, the arrangement being such that each knob can be rotated independently to have its bridging element extended across selected ones of the fixed contacts 57 through 62 (see FIG. 3). These last-mentioned contacts are formed as a part of the aforementioned printed circuit on terminal board 48 and are connected with individual ones of the previously mentioned contacts 42 through 47 by means of the various conductor strips 63.

From the above discussion it will be seen that if both knobs 50 and 52 are adjusted to have their bridging elements 54 and 56 located in the FIG. 3 positions, then in that event all of the contacts 42 through 47 will be in circuit between the two supply lines 70 and 76 and the heater line 71. However, if, for example, knob 50 is rotated to have its bridging element 54 extended only across three of its contacts, as for example contacts 42 through 47, then in that event only five of the contacts 42 through 47 will be in circuit, i.e., the circuit through contact 45 will be interrupted. Similarly, either of the bridging elements 54 or 56 may be manually adjusted to have any or all of their contacts 57 through 62 bridged or to place selected ones of the contacts 42 through 47 in circuit. As previously mentioned, contacts 42 through 47 are in the circuit to the heater 28, so that during rotation of drum 38 the heater 28 will be energized according to the number of contacts 42 through 47 which are in circuit.

The drive motor 32 preferably causes approximately one complete revolution of the drum 38 in a comparatively short time period, as for example two minutes. During this time period heater 28 will be energized one or more times, the number depending in part on the adjusted positions of bridging elements 54 and 56. During each energization of heater 28 the air in the heater chamber is thermally expanded at a very rapid rate so that the diaphragm 30 is moved upwardly rapidly so as to pump air in line 20 and thence into either one of the branch conduits 24 or 26 for developing a pumping pressure on the liquids in either reservoir 10 or 12. The capacity of heater 28 and the size of the chamber above diaphragm 30 are such that each energization of the heater 28 is effective to pump a predetermined volume or metered charge of liquid from a respective one of the reservoirs 10 or 12 into the washing machine tub 14. The volume of each charge is determined by the sizes of the various components, including the size of the chamber above diaphragm 30 and the size of the liquid reservoir, but an illustrative charge is 0.5 fluid ounce, which enables the dispenser to have a total potential of six fluid ounces for both liquids (in the illustrated embodiment). It will be seen that detergent dispenser knob 50 controls four of the contacts 42 through 45, while rinse additive knob 52 controls the remaining two contacts 46 and 47; consequently, the illustrated system is adapted to automatically dispense a potential of four ounces of detergent and two ounces of rinse additive in exact quantities dispensed in a particular wash-rinse cycle being determined by the positions of the independently actuable knobs 50 and 52.

It has been previously pointed out that some additives, as for example the rinse additives, should be dispensed at a time of wash or rinse independent of the time of drum 38, e.g., just prior to the introduction of the rinse water into the tub. Accordingly, in the illustrated embodiment the current supply is not fed to the rinse additive bridging element 56 until some time after initiation of the wash-rinse cycle. The time of feeding is controlled by a conventional timer-driven cam 64 which has the lobe 72 thereon for closing switch 74 to furnish current to the bridging element at a predetermined time after initiation of the wash-rinse cycle. Similarly, current to the detergent bridging element 54 is controlled by the conventional timer cam 66 so that the detergent is dispensed (over a possible time element of two minutes or thereabouts) at a predetermined time after initiation of the wash-rinse cycle. It will be understood that timer cams 64 and 66 are driven at substantially slower speeds than the drum 38 so that potential current is available to each bridging element 54 or 56 for the entire traverse of drum 38.

In the illustrated embodiment timer cams 64 and 65 are carried on the same shaft as timer cams 234 and 237 which control operation of motor 32. The general arrangement is such that when the housewife initiates the wash-rinse cycle the cams are caused to rotate at a slow rate. As soon as the lobe 67 of the cam 66 reaches the switching element 68, current is passed into the line 70, thence through the bridging element 54, and thence into a predetermined number of contacts 42, 43, 44 and 45, the number being determined by the pre-setting of the knob 50. While the lobe 67 depresses the switch arm 69 the heater 28 will be energized a number of times so as to dispense controlled volumetric charges of liquid detergent from the reservoir 10 into the washing machine tub. When lobe 67 passes beyond arm 68 an electrical switch arrangement de-energizes motor 32, and under normal operating conditions there is no further dispensing of liquid until cam 64 has been rotated sufficiently to place its lobe 72 in engagement with the switch arm 74. Depressurization of the switch arm 74 causes current to be supplied to the line 76, from whence it flows through the bridging element 56, and one or both of the contacts 61 and 62. Simultaneously, the switch 74 is again energized so as to rotate the drum 38 for energizing the heater 28 at predetermined time intervals, the action being such as to dispense one or two metered charges of rinse additive from the reservoir 12, depending on the adjusted position of knob 52. Of course if knob 52 is adjusted to place the bridging element 56 out of overlapment with the contacts 61 and 52, then in that event no rinse additive will be dispensed from reservoir 12, i.e., the heater 28 will not be energized.

