

DISPENSING SYSTEM AND METHOD, AND INJECTOR THEREFOR

RELATED APPLICATION

[001] This application is a continuation-in-part application of U.S. Utility Patent Application No. 11/280,577, which is hereby incorporated by reference in its entirety. This application claims priority to U.S. Provisional Patent Application Serial Nos. 60/993,878; 61/069,443; 61/070,986; 61/134,328; and 61/135,259, which are hereby incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[002] The present invention relates in general to dispensing devices. It more particularly relates to a dispensing device which may be utilized to mix two fluids.

Background Art

[003] There is no admission that the background art disclosed in this section legally constitutes prior art.

[004] There have been a variety of techniques and devices to facilitate the washing of a person's hands. For example, reference may be made to U.S. patents and published applications as follows: U.S. patent 5,199,118; U.S. patent 6,236,953; U.S. patent 6,426,701; and U.S. patent application 2007/0157978.

[005] There have been a variety of concerns or problems associated with the mixing or dispensing of two fluids, such as a liquid soap and water. For example, where there is a conventional hand cleaning basin, including those in rest rooms and kitchens, whether at home, restaurant, retail store, hotel, hospital rooms, and others, there are common problems in dispensing, handling, storing and cleaning up liquid hand soap.

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[006] Conventionally, many commercial establishments have installed infrared detector activated no-touch water faucets and no-touch liquid soap dispensing systems as well. This helps alleviate many aesthetic and sanitary problems for both customers and rest room cleanup crews. But there are still major drawbacks for some applications.

[007] In washing their hands, users oftentimes reach to operate a liquid soap dispenser for soap. There are many different and inconsistent ways of pressing, pulling up or down to eject liquid soap. If the dispenser is wall mounted to the side of the sink, excess soap may dribble down to the floor or into a wastebasket. There are often problems, especially with the manual systems, of obtaining a sufficient amount but not too much, liquid soap.

[008] If the dispenser is on the wall opposite to or adjacent to the sink, the excess liquid soap may spill onto the sink or the counter, and create an unwanted unsightly mess. The dispenser may be positioned on the counter and the excess soap may pool thereon in an undesirable way. In any case, in many applications the inadvertent spilling or accumulation of excess soap can be unsightly and a source of constant clean-up and irritation.

[009] As far as soap to be used for hand washing, concentrated liquid soaps, such as Basic H (Shaklee Corp., Pleasanton, CA), are much more efficient to use and less contaminating to the environment. The overall cost is less expensive because of the greatly reduced volume and weight affecting manufacturing, shipping, and storage. Use of concentrated liquid soap results in a great savings of water and time, because they mix quicker with water, lather up more easily, and rinse off much more quickly.

[0010] According to the Centers for Disease Control and Prevention (CDC), the correct way to wash hands thoroughly is to first wet them, and then to apply soap. Next, the hands are rubbed together to mix soap and water, scrubbing all surfaces to dislodge germs. Finally, the hands are rinsed well to remove soap and germs, and then dry the hands.

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[0011] Many people wash their hands "incorrectly." They first apply soap onto the hands, and then turn on the water, which immediately rinses much of the soap off before washing can even begin. In either case, the water and soap come from separate sources, are applied sequentially, and are mixed by rubbing the hands.

[0012] At best, the prevailing correct procedure has a number of draw backs in certain circumstances associated with it. Water, being applied first, may wet most of the hand surfaces, including under the fingernails, making it difficult for the soap to penetrate these hard-to-reach crevices, because surface tension of the water can prevent or at least greatly inhibit the liquid soap from entering the cracks and crevices, as did the water. Standardized testing methods used in the United States to determine the efficacy of surgical hand scrubs focus on the survival of bacteria on exposed skin surfaces. Fingernail crevices are excluded from testing by careful nail clipping and cleaning. Studies seem to suggest that subungual areas of the hand harbor high concentrations of bacteria. The water passage in the faucet can become contaminated under certain circumstances by pathogens, which can persist there undetected, to be spread to users during rinsing. Microbes harbored inside the faucet often may survive rigorous external cleanings.

[0013] Much of the volume of most or many hand washing solutions may be filler added to the soap composition to make it easier for users to control the amount of soap dispensed and as an aid in spreading or distributing it about their hands. There also may be a psychological aspect in that concentrated soaps may not give users the feeling that they are applying sufficient solution to properly perform the cleaning function. Filler, which adds to the bulk, weight and viscosity, also adds to the cost of manufacture, transportation, and storage. Filler also may make mixing the solution on the hands more difficult and takes longer. Because some of the solution may never really become well mixed, rinsing also may take longer, resulting in wasting of water. The excess soap and water may then flow into our waste water systems and is not ecologically desirable. The longer it takes to complete the whole hand washing process, the more likely the washing of one's hands may be performed inadequately and quickly, or may be skipped entirely. Even healthcare workers in hospitals may skip hand washing due to the time consuming nature of the

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process. Hence the CDC promotes the supplemental use of antiseptic gels because they may be more convenient than washbasin washing. However, regular hand washing may still be necessary to remove dirt and viruses.

[0014] In an attempt to facilitate hand washing, several systems to dispense soap and liquids into the water stream have been proposed. U.S. patent 6,471,847 B2, titled Household Liquid Dispensing System, describes a system for dispensing a household liquid through an outlet of a household water system. It can be utilized for showers, bathtubs, laundry tubs and sinks. It has an exterior storage unit of considerable size and complexity with controls to affect both the rate and time fluid or soap is added to the water flow.

[0015] The focus of the system is on the dispensing of soap and requires conscious monitoring of the procedure. The system utilizes either a venturi or gravity feed system to add the liquid to the water. In either case, the water pressure and flow rate have a strong effect on the mixture ratio of fluid to water, and are dependent upon a fairly high speed of water through the system. The soap is not mixed with the water before exiting the outlet, such as a spray head. So both the quantity of soap introduced and degree of mixing with water may be variable for at least some applications.

[0016] U.S. patent 5,961,049, titled Shower Spray with Admixture of Ingredients and Air, accomplishes much the same function as the above cited patent, but is limited by describing the venturi method only. The system has very small liquid storage chambers; however, it can also add air to the mix.

[0017] A more common approach, in which the soap and water are not mixed together, but discharged in proximity is described in U.S. patent 5,114,048, titled Faucet Assembly Having Integral Liquid Product Dispenser. As stated in the patent, the dispenser discharges the liquid products adjacent to the flow of water from the faucet assembly. An advantage to this system appears to be that the soap discharge is over the washbasin.

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[0018] U.S. patent 5,031,258, titled Wash Station and Method of Operation, discloses a system for automating substantially the entire water/soap discharge operation in an effort to streamline hand washing. It too discharges soap and water selectively from separate outlets at the end of a faucet. Hence it has the same limited advantage over current practice of entirely separate water and soap dispensers as the previously cited patent.

[0019] Chemical Injector systems are used to inject fluid chemicals directly into water stream products. Examples are devices sold by Hammonds Technical Services, Inc., Houston Texas. These fluid-powered motor additive injection systems are for relatively large flow rates, starting with 7 gallons per minute. Using a motor driven by the fluid stream, the amount of additive will always match the existing flow rate, maintaining a constant proportion. It is interesting to note that since the injection point of these systems is disposed upstream of the fluid motor, thorough blending of product and additive may be achieved.

[0020] A system for injecting or controllably metering detergent in a dishwashing system, is disclosed in U.S. Pat. No. 5,218,988, titled Liquid Feed System, which describes the use of a peristaltic pump to meter a chemical at the injector port.

[0021] Numerous systems that inject one fluid into the moving stream of a second fluid, such as garden sprayers, rely solely upon a pressure drop in the injector to draw or suck, fluid into the mainstream. This pressure drop may be so reduced at the flow rates, that it may not be a reliable injection mechanism for some applications.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The features of this invention and the manner of attaining them will become apparent, and the invention itself will be best understood by reference to the following description of certain embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

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[0023] FIG. 1 is a partial section, pictorial view of an embodiment of the present invention having manually controlled hot and cold water handles, and a soap injector disposed within the faucet spout;

[0024] FIG. 2 is a system diagram of a faucet having manually controlled hot and cold water handles, and a soap injector in the faucet spout, illustrated in FIG. 1;

[0025] FIG. 3 is a pictorial view of another embodiment of the present invention, a no-touch faucet, with all functions, including that of hot and cold water flow rates, water flow activation, as well as initiation of the soap dispensing sequence, all controlled by the user interacting at a distance with several sensors;

[0026] FIG. 3A is a sectional view of the indicated portion of FIG. 3;

[0027] FIG. 4 is a system diagram of a no-touch faucet as illustrated in FIG. 3;

[0028] FIG. 5 is a pictorial view of yet another embodiment of the present invention, a faucet having electronic control of water flow and temperature, no-touch or automatic activation of flow from the faucet, as well as two different soap solutions;

[0029] FIG. 6 is a system diagram of a faucet having the controls and functionality illustrated in FIG. 5;

[0030] FIG. 7 is a pictorial view of still another embodiment of the present invention, having a separate electronic control retrofitted to operate a conventional manual faucet, so that an existing installed faucet can be upgraded to have the functionality of the present invention;

[0031] FIG. 8 is a system diagram of the faucet retrofit illustrated in FIG. 7;

[0032] FIG. 9 is a left exploded view of the soap injector partially shown in FIG. 1;

[0033] FIG. 9A is a perspective sectional view of the soap injector of FIG. 9;

[0034] FIG. 9B is an enlarged detail view of the indicated portion of FIG. 9A;

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[0035] FIG. 9C is an enlarged view, rotated 1800, of the seep blocker 138 illustrated in FIG. 9;

[0036] FIG. 10 is a system diagram of an experimental testbed for the present invention;

[0037] FIG. 11 is a perspective view of an alternative embodiment of the right side of the injector 140 shown in FIG. 9;

[0038] FIG. 11A is an enlarged perspective exploded partial view of the bottom portion of the left and right sides of the injector, the right side of which is shown in FIG. 11;

[0039] FIG. 11B is an enlarged perspective sectional partial view of the two bottom portions of the injector shown in FIG. 11A;

[0040] FIG. 12 is a pictorial view of yet another embodiment of the present invention, a user programmable faucet, having two soap selector dials, a soap button, a pointing device, and display areas for all of the controls;

[0041] FIG. 13 is a pictorial view of yet another embodiment of the present invention, having the soap dispensing components in a system box with a soap refill container;

[0042] FIG. 14 is a system diagram of yet another embodiment of the present invention, that is a faucet retrofit for a standard manual lavatory faucet, with the plumbing components in a system box, such as shown in shown in FIG. 13;

[0043] FIG. 15 is a left exploded view of yet another embodiment of the present invention, a soap injector with an integrated check valve;

[0044] FIG. 15A is a left assembly view of the injector components shown in FIG. 15, with the check valve ball in strong flow position;

[0045] FIG. 15B is a left assembly sectional view of the injector components shown in FIG. 15A, but with the check valve ball in no flow position;

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[0046] FIG. 16 is an orthographic sectional view of yet another embodiment of the present invention, a soap injector with integrated check valve and inductive proximity sensor, with the check valve ball in back flow position;

[0047] FIG. 17 is a system diagram of yet another embodiment of the present invention, that couples a point of use water heater with a soap dispensing system in a system box;

[0048] FIG. 18 is a system diagram of yet another embodiment of the present invention, that utilizes bleed water pressure to expel soap from the soap container.

