Sept. 21, 1965 S. B. NORRIS, JR 3,207,282

LIQUID VENDING APPARATUS WITH LIQUID PURIFYING MEANS

Filed Nov. 29, 1963 7 Sheets-Sheet 1

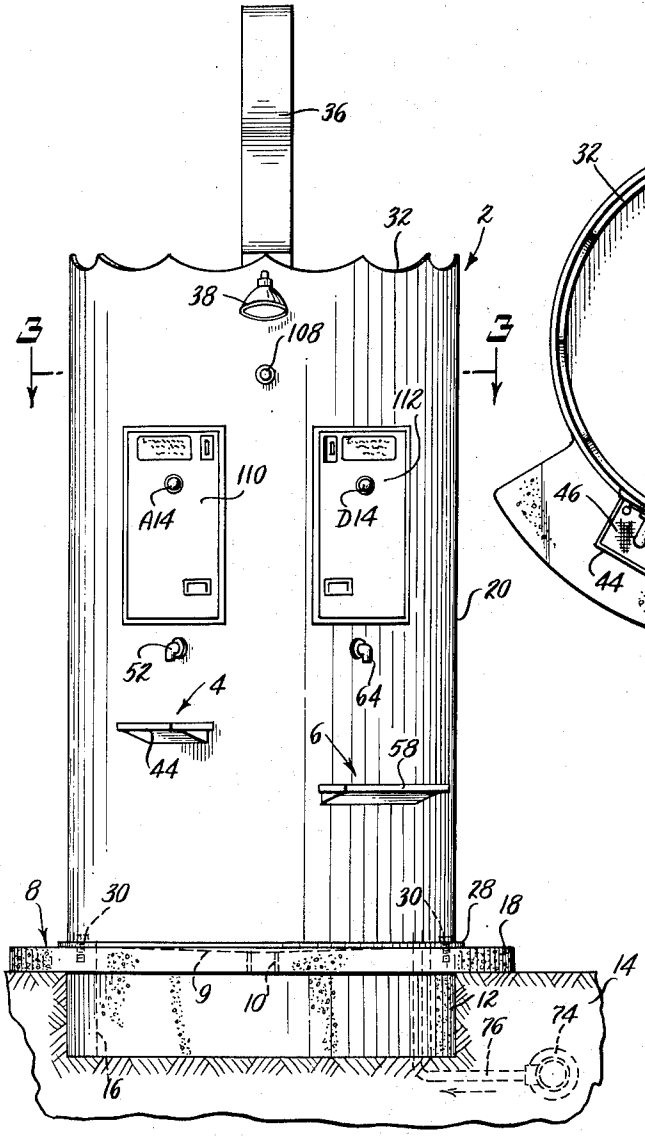



Fig. 2.

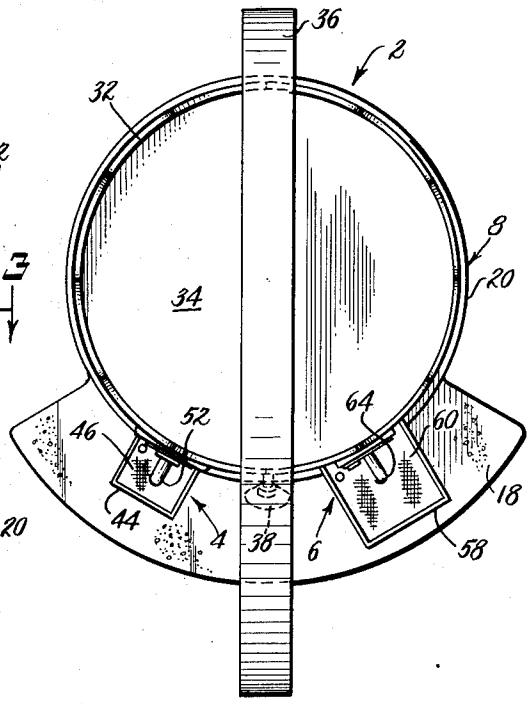



Fig. 1.

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LIQUID VENDING APPARATUS WITH LIQUID PURIFYING MEANS

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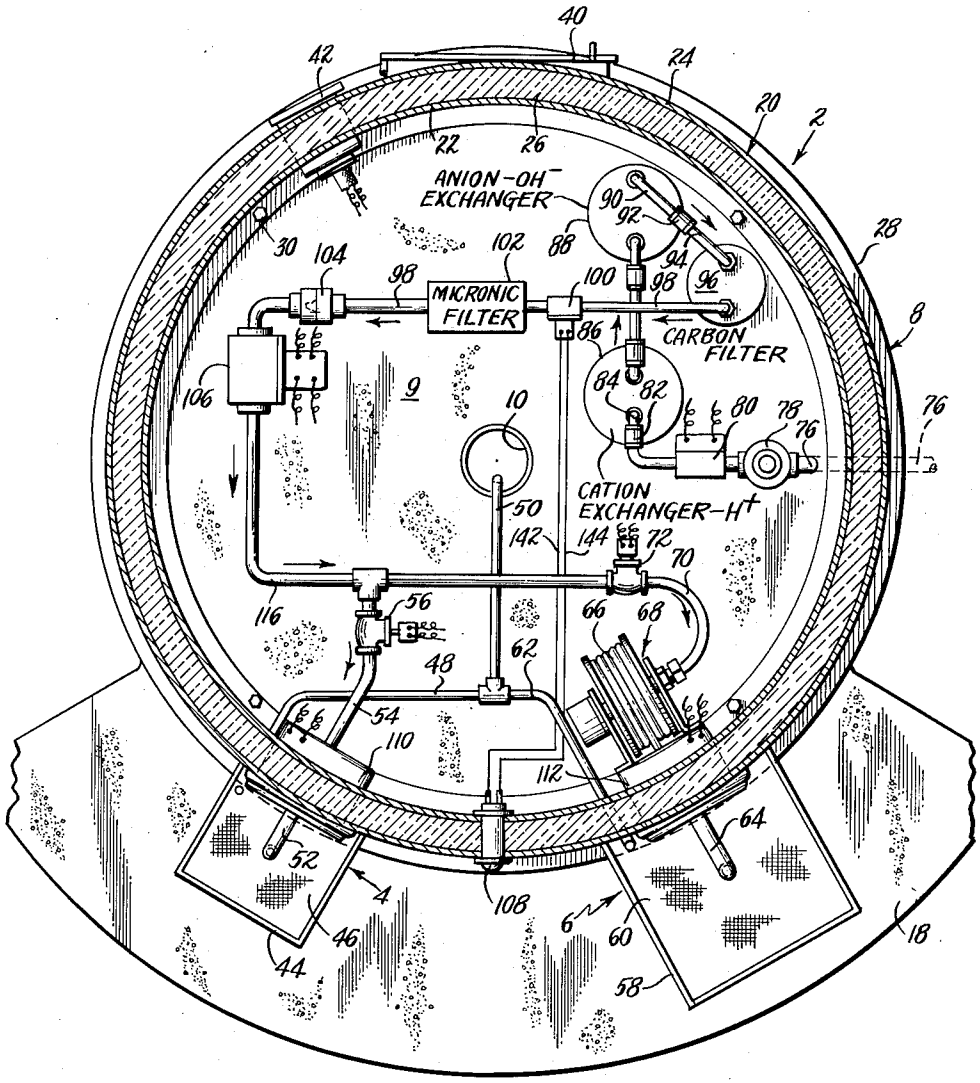



Fig. 3.

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LIQUID VENDING APPARATUS WITH LIQUID PURIFYING MEANS

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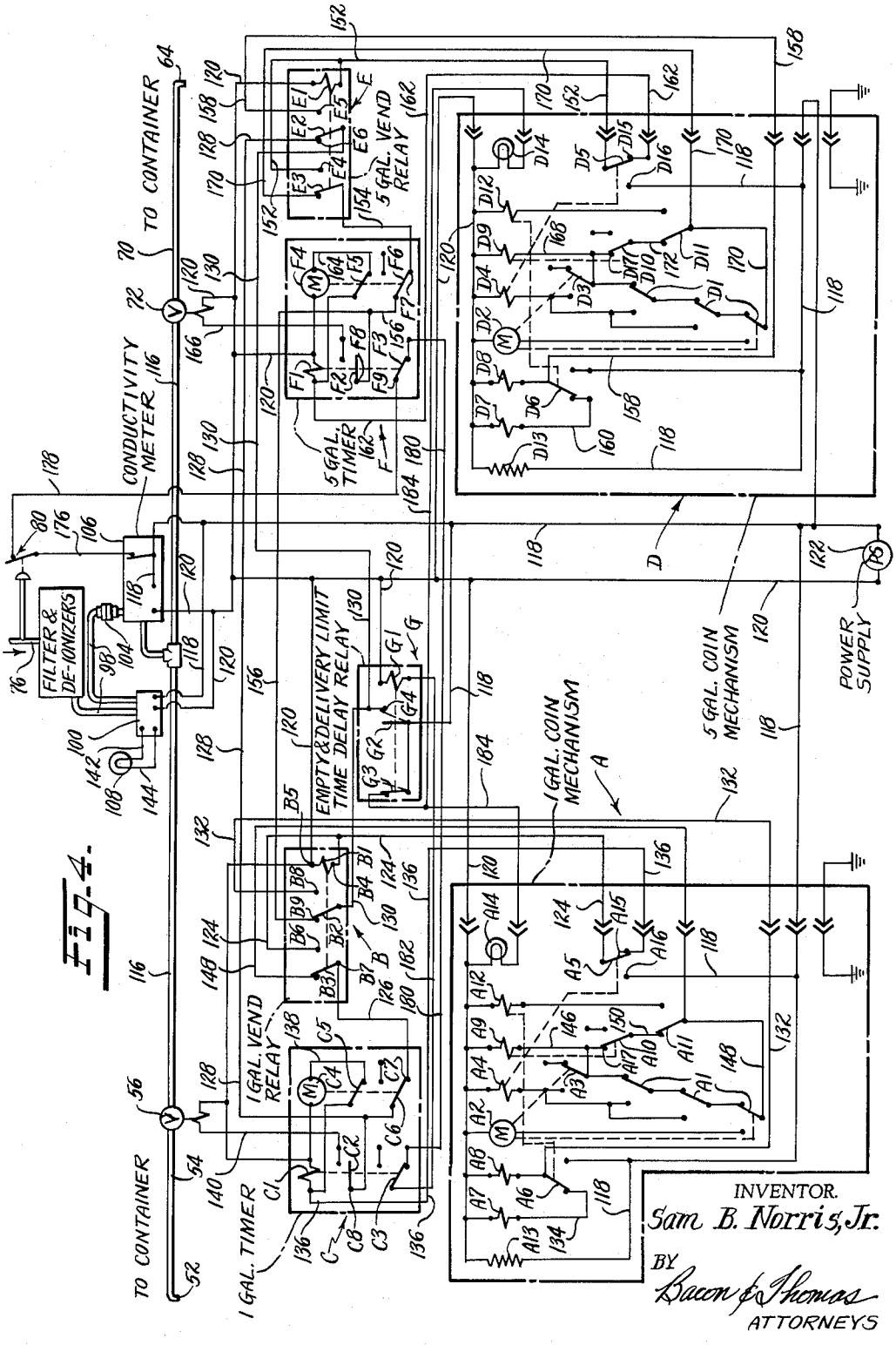



FIG. 4.

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Fig. 5.

