The present invention relates to automatic systems of flush valves in sanitary systems and the principal object of this invention is to provide a practical means for automatically operating the flush valve of a sanitary facility in response to the body capacity of the individual using the particular sanitary facility.

In many plumbing installations it is desirable, for several different reasons, that flush valves be operated automatically rather than manually. This is particularly true in the case of urinals. Where a urinal is manually actuated, it has been observed that the urinal flush valve is not always operated after the urinal is used either because of the reluctance of the user to touch the operating handle of the flush valve, or because of an oversight on the part of the user. This can result in the urinal becoming foul and offensive and constituting a potential health hazard.

In fact, the problem is so acute that many states are now considering making automatic flush valves mandatory in public urinals.

In the past, the most successful type of automatic flush valve has been that which automatically flushes the urinal at periodic intervals. The inherent disadvantage of this type system is that the flushing of the urinal is not associated with the frequency or time of use of the urinal. This results in wasting water when the urinal is not being used with great frequency and results in the mentioned esthetic and health problems when the urinal is used extensively. Also, since the automatic system flushes the urinal periodically, it is possible that an individual could be in the process of using the urinal at the moment it is flushed. This may result in wetting the individual or frightening or disturbing him sufficiently so that he will not be able to complete his use of the urinal.

To overcome these problems with systems which periodically flush the urinal, many automatic systems which are actuated by actual use of the urinal have been developed. However, each of these systems has inherent drawbacks and up till now a completely satisfactory user actuated automatic flushing system for a urinal has not been devised.

In accordance with the present invention a user actuated automatic flush system for a urinal has been devised which overcomes many of the faults of previous automatic systems. This system employs a capacity sensitive means to detect the body capacity of the person using the urinal and has associated therewith electric circuit means responsive to the capacity detected by the capacity sensitive means to operate the flush valve of the urinal after the capacity sensitive means detects that a person has approached the urinal to use it and thereafter has left the area of the urinal. Therefore, any urinal in which this system is installed will remain unflushed so long as no one approaches the urinal to use it, and the urinal will flush only after a person who has used the urinal leaves the area of use of the urinal. Thus, the flushing of the urinal is tied to its frequency of use and there is no problem of splashing or disturbing the user of the urinal since the urinal will not be flushed until the party using it leaves the area of the use of the urinal.

To prevent the urinal from being flushed by an occasional passerby the electric circuit means has been arranged so that a person must remain in a position of use of the urinal for a minimum period of time before the system will operate. This eliminates the wasting of water and prevents starting the occasional passerby.

As in any other system reliability is an important factor in the success of an automatic flushing system, and also in the present system it is important that the capacity sensitive means be able to distinguish very small variations in capacity since it is necessary that the system work without requiring that the user of the urinal touch any fixtures. In the preferred embodiments of the present invention, a unique oscillator is employed which is very reliable and in addition enables detection of capacities as low as 2 picofarads while operating at a frequency in the range of 2 to 4 kilocycles. The fact that this oscillator enables detection of such small values of capacity while operating at such low frequencies means that the system does not interfere with radio transmission and reception in the area while making the system very sensitive to small changes of body capacity in the area of the urinals. The oscillator is fully described and claimed in our pending application, Serial No. 388,644, filed August 10, 1964, now U.S. Patent 3,199,033.

For a better understanding of the present invention and of its advantages, both those mentioned above and others which will be apparent hereafter, reference can be had to the accompanying drawings of which:

FIG. 1 is a schematic representation of an embodiment of the present invention as it would be employed with a urinal; and

FIG. 2 is a schematic of a change which can be made in the embodiment of FIG. 1.

Referring to the embodiment in FIG. 1, mounted on the top of a urinal 19 is an enclosure 12 which contains within it the flush valve 14 for the urinal, a flush valve operating mechanism 16, such as that disclosed in U.S. Patent No. 2,552,625 and a circuitry 56 for controlling the flush valve operating mechanism. The circuit 18 is shown in the drawing outside the enclosure 12 to simplify the drawing of the embodiment.