From the above brief description it will be seen that the FIG. 1 embodiment comprises a number of separate but cooperating components, including:

1. One or more liquid reservoirs 10, 12,
2. An electrically-energized pump 18,
3. A selector valve 22, and
4. A reduced-size manual-electric control structure for pump 18 and the selector valve.

While the construction of the various components specified above may be varied, yet for illustration purposes the drawings herein include specific features which can be employed to advantage in one commercial and practicable embodiment of the invention. These structures are particularly illustrated in FIGS. 3 through 7.

Liquid Reservoir Structure (FIG. 7)

Each of the liquid reservoirs 10 and 12 may be of similar construction, and a description of one will there-
fore suffice for a description of the other. Referring to FIG. 7, reservoir 10 comprises a lower pan-shaped housing member 90 and an upper dish-shaped cover member 82, said members being preferably although not necessarily separately formed and releasably connected with one another to permit periodic cleaning of the interior of the reservoir. Filling of the reservoir with liquid is accomplished through an opening 84 (FIG. 2) in the top wall of reservoir 10, said opening being normally closed by a screw-type cap 86.

Cover 82 is provided with an externally threaded tubular portion 88 which accommodates the liquid discharge tube 90 carried by spigot 16. Tube 90 is provided with a flange 92 which sets atop tubular portion 88; minor portion of the tube 90 being effectuated by a flanged collar 94. Introduction of air into the reservoir is accomplished through a short conduit 96 which extends above cover 82 for connection with the flexible conduit 24 or 26 shown in FIG. 1. The arrangement is such that as structure 18 pumps air into conduit 24 or 26 the increased pressure is transmitted to the space above the liquid 98 within the reservoir. The increased air pressure above liquid 98 develops a pumping pressure on the liquid such as to force some of the liquid upwardly through tube 90, thence into the discharge spout 16, and finally into the washing machine 12.

It will be understood that the capacity of liquid reservoir 10 is sufficient for dispensing a large number of liquid charges into the washing machine after each filling of the reservoir. By this arrangement the reservoir need only be filled with liquid through the opening 84 (FIG. 2) at periodic intervals, as for example, once every one or two weeks in the usual application. During the use of the apparatus the level of liquid 98 will progressively be lowered with each successive dispensing operation, and the volume of air above liquid 98 will vary accordingly. However considering all factors, including minor factors as gas compressibilities (which in preferred applications are of relatively small effect) this variation in air volume does not serve to introduce an appreciable error in the volume of liquid dispensed through the spigot 16, since the above the liquid acts primarily as a force transmitter for the pressure development above the liquid in the reservoir 10.

In practice the space above liquid 98 is vented to the atmosphere after each dispensing operation, and prior to beginning of the next dispensing operation the space above the liquid 98 is automatically sealed from the atmosphere so as to establish an atmospheric pressure condition above the liquid 98.

The subsequent development of an increased pressure through conduit 26 is effective to provide a substantially higher than atmospheric pressure on the liquid, irrespective of the vertical dimension of the air space above the liquid, and variations in the liquid level are not such as to introduce any substantial variation in the volume of material dispensed during each dispensing operation.

The amount of liquid pumped is of course affected by the fact that when the reservoir level is low the last amounts of discharged liquid in each dispensing operation must be raised a relatively long distance, which in effect prevents some of the liquid from being discharged. However the variation in total amount pumped at the different reservoir levels is minimized by making the reservoir relatively flat, as for example with a height of four inches or less, and by making tube 90 with a relatively small lateral cross section.

Selector Valve Structure 22 (FIG. 5)

The illustrated selector valve comprises a housing which may be conveniently formed of two telescoped housing elements 100 and 102 secured together in a suitable manner, as for example through a pin-bayonet slot connection 104 (FIG. 1). The housing is formed with three tubular connectors 106, 108 and 110 which serve to connect the housing interior with the respective tubes 26, 20 and 24. The passage 112 in connector 108 communicates with a chamber 114 defines two opposed annular valve seats 116 and 118. Flow out of chamber 114 is controlled by a rubber valve element 120 which is fixedly carried on a slidable shaft 122, said shaft loosely extending through a passage 124 so that in the illustrated position of the valve element communication is established between passage 112 and the passage 126 formed within connector 110. By this arrangement, during energization of heater 28 the developed air pressure in tube 20 is transmitted through the valve structure 22 to the tube 24 for developing a pumping pressure on the rinse additive liquid in reservoir 12 (FIG. 1).