[0049] FIG. 19 is an orthographic sectional view of the soap container indicated in FIG. 18 with a full refill before attaching to the system box;

[0050] FIG. 19A is an orthographic sectional view of the soap container indicated in FIG. 18 and shown in FIG. 19, but attached to the system box and with a nearly empty soap bag; and

[0051] FIG. 20 is a system diagram of yet another embodiment of the present invention, that utilizes a liquid and/or gas propellant to expel soap from the soap container. Single water and soap sources feed multiple faucets.

DESCRIPTION OF CERTAIN EMBODIMENTS OF THE INVENTION

[0052] It will be readily understood that the components of the embodiments as generally described and illustrated in the drawings herein, could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of the embodiments of the system, components and method of the present invention, as represented in the drawings, is not intended to limit the scope of the invention, as claimed, but is merely representative of the embodiments of the invention.

[0053] A method and system are disclosed for integrated water and soap dispensing. According to an embodiment of the invention, the disclosed dispensing system may include or be combined with a faucet in communication with a water

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supply via a water line and a dispensing device adapted to create a mixture of a liquid such as soap with water in the water line. The soap dispensing device may include an injector, and a liquid container for storing a liquid such as a liquid soap or other.

[0054] In accordance with another disclosed embodiment of the invention, there is provided a user programmable faucet. The programmable faucet may include a spout for dispensing fluid, a manual handle for controlling rate and temperature of fluid dispensed via the spout, a first switch for controlling the introduction of soap into the dispensed fluid, a second switch for selecting the type of soap introduced into the dispensed fluid, a programming button for programming the operation modes for at least one of the first and second switches, and a programming display for displaying the programming status.

[0055] According to another aspect of a disclosed embodiment of the invention, there is provided an injector for mixing fluids. The injector may include a first side and a second side. The first side of the injector may include a fluid inlet, a constricted portion, and a first vortex generating portion. The second side of the injector may mate with the first side of the injector and include a constricted portion and a vortex generating portion. The constricted portions of each side create a constrictor and the vortex generating portions of each side may be located opposite each other when the first and second sides are assembled.

[0056] In accordance with still another disclosed embodiment of the invention, there is provided a hand washing system, which may include a faucet having a spout for dispensing fluids, a soap injector disposed within the spout, and a soap dispensing device adapted to provide soap to the soap injector, the soap dispensing device including a soap pump and a soap container. The soap injector may be adapted to create a soap and water mixture within the spout of the faucet.

[0057] In accordance with yet another disclosed embodiment of the invention, there is provided a hand washing system. The hand washing system may include a faucet in communication with a water supply via a water line, a no-touch soap sensor disposed on the faucet, and a soap dispensing device adapted to be

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activated by the no-touch soap sensor and create a soap and water mixture in the water line. The soap dispensing device may include an injector, a soap pump, and a soap container.

[0058] According to yet another aspect of the disclosed embodiment of the invention, there is provided a hand washing retrofit kit for converting an existing faucet in communication with a water supply via a water line into a hand washing system. The kit may include a control panel adapted to be mounted adjacent the faucet and a soap dispensing device adapted to introduce soap into the water line and activated by the control panel. The soap dispensing device may include an injector, a soap pump, a microcontroller, and a soap container.

[0059] In accordance with the invention, the soapy mess common to washbasins may be eliminated. Hand washing may be quick and easy: Press a button and soapy water comes out of the faucet. To rinse, hold your hands under the same faucet for an automatic flow of water. It may also improve sanitation and hygiene (public health) by making washing quicker, easier, more effective, and therefore more often actually done.

[0060] The present invention may effectively deal with most of the problems associated with current hand washing practice:

- (1) The water/soap mixture may be applied to dry hands, easily and quickly wetting all surfaces and is drawn by surface tension into cracks in the skin and under the nails. It may flow very easily, being of low viscosity and in abundant supply. Disinfectant action may be much more complete and effective. Virtually no time may be wasted, because mixing and spreading of the solution takes but moments.
- (2) Antiseptic hand wash solutions, if used, may tend to disinfect the water passage in the faucet.
- (3) Concentrated soap may be used without need for any fillers. The generous volume of water/soap mixture may be psychologically satisfying by itself. Reduced bulk of soaps used in commercial, public and home situations may lead to significant economies in manufacture,

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transportation and storage. Because of more the efficient application, less soap may be used. Reduced hand rubbing time necessary to mix, clean and rinse may results in water savings, too.

(4) The whole hand washing process may be shortened and made much more convenient and pleasant, so it may be done more effectively and skipped much less often. This may improve our sanitation and hygiene with consequent health benefits.

[0061] The present invention may lend itself to applications in addition to those illustrated here, but be easily understood in light of the flexibility and power of the system. Much of this adaptability and usefulness may derive from the use of electronics and imbedded microprocessors that facilitate sophisticated behavior to accommodate a wide range of anticipated and unanticipated uses. For instance, the separate retrofit control 314, shown in FIG. 7, may be placed at some distance from the delivery spout, located where most convenient for users with special needs, accommodating to their restricted range of reach and other factors. Many with physical limitations find conventional mechanical faucet mechanisms difficult or impossible to manipulate. It may be relatively easy to adapt alternate kinds of interfaces to the soap dispensing system, such as voice activation or electronic control mechanisms with very low force and range of movement requirements, using potentiometer- or rheostat-type dials, and force sensing surfaces and switches that can be provided in a range of sizes and sensitivities — which may be customized to individual users by simply changing microprocessor programming. Non-traditional input controls — at least in the realm of plumbing and water faucets — may be the use of sliders (such as commonly seen on sound boards for audio systems) and touch sensitive flat panel displays. Such computer-type displays may facilitate fully user customizable input to faucet systems that could be useful in experimental testing, such as to determine the efficacy of various "soaps" in cleaning and disinfecting. Not only would such systems provide complete control and repeatability, but also may facilitate documentation of all events. Such a system is anticipated by the testbed system depicted in FIG. 10. Another use of the retrofit control 314, shown in FIG. 7, may be for showers. The control may be mounted on vertical surfaces, such as shower enclosures.

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[0062] Some of the design features shown in the various embodiments of the present invention may find useful application to systems that do not dispense soap. An example may be the no-touch faucet system shown in FIG. 3, that may control the flow of hot and cold water without any physical contact by the user. Another design feature of general application is illustrated in FIG. 1. The manual water handles may intersect with the escutcheon in such a way that there is a smooth surface without any crack or crevice into which fluids, dirt, or pathogens can lodge. This may be very important, because in conventional practice, the movable handle is separated from the escutcheon or fixed portion of the faucet by some sort of gap to allow movement or rotation. In FIG. 1, this gap may be filled in by a flexible silicone gasket that allows the necessary movement of the handle so that the user can still manipulate the faucet controls, but the gasket may be somewhat compressed in installation so that the seal is impervious to fluids and dirt. In addition the surface composed of the gasket and faucet structure around the gasket may be smooth and without interruption to allow easy and complete cleaning of the external faucet surfaces.

[0063] The gasket design as described above may work in consort with the unique property of the present invention to control pathogens that often contaminate the various external and internal surfaces of most faucets often surviving rigorous external cleanings. The soap solution as it is regularly discharged from the faucet, may tend to act upon pathogens in the faucet water passage, greatly reducing the spreading to users during rinsing.

[0064] It may be important that soap dispensing systems have a method to instantly terminate the soap dispensing function. For safety reasons, such as the need for water to cool a burn or flush poison out an eye, there may need to be a "kill" button, or some other intuitive way to instantly terminate the soap mode. Placing a finger on the soap sensor for several seconds may work. Another way may be moving the hand into and out of the sensing area of the soap sensor. A quick succession of two or more taps on the soap switch may accomplish the same thing, depending upon the user interface provided.

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[0065] Feedback is important to soap dispensing systems, so that the user knows what is actually happening — if the faucet is actually delivering a soap mixture or water only. Of course, if the soap is a type that generates a lot of bubbles when the user is soaping up, then the bubbles may be an indication of soap. In addition to bubbles, there may be other ways to make the dispensing of soap more obvious. Dye may be added to the concentrated soap, so that the water may be slightly colored when the soap solution is coming out of the faucet. The color may be more apparent when seen in against a white basin with some depth of water in it. The soap bubbles may also carry the color of the soap. If more than one kind of soap is available from the faucet, each may have a distinctive color, for instance yellow for hand soap and green for produce soap. There may be downsides from using dye — in order to make it obvious enough to even the casual observer, quite a bit of dye may be used, adding to the volume of the concentrated soap. Dye may be considered objectionable or disturbing to users, and may even dye something exposed to the soap solution that is highly water absorbent and of a very light color. Of course the dye may normally go down the drain into the wastewater as a contaminant. Another way to color the water, but without using dye may be to have a colored light source, such as an LED installed in the end of the faucet, conducting light into the water flow. There may a number of novelty products on the market sold for fun and entertainment that do just that, turning running water from a faucet a bright color, such as blue. Some products may be controlled by the water temperature, blue indicating cold and red hot water. Aside from coloring the water itself, a flashing light proximate to the soap activating control may indicate that soap is in the process of being dispensed.

[0066] The soap dispensing system may be added to bidets, so that the cleaning or washing process proceeds with more efficacy than possible with water-only as conventionally done. The additive concentrate should be selected so that it is non-irritating to sensitive tissues. Various solutions may be made available for different situations and differing aesthetic tastes, since bidets are very personal devices.

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[0067] Referring to FIG. 1, an embodiment of the present invention as normally seen by a user looking down onto a countertop and washbasin is shown. The integrated soap and water dispensing system may include a soap injector 20 located internally inside the faucet spout, between a delivery end of spout 28, and the base of spout 30. A manual hot water handle 32, and a manual cold water handle 34, may be manipulated by a user to control water delivered by a water line 24, to the injector 20. A soap button remote 36, located on the countertop 38, may be pressed by the user to initiate soap delivery by a soap line, 26 also connecting to injector 24, where the delivered soap and water may be thoroughly mixed, to flow out of the spout into the washbasin 40. A soap indicator 37 on the soap button remote 36 may be an LED light that flashes when the faucet is actively dispensing soap. The rotatable hot water handle 32 may be separated from the escutcheon 31 by a red gasket 33, made of flexible silicon, which may form a contiguous surface with them, sealing the gap. In a similar manner, the rotatable cold water handle 34 may be separated from the escutcheon 31 by a red gasket 35. The gasket colors, red and blue, may serve to identify the hot and cold water handles.