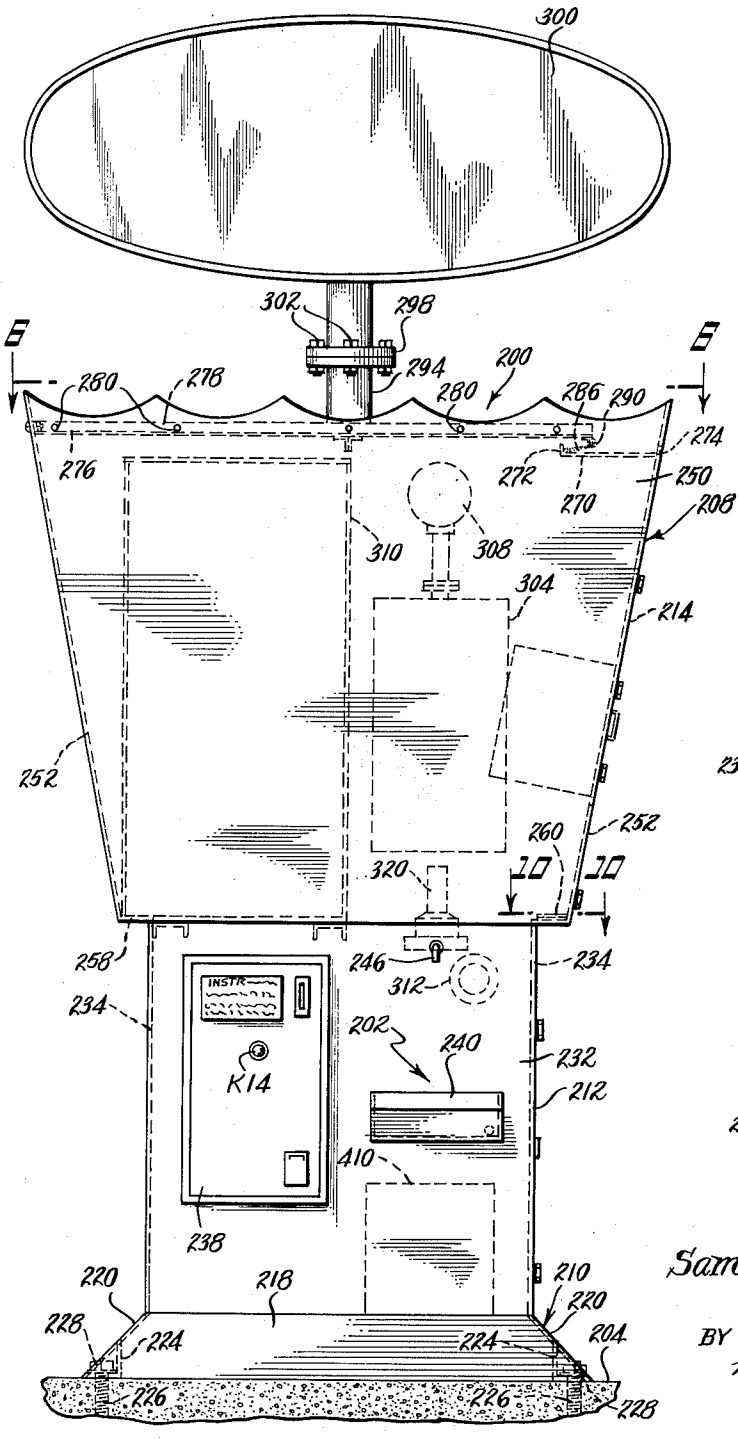
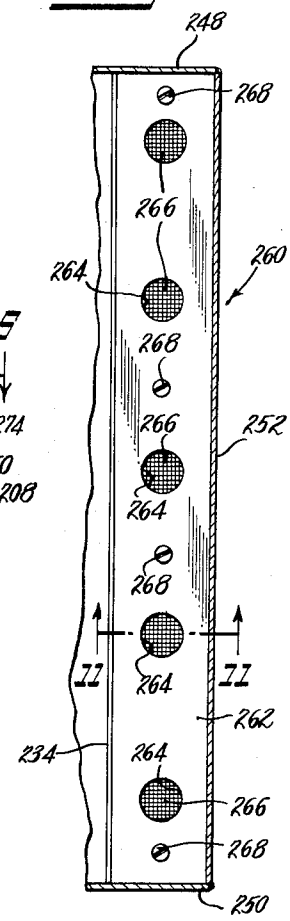



Fig. 10.



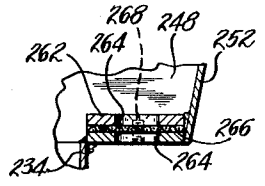




Fig. 11.

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Fig. 6.

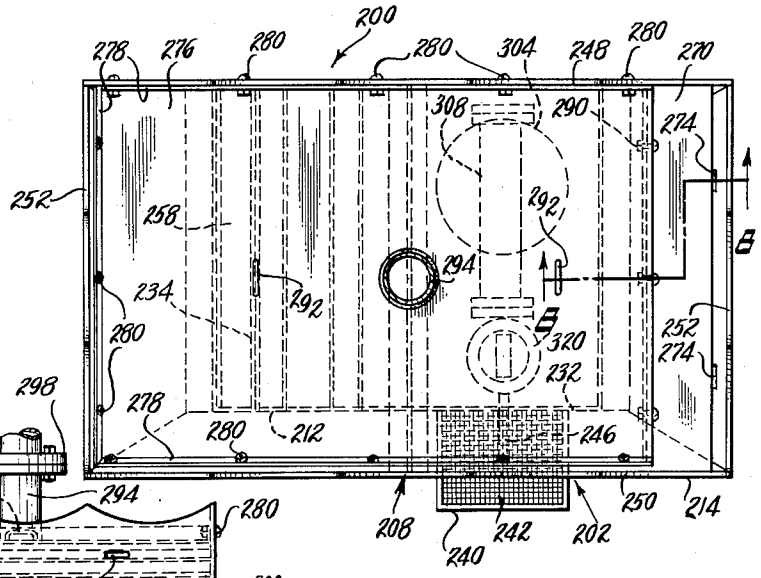



Fig. 7.

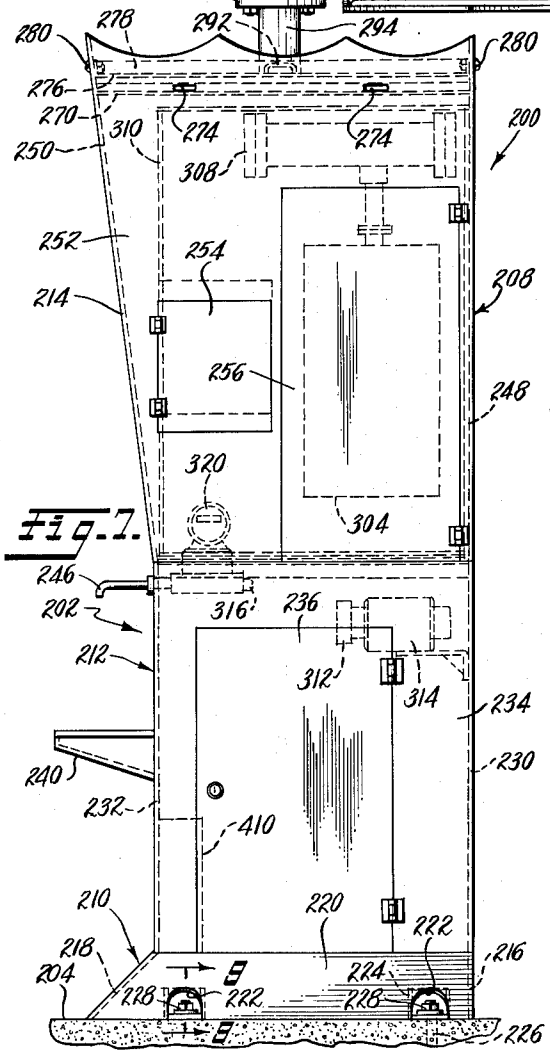



Fig. 8.

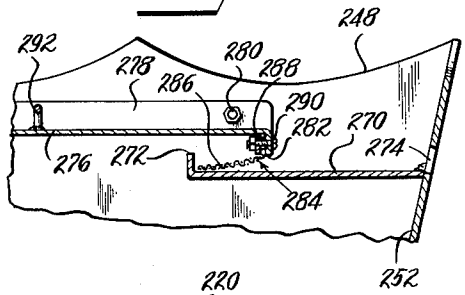
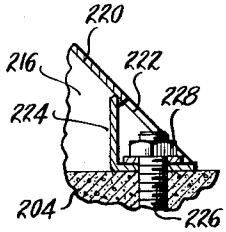



Fig. 9.




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LIQUID VENDING APPARATUS WITH LIQUID PURIFYING MEANS

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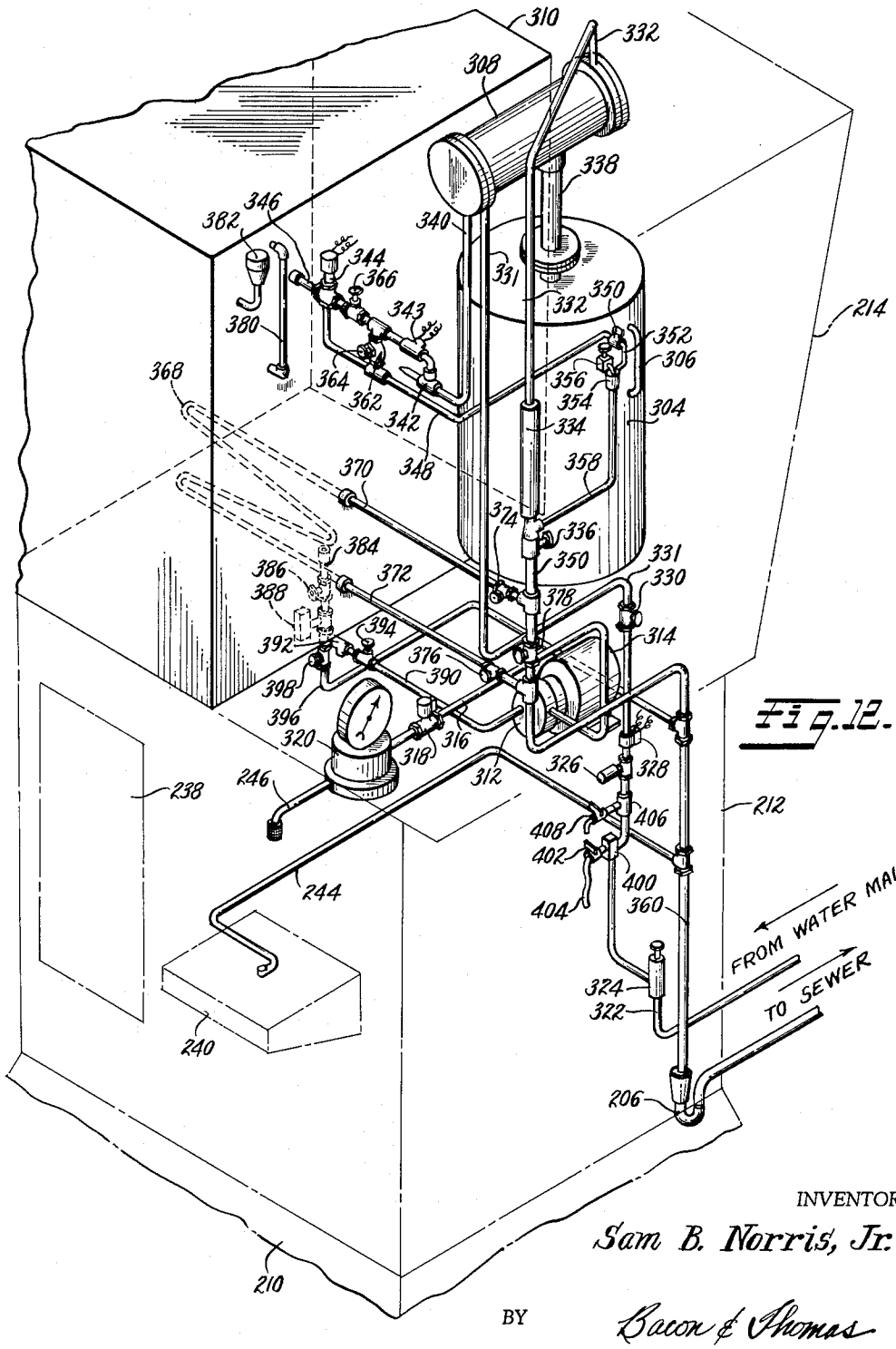



Fig. 12.