Slidable movement of shaft 122 to the right from its FIG. 5 position is effective to place valve element 120 in an intermediate position between the valve seats 116 and 118. The shaft 122 is in part formed by a separately formed element 128 which carries the O-ring valve element 130, and when the valve element 120 is located in an intermediate position between valve seats 116 and 118 the valve element 130 is opened to establish communication between the various connector passages 112, 126 and 132 and the atmospheric ports 134. In this manner atmospheric pressure conditions are established in the chamber above diaphragm 30 and in the spaces above the liquids in the reservoirs 10 and 12. Accordingly, the establishment of atmospheric pressure conditions in these spaces is desirable in order to prevent the development of a low pressure or vacuum condition in the spaces above the liquids in the reservoirs after a series of dispensing operations, since such low pressure or vacuum conditions would tend to prevent the development of a satisfactory pumping pressure on the liquid and would in effect destroy the calibration of the liquid charges being pumped.

Venting of the reservoirs to the atmosphere is also of importance in preventing any possible residual pumping from taking place due to minute pressure effects. In this connection it will be appreciated that in some cases the introduction of hot water into the machine may cause the temperature of the air above reservoir liquid 98 to increase appreciably, as for example to 130° F., or more. Without venting of the reservoir the increase in temperature of the air reservoirs would tend to provide a residual pumping of the liquid out through the spigot at inappropriate times in the cycle.

Shaft 122 can be moved further to the right from its venting position so as to dispose valve element 120 against the valve seat 118, thereby interrupting communication between passages 112 and 126, and establishing communication between the passage 112 and passage 132. When valve 120 is positioned to the limit of its rightward movement the subsequent development of a high pressure in line 20 (by heater 28) is transmitted to the space above the liquid in detergent reservoir 16, and the liquid detergent is thereby pumped into the washing machine tub.

From the above discussion it will be seen that valve element 120 can be positioned in any one of three different positions so as to alternately deliver the pressure from line 20 into detergent reservoir 10, deliver the pressure from line 20 into rinse additive reservoir 12, or establish atmospheric pressure conditions in the air system defined by the two liquid reservoirs and connecting conduits.

Repositionment of the valve 120 is effected by means of cam surfaces formed on the drum 38 (FIG. 1). By reference to FIG. 4, it will be seen that the left end portion of the drum 38 has its periphery contoured to form surfaces spaced different distances from the drum axis. As the drum rotates, these peripheral surfaces sequentially engage a finger 136 formed on an upstanding arm 138. As shown in FIG. 4, arm 136 is pivotally mounted on a suitable fixed base structure 140, and the upper end portion of arm 138 is provided with a circular opening which receives the reduced end portion of shaft 122. A compression coil spring 142 extends between the left end of hous-
In the illustrated embodiment there are three sets of surfaces formed on the left end portion of the periphery of drum 38, namely surfaces 146, 148 and 150. Surfaces 146 are spaced closer to the drum axis than surfaces 148 or 150, and when the finger 136 engages each of the surfaces 146 will be in its least position (FIG. 5) so that the tube 26 is placed in communication with the tube 24 to the rinse additive reservoir 12. In this position of the drum 38 the mechanism is therefore adapted to dispense rinse additive, and in this connection it will be noted from FIG. 4 that drum 38 is provided with two surfaces 146 which thereby enable the dispenser to dispense two volumetric charges of rinse additive into the tub. In the illustrative example energization of heater 28 is effective to dispense one ounce of liquid during each dispenser operation, and the device is therefore adapted to dispense two ounces of rinse additive, one ounce of rinse additive, or no ounces of rinse additive, depending on the pre-set position of the previously mentioned bridging element 56 (FIG. 3).

Surfaces 148 on the drum 38 are spaced slightly further from the drum axis than the surfaces 146, and therefore when the drum surfaces 148 are engaged with the finger 136 the valve element 120 will be located in an intermediate position such that all of the tubes 20, 24 and 26 are vented to the atmosphere through ports 134. These venting operations take place after each dispensing operation, and it will be noted that in the illustrated embodiment there are provided two venting surfaces 148 corresponding to the six dispensing contacts shown in FIG. 3.

Drum surfaces 150 are spaced further from the drum axis than the surfaces 148, and when any of drum surfaces 150 are engaged with the finger 136 the valve element 120 will be located in a position abutting valve surface 118. In this position the tube 20 is placed in communication with the tube 26 so as to communicate the pumping pressure to the detergent reservoir 10. It will be noted from FIG. 4 that drum 38 is provided with four surfaces 150 corresponding to the four detergent contacts shown in FIG. 3. By this arrangement the pump space above diaphragm 30 (FIG. 1) is communicated to the detergent reservoir 10 at four different times during a revolution of the drum so that it is possible to pump four slugs of detergent into the washing machine, providing of course that bridging element 54 is located in its FIG. 1 position. If the bridging element is located in its FIG. 2 position across only three or two or one or none of the contacts, the number of detergent dispensing slugs will be varied accordingly.

