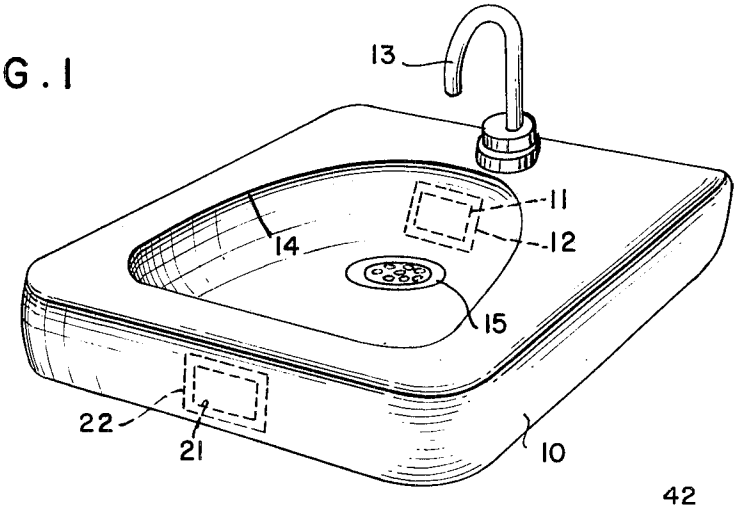
April 14, 1970 N. A. FORBES 3,505,692

PROXIMITY CONTROL FOR A LAVATORY

Filed Sept. 18, 1967

FIG. 1



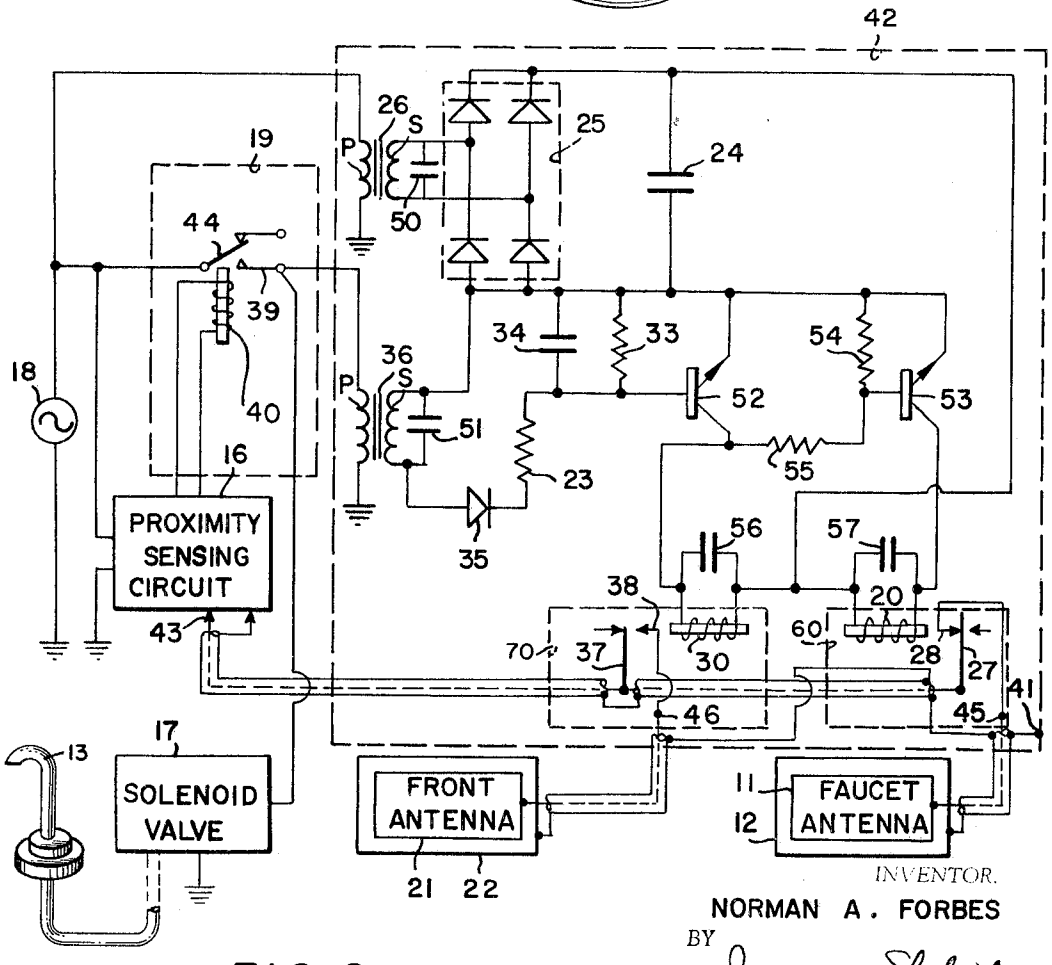


FIG. 2

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PROXIMITY CONTROL FOR A LAVATORY