[0068] Referring now to FIG. 2, a system diagram of the present invention of FIG. 1, the operation of the faucet is conventional, unless or until the user presses the soap button remote 36, bringing the below countertop components into play. But before then, the hot water supply 42 and cold water supply 44 may feed water to their respective manual hot and cold water valves 32 and 34, which may be controlled by the user manipulating the respective handles for each valve. As in a conventional faucet hot and cold water flows come together at the base of the spout 30, and continue up the spout to be discharged at the delivery end of the faucet 28. But, in this embodiment of the present invention, the water flow may pass through the soap injector 20, before being discharged. When the user presses the soap button remote 36, a signal may be transmitted to the microcontroller 50, the switch data may be sent by radio signals, in which case the soap button remote 36, if it contains a battery powered transmitter (not shown), may be moved about freely within radio range of a receiver (not shown) associated with the microcontroller 50. If the soap button remote (in the system diagram, "soap switch") 36 is fixed in place

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on the countertop 38, the connection may be by electric wire, eliminating the radio link. The microcontroller 50 may be preprogrammed to operate the soap delivery system which may have a soap pump 46, which may send soap stored in the soap container 48 through the soap line to injector 26. The soap injector 20 may mix the soap into the water flow before the mixture is discharged. NOTE: This and the other system diagrams are diagrammatic and do not show electric components such as power supplies, electric lines, motors, and electronic circuitry; nor do they show various displays providing feedback to the user, some of which may be controlled by the microcontroller, and others integrated with the input devices and operated directly without mediation. Among the several types of pump that would be suited for the soap pump 46 may be small peristaltic tubing pumps, such as dosing pumps supplied by Automated Aquarium Systems, Inc., Tustin, CA. Such pumps may be highly resistant to back pressure that may occur should the faucet be blocked when water is flowing into the soap dispensing system. They may make a positive seal, so soap may not be accidentally discharged to the injector 20.

[0069] Referring now to FIG. 3, another embodiment of the present invention as normally seen by a user looking down onto a countertop and washbasin is shown. This no-touch faucet may not only feature a fully automatic no-touch soap dispensing system, but also no-touch hot and cold water control. The automatic sensor 170 may control flow from the faucet in the conventional automatic faucet way — turning on when the sensor detects an object (normally hands) over the washbasin. The soap sensor 68 may trigger the soap dispensing system function when a hand is held or waved over the sensor. A soap indicator 169 may be an LED light that flashes when the faucet is actively dispensing soap. For hot water, the user may easily place an open hand, face down, above the hot water symbol 158, controlling the hot water flow rate by varying how far the hand is above the hot water symbol 158, which may be atop and centered on the hot water raised spherical surface 162. Within the several-inch range that the hot water sensor 154 responds to, the higher the hand, the more hot water. Moving the hand within close range (less than an inch) above the hot water symbol 158 shuts off the hot water. The user may instantly control or modulate the water flow by moving a hand horizontally into the sensing area, which, for easy visualization by users, may be

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described as a column several inches wide extending from just above the hot water raised spherical surface 162. The hot water display 164 may show how strong the water flow is. When the display is dark, the water may be off; when the full semi-circular width is all bright red, the water may be full on. Intermediate flow rates may be indicated by a smaller colored area, such as shown here by the cold water display 166. (There is a cold water sensor 156, on the side of the faucet opposite the hot water sensor, but it is not shown in this figure.) Cold water may be controlled in the same manner as hot water, but with the user's hand above the cold water symbol 160. Note: The hot water symbol 158 and the raised spherical surface 162 may be visual clues, targets, or reference points to the user, and may be otherwise non-functional. Both the hot water sensor 154 and the cold water sensor 156 may be composed of an array of infrared sensors, each designed to detect objects within a specific volume of space with overlapping zones, so that taken as a whole, the array may sense the location of a hand with sufficient resolution to satisfy users that they have good control over water flow. When flow has already been established by the user, the hot and cold water flows may maintain the same rate until either a preset period of time has lapsed without additional user input, in which case, to conserve water and to reduce the possibility of water damage from a continuously running faucet, the faucet may automatically shut off, or the other case being when the user reintroduces a hand above a water control sensor, such as the hot water sensor 154. In the latter case, the system may recalibrate itself, so that it takes the new hand position above the sensor as setting the current rate of flow. This may be true, so long as the user introduces the hand within the normal operating range of the sensor. Thus, the user may actually feel "in control" of the water flow. Easily moving the hand up or down may have the expected effect — either increasing or decreasing the flow — not suddenly jumping to a different rate, because the user has not introduced the hand precisely at the same distance over the target, such as the hot water symbol 158, that the hand had been when the rate was set previously. Of course this may change the range of hand movement available before reaching both of the extremes (off and full-on), but may be instinctively, if not intellectually understood by the user. An analogy would be that when a user reaches out to adjust the flow of water with a manual handle or knob that is essentially circular

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without any protruding handle, the user may simply turn it one way or the other to effect the desired change, without paying attention to how far (degrees of rotation) that the faucet is already turned from the closed position. Some systems like this have to be counterintuitive (intellectually) to interface correctly with the people's intuitive (instinctive) behavior.

[0070] Referring now to FIG. 3A, which clearly shows the somewhat subtle cross-section of the raised spherical surface 162.

[0071] Referring now to FIG. 4, a system diagram of the present invention of FIG. 3, the operation of the faucet may be designed to be "transparent" to the user. That means they may not have to think about how to use it — it just works in ways that are obvious and expected. Of course, even in appearance, it may differ from conventional faucets, primarily by not having any handle to control hot and cold water flow. To a large degree, the system design, including how it is programmed may be essential to achieving the goal of satisfying the user. Starting with the hot water supply 142 and the cold water supply 144, the flow of water through the faucet and intervening soap dispensing system may be controlled by proportional solenoid valves, which are not simply on/off valves as typically associated with solenoids, but fully proportional with a smooth range of flow rates from full open to closed. IQ Valves, a division of Technocraft, Inc., Melbourne FL may be a source of such products. A microcontroller 188 may control these valves with inputs from the hot water sensor 154, the cold water sensor 156, the soap sensor 168, and the automatic sensor 170. Also controlled by the microprocessor may be the soap pump 146 for delivering soap from the soap container 148 to the soap injector 120 from which water or a soap solution flows out of the faucet spout 152.

[0072] Referring again to FIGS. 3 and 4, a system and method to quickly and easily program or reprogram the microcontroller 188, is described. Taking advantage of the capabilities of the automatic sensor 170, which may include two-way communication, bringing a hand held, portable device (not shown) within the operating range and in front of the sensor 170, may enable the portable device, which is equipped with a sensor with similar capabilities to exchange information.

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The portable device may store computer code that contains instructions for the microcontroller to affect the desired behavior of the soap dispensing system. The operator of the portable device may activate control(s) so that the device detects signals (such as infrared) sent out by the sensor 170 in normal detection function. In response, the portable device may send out a coded signal that may be read by the sensor 170, and interpreted as the signal for the sensor 170 communicating with the microcontroller 188, as components of the soap dispensing system, to receive and store programming information. After transmission of a coded signal sequence, the soap dispensing system may send back to the portable device an encoded value that corresponds to a check function of the programming information package it was sent. If the portable device reads the same encoded value it had calculated would be associated with the information it had just sent, it may tell the soap dispensing system that the exchange is completed. This entire sequence may take a matter of seconds and involve no physical contact between the programming device and the soap dispensing system, so that a number of soap dispensing systems may be programmed in a short time by one person.

[0073] Referring now to FIG. 5, another embodiment of the present invention as normally seen by a user looking down onto a countertop and washbasin is shown. This tilt handle kitchen faucet 292 may function like a conventional mechanical faucet until the automatic button 204, is pressed, making the faucet responsive to the automatic sensor 294, then the faucet may function like a conventional automatic faucet. The faucet mode may be indicated by the automatic mode indicator 206. Pressing either the soap #1 switch 296 or soap #2 switch 200 may activate the soap dispensing system, so the faucet may also dispense soap. Pressing on an already selected soap switch, as indicated by the soap #1 indicator 298 or the soap #2 indicator 202 may switch the faucet back to water only. The soap #1 indicator 298 and the soap #2 indicator 202 may flash when the faucet is actively dispensing the respective selected soap. The automatic sensor 294 may not be fixed, but rotate with the spout. This may be convenient and easily understood by the user. The single handle water control 290 may be moved by the user up-and-down for flow control, hot and cold water 290A, and pivoted from side-to-side for temperature control, hot and cold water 290B. This type of handle and

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motions are conventional, but in this embodiment of the present invention, the lever motions may not be directly linked to mechanical valving, but may operate electronic input devices such as potentiometers, which may send electrical signals to the microcontroller 288, which may be programmed to respond in various ways to user inputs, not necessarily in direct proportion to input by the user. For instance, when the faucet is delivering soap #1 as a mixture, which might be a produce cleaning soap, the flow rate may be automatically reduced for better control in washing off fruit or vegetables. When the user presses the soap #1 switch 296, to return the faucet to water only, the flow rate may then be automatically increased to the previously user established rate. If so programmed, even while delivering a soap mixture, the user may retain the ability to control the flow rate by means of the single handle water control 90. When the faucet is delivering water only, the user may always retain full control over water flow by means of the single handle water control 290.

[0074] Referring now to FIG. 6, a system diagram of the present invention of FIG. 5, it may be quite similar to FIG. 4, but with FIG. 6 having two additional inputs, the automatic button 204 and the soap #1 switch 296, which may be used to operate the soap #2 pump 280, requiring the two soap injector 274, which has two soap lines to injector 220 instead of one.