It will be understood that the contactor 49 on the drum 38 (FIG. 1) is so positioned with respect to the various drum surfaces 146, 148 and 150 that energization of heater 28 takes place when arm 138 is in the appropriate location, i.e., when valve element 120 is located either against seat 116 or against seat 118. The cycle of motions is such that when the vent surfaces 148 are engaged with the finger 136 heater 28 is de-energized, i.e., the contactor 49 is located out of engagement with any of the various contacts 42 through 47.

**Pump Structure 18 (FIG. 6)**

In the illustrated embodiment the pump structure comprises two housing elements 152 and 154 defining an interface which receives the diaphragm 30. Suitable connector clips 156 are provided to connect the housing sections together and operatively mount the diaphragm. The diaphragm carries a circular disc 158 of metal or other rigid material which enables the diaphragm to function much like a piston during its reciprocating movement. In this connection use of a piston for element 30 might under certain circumstances be feasible, although it is preferred to use a diaphragm or bellows structure because of their easier sealing and operating characteristics.

Disposed within the lower chamber 200 of housing 152 is the heater structure 28. This heater structure may be varied considerably in detail, but preferably the heater structure should be located centrally within the chamber and extend throughout a large volumetric portion thereof so as to quickly and efficiently heat a part of the liquid in the chamber and thereby provide a rapid time response to the introduction of electric current through the heater. In the illustrated embodiment the heater consists of a plurality of heater wires 160 trained around an X-shaped frame structure defined by the two crossed frame elements 162 and 164, the X-shaped character of the frame being more readily apparent from FIG. 1. Preferably the frame structure is of a low mass construction so as not to appreciably subtract heat from the output of the heater turns.

It will be seen from FIG. 1 that the heater wires extend through various different areas of chamber 200 so as to develop an extensive heating action on the chamber air, said heating turns being spaced from one another to permit air to circulate between the heater wires and within the supporting frame. The total length of heater wire may be varied within limits, depending on the particular heater structure employed, but in one illustrative embodiment heater wire has been employed in a length of about twelve feet. In this embodiment the wire was No. 34 chromel wire having a diameter of .0063 inch and having a resistance such as to have an output of about seventy-five watts from a conventional one hundred twenty volt supply.

The heater may be fed with current through conventional terminals such as the flat terminals 166 and 168 shown in FIG. 6, said terminals being suitably connected with the upstanding conductor arms 170 disposed within the housing element 152 alongside of the heater frame.

When the heater is in a de-energized condition the compression spring 172 is effective to force the diaphragm 30 to its FIG. 6 position where it is located against the tab-like stop elements 174. Elements 174 may be mounted within housing 152 in any suitable manner, as for example by means of a plurality of lugs 176 formed integrally with the housing body.

The heater 28 preferably develops a considerable quantity of heat in the chamber below diaphragm 30, and before the spring 172 can move the diaphragm to its FIG. 5 position the heated air within the lower chamber is preferably vented to the atmosphere otherwise the heated air would prevent or retard the spring from performing its function immediately after heater de-energization. In order to vent the lower chamber at the appropriate times in the cycle there is provided in the lower wall of housing 152 a port 180 which connects with a flexible conduit 182. Conduit 182 leads to a fitting 194 (FIGS. 1 and 4) having an opening 186 discharging to the atmosphere. Opening 186 registers with a rubber valve element 188, FIGURE 4, carried on the sheet metal arm 190.

As shown in FIG. 4, arm 190 is provided with a spring hinge 192 which serves to pivotally mount the arm and maintain the finger portion 194 thereof in engagement with the periphery of drum 38. By reference to FIG. 1, and particularly to the dotted line 196 thereof, it will be seen that finger 194 registers with those portions of drum surfaces 148 and 150 spaced to the right of the radius thereof which are engaged by the finger 136. In effect, therefore, the drum 38 has two separate series of cam surfaces formed thereon for actuation of the two different arms 138 and 190. When cam surfaces 148 are engaged with finger 194 the valve element 120 (FIG. 4) is engaged with the end of fitting 184 so as to seal the opening 186 against discharge of air from housing chamber 200; in this position energization of heater 28 is effective to heat the air trapped below diaphragm 30 so as to raise the diaphragm and effect a liquid-pumping
action. When drum 38 is in position with cam surfaces 150 engaged with finger 94 the rubber element 188 is spaced away from the adjacent end of finger 184 so as to allow the heated air from heater chamber 200 to escape into the atmosphere and thereby permit the compression spring 172 to move the diaphragm downwardly to its FIG. 6 position.