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U.S. Cl. 4—166 19 Claims

ABSTRACT OF THE DISCLOSURE

A proximity control arrangement for a lavatory utilizing a dual antenna system for sensing the simultaneous presence of the user in front of the lavatory and the positioning of his hands beneath its water faucet. One antenna is disposed in the area beneath the faucet and, after sensing the presence of the user's hands, causes the proximity circuit arrangement to turn the water on and to simultaneously switch to a second antenna, secured along the leading edge of the lavatory, for sensing the presence of the user. When the user leaves the lavatory, the proximity circuit arrangement interrupts the water flow; and after a predetermined delay during which the lavatory surfaces drain dry, the circuit switches the apparatus back to sensing with the first antenna in readiness for the next cycle of operation.

The present invention relates to a proximity control system and apparatus for use with a lavatory or other plumbing equipment.

More specifically, the present invention relates to an improved proximity sensing control arrangement for use with a lavatory utilizing a dual antenna system for sensing the presence of a user and automatically operating the lavatory.

Most conventional lavatories include one or more fluid valves which are turned on manually by the user who operates the valving device. In many lavatories in public places, valving devices are often spring-loaded and must be manually held in the "on" position in order that the water supply continue to flow from the spout. These valving devices do not permit the user the freedom to employ both of his hands simultaneously in washing them beneath the spout. In lavatories located in industrial and commercial areas, the valving devices often become contaminated with dirt, grease or ink while manually operated by the user to wash his hands.

In an attempt to overcome these disadvantages, lavatories have been provided with proximity sensing circuits which are responsive to the hands of the user being inserted beneath the lavatory spout. These lavatories generally utilize a single antenna sensing device which is positioned in an area beneath the water spout and designed to detect the presence of the user's hands. After the water is turned on, however, the antenna may be said to have difficulty in distinguishing between the presence of the water in the basin flowing from the spout and the user's hands. The water will thus continue to flow from the spout of the lavatory even after the user removes his hands from the basin of the lavatory. In attempts to overcome these difficulties, a proximity antenna has been mounted on the front or leading edge of the lavatory away from the basin and water supply. Such a lavatory, however, suffers from the disadvantage in that persons who merely pass in front of the lavatory or stand or sway in front to adjust themselves before a mirror above the lavatory, often turn the water supply on and thus cause an unnecessary wastage of water.

Accordingly, the present invention overcome all of the above mentioned difficulties by providing an improved

proximity sensing lavatory having a high reliability dual sensing antenna system. The novel lavatory utilizes a first sensing antenna which may be positioned beneath the outlet of the water spout behind the basin of the lavatory. The second antenna may be positioned along the leading edge of the lavatory as, for example, in front of its basin. The second antenna, however, remains normally disconnected from the proximity sensing circuit until the user places his hands beneath the water faucet in the vicinity of the first antenna. The first antenna is geared to equipment which will then cause the proximity sensing circuit to operate a solenoid valve to permit the water to flow from the spout. The proximity circuit will also be geared so as to simultaneously disconnect the first antenna from its input and connect itself to the second antenna positioned at or in the region of the leading edge of the lavatory. The water will continue to flow from the faucet until the user withdraws from the lavatory and is out of the range of the second antenna. The water flowing in the basin will not affect the proximity sensing circuit since the first antenna has been disconnected from the circuit from the time the water started to flow. After the water from the faucet stops flowing, the proximity sensing circuit arrangement will operate to disconnect the second antenna and reconnect the first antenna to its input in readiness for another cycle of operation.

It is therefore an object according to the present invention to provide an improved proximity control arrangement for use with a lavatory having a dual antenna sensing system responsive to the approach and withdrawal of the user.

It is a further object according to the present invention to provide a proximity control for use with a lavatory which conserves water by operating only when required by the user.

It is another object according to the present invention to provide a proximity control which is simple in design, easy to manufacture and reliable in operation.

Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings which disclose certain embodiments of the present invention. It should be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention as to which reference should be made to the appended claims.

In the drawings wherein similar reference characters denote similar elements throughout the several views:

FIG. 1 illustrates the placement of the dual antennas of the proximity control system according to the invention within a lavatory; and

FIG. 2 is a schematic representation, partially in block diagram, of the control circuit of FIG. 1.