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LIQUID VENDING APPARATUS WITH LIQUID PURIFYING MEANS

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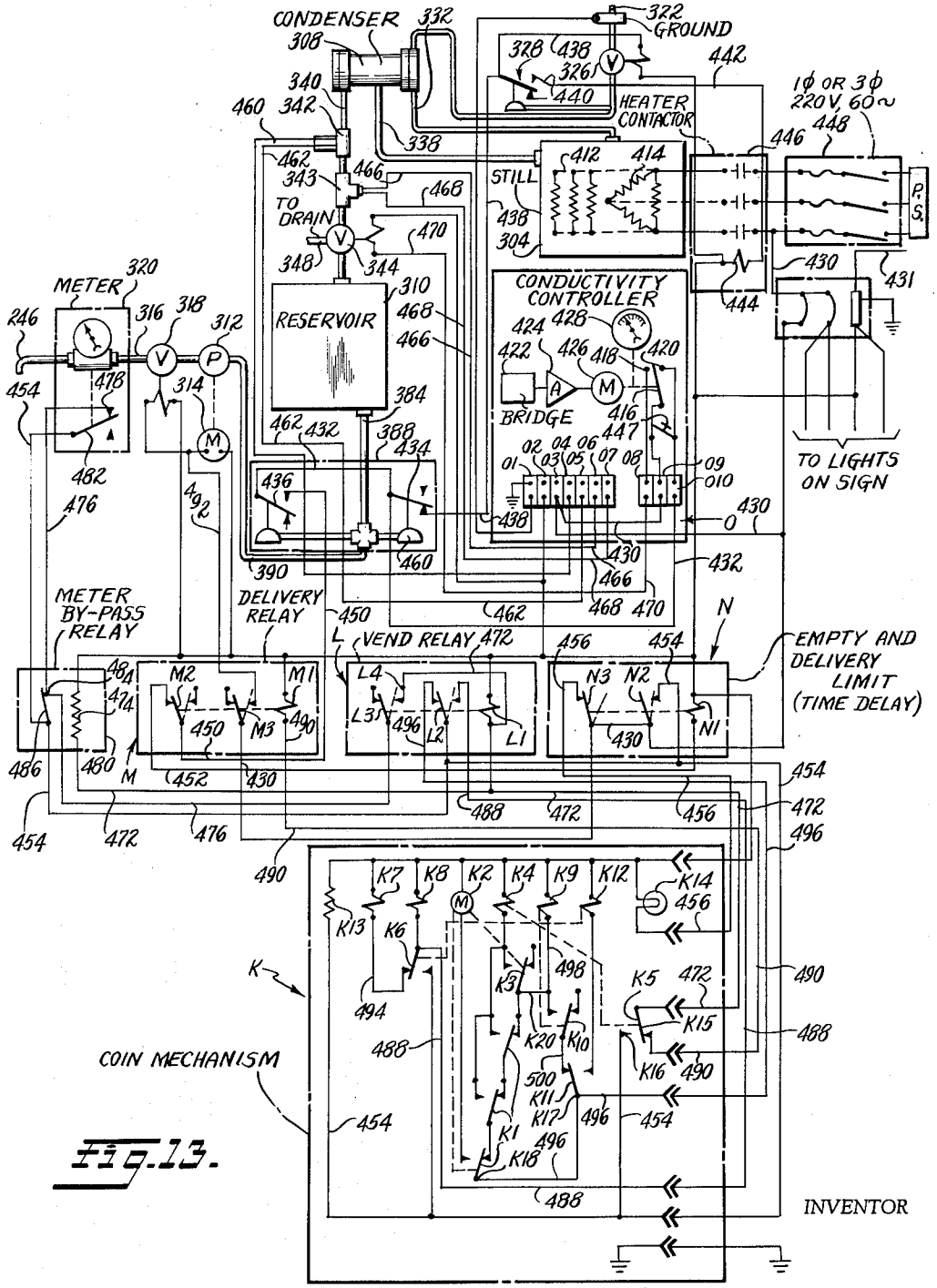



Fig. 13.

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United States Patent Office 3,207,282 Patented Sept. 21, 1965



3,207,282

# LIQUID VENDING APPARATUS WITH LIQUID PURIFYING MEANS

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Filed Nov. 29, 1963, Ser. No. 326,974
26 Claims. (Cl. 194—13)

This application is a continuation-in-part of U.S. application Serial No. 296,775, filed July 22, 1963, and entitled Liquid Vending Apparatus.

This invention relates generally to coin-controlled liquid vending apparatus, and in particular to vending apparatus for the bulk vending of water. More particularly, it relates to a bulk water vending machine including apparatus for purifying water taken from a well, reservoir, municipal water system or other source, by removing certain minerals and other impurities therefrom. The invention combines demineralization equipment, e.g., ion-exchangers or distillation units, with a vending operation in a novel and useful manner.

Liquid vending machines of the type described in this and said prior application are especially useful in arid geographical regions, such as the southwestern parts of the United States, where available water may contain a high mineral content, or be otherwise less pure than desired for drinking, cooking, use in automobile batteries, steam irons and the like. The present vending machine is adapted for either permanent or temporary installation along highways, in parking areas, parks, motel areas, and other locations readily accessible to the automobile traveling public, and is supplied with water by connecting it to a municipal water system or other source of water under pressure. Water supplied to the apparatus is first purified by removing certain minerals and other impurities, and is then bulk vended in preselected quantities.

The vending apparatus of the invention is illustrated herein in two embodiments, both of which are shown to be connected directly to the water supply sources, e.g., to a municipal water system or other local water supply. Both utilize water main pressure to supply them with water, although it is contemplated that a feedwater pump can be employed if main pressure is too low. The second embodiment includes a reservoir for storing purified water, and a pump is employed to deliver water therefrom during the vend cycle.

Both embodiments of the present liquid vending apparatus are coin-operated, and are arranged to dispense, or vend, a given quantity of water for a set price. In the first embodiment, the quantity of liquid vended is measured by a timed flow of water at constant pressure, whereas in the second embodiment positive displacement electricontact flow meter is employed. It will be understood that these are representative of the various means that may be employed to accurately dispense a measured quantity of water.

Water received from the local water supply is purified by the deionization or distillation apparatus of the invention before being dispensed; that is, the mineral content of the water is lowered to a level acceptable for most uses, and certain other impurities are removed. In the first embodiment of the invention, such purification is obtained during vending by passing water from the supply through conventional ion exchange deionizers and associated filters, and in the second embodiment an electrically-operated still apparatus is utilized to purify water from the supply, which is then delivered to a non-corrosive storage tank for subsequent vending.

The coin-controlled mechanism for operating the vending apparatus is connected into an electric circuit, which also includes means for sensing the degree of purity of the water to be vended. The purity sensing means is arranged in both embodiments of the invention so that it



will deactivate the coin mechanism when water to be dispensed is of less than a desired preselected purity. Thus, a vendee is assured that any water which he obtains will have a degree of purity that meets the purity standard established for the vending apparatus.

It is an object of the invention to provide a coin-operated, automatic bulk vending apparatus for purifying water and dispensing measured quantities of purified water.

Another object is to provide a coin-operated bulk vending apparatus for connection to a local water supply, and constructed to receive, purify and vend measured quantities of water from said supply.

It is also an object to provide a coin-operated bulk vending apparatus for purified water, incorporating means to render the delivery apparatus thereof ineffective if the water to be dispensed does not satisfy a preselected purity standard.

A further object is to provide a coin-operated liquid bulk vending apparatus equipped with a still for purifying water drawn from a local water supply, and arranged for automatic operation.

Still another object is to provide a coin-operated, bulk liquid vending apparatus constructed to dispense a preselected quantity of purified water in exchange for the deposite of coins totaling a given price.

Other objects and many of the attendant advantages of the present invention will become apparent from the following detailed description and the accompanying drawings, wherein:

FIG. 1 is a top plan view, showing a first embodiment of the liquid vending apparatus of the invention installed for operation;

FIG. 2 is a front elevational view of the apparatus of FIG. 1;

FIG. 3 is an enlarged horizontal sectional view taken along the line **3—3** of FIG 2, illustrating ion-exchange water purifying and liquid dispensing apparatus;

FIG. 4 is a circuit diagram diagrammatically illustrating the electrical control features of the vending apparatus of FIG. 1;

FIG. 5 is a front elevational view of a second embodiment of the vending apparatus of the invention;

FIG. 6 is a top plan view of the apparatus of FIG. 5, with the sign removed;

FIG. 7 is a fragmentary, side elevational view of the apparatus of FIG. 5;

FIG. 8 is an enlarged fragmentary, sectional view taken along the line **8—8** of FIG 6;

FIG. 9 is an enlarged fragmentary, vertical sectional view taken along the line **9—9** of FIG. 7;

FIG 10 is an enlarged fragmentary, horizontal sectional view taken along the line **10—10** of FIG. 5;

FIG. 11 is a vertical, sectional view taken along the line **11—11** of FIG. 10;

FIG. 12 is a diagrammatic view in perspective, showing the water purification and dispensing apparatus for the embodiment of FIG. 5; and

FIG. 13 is a circuit diagram diagrammatically illustrating the features of the electrical control circuit for the vending apparatus of FIG. 5.

Referring now to the drawings, the first embodiment of the vending apparatus of the invention is indicated generally at **2** in FIGS. 1–3, and includes dispensing stations **4** and **6** for dispensing one-gallon and five-gallon quantities of purified water respectively, in exchange for the deposit of coins totaling a specified value. The vending apparatus, or machine, **2** rests upon a concrete base **8** having a top surface **9** that tapers toward a central drain opening **10**. The base **8** is secured to footings **12** placed in the earth **14**, said footings enclosing a sump **16** with which drain opening **10** communicates. As is best shown in FIG. 1, a concrete apron **18** extends in

an arc around the front of the vending apparatus beneath the dispensing stations **4** and **6**.

The vending apparatus, or machine, **2** includes a cylindrical housing **20**, which is comprised of inner and outer cylinders **22** and **24**, respectively, (FIG. 3) having insulation **26** disposed therebetween. The cylinders **22** and **24** have an annular base flange **28** secured to the lower ends thereof, which is secured to the concrete base **8** by bolts **30**. The upper end of the cylindrical housing **20** terminates in a scalloped edge **32** (FIG. 2), and a recessed top plate **34** is secured therein.

Supported upon the recessed top plate **34** is an advertising sign **36**, which is preferably provided with internal lighting arranged to be operated automatically by circuitry associated with the control circuit of the invention. In addition to the lighted sign **36**, a light **38** for illuminating the area after dark is provided on the front of the vending apparatus **2**.

The housing **20** contains the water purification and vending equipment of the invention, access to which is provided by a door **40** positioned on the rear side thereof. The control circuitry for the vending apparatus is connected to a control box **42**, which is mounted on the rear of the housing **20** adjacent to the access door **40**.

The one-gallon dispensing station **4** includes a shelf **44** secured to the front of the housing **20**, arranged to support a liquid container provided by the customer. The shelf **44** is fitted with a screen **46**, and defines a tray for receiving spilled or overflow liquid. A conduit **48** extends from the shelf **44**, and is connected with a drain conduit **50** leading to the drain **10**. A nozzle **52** is positioned above the shelf **44**, and projects outwardly from the housing **20** a distance sufficient to be positioned over the filling opening of containers placed on said shelf. The nozzle **52** is supplied with liquid from a conduit **54**, said conduit having a solenoid valve **56** connected therein.