[0075] Referring now to FIG. 7, another embodiment of the present invention as normally seen by a user looking down onto a countertop and washbasin is shown. What's new here is not the kitchen faucet 312 — it's completely conventional, and works like a standard mechanical faucet — until the retrofit control 314, is turned on by pressing the retrofit control on/off switch 320. This retrofit control 314 may be attached to the sink top surface 308 or countertop with electrical connections passing through a hole to the soap dispensing system under the counter. When the retrofit control 314 is on, as may be indicated by the retrofit control on/off indicator 322, the hot water dial 316 and cold water dial 318 may control water and soap solution temperature in the conventional way. Pressing any of the three buttons or switches, the water only switch 324, the soap #1 switch 396, or the soap #2 switch 300, may activate that particular discharge. Another press

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may turn it off; pressing one of the other two buttons may immediately switch to that discharge. Selection of soap #1 may be indicated by the soap #1 indicator 398; and selection of soap #2 may be indicated by the soap #2 indicator 302. Before using the retrofit control 314, the manual hot water handle 332 on the faucet 312 may be turned off, and the manual cold water handle 334 may be turned on full, thus assuring that all the fluids delivered by the faucet 312 pass through or come from the soap dispensing system. In order to return to full manual operation of the faucet 312, the retrofit control 314 may be turned off by pressing the retrofit control on/off switch 320. Should the manual cold water handle 334 be closed either by accident or by intent while the soap dispensing system is in operation, water pressure may build up within the soap dispensing system to the pressure of the higher of the two incoming lines (from the hot water supply 342 or from the cold water supply 344). Because of this, the soap dispensing system may be able to withstand such pressures which can range up to over 100 psi. Normally, embodiments of the present invention are not exposed to other than minimal internal pressure, because they may deliver fluids to a line that is open all the way to the delivery end of the spout. In "normal" operation, with the retrofit control 314 turned off, the proportional solenoid valve for hot water 384 may be closed, and the proportional solenoid valve for cold water 386 may be open. These valves may be respectively, "normally closed," and "normally open" — the states of the valves when no electric current is applied to operate them. This, in "normal" operation, the cold water may be routed through the soap dispensing system at the full pressure of the cold water supply 344. An easy-to-install retrofit kit may make it possible for those who wish, to keep their existing faucet and still upgrade to the soap dispensing system.

[0076] Referring now to FIG. 8, a system diagram of the present invention of FIG. 7, it is clear that both the water from the hot water supply 342 and from the cold water supply 344 may be diverted through the soap dispensing system before entering the faucet 312 through the cold water line. The hot water "T" connector 326 may be spliced into the original hot water line; the original cold water line may be cut, and the cold water connector 328 may splice the line to the soap dispensing system at the hot water proportional solenoid valve 384; the retrofit water connector 330 may connect the soap dispensing system to the cold water line extending to the

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faucet 312. The hot water check valve 332 and the cold water check valve 333 may eliminate the possibility that water could flow back into either the hot water supply 342 or the cold water supply 344 looping through the soap dispensing system. This may happen if the user closed the manual cold water handle 334 when both hot and cold water are entering the soap dispensing system. The check valves may also stop any stray soap from entering the water supply — which may be mandated by plumbing code.

[0077] Referring now to FIG. 9, an exploded view, internal details of the soap injector 420 are shown. There may be two halves or sides to the injector, the left side of injector 434, and the right side of injector 440. As shown here, only the left side of injector 434 may have a soap hole 436, a soap line to injector 426, and a seep blocker 438. This type of injector may deliver only one kind of soap. The two soap injector 374, as indicated in FIGS. 8 and 10 may be essentially the same, but with both halves the same as the left side of injector 434, so both sides have a soap hole 436, a soap line to injector 26, and a seep blocker 438. Each side of the injector 20 or the two soap injector 374 may have a clockwise vane 450 and a counterclockwise vane 442, which may act upon the fluids flowing through the injector so they are thoroughly mixed together into a consistent solution. The two sides of the injector may be located in correct alignment for bonding by several alignment bumps 446, that fit into several alignment recesses 444.

[0078] Referring now also to FIG. 9A, a perspective sectional view of the soap injector 20. The water flow into injector 454 may enter through the water line to injector 24, which is bonded to the injector 20. The soap flow into injector 452 may come in through the soap line to injector 26. The flow out of injector to faucet 456 may exit through the water line to faucet 22, which is bonded to the injector 20.

[0079] Referring now to FIG. 9B, an enlarged detail view of the indicated portion of FIG. 9A, the details of the attachment of the soap line to injector 26 are shown. It may terminate in the base of soap line to injector 458, which may be bonded to the left side of injector 434, capturing the seep blocker 438, which may be made of a flexible material, such as silicone rubber.

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[0080] Referring now to FIG. 9C, the opposite side of seep blocker 438, shown in FIG. 9 is enlarged to the same scale as FIG. 9B. There may be a cut 460 in seep blocker, which may be a clean cut (no material removed) through the thin membrane, allowing the passage of soap when pressure is applied by the soap pump 376. In this case the cut may be in the form of an "X", while other forms of cut may be used, such as a simple "I" cut, which may be conceived of as the "X" with one leg left off. The "X" type of cut may open with less pressure than the "I" cut. The purpose of the seep blocker 438 may be to keep soap in the soap line to injector 26 from seeping or diffusing into the water in the injector when no soap is being pumped. The conical space downstream of the seep blocker 438 may be part of the seep hole 436, and designed to allow the flexing of the membrane and it's opening to allow soap to pass through. This space may be very small, so that only a minuscule amount of soap can commingle with water standing in the injector. Thus a water only discharge may have so little soap that it will be of no consequence in normal operation. This may also keep soap from getting into the plumbing upstream of the soap dispensing system should there be a failure in water pressure. If this were not so, some kind of anti-siphon valve may be required in soap dispensing system installations that connect with municipal water supplies. The normal position of the seep blocker 438 may be with the cut in seep blocker closed due to the plastic memory of the flexible material. Varying the thickness and type of cut in the membrane may vary the force of closure. Even very thin membranes may be quite resistant to allowing the passage of soap.

[0081] Referring now to FIG. 10, a system diagram of the present invention in the form of a testbed or experimental setup is shown. This system is disclosed because some of the features may be useful not only for technical and scientific studies beyond the development and documentation of soap dispensing systems themselves, but may also have application in industrial settings. A feature of this system may be the presence of the flow meter 470. This may provide essential feedback, actually measuring the true rate of water flow through the system. In other systems, certain assumptions are made, primarily concerning the incoming pressure from the water lines. Based on empirical experience for most purposes, a

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reasonable prediction can be made as to flow rates (as controlled by the proportional solenoid valves) that will occur at certain valve settings. In such cases, obviously, both knowing the water line pressure and minimizing deviations from that line pressure may result in more predictable soap dispensing system performance. In general such other systems assume water flow rates and inject soap accordingly to achieve the desired mix of soap and water. The experimental testbed may also feature a pressure regulator 462, which may stabilize water in the system at a set pressure for consistent results. Most relatively inexpensive regulators have a tendency to leak, so that the pressure internal to the soap dispensing system may build up to be higher than anticipated when the proportional solenoid valve 386 is throttled. The solution may be a controlled leak, determined by setting of the manual ball valve 464, emptying the "leaked" water into the drain 468. The rate of leakage may be determined visually observing the rate of water flow into the drain 468. Pressure build up in the line upstream of the proportional solenoid valve 86 may make the valve somewhat unstable in its response. In other words, the valve may most accurately meter water flow when water pressure feeding it is known and relatively constant. The pressure test gage 466 may allow for monitoring of the pressure upstream of the proportional solenoid valve 386.

[0082] Operation of the testbed confirmed several sequencing related elements of special import to effective operation of the present invention:

[0083] Faucet precharging occurs by providing a short burst of soap solution immediately after the user initiates a soap request. The purpose of this short burst of soap solution is to fill the faucet volume between the injector and the outlet end of the faucet with the soap mixture, so that when the user places their hands under the faucet, the proper soap mixture may be all they receive. If this was not done, the volume between injector and outlet would normally be filled with water only, so if the user placed hands under the faucet to soap up, they might first receive some water before the soap solution arrived, so that some of the initial wetting of the hands could be with water only, which may adversely affect the hand washing process.

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[0084] The faucet precharging may occur in response to the user activating the soap button. After activation of the soap button, soap may be immediately provided to the soap injector and the water valve may be controlled to allow a flow of water through the soap injector to create a soap and water mixture for a predetermined period of time. During this predetermined period of time, the water only filled in the volume between the soap injector and the outlet end of faucet may be forced out of the faucet and replaced by the soap and water mixture. At the end of the predetermined period of time, the flow of soap to the soap injector and flow of water through the in soap injector may be stopped. Once the user initiates washing their hands, the soap and water mixture may immediately flow from the faucet.

[0085] Faucet flushing occurs at the end of the faucet soaping sequence and may normally not be noticed by the user, and may have minimal effect on the cleaning process. The purpose of this action is comparable to Faucet Precharging, but with the purpose of filling the volume between injector and outlet with water only, so that the next time the faucet discharges fluid, it may be water only, which is appropriate for the next discharge, which is Faucet Watering.

[0086] During the faucet soaping sequence, soap may be provided to the soap injector and the water valve may be controlled to allow water to flow through the soap injector for a first predetermined period of time to provide the soap and water mixture out the faucet to facilitate the user washing their hands. At the end of the faucet soaping sequence, the flow of soap to the soap injector may be stopped while the flow of water through the soap injector may continue for a second period of time. During this second period of time, the soap and water mixture may be purged from the soap injector and the volume between the soap injector and the outlet end of the faucet and replaced with water only to insure that water only flows from the faucet during the next flow of fluid from the faucet.

[0087] It is to be noted that both faucet precharging and faucet flushing may require less water if the volume of the faucet water passageway from the injector to the outlet end of the faucet is at a minimum. A smaller diameter and shorter water passageway may thus be desirable. In this regard, the faucet illustrated in FIG. 1, in

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which the injector is in close proximity with the faucet discharge may be a nearly optimal design.

[0088] Referring to FIG. 11, a perspective view, internal details of the right side of an alternative embodiment of the soap injector 20 is shown. The right and left sides of the injector may be similar, in the same way the right and left sides of the injector shown in FIG. 9 may be similar: either one side or both sides may have a soap hole 436, a soap line to injector 26, and a seep blocker 438 as shown in FIG. 9. The two sides of the injector also may be located in correct alignment for bonding by several alignment bumps 446, that fit into several alignment recesses 444, again as shown in FIG. 9. But instead of utilizing vanes to act upon the fluids flowing through the injector, this embodiment may utilize two slots, slot in right side of injector 476 and slot in left side of injector 480, both of which are in their respective shelves, shelf in right side of injector 474 and a shelf in the left side of injector (not shown). Again, please note that both the right and left sides of the injector may be identical. Water entering the injector may pass through both slots and may be directed in a counterclockwise rotation by the angled shape of the slot. This rather violent swirling action may act upon the fluids flowing through the injector so they may be thoroughly mixed together into a consistent solution. The soap may enter this injector in the same manner soap enters the injector shown in FIG. 9. However, there may be no additional mechanical stirring devices, either vanes or slots downstream of the soap injection. The swirling and turbulence created by the slots may be sufficient to accomplish the mixing.

[0089] Referring now to FIG. 11A, an enlarged perspective exploded sectional view of the bottom portion of the left and right sides of the injector. The bottom portion of sectioned left side of injector 478 and the bottom portion of sectioned right side of injector 482 are shown oriented as they may be before being bonded together. The slot in left side of injector 480 is also shown.

[0090] Finally, referring to FIG. 11B, an enlarged perspective sectional view of the two bottom portions of the injector, 478 and 482 of FIG. 11A are shown here bonded together, with a seam between left and right sides of injector 484, where the

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two sides come together. This figure shows the relationship of the two slots, 476, and 480.