Referring to FIG. 1 there is shown a lavatory **10** having a spout **13** disposed over basin **14**. A drain **15** is provided at the lowest point within basin **14**, preferably beneath the opening of faucet **13** as shown. Secured behind basin **14**, along its vertical wall beneath faucet **13**, is a first sensing antenna **11**, shown in dotted lines. Antenna **11** also includes a wire shield **12** surrounding it and secured against the inside wall of the basin. Lavatory **10** also includes a second sensing antenna **21**, also shown in dotted lines, secured beneath and behind the leading edge of the lavatory in front of basin **14**. Antenna **21** also includes a wire shield **22** surrounding it and secured to the leading edge. Both antennas and their shields may, of course, be concealed within or under the lavatory.

Referring to FIG. 2, there is shown, partly in schematic form, the connection of the antennas **11** and **21** to a proximity sensing circuit **16** capable of detecting antenna

capacitance changes. The proximity sensing circuit is of a type that provides a shield or guard terminal which can be used to shield the antenna lead wire from grounded objects. Such a guard circuit is commonly used in sensitive capacitance measurements, and is well known to the art of instrumentation. In such proximity sensing circuits, the shield or guard is not grounded, and objects connected to the shield or guard have negligible effect on the antenna. Apart from the shield or guard terminal, the proximity sensing circuit is one serving merely to respond to changes in capacity to operate a translating device or other apparatus.

Coupled to the output of sensing circuit **16** is a relay **19** having a coil **40** and a contact arm **44**. In the de-energized state of relay **19** (as shown), contact arm **44** is disconnected from contact **39**. Line power source **18** is connected permanently to the primary winding P of transformer **26**. The secondary winding S of transformer **26** is coupled to a conventional full-wave rectifying bridge **25**. In addition, a capacitor **24**, connected across the D-C terminals of bridge **25**, serves as a filter for the rectified current applied to relay coils **20** and **30** of relays **60** and **70**, respectively.

While the circuit of FIG. 2 remains in a de-energized state, i.e., in the condition shown in FIG. 2, the primary winding P of transformer **36** is connected to the contact arm **39** of relay **19**, this relay remaining de-energized. Hence, substantially no voltage will be applied by the secondary winding S of transformer **26** to the base-emitter terminals of transistor **52** over the half-wave rectifier-filter circuit which includes rectifier **35**, bleeder resistor **33** and capacitor **34**. Thus, the base terminal of transistor **52** will draw essentially no current. While transistor **52** remains non-conducting, this condition does not interfere with the conductivity of transistor **53**, the base electrode of which can receive current flowing through resistor **55** and hence transistor **53** draws appreciable current at this time. When transistor **52** becomes conductive later in the cycle, the junction of resistor **55** and the collector of transistor **52** are essentially connected to the emitter of transistor **53**, and the base current of transistor **53** falls to a very low value so that transistor **53** essentially becomes non-conducting.

While the circuit of FIG. 2 continues to remain in a deenergized state with an appreciable current flowing to the base electrode of transistor **53**, the winding **20** of relay **60** will be energized by the flow of current supplied from transformer **26** over the circuit of rectifier **25**, the winding **20** of relay **60**, the collector-emitter electrodes of transistor **53** and back through rectifier **25**. When the armature **27** of relay **60** is closed against its contact **28**, the antenna **11** will be connected to the input terminal **43** of the proximity sensing circuit **16**. Hence, the antenna **11** will be ready to respond to a significant change in capacitance arising from a user placing his hands in the vicinity of the faucet **13**. The winding **30** of relay **70**, which is connected to the transformer **26** and rectifier **25** by a circuit which is parallel to the winding **20** of relay **60**, will not be energized by its connection to the collector-emitter circuit of transistor **52** due to the absence of appreciable current flowing to the base of transistor **52**. Relay **70** will therefore remain released. Hence, antenna **21** will remain disconnected from the input terminal **43** of the proximity sensing circuit **16** because of the disconnection of the armature **37** from its contact **38**.

The relay coils **20** and **30** may be of any well known type, but they are preferably parts of reed relays having contacts which are suitable for switching very small currents. Capacitors **50**, **51**, **56** and **57** are employed for transient voltage suppression.

It will be apparent that, after antenna **11** responds to the presence of part of a user's body, the proximity circuit **16** will cause relay **19** to operate. The closure of the contact **39** will connect the A.C. voltage source **18** to transformer **36**. Rectified current will now flow through the above-noted rectifier-filter circuit, which includes rectifier **35**, to the base-emitter circuit of transistor **52**, thereby rendering transistor **52** conducting. Relay **70** will now operate and connect the antenna **21** to the input terminal **43** of the proximity circuit **16** via the armature **37** and contact **38** of relay **70**.

