Aug. 26, 1969 MASUO ICHIMORI ET AL 3,462,769

APPARATUS FOR AUTOMATIC WASHING OF A FLUSH LAVATORY

Filed Nov. 15, 1966 3 Sheets-Sheet 1

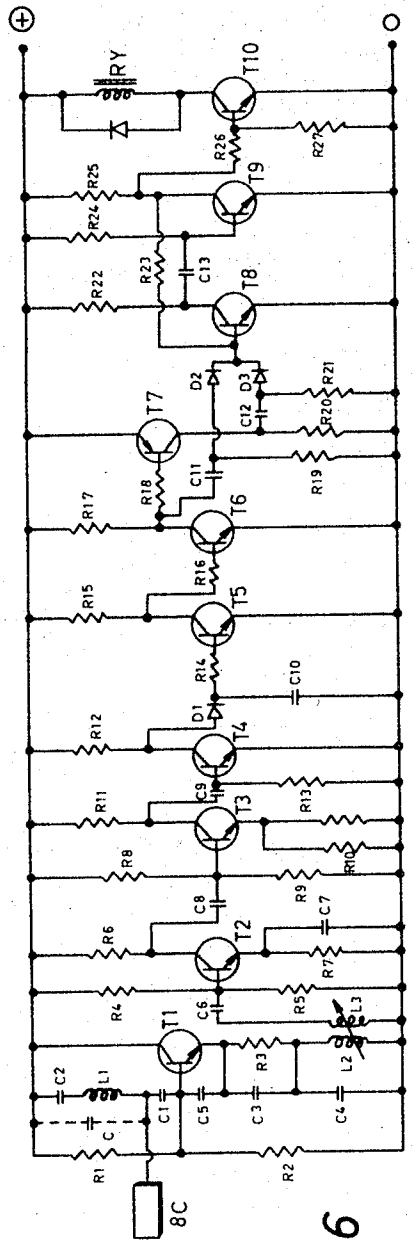


Fig. 6

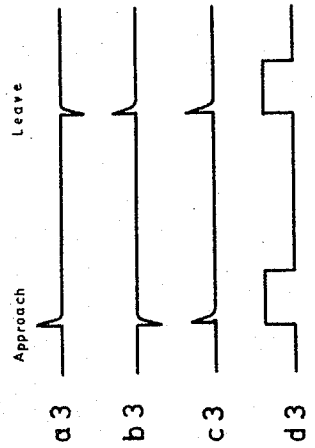


Fig. 7

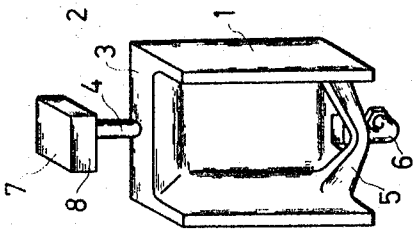


Fig. 1

INVENTORS.
MASUO ICHIMORI
BY TADAYUKI ISHIKAWA
Kurt Kelman
AGENT

APPARATUS FOR AUTOMATIC WASHING OF A FLUSH LAVATORY

Filed Nov. 15, 1966 3 Sheets-Sheet 2

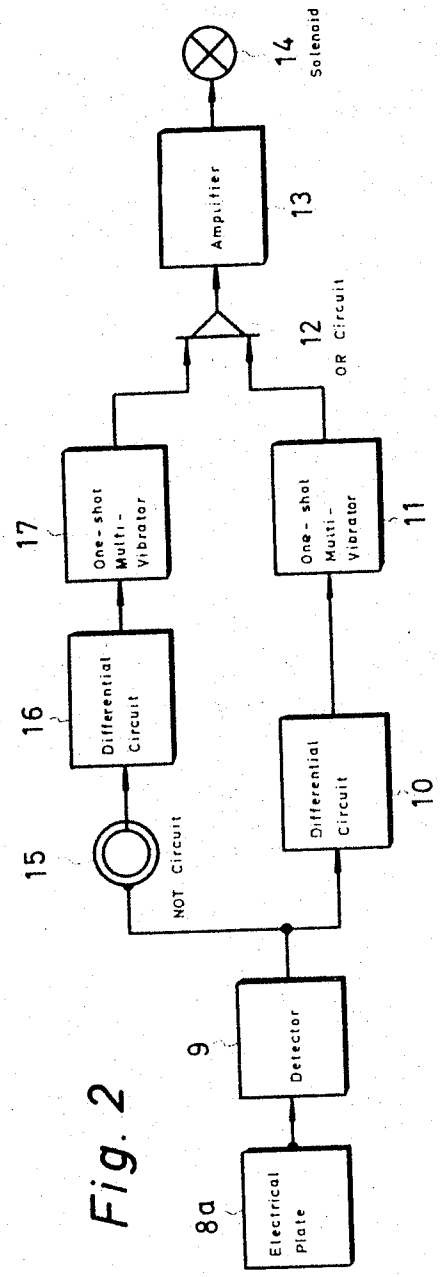


Fig. 2

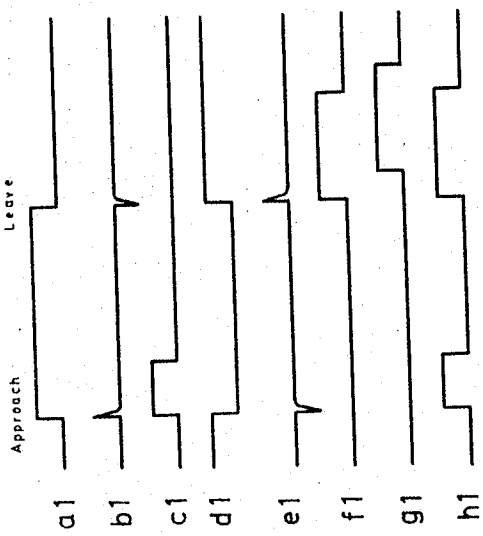


Fig. 3

INVENTORS.
MASUO ICHIMORI
TADAYUKI ISHIKAWA

BY Kurt Kelman
AGENT

APPARATUS FOR AUTOMATIC WASHING OF A FLUSH LAVATORY

Filed Nov. 15, 1966 3 Sheets-Sheet 3

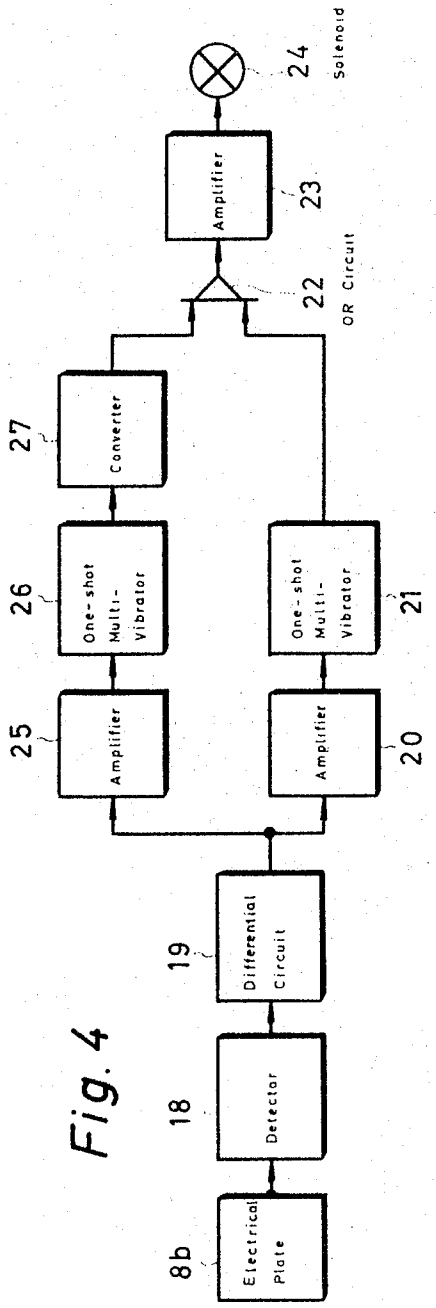


Fig. 4

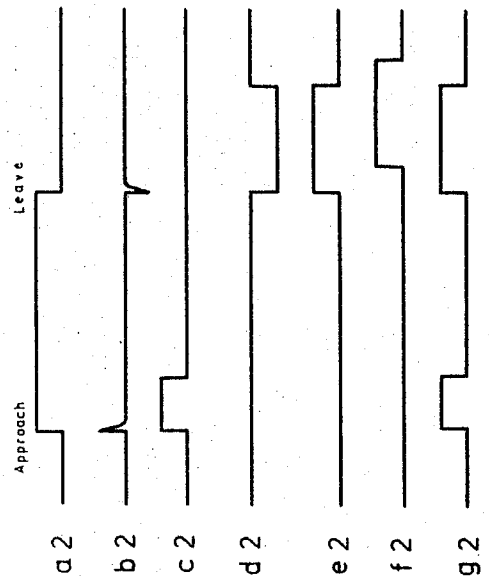


Fig. 5

INVENTORS.
MASUO ICHIMORI
BY TADAYUKI ISHIKAWA
Kurt Kelman
AGENT

United States Patent Office 3,462,769
Patented Aug. 26, 1969

3,462,769

APPARATUS FOR AUTOMATIC WASHING OF A FLUSH LAVATORY

Masuo Ichimori and Tadayuki Ishikawa, Kyoto-fu, Japan, assignors to Tateisi Electronics Co., Kyoto-shi, Japan, a corporation of Japan

Filed Nov. 15, 1966, Ser. No. 594,491
Claims priority, application Japan, Nov. 27, 1965, 72,717/65
Int. Cl. E03d 5/10
U.S. Cl. 4—100 5 Claims

ABSTRACT OF THE DISCLOSURE