The five-gallon dispensing station **6** is similar to the dispensing station **4**, and includes a tray-defining shelf **58** fitted with a screen **60**, said shelf being connected to the drain **10** by a conduit **62**. A nozzle **64** is received in a bracket above the shelf **58**, and is connected to one end of a hose **66**. The hose **66** is wrapped on a retracting reel apparatus **68** mounted within the housing **20**, and is supplied with liquid by a conduit **70** having a solenoid valve **72** connected therein. The reel apparatus **68** is conventional, and hence will not be described further herein. The nozzle **64** and the reel apparatus **68** offer a choice to the customer, whereby he can either place a container on the shelf **58** beneath the retracted nozzle **64**, or extend the hose **66** to his automobile or other vehicle for filling a container carried therein.

The vending apparatus **2** is connected to a municipal water system or other local water supply, which supplies raw water thereto. A purification system, e.g., deionization units and associated filters is contained within the housing **20** and comprises an integral part of the vending apparatus. Raw water from the water supply flows therethrough, whereby it is purified by removing certain minerals and other impurities. The purified water is then dispensed through either the dispensing station **4** or the station **6**, depending upon which is utilized by the customer.

Raw water from the supply source is purified in the vending apparatus **2** by conventional cation and anion ion-exchange units known as deionizers, and associated carbon filter apparatus. The ion-exchange units are preferably of the type which can be removed for regeneration, although the provision of similar units which are designed to be regenerated while installed in the vending apparatus **2** is within the teaching of the invention. The construction and operation of such commercially-available ion-exchange equipment is known, and hence will not be described in detail herein.



The vending apparatus **2**, as shown in FIG. 2, is installed in proximity to a water main **74**. A service conduit **76** is connected to the water main **74**, and has a conventional vacuum breaker **78** connected therein for preventing undesirable backflow in the event of a pressure differential in the direction of the main. A fluid pressure-operated switch **80** for breaking an electrical circuit on low line pressure is connected into the conduit **76** after the breaker **78**, and said conduit **76** terminates in a quick coupling connector **82**.

The quick coupling connector **82** is connected to the inlet **84** of a cation ion-exchange unit **86** which operates on a hydrogen cycle to exchange calcium, magnesium sodium, and other cations for hydrogen ions. The outlet of said unit **86** is connected to the inlet of an anion ion-exchange unit **88** which completes the deionization of the water by transfer of $OH^-$ ions for chloride, sulfate and other anions present. Alternatively, both of the units **86** and **88** may be of the mixed bed type, in which case only one or both units may be used as desired. The outlet **90** of the unit **88** is connected by a quick coupling connector **92** to the inlet **94** of a conventional activated carbon filter **96**, which absorbs from the water such dissolved gases as chlorine and carbon dioxide, and which removes organic tastes and discoloration from the water.

From the carbon filter **96** water flows in a conduit **98** through an electrical purity indicator **100** and a micronic filter **102**, which filter stops carbon carry-over in the now purified water. The conduit **98** leads from the filter **102** through a restrictive orifice **104** to an electric conductivity meter **106**, which measures the conductivity of water passing therethrough and actuates a switch in a control circuit when the conductivity exceeds a certain value. A signal light **108** is mounted in the front of the housing **20**, and is connected to the purity indicator **100**. The light **108** and the meter **100** can be of the general type described in U.S. Patent 2,760,152, and are constructed and provided with the necessary circuitry so that said light will be lit when the purity of the deionized and filtered water is at least equal to a preselected purity standard.

The conductivity meter **106** is connected electrically with the one-gallon and five-gallon coin boxes **110** and **112** and with the control circuitry of the vending apparatus **2**, and is arranged to deactivate said vending apparatus if ionized impurities in water passing therethrough exceed a pre-set purity level. After passing through the deionization equipment, the carbon filter **96**, and the micronic filter **102**, it is desired that the resultant "purified" water will contain no more than about three parts per million (p.p.m.) of ionized impurities.

The conductivity meter **106** may be any of a number of commercially-available devices. One such device is arranged to measure the electrical conductivity of "purified" water passing therethrough by use of a conventional bridge circuit, and the electrical signal from any unbalance thereof operates the motor of an inductor gauge. This motor can be arranged to operate a switch connected into the control circuitry of the vending apparatus for deactivating the coin boxes **110** and **112** when a preset purity level, such as 3 p.p.m. of dissolved electrolyte has been exceeded; that is, said coin boxes **110** and **112** are arranged to be deactivated by the meter **106** when the measured water conductivity exceeds a pre-set value, said value being chosen to correspond to the desired purity standard for the purified water. Conductivity-measuring purity meters such as the meter **106** are readily available commercially, and hence their construction will not be described in detail herein. It will also be apparent that devices of the type disclosed in Patent No. 2,760,152 may be modified to trigger the control circuitry when the conductivity of the water exceeds a predetermined level.

From the conductivity meter **106** the purified water

flows through a conduit **116** which supplies water to the solenoid valves **56** and **72**. The restrictive orifice **104** is designed to maintain a substantially constant pressure in the conduit **98**. The solenoid valves **56** and **72** are both arranged to be operated by the control circuitry of the invention, which circuitry includes a timing mechanism associated with each of said valves. By properly correlating the value of the constant pressure maintained by the restrictive orifice **104** with the open time period for the valves **56** and **72**, as measured by said timing mechanisms, precisely measured quantities of water can be delivered through the nozzles **52** and **64**.

While it is intended that the vending apparatus **2** will rely on water main pressure for its operation, it is to be understood that in some instances the value of such pressure can be too low. In these instances, a pump and motor can be connected into the service conduit **76**, and can be arranged to pump water through the vending apparatus **2** when the coin boxes **110** and **112** are operated. Similarly, where the vending apparatus is supplied from its own well or reservoir, conventional pump and pressure tank systems may be included.

Further, in cold climates it may be necessary to install conventional heating equipment, such as equipment of the infra red type, within the housing **2** to prevent freezing of water contained in the pipes and other equipment. It will also be understood that the bulk vending apparatus **2**, if desired, can utilize only one dispensing station, or that a plurality in excess of two might be employed; in either instance, the inventive principles remain unchanged.

Referring now to FIG. 4, it will be seen that the electrical components for the dispensing operation associated with the dispensing station **4**, which, for convenience, has been referred to as the one-gallon operation, are shown to the left of the drawing, and that those electrical components associated with the dispensing station **6**, which, for convenience, has been referred to as the five-gallon operation, are shown to the right of the drawing. The components for the one-gallon operation comprise a coin mechanism A, a vend relay B, and a timer C. The components for the five-gallon operation similarly comprise a coin mechanism D, a vend relay E, and a timer F. A single empty and delivery limit time delay relay G serves both systems.

The structure of the individual components of the circuit is conventional, and forms no part of the invention. However, these components, as will be seen from the following description, are combined in a novel and advantageous manner, and are tied in with the conductivity control for insuring delivery of pure water.

To prevent errors in delivering quantities of the one- and five-gallon systems, a normally closed contact on each vend relay is connected in each vend circuit in such a manner that when a fill cycle (1 or 5 gallons) is in progress, the other (one or five-gallon) vend circuit is inoperative (coins are rejected) until the fill cycle in progress is complete. In other words, the system is interlocked to prevent simultaneous delivery through both of the dispensing stations **4** and **6**.

The system is such that by simple adjustment of the timers and coin mechanism adjustment, any quantity of purified water can be delivered with either vend circuit within the price limitations of the coin mechanisms; that is, 1, 5, 10, 15, 20, etc. gallons could be delivered from either the dispensing station **4** or the station **6**. The timers associated with the solenoid valves **56** and **72** of the two vending circuits typically will have a range of 150 seconds, and if this is not sufficient, timers with other time ranges can be readily interchanged simply by unplugging one unit and replacing it with another.

Empty and delivery limit lockout contacts are connected to a common time delay relay to lock out both vend circuits in the event of abnormally long delay cycles, or a loss of intake pressure. The intake pressure is measured in the service conduit **76** by the pressure switch **80**, which is adjusted and arranged to deactivate the circuit at a pre-set pressure value.

For convenience, the letter identifications A through G will be used in conjunction with the reference numerals shown on the particular electrical components in FIG. 4. For example, when referring to an element of the one-gallon coin mechanism, the number of the component will be preceded by the letter A.

The one-gallon coin mechanism A has coin switches **A1**, which are actuated by 5¢, 10¢ and 25¢ coins, a stepping motor **A2**, stepping switch **A3**, stepper relay coil **A4**, stepper vend switch **A5**, reset switch **A6**, escrow cash box relay coil **A7**, stepper reset coil **A8**, coin return relay coil **A9**, hold switch **A10**, cancel switch **A11**, escrow coin return relay coil **A12**, coin box resistance-type heater **A13**, and an indicator light **A14**. Similarly, the five-gallon coin mechanism D is provided with elements **D1** through **D14**. The coin mechanism A is adjusted to actuate upon a total deposit of a certain amount of coin, say 25¢, and the coin mechanism D is adjusted to actuate upon a total money deposit of another value, say 50¢ in coin. Such coin mechanisms are conventional, and may be obtained from National Rejectors, Inc., or other commercial sources.

The one-gallon vend relay B includes a relay coil **B1** and switches **B2** and **B3** actuated thereby. The five-gallon vend relay E identically contains relay coil **E1** and switches **E2** and **E3**. The one-gallon timer C is provided with a clutch coil **C1** and associated switches **C2** and **C3**, and with a timer motor **C4** and associated switches **C5** and **C6**, which are actuated at the end of the time cycle for which the motor is set. Likewise, the five-gallon timer F is provided with elements **F1** through **F6**. The timer motors C4 and F4 are pre-set, so that, for a given value of constant fluid pressure established by the restrictive orifice **104**, the one-gallon timer C provides a time cycle which will permit one gallon of purified water to be dispensed at the constant flow rate established by said pressure regulator, and the five-gallon timer F will provide a longer time cycle which will permit five gallons of purified water to be dispensed at said constant flow rate.

The empty and delivery limit time delay relay G is provided with a normally energized coil **G1** and with switches **G2** and **G3**. This relay is such that when the coil G1 is de-energized, the switches G2 and G3 will activate after a pre-set time interval from the position shown in dashed lines to the position shown in solid lines. Time delay relays of this type, with an adjustable range of 0–15 minutes, are commercially available and are suitable for the purposes of the invention. The pre-set time in the present instance will be in slight excess of the time limit of the five-gallon timer F1. If the time for the five-gallon delivery is 1½ minutes, the timer for the unit G may, for example, be set to actuate at the end of two minutes.

The control features for the apparatus of FIGS. 1–4 will be further described by reference to a typical operation.

*Operation of the one gallon circuit*

The circuit is supplied with current through leads **118** and **120**, from a source **122**. When sufficient coins have been placed in the coin mechanism A, the stepper motor **A2** will be actuated to move vend switch **A5** from contact **A15** to contact **A16**, thereby connecting line **118** to line **124**. Line **124** is connected to the vend relay coil terminal **B4** and line **120** is connected to coil terminal **B5**, and thus after actuation of switch **A5** actuation of the vend relay B will occur. Line **124** is also connected to contact **B6**, and is thus connected through contact B7 to line **126** when vend relay is energized to close switch **B3**.

Line **126** is connected to one gallon timer contact **C7**, and through switch **C6** to line **128**. Line **128** is connected to one gallon timer contact **C8**, which will be

discussed later in the sequence, and to five gallon vend relay contact E6, which is connected to line 130 through switch E2 when no delivery is being made in the five gallon circuit. Line 130 is connected to contact G4, and through switch G2 to line 118 when coil G1 is energized. It is assumed at this time that the empty and delivery limit relay G is energized as shown, with the switches G2 and G3 in the dashed position. The empty and delivery limit circuit will be discussed later in the sequence.