The circuit of FIG. 2 operates as follows:

When the user approaches lavatory **10** and places his hands in the vicinity beneath faucet **13**, the presence of his hands is sensed by the change in capacitance between antenna **11** and ground, causing proximity circuit **16**, which is connected thereto via the armature **27** and contact **28** of relay **60**, to operate. This energizes relay **19** and solenoid valve **17**. As is well known, solenoid valve **17** is connected to and controls the water pipeline connection that feeds faucet **13** so that water will begin to flow into the basin of the lavatory. Any type of solenoid valve will be appropriate for this arrangement of this invention. Contact arm **44** of relay **19** will close its contact **39** and cause coil **30** of relay **70** to be energized by means of transistor **52** over the network connecting transformer **36** to relay coil **30**. Antenna **21** will now be connected to the input terminal **43** of proximity circuit **16**. Simultaneously, transistor **53** will ceas e conducting and thus will de-energize relay coil **20** so that contact arm **27** will become disconnected from contact **28**. Antenna **21** will continue to sense the presence of the user in front of the lavatory and maintain solenoid valve **17** in an energized condition while the user is in proper position. As soon as the user withdraws from the range of antenna **21**, proximity sensing circuit **16** will de-energize solenoid valve **17** and relay coil **40**. Hence, antenna **11** will once again become connected to the input terminal **43** of proximity circuit **16** in readiness for the next cycle of operation.

Relays **60** and **70** and their associated circuitry and contacts may be contained within a shielded mounting **42** shown in dotted lines and secured in an accessible position in a chamber or other location beneath or adjacent to lavatory **10**. Shielded case **42** is connected at terminal **41** to both shields **12** and **22** surrounding or supporting the antennas. These connections may be conveniently performed by utilizing shielded coaxial cables having insulated center conductors connected from terminals **45** and **46** to antennas **11** and **21**, respectively.

In an actual embodiment of the present invention, lavatory **10** was constructed from non-conducting material so that both antennas **11** and **21** would be effective through the walls of basin **14** in sensing proximity. Typical component values were chosen as follows:

Transformers **26** and **36**—Primary 120 v., secondary 6 v.
Capacitors **50** and **51**—0.1 μf., 25 v. rating.
Capacitor **24**—250 μf., 50 v. rating
Capacitor **34**—50 μf., 10 v. rating
Capacitors **56** and **57**—0.01 μf., 25 v. rating
Relay coils **20** and **30**—300 ohm coils
Power source **18**—120 v. AC, 60 cycles
Resistor **23**—10 ohms
Resistors **33**, **54**—106 ohms
Resistor **55**—47,000 ohms

In addition, the following capacitance measurements were made at the antennas:

Capacitance of one antenna to ground equals 7.9 pf.
Capacitance of one antenna to shield equals 70 pf.
Capacitance of shield to ground equals 260 pf.

With the above parameters, each antenna could be adjusted to operate proximity circuit **16** by moving the hand to a distance of approximately 5–6 inches from the antenna.

From the above measurements, it should be noted that by isolating antenna relays **60** and **70** and the shields of the antennas from ground, the electronic hardware mounted close to the antenna will have negligible effect

upon the sensitivity of the proximity circuit so long as the shields are between the antennas and grounded hardware. It can be appreciated that if the antenna shields were directly connected to the ground, the sensitivity of the proximity circuit would be greatly reduced.

Thus, the antenna **11** responds to the positioning of the user's hands under or within short range of the faucet **13**. The proximity circuit **16**, under the control of antenna **11**, turns on the solenoid valve **17** and, almost simultaneously, disconnects antenna **11** from the sensing circuit **16**. The proximity circuit **16** substitutes antenna **21** in place of antenna **11**. Antenna **21** will continue to hold the sensing circuit **16** activated until the user leaves the scene of the lavatory **14**. When this happens, antenna **21** will be disconnected from sensing circuit **16** and replaced by antenna **11**. This restores the status quo for another cyclical sequence.

Shielded case **42**, and the outer conductors of the coaxial cables connected to shielded case **42**, must be connected to the "guard" terminal mentioned formerly, so that the switching described above can be accomplished without introducing additional capacitance from antenna **11** to ground or from antenna **21** to ground. The purpose of isolating transformers **26** and **36** is to keep the impedance from shielded case **42** to ground at a high level. In the example of FIG. 2, this shield-to-ground impedance is essentially the primary-to-secondary interwinding capacitance of transformers **26** and **36**.