When an electrostatic capacity detecting apparatus detects the approach of a user to a toilet fixture, a valve is opened a predetermined time and a preliminary flushing of water is effected. When the apparatus detects departure of the user from the fixture, the valve is again opened another predetermined time to make a further flushing of water.

The present invention relates to apparatus for automatic washing of a flush lavatory, and particularly relates to a control apparatus which actuates means to supply amount of water to a toilet fixture responsive to the presence of a user.

In the prior art, utilization of a stool or a urinal is detected by means of a user approach detecting apparatus which is mounted in an appropriate place near the stool or the urinal. A flush of water is discharged in response to means for detection that the user left the toilet fixture. However, the operational effect of washing after the fixture is used is insufficient.

More particularly, when an automatic flushing apparatus of this type is installed in a place when the flushing apparatus is not used often, the inner surface of the fixture is under such a dry condition that only one flush after using cannot bring out sufficient washing effect. This is, proved by an experiment in which some colored ink is put on the dry inner surface of the stool before the stool is used and one flushing is made; after this operation some of the colored ink is left unwashed away from the surface. However, when a considerable amount of flushing water is used for washing, the washing effect may be complete but economically this amount of water becomes intolerable.

The present invention overcomes the difficulty stated above. Specifically, in the invention of subject application, after an electrostatic capacity detecting apparatus detects approaching of a user to the fixure, a valve is opened a predetermined time and a preliminary flushing of water is brought about. After the apparatus detects the departure of the user from the place where the stool is installed, the valve is again opened another predetermined time to effect a further flushing of water.

By this process the number of flushings apparently increases, but the washing effect is rather improved in a flushing in which a predetermined quantity of water is flushed in two parts, one before using the fixture and the other after using the fixture, as opposed to a flushing in which the total of the predetermined quantity of water is flushed once after the fixture is used, even though the one flush is less in quantity than the other flush. This is clearly due to the fact that when the dry inner surface of the fixture is moistened by means of even a small quantity of preliminary flushing of water, the material to be washed away does not tend to adhere to the inner surface so that

the washing effect after the fixture is used may be sufficient even if the water is half or less of the total quantity of the predetermined water.