[0091] FIG. 12 is a pictorial view of a user programmable faucet, but may still be usable as a "standard faucet". By manipulating the pointing device 698, and referring to the display/programming and status 600, the degree of sophistication in programming may be selected by the user, such as increasing the concentration of soap for handwashing or creating a unique sequence of soaping/pausing/rinsing for cleaning a number of items in assembly line fashion. The faucet may respond differently to different users — one wanting a lot of soap for handwashing and long time for scrubbing up — another choosing little soap and a quick scrub time. Or the soap switch 690 may be programmed to give a "quickie wash" when given a tap and a "standard wash" when pressed normally. The display/programming and status 600 may show any desired information, including new or updated material provided by soap manufacturers to facilitate use of their products; here it shows the amount of the various products in the under counter containers.

[0092] The display on the right side of the faucet base may have three areas: the left display area/soap switch 692 relating to the soap switch 690; the middle display area/selector dial 1 694 relating to the selector dial 1 686; and the right display area/selector dial 2 696 relating to the selector dial 2 688. An initial press on the soap switch 190 may be programmed to turn on the faucet, with subsequent single presses selecting the chosen type of soap as selected by selector dial 1 686, as indicated in the display area/selector dial 1 694 — as shown here, PRODUCE. Two or more quick presses may turn off the soap so that the faucet delivers water only. Turning selector dial 2 688 through 3 detent positions from left to right may select the mode; MANUAL, AUTOMATIC (as shown here), or SENSOR.

[0093] Referring to FIG. 13, a pictorial view of a system box with injector 802, and replaceable soap refill container 808 is shown. Also refer to FIG. 14, a system diagram showing the system box 802 of FIG. 13 in a soap dispensing system. The system box 802 may normally be attached under the counter with the line from the hot water supply 842 disconnected from the faucet and reconnected to the "in"

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connection (from supply) shown in FIG. 13. A new hose may be connected between the system box 802 and the hot water side of the faucet, and the manual hot water valve 832. The soap refill container 808 may be screwed in place on the system box with injector 802, and a soap button remote 36 as shown in FIG 1 may be placed on the counter top 38, also shown in FIG. 1. After attaching a new refill, the priming switch 804 may be pressed to purge air out of the system, and the soap dial 806 may be set for the desired concentration. The refill light 810 may come on when the soap level in the soap refill container 808 drops below a predetermined level, giving the user sufficient warning to refill before running out of soap.

[0094] When the soap refill container 808 is unscrewed from the system box with injector 802, the soap intake tube 812 may be exposed. This tube may draw soap from the container to feed the soap pump 846. But it may also function as a sensor to determine when the level of soap lowers to a point when the event is signaled to the microcontroller 888. The non-conductive plastic soap intake tube may have two conductive strips on either side separated by several millimeters. These strips may run the length of the tube, each connecting inside the soap refill container 808 to electronic circuitry that determines if there is current flow between the two strips. The electronics may detect an open or closed circuit with the water in the soap acting as a conductor bridging the two strips. Actually, the conductors may be in two segments, an upper part of conductor 814 and a lower part of conductor 818, separated by a conductor cut 816 that electrically isolates the two parts of the conductors. The cut in the strips may determine the critical soap level. Once the soap drips below the conductor cut 816, the circuit may be open without any current flow between the strips. (The continuation of the conductive strips below the cut may purely be for convenience in manufacture. It may be easier to mechanically remove a small section of the strips in a simple and quick machining operation than removing the entire conductor below the cut.)

[0095] Referring to FIG. 15, a left exploded view of a soap injector with an integrated check valve shows the three components of the check valve: a stainless steel check valve ball 726, a tough plastic check valve cage 724, and a flexible (silicone rubber) check valve channel 728. These components may be captured

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inside two check valve injector case sides 722, with a venturi 723, and two counterclockwise vanes 742 for mixing soap and water. FIG 15A, a left assembly view of the components of FIG. 15, shows that with sufficient flow of water through the injector, the check valve ball in strong flow position 730 may be carried up against the check valve cage stop 732 at the top of the check valve cage 724 allowing water to pass through the injector. As shown in FIG. 15B, a left assembly section view of the components shown in FIG. 15A, when water flow stops, the check valve ball may be drawn down by gravity, settling onto a tapered hole in the check valve channel 728. The check valve ball in the no flow position 734 may rest on the curved intake lip making a secure seal. Any reverse flow or backflow caused by a service interruption in water may draw the ball down into the check valve channel 728. The gentle taper may allow the ball easy entry with very low backpressure. As shown in FIG. 16, an orthographic sectioned view of a soap injector with integrated check valve and inductive proximity sensor, with even higher suction, the check valve ball in back flow position 740 may finally stop at the radiused end of the hole, where water enters the injector. The ball may be forced up, out of the channel with resumption of normal water flow pressure. The unique design with the flexible channel may distinguish this check valve. The chosen durometer of the rubber and the taper of the hole may determine the pressures necessary to firmly lodge and dislodge the ball.

[0096] Conventional check valves have a spring pressing on the ball to force it against a metal or hard plastic bore hole. Check valves, often double check valves, are backflow prevention devices designed to protect water supplies from contamination. Such valves are commonly required at the building level, and lacking such, residential installations of soap dispensing systems, as in the present invention, in which soap and water delivery systems are connected, will likely be required by plumbing codes to have a check valve device associated with them.

[0097] FIG. 16, an orthographic sectioned view of a soap injector with integrated check valve and inductive proximity sensor shows the check valve ball in back flow position 740 located in the sensing field 738 of the inductive proximity sensor 736 that may detect the presence of the stainless steel target when it enters

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the sensing field 738, which may detect the ball when it is between the no flow position 734 and the back flow position 740. The inductive proximity sensor 736 may not detect the presence of the target when it is in the strong flow position 730, allowing for the operation of the soap pump to inject soap into the water.

[0098] Whenever the ball is detected by the sensor, the microcontroller may be programmed so that the soap pump will not operate. Thus the user may press on the soap switch, but the system may not respond. This may also happen with cold water flow rates too low for a proper mix of soap and water, which, appropriately, will not lift the check valve ball 726 out of the sensing field 738. Another reason for having this lock out behavior of the soap pump with low or no flow water situations may be to avoid a build-up of pressure inside the injector that could cause rupture or other system failure. If soap were pumped and the manual hot water valve is closed, there may be no place for the soap to go.

[0099] FIG. 17 is a system diagram showing a point of use water heater coupled with a soap dispensing system. The system may perform as a conventional point of use water heater until the soap switch 936 is clicked. The flow meter 970 and temperature sensor 942 may be integral with most water heaters 944, so that the heater may maintain the desired water temperature over a range of water flow rates as determined by the user manipulating the manual hot water valve 932. (The greater the flow rate, the more heat may be required to heat the water.) Note that this system may allow the user to obtain water at a different temperature when selecting the soap dispensing function than was flowing just prior to clicking the soap switch 932. This is appropriate because the faucet may be being used for a different function — washing, as opposed to rinsing for example.

[00100] We may take advantage of the flow meter 970 to modulate the rate of soap pumping to adjust the flow of soap up or down with the water flow rate, maintaining a constant soap concentration at all flow rates above some preset minimum.

[00101] FIG. 18 is a system diagram of a soap dispensing system that may utilize bleed water pressure to expel soap from the soap container. No soap pump

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may be needed! This system may take advantage of the inherent flow restricting property of the venturi design of the injector. Comparing pressures upstream and downstream of the injector venturi, the pressure will be greater upstream.

Depending upon system requirements, the internal shape of the injector may be actually designed to create additional drag on the water passing through to boost the relative pressure differential. FIG. 18 shows the bleed water line coming off before the injector. In practice, it may be convenient to integrate the bleed line into the injector 1020 itself. The pressure applied to inject soap into the water stream may vary dynamically with the flow rate out of the faucet. The system may automatically maintain a stable proportionality or dilution of soap with water!

[00102] Water flowing through the bleed water line may enter the attached container with soap bag 1046, displacing soap from the container. A soap valve 1050 may turn the soap flow on or off, so that the delivery of soap may occur only when desired for correct system operation. A soap flow restrictor 1048 may be used to meter the soap flow rate in relation to the water flow rate. There may be various size fixed or interchangeable restrictors with variously sized orifices, as appropriate for the viscosity and type of soap and purpose of the soap to control the flow rate. A needle valve may be appropriate for this purpose to precisely regulate relatively small flow rates. The soap dial 1006 may allow the user to set the soap concentration.

[00103] FIG. 19 details the container with soap bag 856, showing a full soap bag 856 before attaching the refill container 852 to the refill plug 858, which is part of the system box with the injector 802 of FIG. 13. The user may insert the soap connector 854 into a socket in the middle of the refill plug 858. Then the user may attach the container to the system box. An O-ring 860 may seal the connection.

[00104] After attachment, the user may press the purge button, which may cause the system to operate as if dispensing soap for an extended interval, such as 15 seconds, to fill the space above the soap bag 856 with water from bleed water line 878. In normal use, the consumption of soap leads to the situation shown in FIG. 19A, in which bleed water has come in by the bleed water line 874, with water

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serving as a propellant to enter the space above the empty portion of soap bag 870. This may displace the air trapped in the system when the refill container 852 was attached. The air may easily escape out the air vent 864, past the ball float (vent open) at 862. But when the bleed water reaches the ball float, it may float up — ball float (vent closed) at 880 and seals the air vent 864. Incoming water 878 from bleed water line may force soap out the soap line with soap 876, so that it may be mixed with water in the injector.

[00105] FIG. 20 is a system diagram of a soap dispensing system that utilizes a liquid and/or gas propellant to expel soap from the soap container. Single water and soap sources feed multiple faucets. Soap may be forced out of the soap container 1282 with propellant and soap to the injectors 1220 by a propelling or pressurizing agent. Liquefied gas may have the advantage of maintaining a consistent pressure as the gas expands to displace the soap.

[00106] The soap may be physically separated from the gas by a piston barrier or contained within a flexible bag (bag-in-can) similar to the arrangement of FIG. 19, guaranteeing that only pure product may be dispensed. Propellant and soap refills may be supplied in a single container, as in pressurized aerosol cans, which, after being secured to the system box with injector 802, supply soap as needed. Alternatively, a non-pressurized refill container may contain only soap with system pressurization coming from a separate container, replaced at longer intervals.

[00107] The system is designed with standard rates of water and soap flow when dispensing a soap/water mixture. If desired, water only flow rates may be user controlled.

[00108] From the description above, a number of features of the present invention may be present in the disclosed and other embodiments of the present invention. One or more of these features include, but are not limited to the following for the integrated soap dispensing system:

- (a) The operation of the system by users may be as simple, as quick and as effective as possible. This is important because most users do not

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consider hand washing a pleasant experience to be indulged in for pleasure, like showering. The system may minimally obtrude on the appearance of the wash station which also makes it more attractive to users and those who must maintain it too.