Vend relay B is now energized through an alternate circuit, and remains energized throughout the vend cycle. When relay B is energized switch B2 is actuated to contact B8, thus connecting line 130 to line 132 to thereby energize stepper reset coil A8, which in turn resets the stepper vend switch A5 to contact A15. Line 132 is connected to line 134 through reset switch A6 when coil A8 is energized, and energizes the escrow cash box solenoid coil A7. This causes the coins totaling the vend price to be deposited into the coin box.

Coils A8 and A7 are energized throughout the vend cycle, and the stepper vent switch A5 must reset to terminal A15 before delivery is initiated. Line 124 is connected to line 136 when switch A5 returns to terminal A15, which energizes timer clutch coil C1 and, through switch C5 and line 138, the timer motor C4; with the timer clutch coil C1 and the motor C4 energized, the timer motor begins its cycle. The switches C2 and C3 on the timer associated with the clutch coil C1 actuate instantly upon energization of said coil, while the switches C5 and C6 associated with the motor C4 do not actuate until the pre-set time setting of the timer has elapsed.

Line 128 connected to switch terminal C8 is now connected to line 140 through switch C2, whereby the delivery solenoid valve 56 is actuated and moved to an open position. Water now flows from domestic source line 76, through the filters and de-ionizers, and to line 98, where it is sampled by the conductivity meter 106. The water then passes from the meter 106 to conduit 116, and then through open valve 56 to line 54, which terminates in nozzle 52. The function of switch C3 is discussed later in the empty and delivery limit circuit.

During delivery, water also passes through meter 100, which is supplied power from lines 118 and 120. Leads 142 and 144 extend to lamp 108, which operates as explained earlier to indicate water impurity. Upon completion of the delivery time interval switch C5 is actuated and de-energizes the timer motor C4, and switch C6 is actuated to disconnect line 128 from line 126 to de-energize line 124 connected to coil B1 through activated switch B3, thus de-energizing vend relay B. Line 136 is also de-energized by the actuation of switch C6, as it is connected to line 124 through the stepper vend switch A5; this de-energizes the timer clutch coil C1. De-energization of the timer clutch coil C1 causes the timer to reset to its pre-set position, and causes all switches C2, C3, C5 and C6 to revert to their positions as shown before said coil was energized. The delivery solenoid valve 56 is de-energized when switch C2 opens, and said valve then closes. Line 132 is disconnected from line 130 when the vend relay B is de-energized, whereby stepper reset coil A8 and the escrow cash box solenoid A7 are also de-energized.

The coin return solenoid A9 is normally energized, except during delivery through either the one or the five-gallon circuits, and except when the machine is empty or has timer trouble. Once de-energized, it must be again energized before coins will be accepted by the coin mechanism A. The coil A9 is first energized by line 146 through the coin switches A1 to line 148. Line 148 connects through switch B3 to line 126, which is energized in a manner already discussed. Upon energization, the coin return solenoid A9 is connected to line 150 through its own holding switch A10, which is then actuated to contact A17 as shown. Line 150 connects to line 148 through the cancel switch A11. This completes the discussion of the one-gallon vend cycle.

*Operation of the five gallon circuit*

When sufficient coins have been placed in the coin mechanism D, the stepper motor D2 will be activated to actuate vend switch D5 from contact D15 to contact D16, thus connecting line 118 to line 152. Lines 152 and 120 are connected to the vend relay coil E1, and thus said coil is energized upon actuation of switch D5 to move switches E2 and E3 to contacts E4 and E5. Line 152 is also connected to contact E4, and is thus connected through switch E3 to line 154 when vend relay coil E1 is energized.

Line 154 is connected to five-gallon timer contact F7, and by switch F6 to line 156. Line 156 is connected to timer contact F8, which will be discussed later in the sequence, and also to one gallon vend relay contact B9, which is in turn connected to line 130 through switch B2 (when no delivery is being made in the one-gallon circuit). Line 130 is connected to contact G4, and through switch G2 to line 118 when coil G1 is energized. It is assumed at this time that the empty and delivery limit relay G is energized as shown, with the switches G2 and G3 in their dashed positions. The empty and delivery limit circuit G will be discussed later in the sequence.

Vend relay E is now energized through an alternate circuit, and remains energized throughout the vend cycle. Switch E2 is thus actuated to connect line 130 to line 158, thus energizing stepper reset coil D8 in the five-gallon coin mechanism D, which in turn resets the stepper vend switch D5 to contact D15, as shown. Line 158 is connected to line 160 through reset switch D6, and energizes the escrow cash box solenoid D7; this causes the coins totaling the vend price to be deposited into the coin box. Coils D8 and D7 are so connected as to be energized throughout the vend cycle, and the stepper vend switch D5 must reset before delivery is initiated.

Line 152 is connected to line 162 when switch D5 returns to contact D15, thus energizing timer clutch coil F1 and, through switch F5 and line 164, the timer motor F4. With the timer clutch coil F1 and the motor F4 thus energized, the timer begins its cycle. The switches F2 and F3 associated with clutch coil F1 are actuated instantly when said coil is energized, while the switches F5 and F6 associated with the motor F4 are not actuated until the pre-set time setting of the timer has elapsed. Line 156 connected to clutch contact F8 is connected to line 166 through switch F2 after coil F1 is energized, and said line 166 energizes the delivery solenoid valve 72, thus actuating the valve to move it to an open position. Water then flows from domestic source line 76 through the filters and deionizers to line 98, where its conductivity is sampled by the purity meter 106. The water then passes from line 98, through the orifice 104, into conduit 116, and thence through open valve 72 to line 70 and the nozzle 64.

The function of the timer clutch switch F3 is discussed later in connection with the empty and delivery limit circuit. Upon completion of the delivery time interval, switch F5 is opened and de-energizes timer motor F4. Simultaneously, switch F6 opens to disconnect line 156 from line 154, which de-energizes line 152 connected to coil E1 through switch E3, thus de-energizing vend relay E and causing switches E2 and E3 to return to their full line positions. Line 162 is also de-energized, as it is connected to line 152 through the stepper vend switch D5. This de-energizes the timer clutch coil F1, thus de-energizing the timer clutch. Release of the timer clutch F1 causes the timer to reset to its pre-set position, and causes all timer switches F2, F3, F5 and F6 to revert to their positions as shown before the coil F1 was energized.

The delivery solenoid valve **72** is de-energized when switch F2 opens, and thereupon returns to a closed position to stop the flow of water from nozzle **64**. In addition, line **158** is disconnected from line **130** when the vend relay E is de-energized as described above, and thus the stepper reset coil D8 and the escrow cash box solenoid D7 are also de-energized.

The coin return solenoid coil D9 is normally energized, except during delivery through either the one or five-gallon circuits, or when the machine is empty or has timer trouble; it must be energized before coins will be accepted by the coin mechanism D. When vend relay coil B1 is energized during operations of the one-gallon circuit, coil D9 will be de-energized by switch B3. Similarly, when vend relay coil E1 is energized, coil A9 will be de-energized by switch E3; this arrangement prevents simultaneous deliveries through both the one and five-gallon circuits.

The coil D9 is first energized by line **168** through the coin switches D1 to line **170**; line **170** connects through switch E3 to line **154**, which is energized as described by previous discussion. Upon energization, the coin return solenoid coil D9 is connected to line **172** through its own holding switch D10, which is actuated to contact D17 as shown. Line **172** connects to line **170** through the cancel switch D11. This completes the discussion of the five-gallon vend cycle.

*Operation of the empty and delivery limit circuit and of the conductivity control*

The empty and delivery limit circuit must be completed before deliveries can be initiated through either the one-gallon or the five-gallon systems. If the circuit is not complete, coins inserted into either the coin box **110** or the coin box **112** will be rejected, and the empty lights A14 or D14 will be illuminated.

Line **120** is connected to the empty and delivery limit relay coil G1, and line **118** is connected to one terminal of a relay switch **174** provided in meter **106**. The meter **106** measures conductivity of water passing therethrough and is constructed and arranged so that if water flowing from the filters and de-ionizers is of sufficient purity (as indicated by its conductivity) conductivity relay switch **174** will be closed as shown. Line **118** is connected to line **176** through switch **174** to the pressure switch **80**, which is in the closed position shown when the water main pressure is adequate for proper operation of the apparatus. The pressure switch **80** can be adjusted to actuate, or open, at any desired domestic water pressure. Line **176** is connected to line **178** through the closed pressure switch **80**, and said line **178** connects to the five-gallon timer terminal F9, and to line **180** through switch F3. Line **180** is connected to line **182** through one-gallon timer switch C3, and extends to coil G1, thus completing the circuit to said empty and delivery limit time delay coil G1.

Each time a delivery is initiated, switch C3 or switch F3 is actuated to de-energize coil G1. However, switches G2 and G3 do not actuate instantly to their solid line positions when coil G1 is de-energized, because of the time delay feature built into the relay. The timing adjustment on relay G, as explained above, is set to exceed the normal maximum delivery time set on the timers C and F, this feature of the circuit preventing excessive water losses in the event of a timer component failure.

Line **118** is connected to the switches G2 and G3. When pressure in service conduit **76** becomes too low, thus opening switch **80**, or when the conductivity of water in conduit **98** becomes too high, thus opening switch **174**, or when trouble occurs in a timer, the empty and delivery limit relay coil G1 is de-energized, as will be readily understood from the above description. When this occurs, and after the pre-set time delay for relay G, the switch G2 opens and the switch G3 will be actuated to the position shown in solid lines, thus connecting line **118** to line **184**. Line **184** connects to the empty lights A14 and D14 on the one and five-gallon coin mechanisms A and D, respectively, and thus said empty lights will light when coil G1 is thus de-energized. Further, when switch G2 opens the line **130** is de-energized, thus de-activating the liquid dispensing equipment.

It is thus seen that the control circuitry of FIG. 4 will operate to deliver a desired quantity of deionized, or purified, water in exchange for a set price. In addition, it is seen that the circuit is arranged so that if low inlet pressure develops, or impurities use above a pre-set level, or trouble occurs in the timers, the coin mechanisms will be de-activated and the empty lights A14 and D14 will be lighted. The lamp **108** furnishes a continuous check on water purity.

The exchange deionization apparatus utilized for purifying water in the embodiment of FIGS. 1–4 may not be the most desirable water purification means in all instances, for example, when a very hard, or heavily mineral-laden, water supply, e.g., sea water, is utilized, or where purification by distillation is more practical, e.g., in localities where replacement or regeneration of the ion-exchange units would be a problem. Accordingly, a second embodiment of the invention is illustrated in FIGS. 5–13, which incorporates an electrically-operated still apparatus for automatically purifying water from the supply main, the purified water being stored in a reservoir for subsequent dispensing.

Referring now to FIGS. 5–13, the still-equipped vending apparatus is indicated generally at **200**, and is shown to have a single dispensing station **202**. While only one dispensing station is shown, it is, of course, to be understood that with suitable modifications more than one such station might be employed. Thus, dual dispensing stations and circuitry as in the first embodiment can readily be adapted to the distillation unit and conversely the single supply system as shown with the distillation unit can readily be modified for use with ion-exchange demineralizers. The vending apparatus **200** is disposed to rest upon a concrete base **204**, which is provided with a drain **206** (FIG. 12). The apparatus **200** includes a housing **208** having a generally rectangular cross-section, said housing including a base portion **210**, a lower portion **212**, and an upper portion **214**, said upper portion including outward inclined front and side panels.