Therefore, it is an object of the present invention to provide an apparatus to flush washing water for a toilet fixture both prior to and after stool use by detecting capacity variation caused by user's approach to the fixture and thereby detecting the fixture user being at the position in which he assumes in using the fixture.

It is another object of the present invention to provide washing apparatus being equipped with a control circuit to control amount of the flushing water after using a fixture being larger than amount of the flushing water prior to fixture use.

Further objects and advantages of the present invention will become apparent from the following description and annexed drawings. Though the present invention can be applied to not only a stool but also a urinal, the following embodiment of the present invention is applied to a urinal.

FIG. 1 is a perspective view of a urinal embodied with the present invention,

FIG. 2 is a block diagram of an embodiment in accordance with the present invention,

FIG. 3 shows wave forms observed at each block in FIG. 2.

FIG. 4 is a block diagram of another embodiment in accordance with the present invention,

FIG. 5 shows wave forms observed at each block in FIG. 4,

FIG. 6 is an electrical circuit of a further embodiment of the present invention, and

FIG. 7 shows wave forms observed at each block in FIG. 6.

Referring to FIG. 1, there is shown the constructive relation between a urinal and an apparatus emboding the present invention. A urinal **1** is shown mounted on the side of a wall **2**. On the upper surface **3** of the urinal **1** there is connected a water supply pipe **4** which is used to supply flush washing water to the urinal **1**. The supplied water from the supply pipe **4** to the urinal **1** is eventually drained by pipe **6** connected with the lower portion **5** of the urinal **1**. A control means contained in box **7** operates to control the flow of water supplied to the water supply pipe **4**. In the control box **7**, there is contained an electrical circuit and an electro-magnetic flow valve. The surface **8***a* of the control box **7** which is facing toward a urinal user is a form of an electrical capacitor plate. When the urinal user approaches the electrical capacitor plate **8***a*, the said electrical circuit connected with the electrical plate **8***a* detects his approach and operates to control the said valve so that washing water may be supplied for a predetermined period, and on the other hand when he leaves the field of influence over electrical plate **8***a*, the said electrical circuit detects his departure and operates again to control the said valve so that washing water may be supplied for a predetermined period. This operation of the electrical circuit and electro-magnetic valve will be described in detail hereinafter.

As illustrated above, FIG. 2 is a block diagram of an embodiment of the present invention and FIG. 3 shows wave forms observed at each block in FIG. 2. The operation and merit of the present invention will be expained by using FIG. 2 and FIG. 3, as follows:

When the urinal user approaches the electrical plate **8***a* the electrostatic capacity of the electrical plate **8***a* changes. A detector **9** senses this static capacity variation and thereby supplies an output signal. Wherein, the detector **9** keeps the output signal thereof till the urinal user leaves the area of the electrical plate **8***a* and the output is a signal such as shown in FIG. 3 (*a*1). This output signal is supplied to a differential circuit **10** so as to

produce a rising signal such as shown in FIG. 3 (*b*1), and then the signal is supplied to an one-shot multi-vibrator **11** which is a kind of monostable one-shot multi-vibrators. The one-shot multi-vibrator **11** produces an output having a predetermined time width such as shown in FIG. 3 (*c*1). The output signal shown in FIG. 3 (*c*1) operates to energize, through an OR circuit **12** and an amplifier, a solenoid **14** of the electro-magnetic valve so as to supply washing water for a predetermined period. Therefore, it becomes possible to wash the urinal before the urinal user uses the urinal.

On the other hand, as the urinal user leaves the urinal, the electrostatic capacity of the electric plate becomes decreased and thereby the output of the detector **9** becomes zero as shown in FIG. 3 (*a*1). An output of a NOT circuit **15** connected to the detector **9** is, as shown in FIG. 3 (*d*1), reversed in phase with respect to the wave shown in FIG. 3 (*a*1). Therefore, when the urinal user leaves the urinal and the detector **9** supplies no output, the output wave form shown in FIG. 3 (*d*1) of the NOT circuit **15** rises and the output is transformed in form as shown FIG. 3 (*e*1) by a differential circuit **16**. The output as shown FIG. 3 (*e*1) is supplied to an one-shot multi-vibrator **17** which is a kind of mono-stable one-shot multi-vibrators. The one-shot multi-vibrator produces such an output having a predetermined time width as shown in FIG. 3 (*f*1), by which the solenoid of the electromagnetic valve is energized. The time width of the output from the one-shot multi-vibrator **17** is designed to be longer than that of the said one-shot multi-vibrator **11** so as to promote the washing efficiency. Accordingly, in this case, the operation of the solenoid initiates at the urinal user's approach and leaving as shown in FIG. 3 (*h*1) and the electro-magnetic valve supplies amount of washing water corresponding to respective operation period of the solenoid.