(b) The system may be unique in its precision in metering and thoroughly mixing soap and water, something that becomes more important when sanitation and hygiene are considered. The mixing of soap and water in other systems is haphazard and may be very poorly accomplished.

(c) The system may also be unique in that the soap dispensing side of the system interacts with and may override the water only side of the system, so that the soap dispensing mode may be initiated at any time by the user, even when water is already flowing from the faucet, and so that there may be an interval after soap dispensing is completed, during which time the water only flow cannot be initiated by the user.

(d) The faucet, or the discharge tube or nozzle of the faucet may be repeatedly washed by the water/soap solution, and if the soap is a disinfectant, providing disinfectant action internally in the faucet, tending to keep the faucet free of contaminants.

[00109] While particular embodiments of the present invention have been disclosed, it is to be understood that various different embodiments are possible and are contemplated within the true spirit and scope of the appended claims. There is no intention, therefore, of limitations to the exact abstract or disclosure herein presented.

DISPENSING SYSTEM AND METHOD, AND INJECTOR THEREFOR

**ABSTRACT OF THE DISCLOSED
EMBODIMENTS OF THE INVENTION**

The disclosed dispensing system, and method may be used in combination with a faucet in communication with a water supply via a water line, and includes a liquid dispensing device adapted to create a liquid such as liquid soap, and water mixture in the water line. The dispensing device may include an injector, and a soap container for the liquid soap or other. The system may provide for storage of liquid soap or other, and may also have the injector in line with the faucet water line. The injector may create strong vortices that effectively commingle the liquid soap or other liquid with water into a thoroughly mixed solution that is discharged at the faucet outlet.

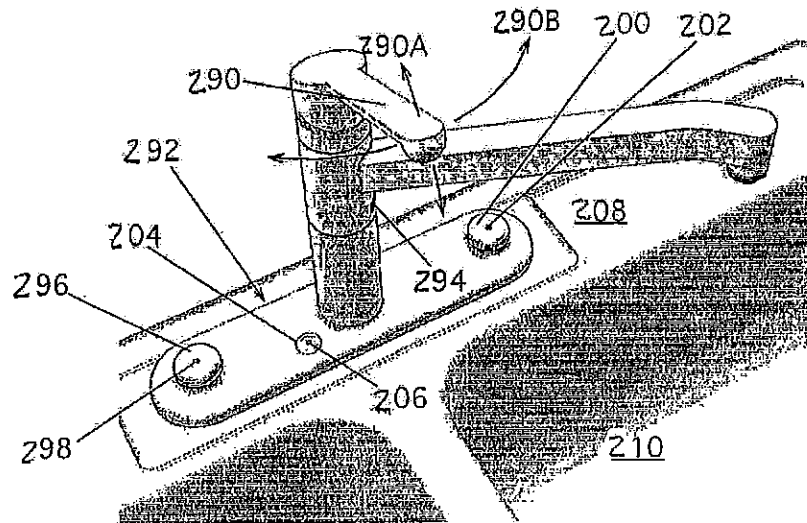


FIG. 5

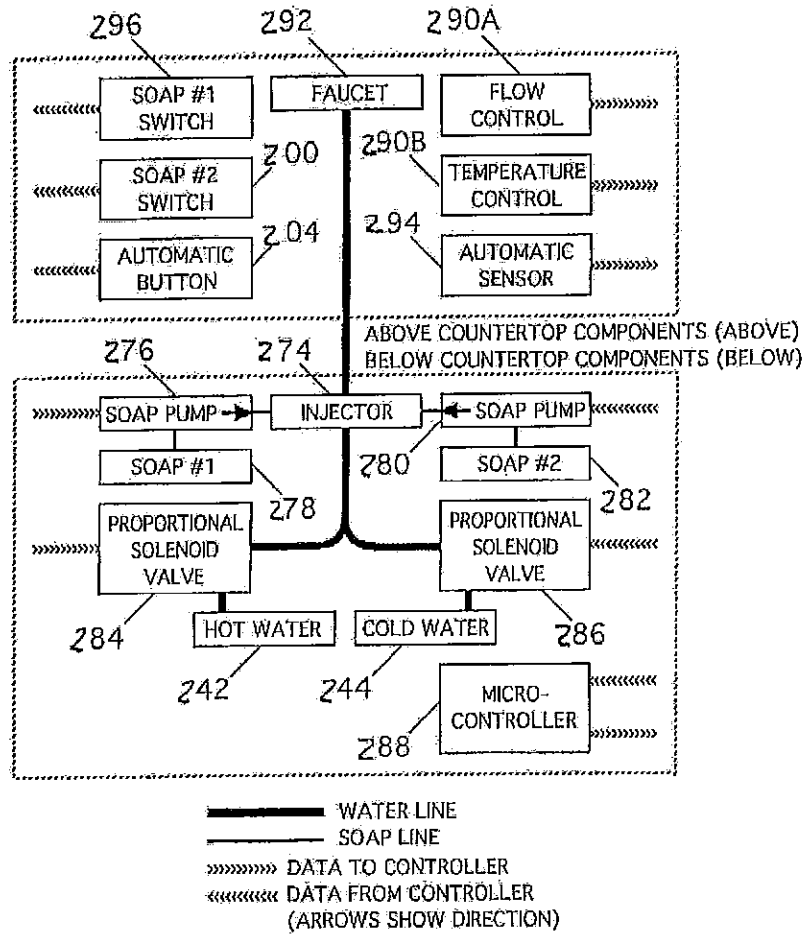


FIG. 6

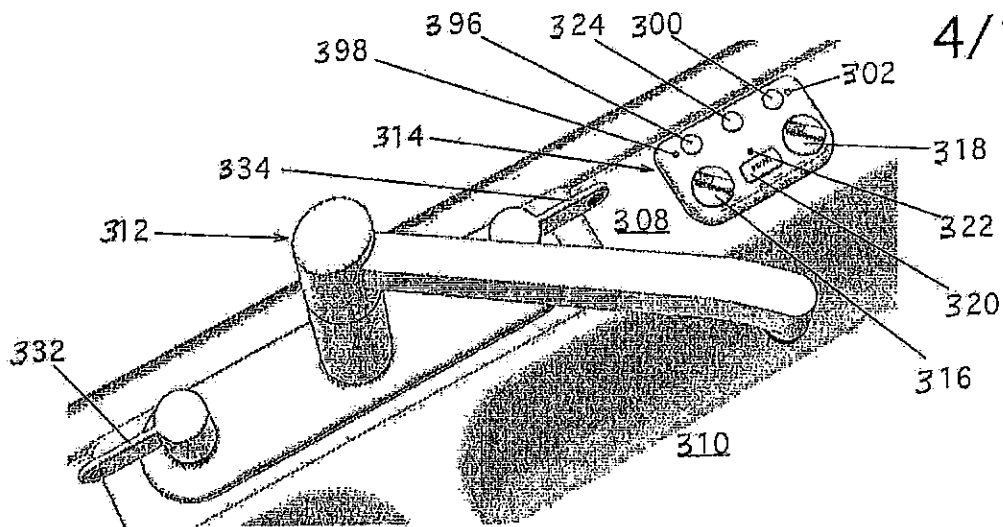
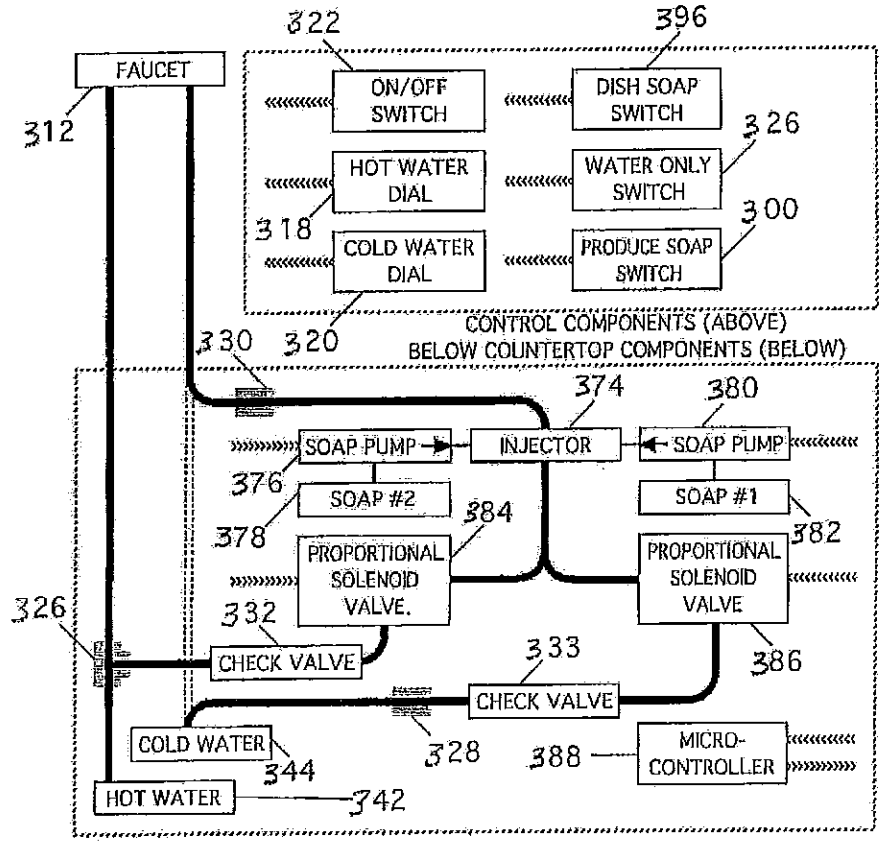


FIG. 7









 CONNECTORS USED TO ATTACH RETROFIT TO EXISTING PLUMBING
 WATER LINE BEFORE RETROFIT
 WATER LINE
 SOAP LINE
 DATA TO CONTROLLER
 DATA FROM CONTROLLER (ARROWS SHOW DIRECTION)