The housing base **210** is disposed to rest upon the concrete base **204**, and includes a vertical back plate **216**, and outwardly and downwardly-inclined front and side plates **218** and **220**, respectively. The plates **216**, **218** and **220** are welded together along their mating edges, and each of the side plates **220** has a pair of spaced cutouts **222** in the lower edge thereof. As is best shown in FIGS. 5, 7 and 9, angle irons **224** are welded to the inner surfaces of the side plates **220** in position to confront the cutouts **222**, and studs **226** are embedded in the concrete base **204** and extend through bores in the horizontal flanges of said angle irons **224**. Nuts **228** are received on the upper ends of studs **226**, and function to anchor the housing base **210** to the concrete base **204**.

The housing lower portion **212** includes vertically disposed back and front plates **230** and **232**, respectively, which are welded along mating edges to a pair of vertically-disposed side plates **234**. The right-hand side plate **234** in FIG. 5 has a large access door **236** mounted therein, and the dispensing station **202** is supported by the front plate **232**, along with a coin box **238**.

The dispensing station **202** includes a shelf **240** secured to the front plate **232** for supporting a vessel to be filled with water, said shelf having a screen **242** therein and defining a tray for receiving spilled or overflow water. The tray defined by the shelf **240** is drained by a conduit **244**, which communicates with the drain **206** in a manner to be more fully described hereinafter. A nozzle **246** is mounted on the front plate **218** above the shelf **240**, and is connected to the dispensing equipment contained within the housing **208**.

The housing upper portion **214** includes a vertical back plate **248** having a generally trapezoidal shape, the lower edge of said back plate **248** being wider than the back plate **230** of the housing lower portion **212**. The side edges of the back plate **248** taper upwardly and outwardly from the lower edge thereof and said lower edge of said plate is welded to the top edge of the back plate **230**.

The housing upper portion **214** also includes an outwardly-inclined front plate **250**, corresponding generally in shape to the back plate **248**, and a pair of side plates **252** having forward edges that taper upwardly and outwardly from their lower edges. The plates **248**, **250** and **252** are welded together along their mating edges, and the lower edge of the front plate **250** is welded to the front plate **232** of the housing lower portion **212**. The top edges of the plates **248**, **250** and **252** are scalloped, and the right-hand side plate **252** is provided with small and large access doors **254** and **256**, respectively.

A rectangular filler plate **258** is welded between the lower edge of the left-hand side plate **252** and the housing lower portion **212** to close said space, and a ventilator assembly **260** is welded between the lower edge of the right-hand side plate **252** and said housing lower portion. As is best shown in FIGS. 10 and 11, the ventilator assembly **260** comprises a pair of rectangular, elongated plates **262** having a plurality of aligned openings **264** extending therethrough. A screen **266** is sandwiched between the plates **262**, and said screen and said plates are secured together by spaced screws **268**. The ventilator assembly **260** thus provides ventilation into the bottom of the housing upper portion **214**, while insuring that insects and other foreign matter cannot enter said housing.

The housing **208** is closed at its upper end by structure including a tray **270**, said tray being welded to the right-hand side plate **252** and between the front and back plates **250** and **248**, respectively, and being recessed below the upper end of said housing **208**. The tray **270** has a width equal to about one-seventh the length of the top of the housing **208**, and includes an upwardly-directed flange **272** on its free edge. The side plate **252** to which the tray **270** is welded is provided with a plurality of drain holes **274**, positioned immediately above said plate.

A recessed lid **276** is received within the upper end of the housing **208**, and extends from the left-hand side wall **252** for a major portion of the length of said housing; as is shown in FIG. 8, the free end of the lid **276** overlaps the tray **270** a distance equal to about ⅓ the width of the latter. The lid **276** is provided with upwardly-directed flanges **278** along three sides thereof, and is secured to the left-hand side plate **252**, and the back and front plates **248** and **250**, respectively by bolts **280**.

The free edge of the lid **276** has a downwardly-directed flange **282**, and said lid **276** is spaced vertically from the tray **270**, whereby to define a ventilation opening **284**. The ventilation opening **284**, as best shown in FIG. 8, is protected against the entrance of foreign matter by a screen **286**, said screen being secured to the flange **282** by a bar **288** and bolts **290**, and extending downwardly and inwardly into engagement with the tray flange **272**.

The lid **276** is further provided with handles **292**, and has an upwardly-projecting cylindrical standard **294** welded centrally thereof that terminates in a flange **296**. The lower flanged end **298** of an advertising sign **300** (FIG. 5) is secured to the flange **296** by bolts **302**, said sign being similar to the sign **36** of FIGS. 1–4, and preferably including internal lighting for illumination at night.

The dispensing equipment for the liquid vending apparatus **200** is contained within the housing **208**, and includes an automatically-operated electrical still apparatus which is supplied with raw water from a municipal water system or other available water supply. Said still can also be gas fired or heated with waste steam if available. The still apparatus distills the incoming raw water, and delivers it to a sealed reservoir contained within the housing upper portion **214**. A pump is mounted within the housing **208**, and is operated by a coin deposit of the correct amount in the coin box **238** to dispense distilled water from the sealed reservoir. An electric, positive-displacement meter is connected in the line between the sealed reservoir and the nozzle **246** for measuring the quantity of purified water being vended, and is connected electrically to deactivate the pump circuit of the apparatus when the correct quantity of purified water has been dispensed.

A conductivity meter is connected with the dispensing equipment as in the previous embodiment. This meter is of the commercially-available variety that can be provided with means to operate a switch in an electrical circuit and the device will be sometimes hereinafter referred to as a "conductivity controller." The conductivity controller is connected with the circuitry of the apparatus to deactivate the dispensing equipment when the pre-set, permissible level of impurity has been exceeded, and to shut down operation of the entire apparatus. It is used as a safeguard in the event that some malfunction of the still would cause raw water to be introduced into the pure water reservoir.

The dispensing equipment of the embodiment of FIGS. 5–13 is illustrated diagrammatically in FIG. 12, wherein is shown an electrically-operated still **304** equipped with a liquid level sight gauge **306**, and which includes a condenser **308**. The still **304** and condenser **308** are commerically available as an assembled unit, and the construction and operation of equipment of this type is well known. Hence, they will not be described in detail herein, except where necessary to an understanding of this invention.

Positioned to the left of the still **304**, and supported within the housing upper portion **214**, is a reservoir **310**, said reservoir being sealed and constructed from stainless steel, or other suitable material which will not add impurities to water contained therein. A pump **312** having a motor **314** is positioned below the still **304**, and is connected by a conduit **316** through a solenoid delivery valve **318** to an electric, positive-displacement flow meter **320**. The meter **320** is of the commercially-available type that can be set to measure a specified volume of liquid and actuate an armature which in turn controls a switch. This switch is connected into the control circuit to deactivate the delivery equipment when such quantity of water has been delivered. The liquid outlet from the meter **320** is connected to the nozzle **246**.

The liquid dispensing equipment, housed within the housing **208**, is supplied with raw water from the water supply source through a service conduit **322**, said conduit having a conventional vacuum breaker **324** connected therein to prevent backflow into the water supply in the event of a pressure differential in that direction. The service conduit **322** also has a solenoid valve **326** connected therein, above which is positioned a fluid pressure responsive electrical switch **328**, and extends through a manually operable needle valve **330** and conduit **331** to the inlet of the condenser **308**. Incoming raw water, which is relatively cool, is pre-heated in the conventional manner by passing it through coils in the condenser **308**, and is then exhausted therefrom into a conduit **332** connected with the upper end of an injector **334**. The injector **334** is connected with the still **304** by a nipple **336**, through which part of the pre-heated raw incoming water passes into said still. The remaining portion of the pre-heated raw water passes through the injector and serves a function later to be described.

The still **304** includes electrical heating elements (shown in the circuit diagram FIG. 13) arranged for either single-phase or three-phase operation, and is constructed to convert incoming, mineral and other impurity-laden water into steam. The steam rises through a conduit **338** into the condenser **308**, where it is condensed to liquid, which flows outwardly through a conduit **340**. The conduit **340** has a conductivity-sensing element **342**

and temperature-sensing element **343** connected therein, and extends to the inlet of a three-way solenoid valve **344**.

The operation of the three-way solenoid valve **344** is controlled electrically by a control circuit including the conductivity controller in a manner to be described hereinafter, so that when the water flowing from the condenser **308** is of the desired purity it will flow through a nipple **346** into the pure water reservoir **310**.

If water flowing from the condenser **308** is not of the desired degree of purity, the three-way valve **344** is arranged to be automatically actuated to drain the impure outflow of the condenser **308** into a conduit **348**. The conduit **348** terminates in an open petcock **350** connected by tubing **352** with the overflow funnel **354** for the still **304**. During still operation overflow water passes continuously from the still **304** into said funnel **354** through an overflow petcock **356**. Conduit **358** connects said funnel **354** with an inlet chamber of injector **334** so that the portion of the water which passes through the injector carries the still overflow water through drain conduit **360** to drain **206**. Conduit **244** from the shelf **240** is also connected to said drain pipe **360**.

The outlet piping arrangement from the condenser **308** also includes components for manually by-passing the three-way solenoid valve **344** to conduct condensed liquid to drain. Referring to FIG. 12, a by-pass **362** connects the conduits **340** and **348** before the three-way solenoid valve **344**, said by-pass including a manually-operable valve **364**. A shutoff valve **366** is disposed between the by-pass **362** and the solenoid valve **344**, and liquid from the condenser **308** can thus be directed to drain by closing the valve **366** and opening the by-pass valve **362**.

During operation of the still **304** there is a constant overflow through the injector **344**, which overflow carries off dissolved salts and passes into the drain conduit **360**. Since both this overflow and the injector water are warm, the combined flow can be utilized for heating the distilled water contained in the reservoir **310** to provide protection against freezing in cold weather. For this purpose, the reservoir **310** is provided with a coil **368**, the inlet and outlet ends of said coil **368** being connected with the drain conduit **360** by feed and return conduits **370** and **372**, respectively. The conduits **370** and **372** have manually-operated feed and return valves **374** and **376** connected therein, respectively, and a shutoff valve **378** is connected in the drain conduit **360** between the conduits **370** and **372**. Warm overflow water from the still **304** and condenser can thus be directed through the coil **368** by opening the feed and return valves **374** and **376**, and closing the shutoff valve **378**.

The reservoir **310**, as has been described, is constructed from, or at least is lined with, a material such as stainless steel, which will not add impurities to water contained therein. In addition, said reservoir is equipped with a liquid level-indicating sight glass **380**, and with a sterilizing vent unit **382**. The vent unit **382** is preferably of the type having a removable cartridge which contains a bacteriacide, so that air passing therethrough as water is added or removed from the reservoir **310** is purified of airborne particles and bacteria. Vent units of this type are commercially available, and can be obtained from the Barnstead Still & Sterilizer Co.

An outlet conduit **384** is connected to the bottom of the reservoir **310**, and has a manually-operated valve **386** and a pressure-responsive controller **388** connected therein. The pressure-responsive controller **388** is arranged to detect pre-selected high and low water levels within the reservoir **310**, and includes switch means connected into the electrical circuitry of the invention, as will be described in detail below, to deactivate the still apparatus when the level of liquid within the reservoir **310** reaches a pre-set maximum level, and to activate said still apparatus when said water level declines below a minimum value; the switch means of pressure controller **388** is also connected to deactivate the dispensing equipment when there is insufficient purified water in the water reservoir **310** to satisfy the quantity demanded for one cycle of operation.

A conduit **390** is connected with the outlet conduit **384** through a strainer **392**, and has a manually-operable valve **394** connected therein. The conduit **390** extends to the inlet of the pump **312** for conducting purified water thereto. It is to be understood, of course, that the various conduits and other fluid handling components in both embodiments of the invention are constructed from a material which will not add impurities to purified water passing therethrough.