The above description is made of an apparatus which actuates the solenoid **14** of the electro-magnetic valve to supply washing water instantly after the user leaves the vicinity of the fixture. However, it is often desired for an apparatus to supply washing water not instantly but with some time delay after use. Especially, in case that the washing water is dispersed in flowing out, an apparatus which supply washing water with some time delay after use of the fixture is quitely preferable. The provision of a delay circuit (not shown) in series with the circuits **15–17** makes possible the supply washing water with some time delay after use of the fixture. In other words, by the provision of a delay circuit, it is possible to actuate the solenoid of the electro-magnetic valve as shown in FIG. 3 (*g*1) which has some time delay with respect to FIG. 3 (*f*1). Accordingly, the solenoid **14** operates as shown in FIG. 3 (*h*1) when the urinal user approaches and leaves the urinal and thereby amount of washing water to be supplied corresponds to respective operation period of the solenoid.

FIG. 4 is a block diagram of another embodiment of the present invention and FIG. 5 shows wave forms of respective outputs from each block in FIG. 4. This embodiment utilizes the following principle. This principle is that when positive and negative signals are supplied to an amplifier comprising NPN type semiconductor, the amplifier responds to only the positive signal and does not responds to the negative signals and that when positive and negative signals are supplied to an amplifier comprising PNP type semiconductor, the amplifier responds to only the negative signal and does not respond to the positive signal. In accordance with the present invention, the signal from the detecting device through the electrical plate 8*b* is a constant level signal during the time from the user's approach to the fixture to his departure therefrom. Therefore the present invention supplies washing water by using a signal obtained by differentiating this constant level signal at the time when the user approaches the urinal and leaves. A differential signal in case of the user approaching the urinal and a differential signal in case of the urinal user leaving the fixture are reversed in phase each other, and therefore if the amplifier circuit comprises an PNP type semiconductor or a PNP type semiconductor, it is noted that the amplifier circuit responds only to one of the passive and negative pulse signals.

Illustrating more particularly, if the amplifier circuit comprises only a PNP type semiconductor, the circuit will respond to only the negative pulse signal of the supplied positive and negative signals and if the amplifier circuit comprises only an NPN type semiconductor, the circuit will respond to only the positive pulse signal of the supplied positive and negative pulses. In other words, if the amplifier circuit comprises only a PNP type semiconductor or an NPN type semiconductor, the circuit responds to either one of the supplied pulse signals and, therefore, an apparatus utilizing an NPN type semiconductor amplifier or a PNP type semiconductor amplifier can't operate to actuate the electro-magnetic valve to supply washing water in response to both the urinal user's approach and leaving.

Accordingly, this embodiment utilizes a PNP type semiconductor and an NPN type semiconductor so that a positive pulse signal supplied from a differential circuit through a detecting device may actuate a circuit comprising the NPN type semiconductor to open an electromagnetic valve in case of the urinal user approaching the urinal and so that a negative pulse signal supplied may actuate another circuit comprising the PNP type semiconductor to open the electro-magnetic valve in case of the urinal user leaving the urinal.