One of the leads 20 for excitation of the flush valve operating mechanism 16 is connected to a terminal 22 of the 115 v. 60 cycle line. The other lead 24 of the motor is connected to the armature 26 of the relay 28. The normally open contact for this armature 26 is connected to the other, grounded, terminal 32. When the relay is energized the 115 v. 60 cycle line is therefore connected to the valve operating mechanism 16 causing it to flush the urinal, and when the relay is deenergized the circuit between the 115 v. 60 cycle line and the mechanism for operating the valve is open so that the urinal will not be flushed by the valve operating mechanism 16.

Controlling the energization and the deenergization of the relay 28 is a circuit 34 which controls the current flow through the coil 33 of the relay as a function of the capacity between ground and a metal plate 36 positioned on the front of the enclosure 12. This circuit 34 has an oscillator 38 which is coupled by a capacitor 40 to the metal plate 36. The oscillator has variable capacitor 42 connected between the capacitor 40 and the grounded terminal 32, a neon tube 44 and a resistor 46 connected in shunt across the variable capacitor, a fixed capacitor 48 and resistor 50 connected in shunt across the neon tube 44.

The capacitors 42 and 48 are charged from a D.C. power supply 52 which consists of a diode 54, a resistor 56 and a capacitor 58 connected in series across the terminals 22 and 32 of the 115 v. 60 cycle source. A resistor 60 connects the point common to capacitors 40, 42 and 58 to the point common to capacitor 58 and resistor 55 so that the D.C. potential output of the power supply 52 is applied across the variable capacitor 42 and current...
flows through resistor 60 from the D.C. power supply charging capacitors 42 and 48 with respect to ground. When either capacitor 42 or 48 exceeds the breakdown potential of the neon tube 44, the neon tube 44 breaks down and both capacitors 42 and 48 discharge through it. Discharge current for capacitor 42 travels from one side of the neon tube 44 and resistor 46 to the other side of the capacitor while the discharge current for capacitor 48 travels from the one side of the capacitor 48 through the neon tube 44 and resistor 50. When the voltage on the capacitors 42 and 48 drops due to discharging through the neon tube 44, eventually the current through the neon tube 44 will fall below the level necessary for maintaining conduction in the neon tube 44 and the neon tube will extinguish, cutoff off the discharge path for the capacitors. With the discharge path for the capacitors 42 and 48 cut off they again start to be charged by the current flow through resistor 60 and thus the charging and discharging cycle repeats itself. This alternate charging and discharging of the capacitors 46 and 50 produces a series of pulses across each of resistors 42 and 48 which are summed to produce a differential output across both resistors 46 and 50 since current through these resistors is in opposite directions.

The value of the capacitors 42 and 48 are equal as are the values of the resistors 46 and 50. Thus the differential output across the resistors 46 and 50 is theoretically the lowest voltage possible across the two resistors with the circuit operating as described above.

When a person approaches the urinal to use it he comes between the plate 36 and ground so that the capacity between the plate 36 and ground is increased. When he is positioned to use the urinal this increase is about 2 to 3 picofarads. This capacity is then added in series with capacitor 40 across capacitor 42, thus changing the resistance between the ground terminal 32 and resistor 60. This increases the current flow through resistor 46 changing the differential voltage across resistors 46 and 50 from the mentioned null value, making the total voltage across resistors 50 and 46 more positive. Because of the size of the change in capacity, the change in voltage is not very large. However, it is detectable and to increase its magnitude an amplifying circuit 62 is employed.

As pointed out above, the capacitance of capacitors 42 and 48 are equal and the resistance of resistors 46 and 50 are equal. It has been found as is described in the above application that by making these capacitors and resistors equal the oscillator is made insensitive to changes in the characteristics of the neon tube 44 or the voltage supplied to charge the capacitors and has in addition been found to make the oscillator extremely reliable when employed in detecting very small changes in capacity.

With the oscillator circuit as described above, it would be assumed that null voltage of the differential output across resistors 46 and 50 is quite small because capacitor 42 equals capacitor 48 and resistor 46 equals resistor 50. However, because the size of the change in magnitude of the differential output across resistors 46 and 50 caused by a person standing in front of the urinal is quite small, this voltage is sufficient to interfere with the detection of this change in the differential output. Though it is not sure what causes this relatively large null voltage, it is assumed that this is due to the fact that the resistors 46 and 50 are in the charging path of capacitor 48 while there is no comparative resistance in the charging path of capacitor 42. However, no matter what the cause of this null voltage is, it has been found that employing a large resistor 64 and a blocking capacitor 66 in shunt with capacitor 48 materially reduces the null voltage so it is no longer a factor in detecting the changes in the magnitude of the differential output across resistors 46 and 50 due to the body capacity of an individual using the urinal. The differential output across resistors 46 and 50 is fed into the input of the above-mentioned amplifier 62.