A drain outlet conduit **396** is provided for the reservoir **310**, and is connected to the outlet conduit **384** through a manually-operable valve **398**. The conduit **396** is connected with the drain conduit **360**, and the reservoir **310** can thus be drained by merely closing the valve **394** and opening the valves **386** and **398**. The pump **312** and the piping associated therewith can be disconnected for servicing without the loss of water from the reservoir **310** by merely first closing the valve **386**.

Briefly, the embodiment of FIG. 5–13 operates as follows. Upon insertion of the proper coin combination into the coin box **238**, the solenoid valve **318** opens simultaneously with the starting of pump motor **314**. Purified water is then pumped to the customer's container through the positive displacement meter **320** and the nozzle **246**. When a pre-set, measured quantity of water has been dispensed, the meter **320** is actuated to cause the control circuitry to stop the flow of purified water by closing the valve **318** and deactivating the pump motor **314**.

The still apparatus **304** illustrated is of the type which can be cleaned by periodic acidization, and the dispensing equipment of the invention includes components to facilitate this operation. Referring again to FIG. 12, the feed, or service, conduit **322** has a Venturi-type injector **400** connected therein after the breaker **324**, said injector **400** including an inlet petcock **402** provided with a length of flexible tubing **404**. A reducing T **406** is also connected into the service conduit **322**, and is positioned after the injector **400**. The reducing T **406** includes a petcock **408**.

When it is desired to acidize the still, valve **366** is closed and by-pass valve **364** is opened; this switches distilled water to drain. Solid sulfamic or citrus acid is then dissolved in a suitable container (not shown) in which the tube **404** is placed, and the resultant solution is introduced into the still by opening valve **402**, whereupon the Venturi injector **400** will pull the solution into the feed line **322** by the action of incoming water flowing therethrough. The acid works through the still, and the sensing elements **342** and associated control circuitry will cause the three-way solenoid valve **344** to connect to drain. After the acid injection has been completed and at such a time as the distillate goes back on specification, the sensing elements **342** and associated control circuitry will cause the three-way solenoid valve **344** to again connect the conduit **340** with the reservoir **310**. An operator supervising the cleaning process can observe the movement of the three-way valve **344**, and after observing that it has been actuated to the reservoir **310** will open valve **366** and close valve **364**.

The acidization process will normally take no more than about thirty minutes. The solid sulfamic or citrus acid can be placed in solution by merely withdrawing water from the system and running it into the acid container (not shown), the petcock **408** being available for this purpose. Access to the valves **402** and **408** is provided through the access door **236**, which also provides access to the electrical control box **410** for the apparatus (indicated by broken lines in FIGS. 5 and 7).

The control circuitry for the embodiment of FIGS. 5–13, as has been mentioned, incorporates a conventional water conductivity or purity meter which is connected

with the sensing element 342. The conductivity meter measures the conductivity of the distillate which, during proper operation of the still would contain substantially no ionic impurities. It is connected into the circuit so that if the distillate, due to any malfunction of the still or for some other reason, picks up impurities so that the conductivity exceed the pre-set value, the following will occur: substantially simultaneously, the three-way valve 344 will be actuated to switch the distilled water to drain; the electrical heating element of the still will be deactivated; the solenoid valve 326 will be closed; the indicator light mounted in the housing 208 will be turned on; and the coin mechanism of the invention will be deactivated. Thus, as with the embodiment of the invention shown in FIGS. 1–4, the customer is assured that water which he purchases will be of the purity level established as a standard for the apparatus.

Referring now to FIG. 13, the control circuitry for the embodiment of FIGS 5–12 is illustrated diagrammatically. As has been noted, while only one coin mechanism is shown for the embodiment of FIGS. 5–12, it is to be understood that two or more such mechanisms and accompanying dispensing stations might be employed. The components of the circuit in FIG. 13 include a coin mechanism K, a vend relay L, a delivery relay M, an empty and delivery limit time delay relay N and a conductivity controller, or purity measuring meter, O. The structure of the individual components of the circuit illustrated in FIG. 13 is conventional, and forms no part of the present invention. These components, as will be seen from the following description, are, however, combined in a novel and advantageous manner.

The dispensing system for the embodiment of FIGS. 5–13 is such that by merely setting the meter 320 for the desired quantity of purified water to be dispensed and by adjusting the coin mechanism K, nearly any quantity of water can be delivered within the price limitations of the coin mechanism, that is, 1, 5, 10, 15, 20, etc., gallons could be delivered, depending upon the available range offered by the meter 320.

For convenience, the letter identifications K through O will be used in conjunction with the reference numerals shown on the particular electrical components in FIG. 13, as was done for FIG. 4. For example, when referring to an element of the coin mechanism K, the number of the component will be preceded by the letter K.

The coin mechanism K is identical to the coin mechanisms A and D, and includes elements K1 through K14, which correspond to elements A1 through A14 in FIG. 4. The coin mechanism K is adjusted to actuate upon a deposit of coins totaling the desired vend price.

The vend relay L is identical to the vend relays B and E of FIG. 4, and contains a relay coil L1 and switches L2 and L3 activated thereby. Similarly, the empty and delivery limit time delay relay N is identical to the empty and delivery time delay relay G, and includes a normally energized coil N1 and switches N2 and N3.

The control features of the embodiment of FIGS. 5–13 will be further described by reference to a typical operation.

*Operation of the still heater control*

The electric still apparatus 304 can be furnished either single-phase or three-phase electric current, depending on the available power source, P.S., and is equipped with heating elements 412 and 414, respectively, to accommodate either. The standard voltage is 220 volts, and the control circuit for the still 304 is the same for single-phase or three-phase service. Fused connector switch 448 is first closed to energize the control circuitry through line 430 to ground or neutral 431.

The purity, or conductivity, meter O includes a switch 416, which is moved between terminals 418 and 420, depending upon the measured conductivity of the purified water as measured by a bridge arrangement. The bridge arrangement includes a bridge 422, an amplifier 424, and a balancing motor 426, and moves the switch 416 toward the contacts 420 and 418 according to whether the measured conductivity increases or decreases from a preset null point. Indicator dial 428 indicates the degree of conductivity at a particular time. The purity meter, or controller, O includes terminals O1 through O10, the terminal O1 being connected to ground, and the terminal O9 connecting switch 416 to line 430.

When the purity of the delivered water is adequate, i.e., the conductivity of the water is low, switch 416 is moved into contact with terminal 420, and line 430 is then connected to line 432 through said conductivity switch 416 and terminal O10. Line 432 connects to the high level pressure switch 434 and the low level pressure switch 436, which switches 434 and 436 are part of the pressure controller 388 for detecting water levels in the reservoir 310; a high water level in the reservoir 310 will cause the high level switch 434 to open.

When the level of water in the reservoir 310 is below the high mark, line 432 is connected to line 438 through switch 434, and extends to the feedwater pressure switch 328. Line 438 also extends to the feedwater solenoid valve 326, whereby to energize said valve to feed water into the still 304 and apply pressure to the feedwater pressure switch 328.

If feedwater pressure is above the pressure setting of the feedwater pressure switch 328, said switch will move to terminal 440, thereby connecting line 438 to line 442 to energize the operating coil 444 of heater contactor 446. With fused connector switch 448 closed, and heater contactor 446 closed, power is then fed to the electric heaters 412 and 414 in the still 304, thus making the still apparatus operative.

It should be noted that on initial start-up of the still apparatus 304 the conductivity switch 416 must be temporarily bypassed, until water of sufficient purity has reached the measuring element 342; the commercially-available controller O includes means for so doing illustrated by the manually-operated switch 447.

*Operation of the empty and delivery limit circuit*

When the still apparatus 304 produces enough purified water to raise the level of water in the reservoir 310 above the setting of the low level switch 436, said switch activates to connect line 432 to line 450. Line 450 extends to the switch M2 on the delivery relay M, the coil M1 of which is energized only during the period of a sale; when relay M is not energized, switch M2 is in the closed position as shown, and line 450 is thus then connected to line 452. Line 452 connects to the operating coil N1 of the empty and delivery limit relay N, which is a pneumatic time delay relay constructed so that its switches N2 and N3 return to their solid line positions only after expiration of a time delay after the relay operating coil N1 is de-energized; when the relay coil N1 is energized, the switches N2 and N3 actuate instantly to the positions indicated by dashed lines.

The time delay setting of the relay N is adjustable, and is set to exceed the normal delivery time of the vending apparatus. Under normal operating conditions, the switches N2 and N3 of relay N do not actuate from their energized position as shown by solid lines, even though coil N1 is de-energized during each delivery period. If trouble develops in a component of the circuitry, and the delivery time exceeds the time delay setting of relay N, then the delivery will be shut off by the following circuitry. Line 430 connects to both of the switches N2 and N3 of the empty and delivery limit relay N. When relay N is energized as discussed above, the switch N2 connects the line 430 to the line 454, which line 454 is connected to the vend circuit, as will be discussed later. Switch N3 disconnects line 430 from line 456 when it actuates upon energization of coil N1, thus turning off the coin mechanism empty light K14.

In addition to the time limit on delivery feature that the relay N provides, it also serves to deactivate the vend circuit K in the event that the reservoir level drops below the low limit, as measured by switch **436**, or if water impurity exceeds the setting of controller O, as has been previously discussed.

The sensing element **342** of the conductivity controller is connected to the terminals O4 and O5 by leads **460** and **462**, respectively. In addition, temperature-sensing means **343** is connected by leads **466** and **468** to the terminals O6 and O7. When conductivity of the water, as sensed by element **342** and measured by controller O, exceeds the predetermined switch **416** moves to engagement with contact **418**, thus connecting line **430** to line **470**, whereby the three-way solenoid valve **344** is connected to conduit **348** to direct distillate to drain; when purity goes back on standard, switch **416** opens from contact **418**, and the valve **344** thereupon again connects the conduit **340** to the reservoir **310**.

*Operation of the vend cycle*

Assuming that all previously-discussed circuits and conditions are functioning normally, line **454** is energized through switch N2 when coil N1 is energized, as above described.

When coins totaling the vend price have been placed in the coin mechanism K, stepper motor K2 is actuated to move switch K5 from contact K15 to contact K16. Line **454** is then connected to line **472**, which connects to the vend relay coil **L1**, terminal **L4**, and to the meter bypass relay coil **474**. With vend relay coil **L1** energized, the switches L2 and L3 are moved to the dashed line positions, and the coil L1 is then connected to line **545** through an alternate circuit. Further, line **472** is then connected to line **476** through switch L3, said line **476** being connected to contact **478** on the electricontact flow meter **320**. Line **476** is connected to line **454** through switch **482**, and is also connected to contact **484** of meter bypass relay **480**. Line **476** connects to line **454** across switch **486**, when said switch is moved to contact **484**.

In the event that the electricontact flow meter **320** stops such that its switch **482** is left in the open position at the end of a delivery, the meter by-pass relay switch **486** closes around it so that the vend cycle will start properly at the beginning of the next cycle. Relay **480** is a thermal time delay relay, which has a two-second delayed opening when energized. It also has a short delay (approximately one second) before reclosing after it is de-energized.

When coil L1 is energized as above, switch L2 is moved to connect line **454** to line **488**, which is connected to the stepper reset coil K8 in the coin mechanism K. With the stepper reset coil K8 energized, the stepper vend switch K5 is moved to connect line **472** to line **490**; line **490** is connected to the delivery relay coil M1, and thus the delivery relay M is then energized. When the delivery relay M is energized, switch M3 is moved to the dashed line position, thus connecting line **430** to line **492**. Line **492** connects to the delivery solenoid valve **318**, and to the pump motor **314**, both of which are thus energized. With the delivery solenoid valve **318** and pump motor **314** energized, water flows through the electricontact flow meter **320** and nozzle **246** from reservoir **310**.