This embodiment will be explained in detail by using FIG. 4 and FIG. 5. Referring to the figures, an output from a detector **18** comprising an NPN type transistor keeps the same wave form (*a*2) in FIG. 5 as the wave form (*a*1) in FIG. 3 during the time interval from the time when the urinal user comes to the front of the electrical plate 8*a* in his using position till the time when he leaves the using position. When a differential circuit **19** receives this output, the differential circuit **19** produces two pulses with reversed polarity each other as shown in FIG. 5 (*b*2) at the starting point and the terminating point of the said wave form (*a*2) in FIG. 5. Referring to the said two pulses produced by the differential circuit **19**, one positive pulse of the two pulses which is produced by the urinal user's approach is supplied to a one-shot multi-vibrator **21**, which is one kind of so-called mono-stable one-shot multi-vibrators, being composed of an NPN type transistor through an amplifier **20** comprising the same type transistor. On the reception of this positive pulse, the one-shot multi-vibrator **21** produces a constant time width output as shown in FIG. 5 (*c*2). The constant time width output operates to actuate a solenoid **24** of the electro-magnetic valve through an OR circuit **22** and an amplifier **23**. As a result of the electromagnetic valve operation, the urinal will be washed by washing water supplied from the electro-magnetic valve prior to the urinal use. On the other hand, in case of the urinal user leaving the urinal, another pulse, which is reverse in polarity with respect to the said positive pulse, will be produced as shown in FIG. 5 (*b*2). Thus another pulse, that is a negative pulse, does not actuate the said amplifier **20** comprising the NPN type transistor but does actuate a PNP type transistor **25**. By the actuation of this PNP type transistor **25**, a one-shot multi-vibrator **26** which is one kind of so-called mono-stable one-shot multi-vibrators will produce a constant time width output as shown in FIG. 5 (*d*2).

By a converter **27**, this constant time width output will be converted into a positive signal as shown in FIG. 5 (*e*2) so as to actuate the solenoid **24** through the OR circuit **22** and the amplifier **23**. As a result of the solenoid operation, the urinal will be washed when the user leaves the same.

As mentioned above, in order to supply washing water with some time delay after the urinal user leaves the urinal, it has only to provide with a delay circuit (not shown in the drawings) in this embodiment of FIG. 4 as described in FIG. 2. By providing such a delay circuit it will be possible to actuate the solenoid by a signal as shown in FIG. 5 (*f*2) being delayed a little with request to the signal as shown in FIG. 5 (*e*2) and thereby to supply washing water after use.

As illustrated above, it is noted that the solenoid **24** operates as shown by a signal wave (*g*2) in FIG. 5 when the urinal user approaches the urinal and he leaves the urinal and that the electro-magnetic valve supplies amount of washing water corresponding to respective operation period of the solenoid.

FIG. 6 is a detail electric circuit of another embodiment of the present invention, which will be preferable to illustrate a detector especially. Referring to FIG. 6,

Capacitor	C1–C13.
Resistor	R1–R27.
NPN type transistor	T1–T6; T8–T10.
PNP type transistor	T7.
Coil	L1–L3.
Relay	RY.
Static capacity of the electric plate 8*c*	C.

A circuit comprising a transistor **T1**, coils **L1** and **L2**, capacitors **C1–C5** and resistors **R1–R3** is a kind of so-called Colpitts type oscillating circuits which operates to provide a large variation to an oscillating amplitude in response to a little change of the static capacity C caused by the urinal user's approach with respect to the electrical plate 8*c*. Referring to this so-called Colpitts type oscillating circuit, there is provided with a negative capacitive reactance and a positive inductive reactance. The said negative capacitive reactance is permitted between the collector and emitter of the transistor **T1** by connecting a parallel circuit comprising a capacitor **C4** and a coupling coil **L2** to transmitting an oscillating output to the following step and furthermore by connecting a capacitor **C3** in series with the parallel circuit. The said positive inductive reactance is permitted between the base and collector of the transistor **T1** by connecting a series circuit comprising capacitors **C1** and **C2** and an inductance coil **L1**. The resultant series and parallel resonant circuit may select either positive reactance or negative reactance in accordance with a frequency supplied thereto, so it is noted that such resonant circuit has a close correlation with an oscillating condition of the oscillating circuit. In order to initiate an oscillation in this oscillating circuit, the reactance portion between the emitter and the collector of the transistor **T1** should be positive with respect to a predetermined frequency. If adjusting the oscillating circuit to set the value of the positive reactance portion in the neighborhood of the parallel resonance point, the static capacity C of the electric plate 8*c* will increase by the user's approach thereto and thereby the oscillating frequency of the oscillating circuit will be apt to decrease. On the other hand, in the series and parallel resonant circuit which is adjusted the value of the negative reactance portion thereof to that in the neighborhood of the parallel resonance point between the emitter and the collector, the decrease in the oscillating frequency promotes the negative reactance to shift in the more negative direction. Therefore, in the result, the series and parallel resonant circuit operates to increase the oscillating frequency of the oscillation circuit. When the urinal user approaches the electrical plate 8*c*, the static capacity C of the electrical plate 8*c* will increase and the oscillating frequency will also increase. Therefore the value of the pre-adjusted positive reactance will shift to the neighborhood of the parallel resonance point and at least enter into a region of $-\infty$ reactance from a region of $+\infty$ reactance. Accordingly, as the impedance between the base and collector with respect to the oscillating frequency becomes negative, the oscillation will be terminated.