The amplifier 62 has two stages. The first stage of the amplifier comprises a first transistor 68 with its base to emitter path connected across resistors 46 and 50 in series with resistor 70, with a resistor 72 coupling its collector to the output of the D.C. power supply 52, and with a resistor 74 connecting its base to its collector for biasing purposes.

The current amplified differential output of the first stage of the amplifier 62 is fed into the second stage of the amplifier through a capacitor 76, coupling the emitter of the first transistor 68 to the base of a second transistor 78. The emitter of the second transistor 78 is connected to ground while the collector of the second transistor 78 is connected to the collector of the first transistor 68 through resistor 89. A resistor 82 and capacitor 84 are connected in shunt between the collector of the first transistor and the ground terminal 32 for biasing and filtering purposes respectively, and a resistor 86 is connected between the base and the emitter of the second transistor 78 to bias the base with respect to ground so that the first transistor 68 has a resistor 88 connecting its base to its collector for biasing purposes.

The output of the second stage of the amplifier 62 or the collector of the second transistor 78 is connected by a capacitor 92 to the base of a germanium four layer PNPN semiconductor switching device 90, such as a 2N1966. Connected in series between the emitter and collector of this semiconductor switching device 90 is a diode 96 and the coil 94 of a relay 95. In shunt with the coil 94 is a capacitor 98 and in shunt across the emitter and collector of is a diode 100. The emitter of the driving path of the semiconductor switching device 90 is connected in series with a capacitor 102 and a resistor 104 across the excitation terminals 22 and 32 so as to couple the AC source to the semiconductor switching device. However, only negative current can flow through the semiconductor switching device from the A.C. source because positive current is shunted past the semiconductor switching device by the diode 100. Whether negative current actually will flow through the semiconductor switching device 90 will depend on the polarity of the base of the semiconductor switching device which in turn depends on the combination of a bias circuit and the oscillator 58. The bias circuit consists of a resistor 106 connected between the base and emitter of the semiconductor switching device and a resistor 108 and a diode 110 connected between the base of the semiconductor switching device 90 and the A.C. excitation terminal 22. This bias circuit supplies a positive potential to the base while the collector is negative, and while no one is in the area of use of the urinal the pulses supplied by the oscillator through capacitor 92 are not sufficient to drive the base negative while the collector is negative. Therefore, while the urinal 10 is not used, the semiconductor switching device 90 remains nonconductive during the negative half cycles of the excitation applied thereacross. This means that current will flow through the capacitor 102, the resistor 104 and past the semiconductor switching device through the diode 96 and the coil 94 during the negative half cycles. This current flow through the coil 94 is sufficient to energize the relay 95. It is presumed that it is due to the fact that the current is shunted to ground by the diode 100, diode 96 isolates the coil 94 from the path to ground through the diode 100 during this time to prevent deenergization of the relay 95, so that the relay is energized all the time the semiconductor switching device 90 is nonconductive.

With the relay 95 energized the armature 112 of the relay is in contact with contact 114. The armature of the relay is connected by a capacitor 118 to the grounded terminal 32. When the armature 112 is in contact with contact 114 it connects capacitor 118 across a resistor.
120 and the coil 33 which are connected in series between the contact 114 and the grounded terminal 32. Initially there is no charge on the capacitor 118 so that the fact that the capacitor 118 is connected across the coil 33 does not mean that the relay 28 will be energized.

When someone approaches the urinal to use it his body changes the capacity between the plate 36 and ground. As pointed out previously this provides a change of the output between the resistors 46 and 50 to provide pulses greater in magnitude than the mentioned null potential. These pulses of increased potential are amplified by the amplifier 62 and fed to the base of the semiconductor switching device 90 in the form of negative pulses which drive the base of the semiconductor switching device 90 sufficiently negative during the negative half cycles to cause it to conduct. When the semiconductor switching device 90 conducts, all excitation for the coil 94 is shunted past the coil 94, during positive half cycles by diode 100 and during negative cycles by the semiconductor switching device. Therefore, the relay 95 becomes deenergized.