Manual and Electrical Control Structure for the Dispenser

The control structure for the FIG. 1 embodiment is best shown in FIG. 3 and comprises the terminal board 48 having the printed circuit thereon. Board 48 may be positioned at any point on a washing machine, for example, behind the splash back portion or control panel. The manually adjustable knobs 50 and 52 may be positioned on the external face of the splash back portion with suitable indicia appearing on the splash back portion to indicate the settings of the knobs. The splash back portion forms no part of the present invention, and in the interests of clarity it has not been shown in the drawings. The knobs 50 and 52 may be connected with the bridging elements 54 and 56 (FIG. 3) by any suitable means which will permit movement of the knobs to be effective to move the bridging elements. The illustrated knob-bridging element relationship provides for rotary movement of the knobs whereby it will be appreciated that rectilinearly moving bridging arrangements can be used if desired.

In the illustrated embodiment the circuit controlled by each bridging element comprises an annulling conductive ring 206 which may be conveniently formed as a printed element on the board 48 as shown in FIG. 3. Connection of the conductive ring 206 with the respective line 70 or 76 may be effected by a suitable conductive extension 208 formed in the circuit-printing operation. Each bridging element 54 or 56 may be provided with a turned portion thereon to establish a firm connection with the conductive ring 206. It will be appreciated that the turned portion is always engaged with the ring 206 so as to furnish the bridging element with current, providing the other contacts in the circuit are closed.

As previously noted, the printed circuit comprises the six contacts 42 through 47 which register with the rotary contactor 49. Contacts 42 through 47 may be formed as part of an adhesively-mounted flexible spring leaf 41, said leaf having a second contactor 51 formed thereon to traverse the printed conductive ring 53 (FIG. 3). Ring 53 connects with the heater line 71 to feed it with current. It will be understood that for proper operation of the illustrative embodiment, it is necessary to provide some amount during each energization cycle of motor 32, so as to accurately reset the motor for subsequent dispensing operations. Various means may be resorted to for insuring an accurate resetting of drum 38. In the FIG. 1 embodiment resetting of the drum is controlled by the snap switch structure 220 shown in FIG. 3, said structure comprising an actuator arm 222 fulcrummed on a metallic bracket 224 so as to have a portion thereof in alignment with pin 226 carried by the drum. The right end portion of arm 222 is notched to form a mount for switch blade 228. The blade is stressed by means of its central leg 230 which is deiined and compensated into its lumps configuration by having its right end fitted into a notch in bracket 224.

The arrangement is such that during rotation of drum 38 by motor 32 the pin 226 strikes actuator 222 to depress it, for thereby changing the direction of action of the tensioned blade portions in a manner to snap the blade contactor against bracket 224, thereby energizing the circuit to motor 32 and a temporary stoppage of the drum 38. Preferably the drum is temporarily stopped shortly before completing one revolution, for example at about the three hundred thirty degree point (with respect to its starting position), it being appreciated however that other temporary stoppage locations can be utilized if desired. Preferably the temporary stoppage location should be one 3,149,754 wherein the contactor 49 is in a circuit-open condition such that no current is delivered to heater filament 28.

At a suitable point in the cycle the drum is advanced to its starting position (i.e., to the three hundred sixty degree position) by means of the timer-operated switch arrangement shown at 221 in FIG. 3. The arrangement comprises a timer-operated cam 234 having a lobe 236 therein arranged to close the line 238 at a predetermined point in the cycle. Line 236 connects with motor 32 through the bracket 232 so that when lobe 236 closes line 238 the motor 32 is energized to move the drum 38 from its three hundred thirty degree position to its three hundred sixty degree position. It will be realized that switch actuator 222 is so located and dimensioned that pin 226 leaves it at the three hundred sixty degree position, thereby allowing the blade 222 to snap to its illustrated position disconnecting power to motor 32. At this time the switch arm 242 is held open by lobe 236.

In the FIG. 3 arrangement the general sequence is a cycle of operations wherein (1) the motor 32 is operated for about one minute, fifty seconds to impulse heater 28 for additive discharge, (2) cam 234 continues to rotate (while motor 32 is stopped) until the lobe 236 closes line 238, at which time motor 32 is energized for about ten seconds to advance or reset the drum 38 to its starting position, and (3) motor 32 then remains stopped until operated by the main timer switch 235 at the next additive discharge.

The illustrated reset means is of advantage in that it permits any desired sequence of additive discharges without necessarily requiring detergent-rinse-detergent alternations. This feature is of particular importance in those instances where it is not desired to alternate the discharges from the two reservoirs, as for example in a situation where it is desired to discharge two ounces of detergent at the prewash period, four ounces of detergent at the main wash period, and two ounces of rinse additive at the rinse period. In such an arrangement the knob 50-actuator 54 construction would of course be necessary in order to give the appropriate signals to heater 28.

In the illustrated embodiment (FIG. 3) provision is made for enabling the housewife to manually add additional detergent to the machine in the event that unusual observation of the tab suds level (at conclusion of the automatic detergent dispensing) indicates the need for such additional detergent. The manual addition means takes the form of a manually-operated switch 241 located in a line 243. This switch could if desired be located to be energized by knob 50. In such an installation the knob 50 would have six different positions, namely an off position, four automatic detergent dispensing positions, and a manual detergent dispensing position with switch 241 closed. Line 243 could if desired be formed as part of the printed circuit on board 48.