It will be understood from the description above that the oscillating circuit constructed by the transistor **T1** supplies an output having a large variation of amplification which corresponds to a delicate variation of static capacity of the electrical plate. This output from the oscillating circuit is supplies through a coil **L3** to an amplifier comprising transistors **T2** and **T3**. An amplified output from the amplifier is supplied through a detector circuit comprising a transistor **T4** to a so-called switching circuit comprising a transistor **T5** so as to obtain an amplified changed switching signal to be supplied to a transistor **T6**.

Accordingly, in case of the urinal user not approaching the electrical plate 8*c*, the transistor **T6** is kept in the conducting conditon, and on the other hand, in case of the static capacity of the electrical plate 8*c* being varied by the urinal user's approach thereto, the transistor **T6** will be changed to the non-conducting condition. This transistor **T6** is connected to a differential circuit comprising a capacitor **C11** and a resistor **R19**.

Therefore, when the transistor **T6** becomes non-conducting by the urinal user's approach to the electrical plate 8*c*, the said differential circuit supplies a positive differentiated signal. On the other hand, the transistor **T6** is changed from non-conducting to conducting by the urinal user's leaving the vicinity of the electrical plate 8*c*, the said differential circuit supplies a negative differentiated signal as shown in FIG. 7 (*a*3). Among these differentiated signals, only the positive differentiated signal will be supplied through the diode **D2** to the following transistor **T8**. In this case, the said negative differentiated signal is stopped by the diode **D2**.

Referring to FIG. 6, it should be noted that, the transistor **T7** is a PNP type transistor which is reversed in type with respect to NPN type transistors **T1–T6** and **T8–T10**. Therefore, as illustrated in detail above, the transistor **T6** is changed into a non-conductive condition by the user's approach with respect to the electrical plate 8*c* so as to make the differential circuit constructed by a capacitor **C12** and a resistor **R21** supply a negative differentiated signal through the diode **D3**, but the transistor **T7** operates to supply a positive differentiated signal as shown in FIG. 7 (*b*3) supplied from the differential circuit constructed by the capacitor **C12** and the resistor **R21** to the transistor **T8** through the diode **D3** when the transistor **T6** is changed into a conductive condition from a non-conductive condition by the urinal user's leaving the vicinity of the electrical plate 8*c*.

It is understood that only the positive differential signal will be supplied to the following transistor **T8** through the diode **D3**.

As explained above, it should be noted that, as shown in FIG. 7 (*c*3), one positive differentiated signal will be supplied through the diode **D2** to the following transistor **T8** when the urinal user approaches the electrical plate 8*c* and that another positive differentiated signal will be supplied through the diode **D3** to this said transistor **T8**. In other words, the transistor **T7** operates to reverse the output from the transistor **T6** in polarity and this operation is the same as that of the NOT circuit **15** shown in FIG. 2.