With the relay 95 deenergized, the armature 112 moves away from the contact 114 and contacts contact 120. This puts the capacitor 118 in series with a diode 122 and a resistor 124 across the 115 v. 60 cycle line so that the capacitor 118 is still charging. So long as the semiconductor switching device is conductive, the armature 112 remains against the contact 120 and the capacitor charges towards 115 v. However, the charge on the capacitor is limited by a resistor 128 and a neon tube 130 connected between the contact 120 and ground. The neon tube 130 breaks down and conducts when the voltage across the capacitor reaches the breakdown potential of the neon tube. The capacitor 118 then remains at this potential until the relay is reenergized.

The relay is reenergized when the person using the urinal leaves the vicinity of the urinal. This reduces the capacitance between the metal actuator 36 and ground and therefore restores the differential output across the resistors 46 and 50 to null. As pointed out previously, with the output across resistors 46 and 50 at its null value the semiconductor switching device is deenergized, thus allowing current to flow through the coil 94 so that the relay 95 again becomes energized. With the relay 95 energized the armature 112 is against contact 114 so that the capacitor 118 is again connected across coil 28. This time, however, the capacitor 118 is charged and current flows through resistor 120 and the coil 33 energizing the first mentioned relay. This attracts the armature 26 to the contact 30 coupling the flush valve actuating means 16 across the 115 v. 60 cycle excitation which of course, as mentioned above, causes the valve actuating means to flush the urinal. The relay remains energized until the charge on the capacitor 118 is dissipated. The relay 28 becomes energized removing the armature 26 from the contact 30 to cut off the excitation to the valve actuating means 16. Thus it can be seen that the length of the flushing depends on the charge on capacitor 118 which in turn depends on the breakdown potential of the neon tube 130 and the value of resistor 128. The resistor 128 and neon tube 130 are selected so as to give a sufficient flush to clean the urinal, but at the same time are selected to prevent the flushing from being excessive and thus wasting of water and delaying the time when the next person can use the urinal.

It will be noticed that it will take time to charge capacitor 118 through resistor 124, the time of course depending on the respective values of capacitance and resistance. This means that the semiconductor switching device 90 must remain conducting for a certain length of time to charge the capacitor 118 sufficiently to energize the relay 28 which in turn means that a person must stand in position in front of the plate 36 for a given period of time before the relay 28 will be energized. This prevents the urinal from being flushed by an occasional passerby who does not intend to use the urinal but merely happens to stand in front of the urinal to comb his hair or adjust his tie.

Referring to FIG. 2, it shows the use of a thermal switch, such as a Tungson TS X 305C, in place of the relay 28, capacitor 118, diode 122, neon tube 130 and resistors 120, 124, 128. In this circuit the armature 112 is connected to the terminal 22 and one side of the valve actuating mechanism 16 is connected to the grounded terminal 32. One terminal of the heater 132 for the thermal relay 134 is also connected to the grounded terminal 32 and the other terminal of the heater 132 is connected to contact 120. Contact 114 of the relay is connected to the blade 136 of the terminal switch while the other excitation terminal of the valve actuating means 16 is connected to a contact 138 of the thermal switch which remains open so long as the thermal switch is cool. Therefore, the flush valve actuating mechanism 16 normally remains unenergized. However, when someone approaches the urinal and thereby causes the relay 95 to be deenergized, the 115 v. excitation is placed across the heater coil 132. If a person stands in front of the urinal for a sufficient length of time, approximately 8 seconds, the heater coil will heat up. The thermal switch snap blade 136 against the normally open contact 138. This does not energize the valve actuating means 16 because the circuit is still open at contact 114 so long as the relay is deenergized. When a person standing in front of the urinal moves away the relay again becomes energized. This causes the armature 112 to again contact contact 114 completing the excitation circuit for the flush valve mechanism 16. At the same time energization of the relay opens the circuit to the heater coil 132, allowing the heater coil to cool. When the heater coil cools sufficiently the thermal switch blade will again snap causing it to move away from contact 138 and open up the energizing circuit for the valve actuating mechanism 16, thus ending the flushing of the urinal.