FIG. 8

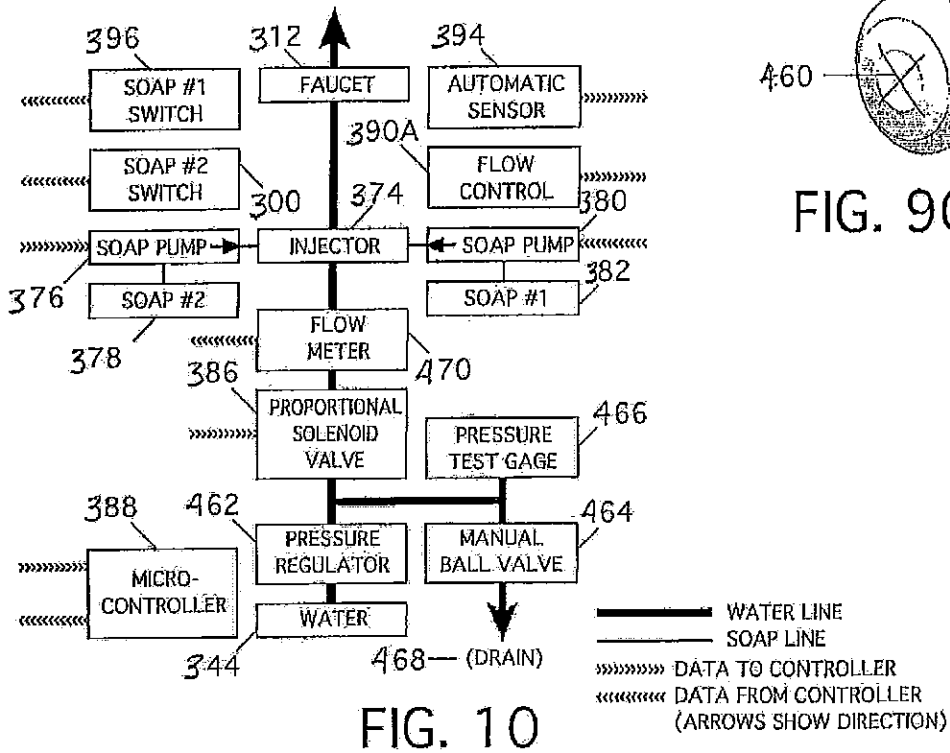
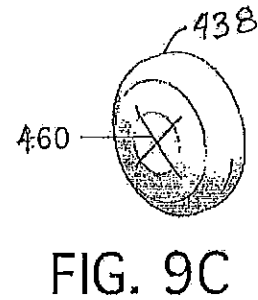
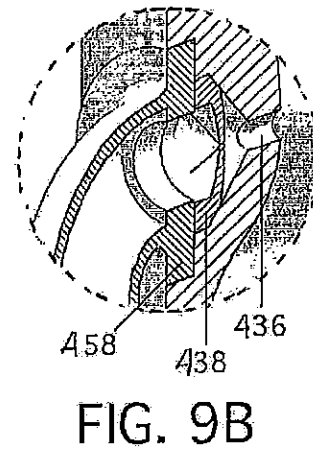
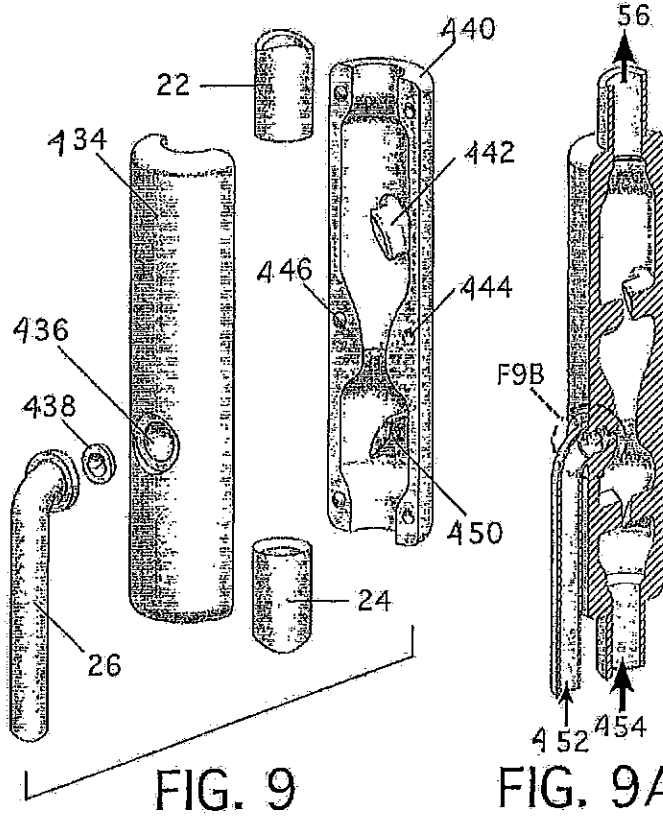


FIG. 10

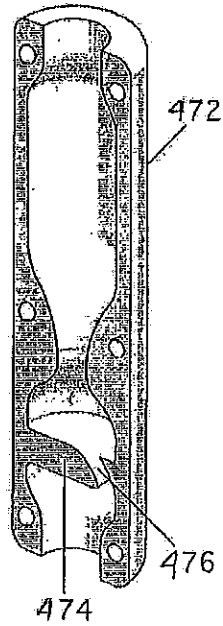


FIG. 11

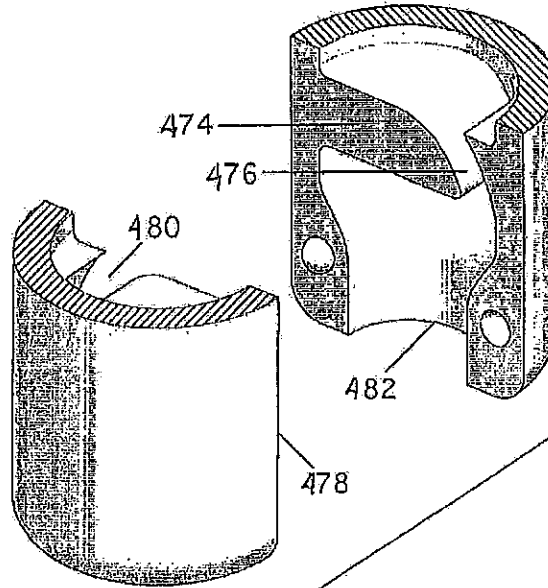


FIG. 11A

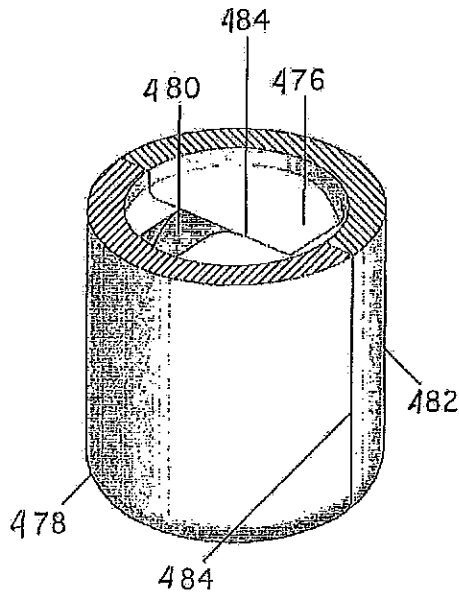


FIG. 11B

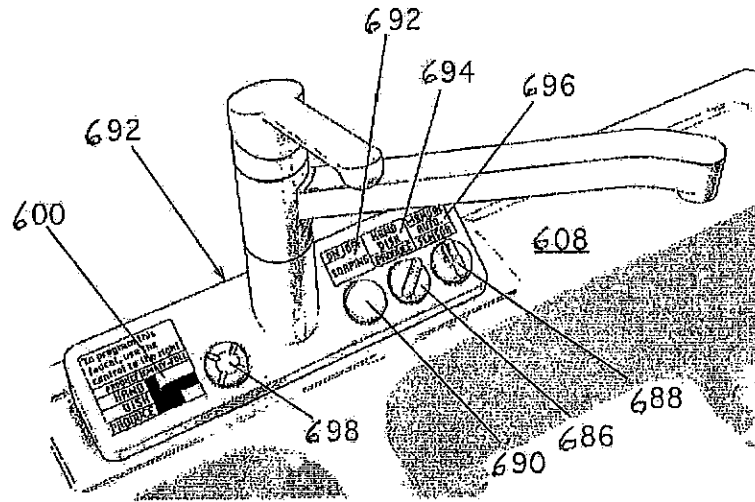


FIG. 12

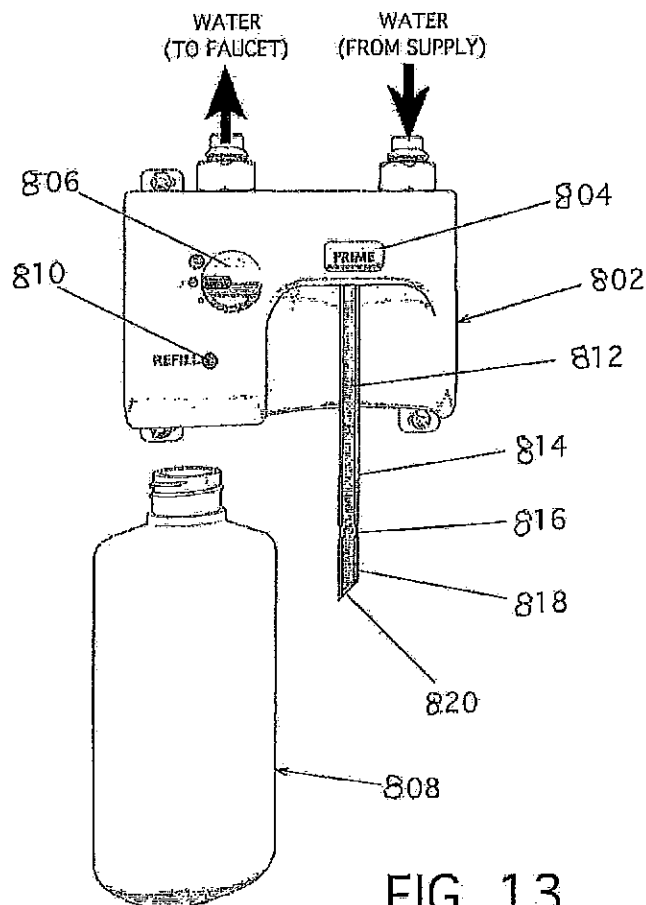


FIG. 13

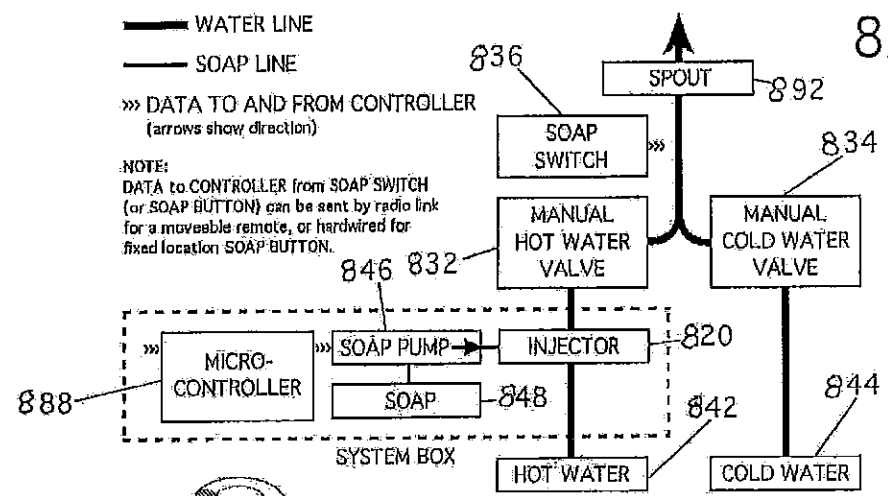


FIG. 14

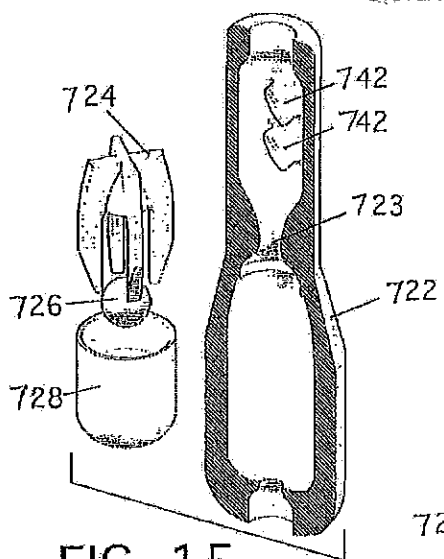


FIG. 15

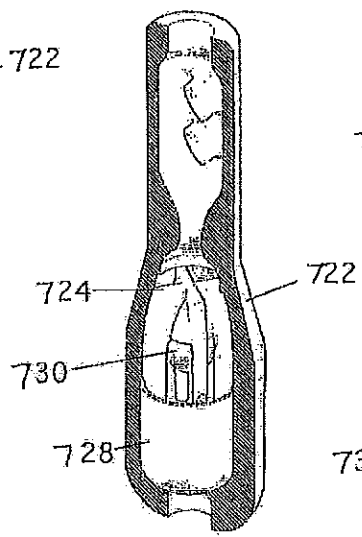


FIG. 15A

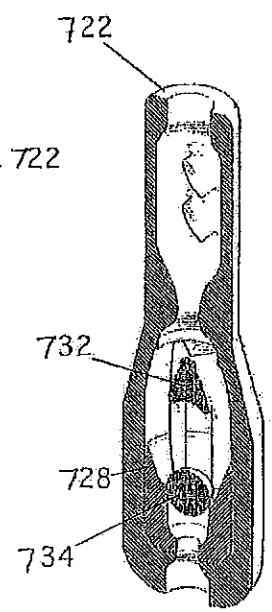


FIG. 15B

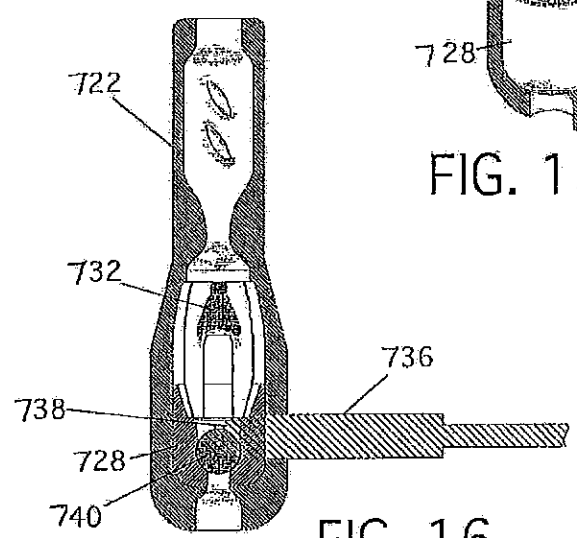


FIG. 16

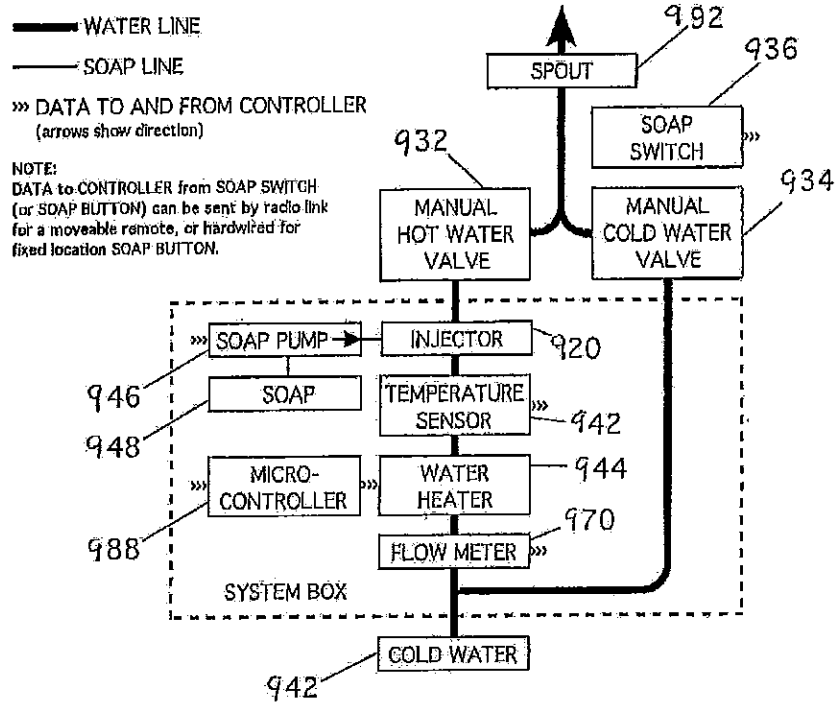
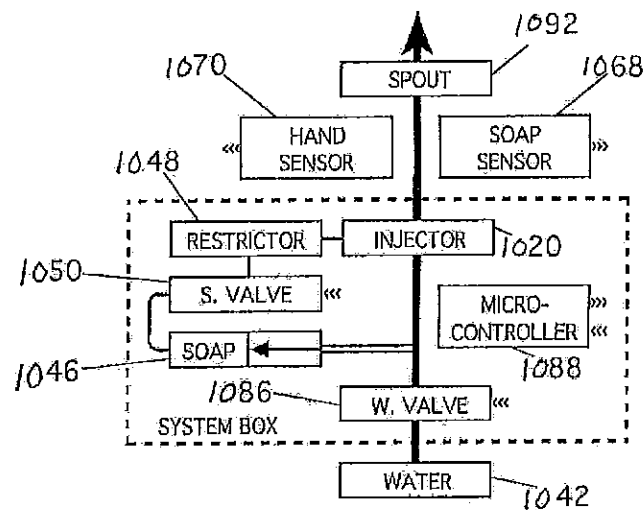


FIG. 17



— WATER LINE
 — BLEED WATER LINE
 — SOAP LINE
 »» DATA TO AND FROM CONTROLLER
 (arrows show direction)

FIG. 18

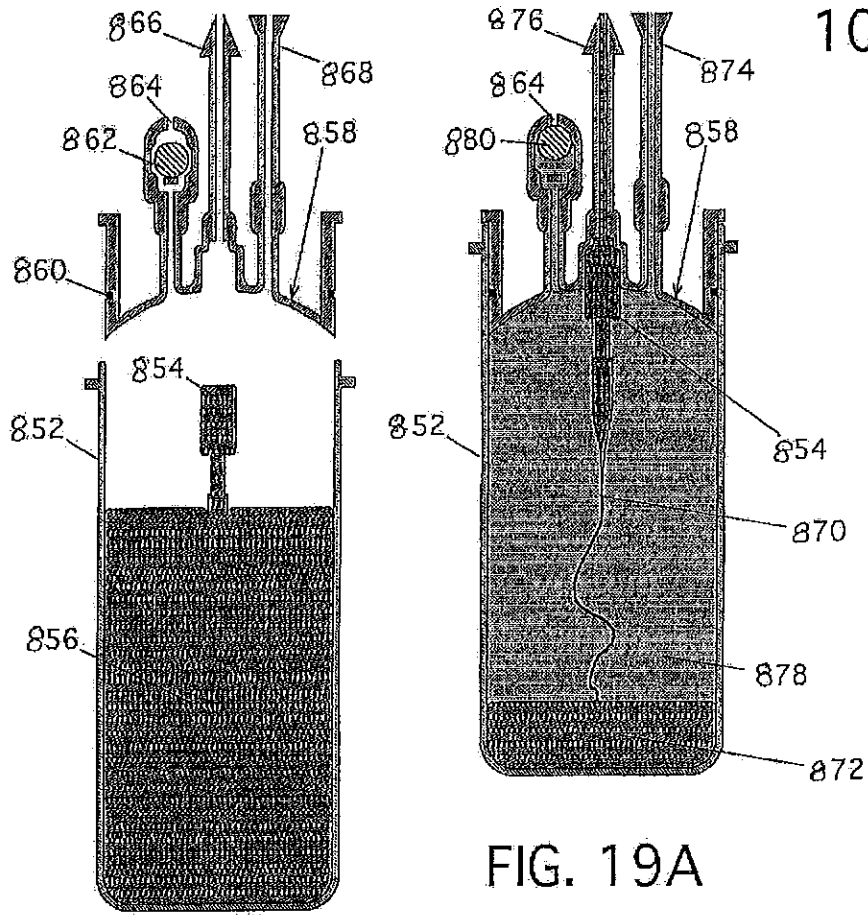


FIG. 19A

FIG. 19

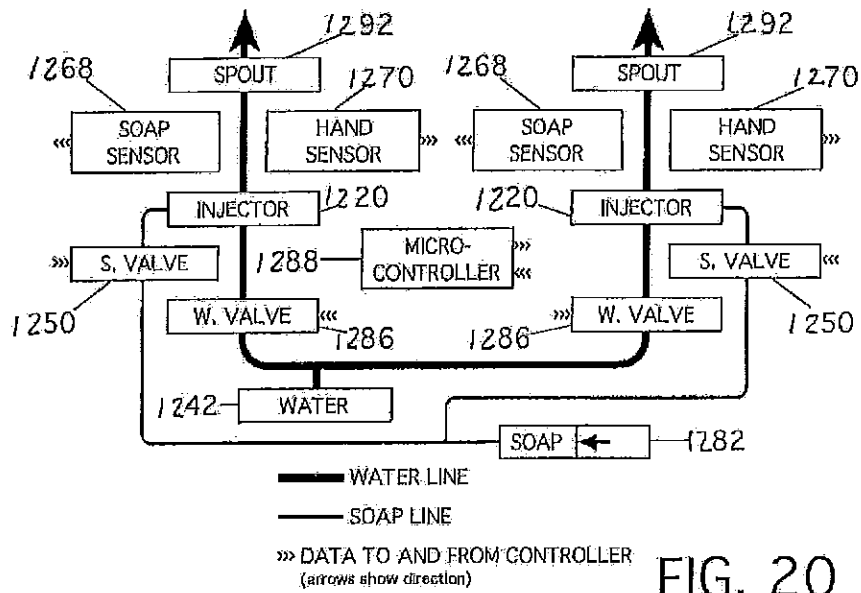


FIG. 20