Line **488** connects through switch K6 to line **494** in the coin mechanism K, which line **494** is connected to the escrow cash box solenoid K7. The coins totaling the vend price are thus deposited into the cash box when line **488** is energized as above. As previously discussed, when the delivery relay coil M1 is energized, switch M2 is moved to de-energize the empty and delivery limit relay coil N1.

When the prescribed quantity of water is delivered, as measured by the meter **320**, the switch **482** is moved from contact **478** to de-energize vent relay L and delivery relay M, thus completing the vend cycle by causing pump motor **314** to stop and valve **318** to close. The vend relay L and delivery relay M then revert to their initial positions, as shown in solid lines.

During the vend cycle, line **496** is de-energized when vend relay switch L2 is moved to the dashed line position. Line **496** connects to terminal K17, to terminal K18, through the coin switches K1 to terminal K20, and then through line **498** to the coin return solenoid K9. The coin return solenoid K9 must be initially energized, or coins will be rejected when deposited and the vend price cannot be established. At the end of the vend cycle, the coin return solenoid K9 is first energized through the coin switches K1. Holding switch K10 is then moved to connect line **498** to line **496**, through the line **500** and the cancel switch K11. This completes the discussion of the vend cycle.

From the above discussion, it will be seen that when the impurity content of the water flowing from the condenser **308** into the reservoir **310** goes above the value set on the purity meter, or controller, O, the following will occur: the three-way valve **344** is actuated to shift the distillate from the reservoir **310** to drain; the still heating elements **412** and **414** are de-energized; feedwater solenoid valve **326** is closed; and the lamp K14 is lighted. Further, if the water level in the reservoir **310** should go below the level required to satisify a vend cycle, low limit switch **436** will be actuated to deactivate the vending mechanism, and when the water level in reservoir **310** goes below the high level the still operation will be started to replenish the water in the reservoir.

Thus, a unique dispensing arrangement has been provided which is interlocked to prevent the dispensing of impure water, or an inadequate amount. In addition, both embodiments of the invention are completely automatic in operation, and are connectable to nearly any available water supply.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

**1.** A vending machine for dispensing purified water, comprising: a housing having at least one purified water dispensing station on the exterior thereof; water treating means within said housing, including demineralization means, and designed to remove dissolved impurities from raw water passing therethrough; means for connecting said water treating means with a source of raw water to be treated; coin-operated dispensing means supported by said housing, and arranged to directly deliver through said dispensing station a predetermined quantity of treated water, only, in response to coin deposition of proper value; and means directly connecting said water treating means with said coin-operated dispensing means to transmit treated water, only, directly from said treating means to said dispensing means.

**2.** A vending machine as defined in claim **1**, including additionally means for indicating the purity of treated water flowing from said water treating means, said indicating means being connected with said means connecting said water treating means with said coin-operated dispensing means.

**3.** A vending machine as defined in claim **1** wherein means are included for detecting the purity of the treated water and for automatically deactivating the dispensing means when impurities in the treated water exceed a predetermined level.

**4.** A vending machine as recited in claim **1**, wherein said demineralization means comprises ion-exchange means.

**5.** A vending machine as recited in claim **4**, wherein said water treating means further includes carbon filter means and micronic filter means, connected in series with said ion-exchange means.

6. A vending machine as recited in claim 1, wherein said demineralization means comprises a still means.

7. A vending machine as recited in claim 6, wherein said still means is arranged to coact with said means connecting said water treating means with a source of water and with said coin-operated dispensing means to provide automatic operation of said machine to provide a substantially continuous supply of pure, treated water for the dispensing operation.

8. A vending machine for dispensing purified water, comprising: a housing; water demineralization means within said housing for removing dissolved impurities from raw water passing therethrough; means for connecting said water demineralization means with a source of raw water to be demineralized; coin-operated dispensing means supported by said housing, and arranged to directly deliver a predetermined quantity of treated, demineralized water only, in response to coin deposition of proper value; means connecting said water demineralization means with said coin-operated dispensing means, and including means for detecting the conductivity of treated water flowing from said water demineralization means; and means connected with said conductivity detection means and with said coin-operated dispensing means, and arranged to coact therewith to deactivate said coin-operated dispensing means when the conductivity of treated water flowing from said water demineralization means exceeds a preselected value.

9. The vending machine of claim 8 wherein the demineralization means is an ion-exchange unit and carbon filter means are provided in series connected relationship therewith.

10. A vending machine as recited in claim 8, wherein said water treating means comprises an automatic electrically-operated still for providing a substantially constant reserve supply of distilled water, said supply of distilled water being connected with said dispensing means.

11. A vending machine as recited in claim 8, wherein said coin-operated dispensing means, said conductivity detection means, and said dispensing means are connected by an electrical control circuit.

12. A vending machine for dispensing purified water, comprising; a housing; water treating means within said housing, said means including a demineralization means for removing dissolved impurities from raw water passing therethrough; means for connecting said water treating means with a source of raw water to be treated; coin-operated dispensing means supported by said housing, and arranged to directly deliver a predetermined quantity of treated, demineralized water, only, in response to coin deposition of proper value; means connecting said water treating means with said coin-operated dispensing means, said means including a flow control valve and means for detecting the purity of treated water flowing from said water treating means; and means connected with said detection means, said coin-operated dispensing means, and said flow control valve, and arranged to coact therewith to close said flow control valve and deactivate said coin-operated dispensing means when the impurity content of treated water flowing from said water treating means exceeds a preselected value.

13. A vending machine as recited in claim 12 wherein said demineralization means is an ion-exchange unit and said water treating means additionally includes a carbon filter means and a micronic filter means, connected in series with said ion-exchange unit.

14. A vending machine as recited in claim 12, wherein said means connecting said water treating means with said coin-operated dispensing means further includes a restrictive orifice for maintaining a constant flow pressure, and wherein said coin-operated dispensing means includes a timer connected with said flow control valve, said timer, said flow control valve and said regulator being arranged to coact upon coin deposition of proper value to dispense a preselected, measured quantity of purified water.

15. A vending machine as recited in claim 12, wherein said last-mentioned means further includes means for closing said flow control valve and deactivating said coin-operated dispensing mechanism when the fluid pressure of said source of raw water falls below a preselected value.

16. A vending machine as recited in claim 12 wherein said means connecting said water treating means with said coin-operated dispensing means further includes a positive displacement flow meter and wherein the means connected to said flow control valve include means responsive to a predetermined volume of flow through said flow meter to close said flow control valve.

17. A vending machine for dispensing purified water, comprising: a housing; water treating means within said housing designed for removing dissolved impurities from raw water passing therethrough, said means including a still means; means for connecting said water treating means with a source of raw water to be treated; coin-operated dispensing means supported by said housing, and arranged to directly deliver a predetermined quantity of treated water, only, in response to coin deposition of proper value; means connecting said water treating means with said coin-operated dispensing means, said means including: a reservoir; conduit means for connecting said still means with said reservoir; a three-way valve in said conduit means, said valve being operable to direct flow from said still means either to said reservoir or to drain; means in said conduit means for sensing the conductivity of water flowing therein to determine the purity thereof; and means connected with said conductivity sensing means, said coin-operated dispensing means, said still means, and said three-way valve, and operable in response to the detection by said sensing means of a water conductivity indicating water purity of less than a desired selected value to: deactivate said coin-operated dispensing means; move said three-way valve to a drain position; and close down the operation of said still means.

18. A vending machine for directly dispensing purified water, comprising: coin-operated dispensing means for directly dispensing purified water, a reservoir connected to said dispensing means, and electrical water still means arranged to treat raw water passing therethrough to remove dissolved impurities therefrom; for replenishing said reservoir, and including additionally means for detecting the level of purified water in said reservoir, said water level detecting means being connected with said still means and with said coin-operated dispensing means, and being arranged to coact therewith to deactivate said still means when said reservoir is filled to a first preselected level, to activate said still means when water in said reservoir falls below said first preselected level, and to deactivate said coin mechanism when the water level in said reservoir declines to a second preselected level, at which second level the amount of water in said reservoir is insufficient to satisfy a dispensing cycle.

19. A vending machine as recited in claim 17, including additionally a fluid pressure operated switch means in said means connecting said water treating means with a source of water to be treated, said switch means being arranged to deactivate said still means and said coin-operated dispensing means when the fluid pressure of said water source declines below a preselected value.

20. A vending machine as recited in claim 18, wherein said coin-operated dispensing means includes: a pump connected with said reservoir; a motor connected to said pump, and arranged to be activated upon coin deposition of proper value; and a positive displacement meter connected with said pump for measuring the quantity of water dispensed, said meter being arranged to deactivate said pump when a preselected quantity of purified water has been dispensed.

21. A vending machine for dispensing purified water, comprising: a housing; water treating means within said housing for removing dissolved impurities from raw water

passing therethrough; means for connecting said water treating means with a source of raw water to be treated; coin-operated, electrically-powered dispensing means supported by said housing, said dispensing means including at least one switch means operable in response to coin deposition of proper value, and means electrically connected to said switch means and operable in response to said coin deposition to measure and deliver a predetermined quantity of treated water, only; means connecting said water treating means with said measuring and delivering means, and including means for sensing the conductivity of treated water flowing from said water treating means for determining the purity thereof; and controller means electrically connected with said sensing means and said coin-operated dispensing means to deactivate the latter if the purity of the treated water, as indicated by the conductivity thereof and as detected by said sensing means, declines below a preselected value.

**22.** A vending machine as recited in claim **21**, including a plurality of said coin-operated switch means for directly dispensing different quantities of treated water, and means electrically connected with each of said switch means for deactivating the remainder thereof when one such means is in an operational cycle.

**23.** A vending machine as recited in claim **21**, wherein said means connecting said measuring and delivering means with said water treating means includes a pressure regulator and a solenoid valve, said valve being electrically connected to said measuring and delivering means, and wherein said measuring and delivering means includes an electrically-powered timer, said measuring and delivering means being arranged to open said solenoid valve for a period of time as measured by said timer upon coin deposition of proper value to operate said switch means.

**24.** A vending machine as recited in claim **21**, wherein said means connecting said water treating means with said measuring and delivering means includes a solenoid valve, and wherein said measuring and delivering means includes a positive displacement fluid measuring meter, said solenoid valve and said meter being electrically connected and arranged to open said solenoid valve and dispense a preselected quantity of purified water as measured by said meter upon coin deposition of proper value to operate said switch means, and to thereafter close said solenoid valve.

**25.** A vending machine as recited in claim **21**, wherein: said water treating means includes a still means having electrical heating elements; said means connecting said water treating means with a source of water includes a feedwater solenoid valve; and said means connecting said water treating means with said measuring and delivering means includes a three-way solenoid valve movable between a normal service position, and a position wherein water from said treating means is directed to drain; said heating elements, said feedwater solenoid valve, and said three-way solenoid valve being electrically connected with said controller means, and arranged so that when water purity declines below said preselected value said heating elements will be deactivated, said feedwater solenoid valve will be closed, and said three-way solenoid valve will be moved to drain.

**26.** A vending machine as recited in claim **25**, including additionally a reservoir in said means connecting said water treating means with said measuring and delivering means, said reservoir being positioned after said sensing means and said three-way solenoid valve, and means for measuring the level of water within said reservoir, said water level measuring means being electrically connected with said heating elements, said feedwater solenoid valve, and said coin-operated dispensing means, and being arranged to: close said feedwater solenoid valve and deenergize said heating elements when said reservoir is filled to a first level; open said feedwater solenoid valve and energize said heating elements when the water level in said filled reservoir is emptied of a preselected quantity of water; and open said feedwater solenoid, energize said heating elements, and deactivate said coin-operated dispensing means when the water level in said reservoir is below that required for a dispensing cycle.

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