In operation, switch 241 is operated when drum 38 is in its momentarily stopped position (three hundred thirty degrees in the illustrative embodiment), with the drum located in such position that the air vents are closed and the detergent reservoir is in communication with the pump 18. Under such conditions closing of switch 241 energizes heater 28 to dispense the liquid detergent.

The housewife may manually dispense more than one slug of detergent by releasing the actuator 241 for a short period of time, for example ten seconds, and then again closing switch 241 to energize heater 28. The ten second release period allows the air surrounding the drum to become cool again so that the next heater energization is effective to expand the air from driving the pump diaphragm upwardly, this pumping action taking place even though there is no venting of chamber 200 during the release period.

The air cooling action in chamber 200 during the release period is believed to take place by reason of convection of radiation actions. Thus, during the first closing of
3,149,754 switch 241 the air immediately surrounding the heater wires is heated to a relatively high temperature, and the other air is not heated quite as much. During the release period the convection action tends to pull all of the chamber 200 air at about the same temperature, and heat is enabled to be lost through the walls of housing 152 in such quantities as to permit a satisfactory stroking of diaphragm 30 by the spring 172.

During the release period the downward movement of diaphragm 30 tends to create a low pressure condition above the liquid in reservoir 80 (FIG. 7), such that atmospheric air is drawn through spigot 16 and into tube 90. If the tube is constructed to have a relatively small internal diameter the atmospheric air displaces the entire column of liquid in the tube and thence bubbles up through the main body of liquid into the space thereafter. If tube 90 is constructed to have a relatively large diameter the atmospheric air may merely bubble downwardly through the tube column of liquid before bubbling up through the main liquid body.

The action during the release period is effective to establish an operating body of air above the liquid in the reservoir such that during depression of switch 241 a satisfactory pumping action is obtained. The pumping action with switch 241 is not as accurate or complete as with the automatic contacts 42 through 45, because there is no venting in the periods between switch 241 closing; however considerable slug quantities can be manually dispensed such that the housewife can conveniently add detergent as need if she feels the pre-selected quantity is insufficient for her wash in a particular instance.

**General Mode of Operation**

In utilizing the apparatus as illustrated in FIG. 1 within a conventional domestic clothes washing machine, the housewife initially fills the reservoirs 19 and 12 with liquid detergent and rinse additive respectively. This liquid-filling operation may be performed periodically, as for example once every one or two weeks, the interval of course depending upon such factors as the size of the reservoirs, the amount of liquid additives used by the housewife, and the frequency of operation of the machine, etc.

Assuming that the dispensers are wholly or partially filled with liquid, the housewife sets the knobs 50 and 52 to the desired amounts of additive in accordance with the character of the particular wash load. She then initiates the wash-rinse cycle by closing the conventional switch 240; this operation is of course different in the various makes and models of machines, and the present invention is not concerned with the exact type of mechanism which is employed for this purpose. Upon energization of the switch 240 the lamps 237, 64, 66, and 234 (all on the same shaft) begin to move. At a predetermined time switch arms 68 and 235 are closed, and a circuit is completed through the line 70 to the appropriate one of the contacts 57 through 60 controlled by the detergent bridging element 54. Simultaneously the motor 32 is energized to rotate the drum 38 so as to cause the contactor 40 to periodically complete circuits across those one of the contacts 42 through 45 put into the circuit by the bridging element 54. Thus during rotation of drum 38 one or more electric current pulses will be shot through the heater element 28 of the pump 18. As each electrical impulse is delivered through the heater wire, the air below the diaphragm 39 is heated rapidly (within a second or two) so as to raise the diaphragm upwardly and deliver an air pulse to the detergent reservoir 19, it being appreciated that during the delivery of each of these pulses one of the cam surfaces 150 (FIG. 4) will be engaged with the finger 156 to correctly locate the flow control element 120 within structure 22 for permitting delivery of the pressure pulse to reservoir liquid. The time interval between the pulses of the various air chambers, including the chambers above the liquid, above and below diaphragm 30, and in the various lines 20, 24, 26 and 82, will be vented to the atmosphere to reset the pulse-transmission system for the next pulsing operation.

After the drum 38 has completed almost one revolution the motor 32 is automatically de-energized by pin 226 and switch 220, and is then maintained de-energized until cam lobes 236 and 239 cause motor movement to drive the drum 38 to its starting position, it being noted that lobe 239 keeps switch 235 closed after switch 226 is opened so that heater 28 is not operated during the drum reset period. During the period before lobe 236 activity the housewife can manually dispense detergent by means of switch 241 if she so desires. After lobe 236 has passed the controlled switch arms the motor remains motionless for a relatively long time period, as for example fifteen minutes.

Then lobe 72 closes switch 74, and lobe 279 simultaneously closes switch 235; a circuit is thereby established through line 76, and one or both of contacts 61 and 62, depending on the position of the rinse additive bridging element 56. Simultaneously with closing of switch 235 the motor 32 is again energized to move the drum 38 through substantially one revolution. As the drum rotates its contactor 40 traverses the six contacts 42 through 47. The contacts 42 through 45 are of course not in circuit, since the switch arm 68 is no longer depressed, according to the present embodiment. The contacts 46 and 47 are connected to the valve structure 80. It will be noted from FIG. 4 that the two surfaces 146 are located so that as the contactor 40 traverses the contacts 46 and 47 the arm 138 will shift the flow control element 120 to a position directing the pressure pulses to the reservoir 12 for pumping of the liquid therefrom into the washing machine.

As drum 38 rotates (to effect rinse additive discharge) pin 226 snaps switch structure 220 from its illustrated position so as to de-energize motor 32 and leave drum 38 in its three hundred thirty degree position. Lobe 279 maintains switch 235 closed, and delivers an air pulse to the detergent reservoir 19 to re-energize the drum 38 at its starting position.

Briefly, the arrangement of FIG. 1 comprises an electrically-energized gas-pump means 18, liquid-reservoir means 10 or 12 for receiving the output from said pump means to effect the discharge of liquid, an electric feeder circuit including contacts 42 through 47 for delivering electrical impulses to the pump means, and an electrical control circuit including the bridging elements 54 and 56 interposed in said feeder circuit to prevent selected ones of the electrical impulses from being delivered to the pump means, whereby the liquid reservoir means will be caused to discharge liquid pulses characterized in accordance with the pattern of impulses delivered to the pump means. In the illustrative embodiment the pattern of impulses is determined by the setting of the knobs 50 and 52, so that the housewife has independent control of the quantities of the detergent dispensed from reservoir 10 and of the rinse additive dispensed from reservoir 12. The drawings show two reservoirs for dispensing detergent and rinse additive respectively, but the system can be enlarged to also include one or more other additive dispensers such as, for example, a bleach dispenser. Also, for cost reduction purposes either the detergent reservoir of the rinse additive dispenser can be eliminated, it being noted that the introduction of the detergent into the washing machine during the time just prior to the initiation of the wash-rinse cycle, and that the housewife can therefore conveniently in some cases add the detergent without need of a detergent dispenser.
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FIGS. 1 through 7 illustrate an arrangement incorporating a single gas pump means 18 for selectively pumping air pulses to the different reservoirs 10 and 12. If desired, any one of the gas pumps can be provided with its own gas pump means, as for example by utilizing the arrangement diagrammatically shown in FIG. 8. The components used in the FIG. 8 arrangement may in some respects be similar to those employed in the FIG. 1 arrangement, and similar reference numerals are therefore employed wherever applicable.

Referring to the FIG. 8 embodiment, it will be seen that during rotation of the timer cams 64 and 66 the gas pump 18 for the detergent reservoir 10 is initially energized to deliver one or more air pulses through the line 20 to the dispenser 10 so as to cause discharge of detergent liquid pulses into the washing machine in the same manner as in the previously described embodiment.

As with the previously described embodiment, the gas pump means is in a de-energized state after the lobe 67 has passed beyond the actuator for switch arm 68. At initiation of the rinse cycle, the lobe 72 of the cam 65 energizes the circuit through switch arm 74, and the contacts 61 and 62 are thereby caused to deliver electrical impulses to the heater of the gas pump 18 for rinse additive dispenser 12.

In the FIG. 8 embodiment the diverter or selector valve 22 is eliminated and each of the reservoirs can be provided with its own gas pump and there is no need for diverting the pump output to one or the other of the reservoirs.

However, it is desirable that the system of passages be vented to the atmosphere between the introduction of gas pulses to the various reservoirs, and the venting mechanism should be automatically operated in timed relation to the cycle of the heater and washing machine. In the FIG. 8 arrangement the venting of the heater chambers for the two heaters may be effected by means of the valve structure 250 shown diagrammatically in FIG. 8. As there shown the valve structure comprises an axially shiftable flow control element 351 urged against the drum 38' by spring 252 and following the contour of the cam surfaces thereon as to alternately open the heater chambers to the atmosphere for air exhaustion purposes and trap air within the heater chambers for pumping purposes. In the illustrated structure drum 38' is provided with four ports spaced lobes 249 and six valleys 248 so as to provide alternate sealing and venting for the various dispensing operations.

Referring to the details of structure 250 it will be seen that element 251 thereof is provided with four annular grooves 252 through 256 which pass through said lobe 257 through 260 formed in the fixed housing 261. Each of the ports connects with a respective one of the lines 262 through 265 which lead to the various portions of the air system to be vented. Element 251 is provided with the central passage 266 which connects with the various annular grooves, the arrangement being such that in its illustrated position element 251 furnishes communication between the atmosphere and the various portions of the air system. Rotation of drum 38' causes lobes 249 to shift element 251 axially so as to seal the passage 266 from the various ports 257 through 260 and thereby condition the system for pumping operations. It will be understood that drum 38' may be controlled in its movements by timer means similar to that shown at 220, 234 and 237 in FIG. 3.

As will be apparent from the drawings the general mode of operation of the FIG. 8 embodiment is similar to that of the FIG. 1 embodiment, hence the preceding description will suffice for an understanding of the general features of the FIG. 8 embodiment.

FIG. 9 shows a mechanism which can be employed to advantage in either the FIG. 1 arrangement or in the FIG. 8 arrangement, and is utilized to automatically reset knob 50 or 52 (FIG. 1) to the zero position after each wash-rinse cycle. By this action the housewife is prevented from inadvertently using undesired additive in the subsequent cycle. This safety feature is of particular advantage when the knob is utilized as a bleach quantity selector, since the inadvertent use of bleach on dark clothes can be disastrous.

The FIG. 9 mechanism comprises a timer cam 270 having the lobe 272 thereon adapted to contact the shaft 274 after dispensing of a particular additive selected by the knob 50 or 52. Shaft 274 is carried by a flexible cable or wire 276 having a turned end portion 278 engaged with the teeth 230 of ratchet 282. A spring 284 is trained between a fixed pin 286 and the shaft 288 of the selector knob to normally urge the ratchet in the arrow 290 direction. Until shaft 274 is deflected by lobe 272 the end portion 278 is in position to prevent such ratchet movement; however when shaft 274 is moved by lobe 272 the spring 284 is able to move the knob and ratchet in the arrow 290 direction for zero reset purposes. It will be understood that shaft 288 carries a bridging element 54 or 56 (FIG. 2) which is automatically moved to a "completely unbridged" position during the arrow 290 movement.

The general sequence of operations of the FIG. 9 mechanism is such that the housewife initially selects the quantity of additive by turning knob 50 or 52 in the arrow 292 direction to the desired position, the teeth of ratchet 282 merely sliding over end portion 278 during this movement without becoming caught thereon. During the wash-rinse cycle the correct quantity of additive is dispensed, and thereafter lobe 272 moves shaft 274 to free the end portion 278 from the ratchet and permit spring 284 to rotate the knob-ratchet-bridging element assembly to a zero safety position. After knob 272 has passed beyond shaft 274 the end portion 278 is moved back into teeth 280 by the spring 294.

At initiation of the next wash-rinse cycle the housewife can turn the knob to any desired position. However if she forgets to correctly set the knob no harm will occur to the clothes (by bleach or other additives) because the previous automatic resetting of the selector knob has moved it to the zero position.

It will be appreciated that while the drawings have shown specific embodiments of the invention and have illustrated particular features of construction which may be employed to advantage in a practical operational structure, yet variations from the illustrated structures may be resorted to without departing from the spirit of the invention as defined in the appended claims.

We claim:
1. A device for feeding metered quantities of liquids including an electrically energized gas pump, the improvement wherein the gas pump comprises an electrically energized heater, an electric feeder circuit for delivering timed electrical impulses to said heater, and an electrical control circuit interposed in the feeder circuit to prevent selected ones of the impulses from being delivered to the heater.
2. In a liquid dispensing system, an electrically energized gas pump, two separate liquid reservoirs receiving the output from said pump to effect discharge of liquid, each reservoir having its own discharge opening, a valve for directing the pump output into a selected one of said reservoirs, said valve comprising an inlet receiving the pump output, a first outlet connected with one of the reservoirs, a second outlet connected with the other reservoir, and a vent; said valve further comprising a shiftable flow-controlling structure positionable in a first location to permit flow from said inlet to said first outlet, shiftable to a second location permitting flow from said inlet to said second outlet, and positionable in a third location permitting flow between said inlet and said vent,
an electric feeder circuit for delivering electric impulses to said pump,
and an electric control circuit interposed in said feeder circuit to develop impulses in said feeder circuit and intermittently actuate said pump.

3. The combination of claim 2 and further comprising a cyclically-operable cam having three lobes thereon sequentially locatable in operative engagement with the flow controlling structure to shift said structure to its three designated locations.

4. In a liquid dispensing system, an electrically energized gas pump, whereby the pump is actuated when the vent is closed and the vent is open between actuations of the pump.

5. In a liquid dispensing system, a pulse-type gas pump, an electric heater for energizing said pump, and intermittent operation of said heater.

6. In a liquid dispensing system, an electric heater energized, a pulse-type gas pump means, a reservoir connected to receive the output from said pump to effect discharge of liquid therefrom, an electric circuit means connected to deliver timed impulses to said pump, vent means connected to divert the output of said pump away from said reservoir, and means to operate said vent means in timed relation to said circuit means impulses,