The arrangement of this invention may obviously be employed to control the operation of the faucet **13** with any number of antenna or capacity combinations, such as **11**, **12** and **21**, **22**. The mechanism may be adjusted to cause the various capacitor combinations to respond to the proximity of different parts of the user's body. Unless all capacitances reached predetermined values, the faucet **13** would fail to operate. And the faucet **13** would continue to operate while any one of said capacitances maintained its predetermined value. But when the charge on the latter capacitance receded from its predetermined value, the operation of the faucet **13** would be stopped.

While only certain embodiments of the present invention have been shown and described merely for the purpose of illustration, it will be understood that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention.

What is claimed is:

1. The combination of a faucet, a plurality of antennas respectively adapted to be exposed to different parts of a user's body, each adapted to change in capacitance by a predetermined amount only when the respective part of the user's body is in close proximity to said faucet, and means to operate said faucet only when all of the respective antennas are changed in capacitances to predetermined values.

2. The combination according to claim **1** including, in addition, means to release said faucet when the capacitances of said antennas fall below their respective predetermined values.

3. The combination according to claim **1**, in which the faucet operating means includes a solenoid valve.

4. The combination of a faucet, a first antenna positioned so as to respond to the proximity of one part of a user's body relative to the position of the faucet, a second antenna positioned so as to respond to the proximity of another part of the user's body relative to the faucet, means responsive to a predetermined change of said first antenna to operate said faucet, means to maintain the faucet operated for a predetermined time interval and to render the faucet operating means non-responsive to said first antenna, means responsive to a predetermined change of said second antenna to continue said faucet operated until the change of said second antenna is reduced below the latter predetermined change.

5. A combination in accordance with claim **4** in which the faucet operating means includes a proximity sensing circuit.

6. A combination according to claim **5** in which the faucet operating means also includes a solenoid valve.

7. An arrangement for the control of a faucet, comprising two antennas positioned on opposite sides relative to the outlet of said faucet, one of said antennas responding by changes in its capacitance when one part of a user's body is in close proximity thereto, and the other antenna responding to changes in its capacitance when another part of a user's body is in close proximity thereto, means to operate said faucet when both antennas respond by predetermined changes in capacitance, and means to release the faucet operating means to prevent the flow of fluid from said faucet when both antennas have failed to respond by predetermined changes in capacitance simultaneously to the proximity of both parts of the user's body.

8. An arrangement in accordance with claim **7** in which said faucet operating means includes a proximity sensing circuit.

9. An arrangement in accordance with claim **7** in which said faucet operating means includes a solenoid valve.

10. The method of controlling the operation of a faucet the flow path of which is positioned between first and second control elements, which consists in operating the faucet only when a user's hand becomes positioned close to said first element, maintaining the faucet operated as long as the user's body is positioned close to the second element even while the user's hand becomes more widely spaced from the first element, and closing said faucet when the user's body becomes more widely spaced from the second element.

11. A proximity control for use with a lavatory for providing an automatic flow of a liquid from its faucet in response to the presence of a user comprising:

a proximity sensing circuit,

valve means coupled to said circuit for controlling the flow of said liquid, and

antenna means coupled to said proximity circuit and disposed within the lavatory for sensing the presence of the body of the user in front of and his hands within the basin of the lavatory.

12. The control as recited in claim **11** wherein said antenna means comprises:

a first antenna normally coupled to said proximity circuit for sensing the presence of the hands of the user within the lavatory basin,

a second antenna for sensing the presence of the user in front of the lavatory, and

means responsive to said first antenna for energizing said second antenna and said valve means and de-energizing said first antenna.

13. The control as recited in claim **12** wherein said first antenna is disposed beneath the faucet and behind the basin wall of the lavatory.

14. The control as recited in claim **13** wherein said second antenna is secured in front of said basin along the leading edge of said lavatory.

15. The control as recited in claim **14** wherein said means for energizing comprises:

switch means coupled to said proximity circuit and responsive to said first antenna for connecting said second antenna to said proximity circuit and disconnecting said first antenna from said circuit.

16. The control as recited in claim **15** wherein said switch means comprises:

a first normally-closed relay for coupling said first antenna to said proximity circuit,

a second normally-open relay for coupling said second antenna to said proximity circuit, and

a master relay responsive to said proximity circuit for opening said first relay, closing said second relay, and operating said valce means in response to the presence of the user within the basin of the lavatory;

and, opening said second relay, closing said first relay and turning off said liquid when the user withdraws from the proximity of said second antenna.

17. The control as recited in claim **16** wherein said valving means comprises at least one solenoid valve for controlling the flow of liquid from said faucet.

18. The control as recited in claim **17** wherein said first and second antennas are electrically isolated from ground potential.

19. The control as recited in claim **18** wherein said first and second antenna relays are isolated from ground potential.

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