The circuit constructed by the transistors **T8** and **T9** is an one-shot multi-vibrator which is a kind of monostable one-shot multi-vibrators. When the said positive differentiated signal



is supplied to the transistor **T8** in the input-side of this one-shot multi-vibrator, the transistor **T9** will be conducting during the predetermined time which is determined by the condenser **13** and the resistor **24** and there-

after the transistor T9 will become nonconducting. In other words, when a positive differentiated signal having a narrow time width is supplied to this one-shot multi-vibrator, the multi-vibrator will operate to supply an output signal having a predetermined time width as shown in FIG. 7 (*d*3).

It should be noted that the positive output signals as shown in FIG. 7 (*d*3) is supplied to an amplifier including a transistor T10 so as to actuate an electro-magnetic valve (not shown) and thereby to supply washing water during the said predetermined duration equal to the time width of the output-signals each time when the urinal user approaches and leaves the urinal.

Referring to the embodiment shown in FIG. 6, when the urinal user approaches and leaves the urinal each water supply duration has a equal time width because the embodiment utilizes only one one-shot multi-vibrator. However, when it is desired to provide each water supply duration with a different time width, it has only to utilize two one-shot multi-vibrators which have different operating durations each other and are connected to the diodes D2 and D3, respectively, so that outputs from both one-shot multi-vibrators may be supplied to the transistor T10 through an OR circuit.

A relay RY connected to the transistor T10 is energized by the conduction of the transistor T10 which is caused by the signal from the one-shot multi-vibrator to actuate an electro-magnetic valve (not shown). The relay RY is energized when the urinal user approaches and leaves the urinal and thereby washing water is supplied to the urinal each time when the relay is energized. The foregoing disclosure is representative of preferred forms of the invention and is to be interpreted in an illustrative rather than a limiting sense, the invention to be accorded the full scope of the claimed appended hereto.

What is claimed is:

1. Apparatus for automatically washing a toilet fixture in two successive steps respectively responsive to arrival and departure of a fixture user, said apparatus comprising:

(a) antenna means having variable static capacity which changes from a first level to a second level upon a fixture user's arrival and from the second level to the first level upon the user's departure;

(b) static capacity variation detecting means responsive to said antenna means and supplying an output signal which changes from a first level to a second level and from the second level to the first level in accordance with the respective changes in static capacity of said antenna means;

(c) a normally closed electro-magnetic valve provided in a washing water supply line of said toilet fixture;

(d) a first electrical circuit connected to said valve and responsive to a change of the output signal from said detecting means from the first level to the second level to open said valve for a predetermined period when a user arrives at the fixture; and

(e) a second electrical circuit connected to said valve and responsive to a change of the output signal from said detecting means from the second level to the first level to open said valve for a predetermined period when the user departs from the fixture.

2. The apparatus as defined in claim 1 which is further characterized in that each of said first and second circuits includes means for controlling the length of time during which said valve is open, the time controlling means of the second circuit being set for a longer period than the time controlling means of the first circuit, whereby the fixture washing operation at the user's departure is of a longer duration than at his arrival.

3. The apparatus as defined in claim 1 which is further characterized in that said second circuit includes time delay means whereby opening of said valve by the second circuit is delayed until after the user has departed from the fixture.

4. The apparatus as defined in claim 1 which is further characterized in that the changes between the first and second levels of the output signal from said detecting means are changes of opposite signal phases to which the respective first and second circuits are responsive.

5. The apparatus as defined in claim 1 which is further characterized in that the changes between the first and second levels of the output signal from said detecting means are changes of opposite signal polarities to which the respective first and second circuits are responsive.

References Cited

UNITED STATES PATENTS

2,786,210	3/1957	Fraser	4—100
2,858,546	11/1958	Tekenos	4—100
2,908,017	10/1959	Whaley	4—100
3,151,340	10/1964	Teshima	4—100
3,314,081	4/1967	Atkins et al.	4—100
3,334,359	8/1967	Weingartner	4—101
3,339,212	9/1967	Atkins et al.	4—100

LAVERNE D. GEIGER, Primary Examiner

HENRY K. ARTIS, Assistant Examiner

U.S. Cl. X.R.

340—258