Described above is a complete embodiment of the present invention and modification of that embodiment. It should be obvious to those skilled in the art that certain changes can be made in these embodiments without departing from the spirit and scope of the invention. Therefore, it will be understood that this is intended to cover all modifications or changes in the disclosed embodiments which do not depart from the spirit and scope of the invention as expressed in the claims.

What is claimed is:
1. An automatic flusher for a toilet comprising:
   (a) capacity sensitive means for detecting body capacity in the area of use of the toilet;
   (b) actuating means for flushing the toilet;
   (c) means responsive to said body capacity for operating the actuating means for flushing the toilet after the capacity sensitive means detects a minimum level of body capacity for at least a predetermined length of time and thereafter detects an absence of such a level of body capacity; and
   (d) means for delaying the flushing of the toilet for a period after said capacity sensitive means detects said absence of body capacity.
2. An automatic flusher for a toilet comprising:
   (a) capacity sensitive means for detecting the presence of a person in the area of use of a toilet and for providing signals indicative of the presence or absence of such a person;
   (b) actuating means for flushing the toilet; and
   (c) electric circuit means including a low frequency oscillator for detecting such signals to determine if the length of time of such presence exceeds the predetermined minimum length of time and for causing said actuating means to flush the toilet only when the length of time of such presence exceeds the predetermined minimum and said presence is no longer detected.
3. An automatic flusher for a toilet comprising:
   (a) a capacity sensitive plate for detecting the body capacity of a person positioned to use the toilet;
   (b) a low frequency oscillator means responsive to change in capacity detected by said capacity sensitive plate resulting from persons approaching and leaving the toilet for providing signals indicative of said changes;
   (c) actuating means for flushing the toilet; and
   (d) means responsive to said signals for operating the actuating means to flush the toilet when the capacity sensitive plate detects the body capacity of a person in the area of use of the toilet and thereafter detects his absence from the area of use of the toilet, said last mentioned means being operative only after the body capacity of a person in the area of use has been detected at least for a predetermined time.

References Cited by the Examiner

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Date</th>
<th>Inventor</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,603,794</td>
<td>7/1952</td>
<td>Bikser</td>
<td>4—100</td>
</tr>
<tr>
<td>2,652,551</td>
<td>9/1953</td>
<td>Gumpertz et al.</td>
<td>340—258</td>
</tr>
<tr>
<td>2,687,499</td>
<td>8/1954</td>
<td>Scothorn</td>
<td>340—258</td>
</tr>
<tr>
<td>2,695,402</td>
<td>11/1954</td>
<td>Gray</td>
<td>340—258</td>
</tr>
<tr>
<td>2,738,448</td>
<td>3/1956</td>
<td>Bokser</td>
<td>4—100</td>
</tr>
<tr>
<td>2,782,208</td>
<td>2/1957</td>
<td>Rug</td>
<td>340—258</td>
</tr>
<tr>
<td>3,129,415</td>
<td>4/1964</td>
<td>McKnight</td>
<td>340—258</td>
</tr>
<tr>
<td>3,151,340</td>
<td>10/1964</td>
<td>Teshima</td>
<td>4—166</td>
</tr>
<tr>
<td>3,193,846</td>
<td>7/1965</td>
<td>Lefebvre</td>
<td>4—100</td>
</tr>
<tr>
<td>3,201,774</td>
<td>8/1965</td>
<td>Uemura</td>
<td>340—258</td>
</tr>
</tbody>
</table>

LAVERNE D. GEIGER, Primary Examiner.
H. ARTIS, Assistant Examiner.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,314,081 April 18, 1967

Carl E. Atkins et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 43, for "system" read -- systems --; column 3, line 21, for "46 and 50" read -- 42 and 48 --; line 22, for "42 and 48" read -- 46 and 50 --; column 4, line 47, for "58" read -- 38 --; column 6, line 13, for "terminal" read -- thermal --; column 8, line 4, for "Bikser" read -- Bokser --.

Signed and sealed this 14th day of November 1967.

(SEAL)
Attest:
Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents