US005432959A

United States Patent [19]

Ellsworth et al.

[11] Patent Number: 5,432,959

[45] Date of Patent: Jul. 18, 1995

[54] **SYSTEM FOR REGULATING WATER FLOW IN A TOILET**

[75] Inventors: **Robert S. Ellsworth**, Fairfax, Va.; **John P. Durban**, Mission Viejo, Calif.

[73] Assignee: **Dakota Technologies Corp.**

[21] Appl. No.: **177,750**

[22] Filed: **Jan. 5, 1994**

[51] **Int. Cl.**[6] **E03D 5/10**

[52] **U.S. Cl.** **4/406**; 4/DIG. 3

[58] **Field of Search** ..... 4/406, 345, DIG. 3

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,334,359	8/1967	Weingartner	4/406 X
3,590,397	7/1971	Akamatsu et al.	4/100
3,908,204	9/1975	Hopkins	4/100
3,965,492	6/1976	Hendricks	4/79
4,392,260	7/1983	Bensen	4/324
4,793,588	12/1988	Laverty, Jr.	251/30.03
4,876,751	10/1989	Van Meter	4/431
4,901,377	2/1990	Weir	4/415
4,918,764	4/1990	Haselswerdt et al.	4/406
4,989,277	2/1991	Tsutsui et al.	4/367
5,036,553	8/1991	Sanderson	4/406 X
5,052,060	10/1991	Makita et al.	4/300
5,187,816	2/1993	Chiou	4/313
5,187,818	2/1993	Barrett, Sr. et al.	4/313

FOREIGN PATENT DOCUMENTS

2681891	4/1993	France	4/406
0197630	8/1990	Japan	4/406
3275825	12/1991	Japan	4/406
4124333	4/1992	Japan	4/406

Primary Examiner—Charles E. Phillips

Attorney, Agent, or Firm—Longacre & White

[57] **ABSTRACT**

The present disclosure concerns an electro-mechanical flushing system for a residential toilet. A powered valve is controlled by a timing circuit to pass one of a plurality of water flow volumes from a toilet tank to a toilet bowl. The same system also establishes an adjustable toilet bowl water level. A manual override feature permits the toilet to be operated in the absence of electrical power.

17 Claims, 4 Drawing Sheets

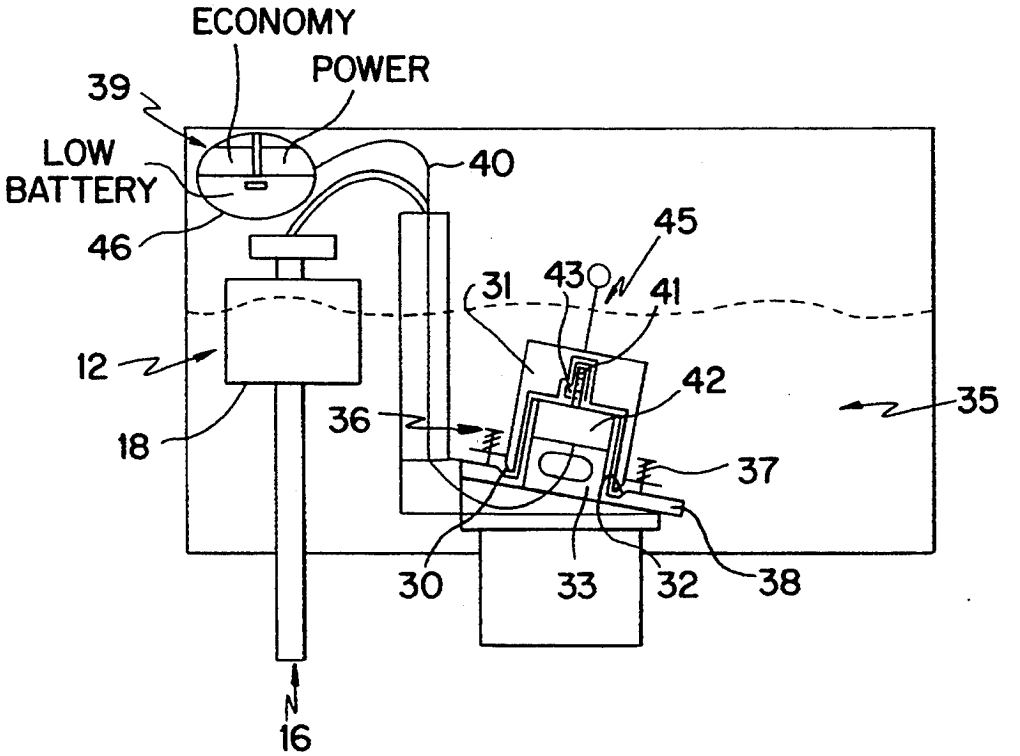


FIG. 1

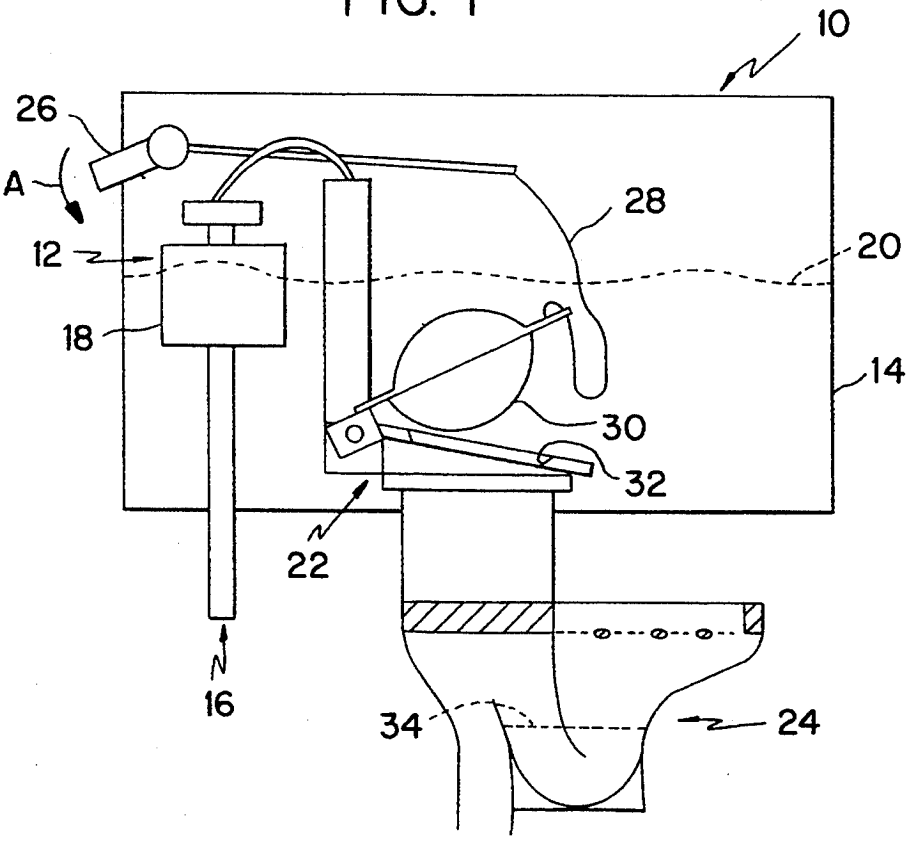

10
26
A
12
18
28
20
14
30
32
22
16
34
24

FIG. 2

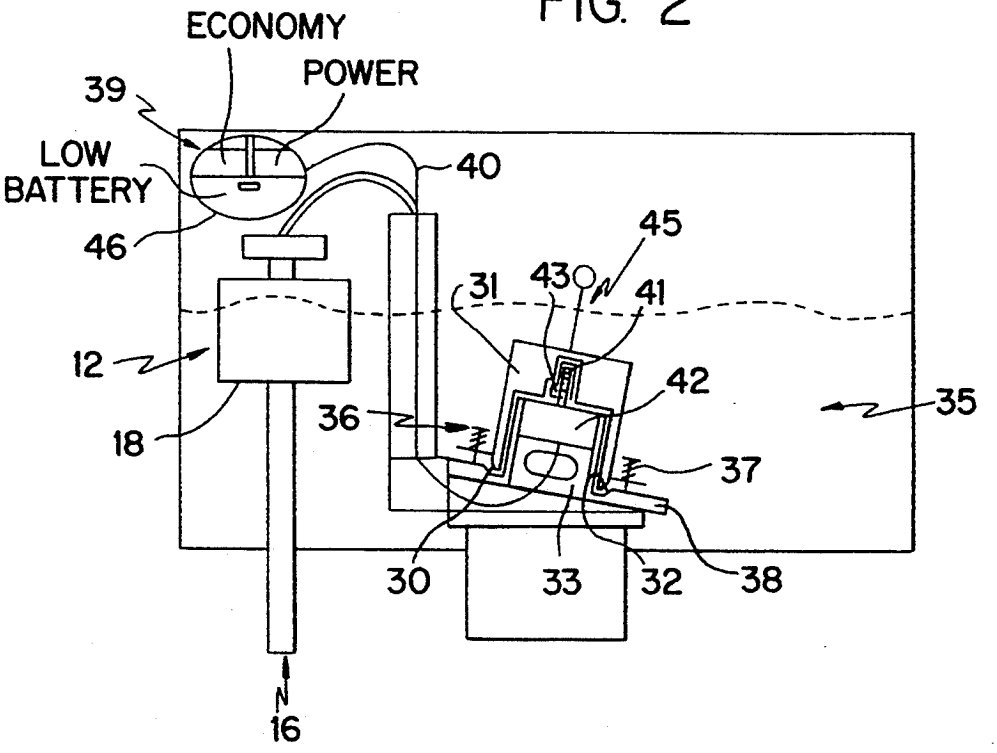

ECONOMY
POWER
39
LOW
BATTERY
40
46
45
31
43
41
12
42
36
35
18
37
30
33
32
38
16

FIG. 3

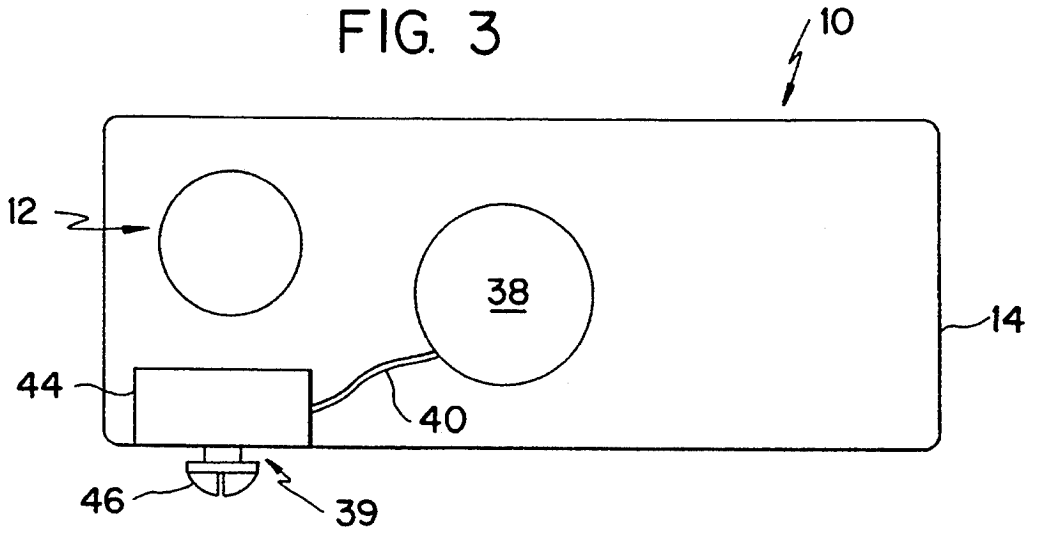


FIG. 4

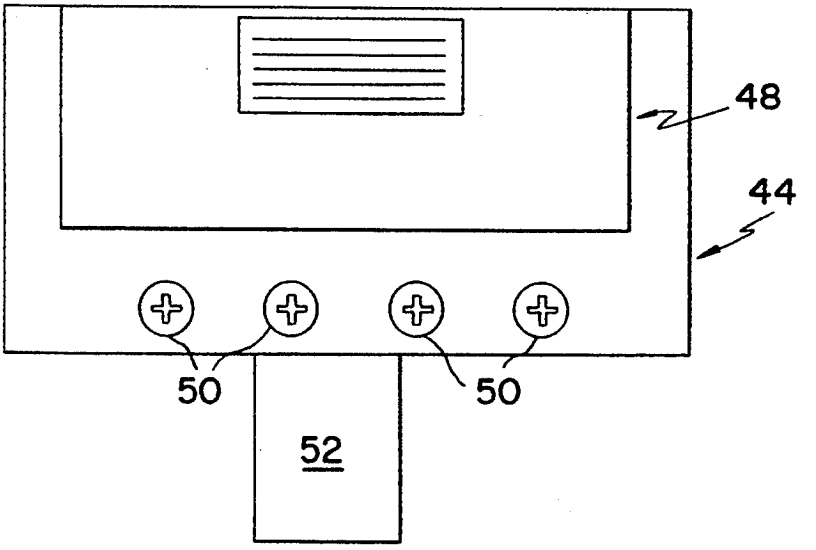
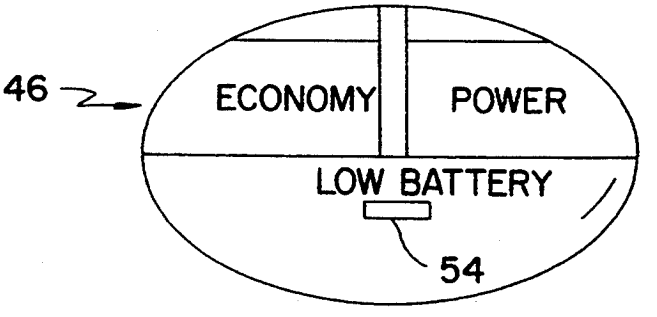


FIG. 5



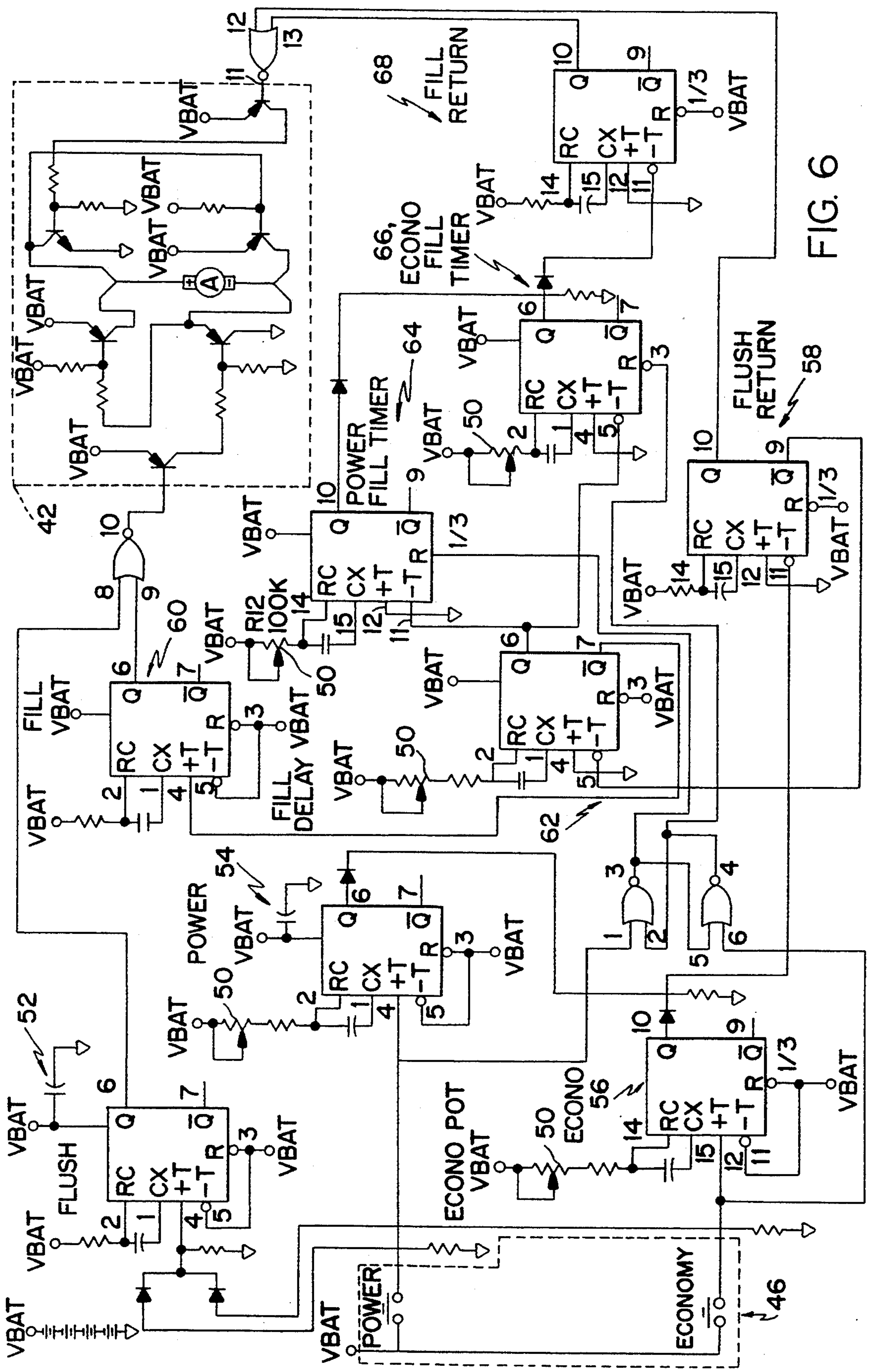

FLUSH
52
FILL
60
FILL DELAY
62
POWER
54
POWER FILL TIMER
64
66, ECONO FILL TIMER
68 FILL RETURN
58 FLUSH RETURN
ECONO
56
ECONO POT
R12 100K
50
42
46
POWER
ECONOMY
VBAT

FIG. 6

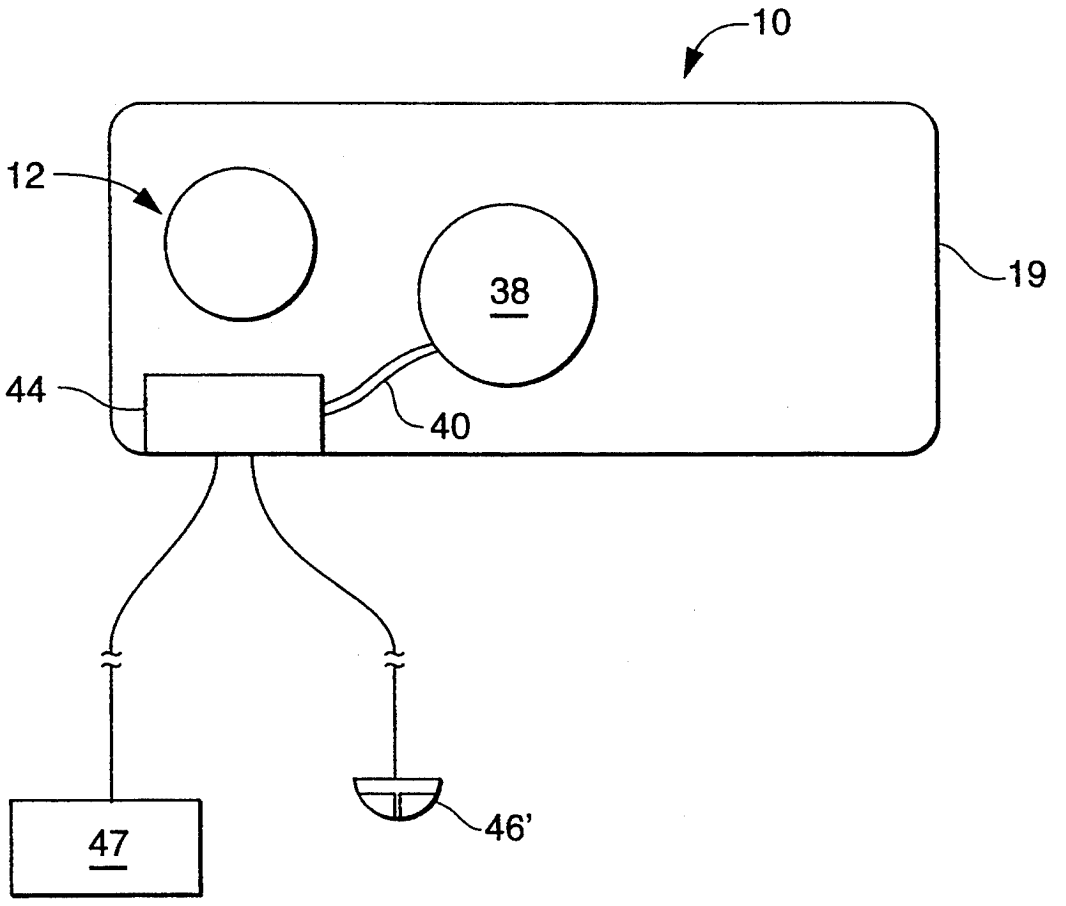


FIG. 7

SYSTEM FOR REGULATING WATER FLOW IN A TOILET

BACKGROUND OF THE INVENTION

a) Field of the Invention

The present invention concerns a system for regulating the flow of water in a conventional, residential toilet. In this application, a residential toilet ,is one in which a first valve controls the flow of water into a toilet tank and a second valve controls the flow of water from the toilet tank into a toilet bowl. On the other hand, a commercial toilet does not have a toilet tank and a single valve controls the flow of water directly into the toilet bowl.

b) Description of Related Art

Referring to FIG. **1**, a conventional, residential toilet **10** includes a first valve **12** regulating water flow into a toilet tank **14** from a water supply **16**. First valve **12** is controlled by a float **18** such that as the water rises to a predetermined level **20** in toilet tank **14**, the buoyancy of float **18** causes first valve **12** to close, thereby inhibiting further water flow into toilet tank **14**.

A second valve **22** is interposed between toilet tank **14** and a toilet bowl **24** to regulate water flow therebetween. Specifically, a "flapper" valve **22** is operated by a handle **26** via a pull chain **28**. Between uses, water level **20** is maintained in toilet tank **14** by virtue of a valve face **30** sealingly abutting a valve seat **32**. Actuation of handle **26** (in the direction indicated with arrow "A") causes pull chain **28** to lift valve face **30** away from valve seat **32**, whereupon water in toilet tank **14** is passed through flapper valve **22** into toilet bowl **24**. Flapper valve **22** is made to be buoyant so that the rush of flowing water from toilet tank **14** into toilet bowl **24** does not re-close flapper valve **22** (FIG. **1** shows the conventional, residential toilet in this state). As toilet tank **14** is drained, the buoyant force on flapper valve **22** is lost and valve face **30** re-engages valve seat **32**, thereby re-closing flapper valve **22**. Concurrent with draining toilet tank **14**, float **18** drops below water level **20**, whereupon valve **12** connects water supply **16** to toilet tank **14**. Refilling toilet tank **14** commences when valve face **30** re-engages valve seat **32**, and terminates when float **18** is buoyantly forced up to water level **20**.

For proper operation, when the flapper valve **22** is closed, it is important that the pressure differential on the opposite sides of the flapper valve **22** overcome its buoyancy. That is to say, the combined force of the static pressure caused by the water in the toilet tank **14** on top of the flapper valve **22**, plus the vacuum caused by the void underneath the flapper valve **22**, exceeds the buoyant force of the flapper valve **22**. This ensures the flapper valve remains closed between uses. Separating the valve face **30** from the valve seat **32** substantially reduces the pressure differential such that the buoyant force of the flapper valve **22** becomes superior to the force caused by the pressure differential. Consequently, the flapper valve **22** remains open from the time handle **26** is actuated, until toilet tank **14** is substantially drained. Further, flapper valve **22** must be sized to pass more water than water supply **16** can simultaneously provide. This ensures water supply **16** cannot maintain flapper valve **22** open indefinitely.

This known arrangement dispenses a single, predetermined water flow volume (based on the water level in a toilet tank of a given volume) without requiring the operator to modulate the duration or sequence for operating the valves. There is no mechanism which enables the user to select between a lower water flow volume, e.g. three gallons for liquid or light wastes, and a higher water flow volume, e.g. five gallons for solid wastes. Additionally, although it may be possible to forcibly alter the relationship between float **18** and the first valve **12** to adjust toilet tank water level **20**, there is no provision in a conventional, residential toilet for adjusting toilet bowl water level **34**.

SUMMARY OF THE INVENTION

An objective of the present invention is to provide an electro-mechanical toilet flush system which overcomes the aforementioned deficiencies in conventional, residential toilets.

Another objective of the present invention is to increase the flexibility of the toilet flush system, increase the reliability of the overall system, as well as allow the entire toilet flush system to be upgraded and improved by the use of electronic controls.

In particular, it is an objective of the present invention to provide an electrically controlled valve whereby different water flow volumes may be selected depending upon the type and volume of waste in the toilet bowl. The electronic control uses timers to precisely regulate water flow between the toilet tank and the toilet bowl. This enables the user to select either a lower ("economy") or a higher ("power") water flow volume, as well as set the water level in the toilet bowl for each flow volume.

It is yet another objective of the present invention to provide an electro-mechanical toilet flush system with a manual override control.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** shows a conventional, residential toilet flush system.

FIG. **2** shows a toilet flush system according to the present invention.

FIG. **3** is a plan view of the component arrangement according to the present invention.

FIG. **4** is a plan view of a control box for a toilet flush system according to the present invention.

FIG. **5** is a front elevation view of a control panel for a toilet flush system according to the present invention.

FIG. **6** is a schematic plan for a control circuit according to the present invention.

FIG. **7** is a plan view of the component arrangement according to a further embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to the present invention such as that shown in FIGS. **2–5**, flapper valve **22**, handle **26** and pull chain **28** are replaced with, respectively, a powered valve **35**, a control unit **39** and a control wire **40**.

Powered valve **35** positions valve face **30** with respect to valve seat **32** by means of an actuator **42**. Actuator **42** may use pneumatic, hydraulic or electrical power to accomplish relative positioning. In the case of an electrically powered actuator, an electric motor or an electric magnet/solenoid may be used. In the preferred embodiment shown in FIG. **2**, an electric motor **42** rotates a screw shaft **41** relative to a nut **43** so as to regulate relative displacement between a fixed housing **38** and an inverted cup **31**. Although elements **41** and **43**

have been disclosed as threadably related, it is envisioned that alternative arrangements may use cam surfaces, one or more detentes, etc. Essentially, elements **41** and **43** must be capable of converting the operation of actuator **42** into relative displacement between fixed housing **38** and inverted cup **31**.

Inverted cup **31** integrally supports valve face **30**. One or more guides **36** (two are shown in FIG. **2**) may also be associated with inverted cup **31** to ensure alignment between valve face **30** and valve seat **32**.

It is envisioned that actuator **42** may be used to separate valve face **30** from valve seat **32** by drivingly displacing inverted cup **31** with respect to fixed housing **38**. A counteractive device, e.g. one or more spring(s) **37** surrounding the guide(s) **36**, may cooperatively assist actuator **42** in re-engaging valve face **30** with valve seat **32**. Inasmuch as the nut **43** is fixed only against rotation with respect to the inverted cup **31**, flushing may also be initiated manually by pulling a handle **45** to axially displace inverted cup **31** with respect to nut **43**.

By virtue of cup **31** being oriented in an inverted position, an air pocket **33** is maintained. When valve face **30** and valve seat **32** are engaged, the pressure differential between the water pressure on cup **31** and the vacuum in air pocket **33** tends to reinforce the engagement. When valve face **30** is slightly separated from valve seat **32**, the aforementioned pressure differential is reduced and the buoyant force established by air pocket **33** in cup **31** tends to maintain the separation. To re-close flapper valve **22**, actuator **42** reversely drives nut **43** in cooperation with the influence of spring(s) **37**.

Powered valve **35** is operated via a control unit **39**. Control unit **39** includes a control box **44** located inside toilet tank **14** and a control panel **46** located outside toilet tank **14**. Control box **44** includes a battery compartment **48**, at least one timing circuit (described below), at least one adjuster **50** for regulating water flow volumes and/or toilet bowl water level **34**, and a connector **52** extending through toilet tank **14** and operatively connecting to control panel **46**.

Control panel **46** includes at least one selector for electing either the power, "P", or economy, , "E", water flow volume Control panel **46** may also include an indicator **54** signifying when the battery power supply is nearly depleted.

As shown in FIG. **7**, control panel **46** need not be contiguous with control box **44**, but rather may be located at a relatively remote location. Further, depressing a selector on control panel **46**, **461** may be used to simultaneously operate an ancillary device such as an exhaust fan or chemical dispenser **47**. Finally, the selector on control panel **46** need not be a button, but rather may also be a voice, thermal, etc. activated selector.

Operation of the present invention will now be described. Water is provided to toilet tank **14** from water supply **16**. First valve **12** and float **18** regulate toilet tank water level **20** within toilet tank **14**. Upon depressing the "E" selector on control panel **46**, powered valve **35** displaces valve face **30** a first distance from valve seat **32**, thereby opening an aperture between toilet tank **14** and toilet bowl **24**. The timing circuit in control box **44** instructs powered valve **35** to close after the precise amount of time has passed to establish the "economy" volume of water to flow through the aperture. Similarly, upon depressing the "P" selector on control panel **46**, powered valve **35** again displaces valve face **30** the first distance from valve seat **32**. However, the timing circuit in control box **44** now instructs powered valve **35** to close after the precise amount of time has passed to establish "power" volume of water to flow through the aperture. Adjuster(s) **50** may be used to establish the time for one or both of the "economy" and "power" volumes of water flow.

A second aspect of the operation of the present invention will now be described. With the present invention it is possible to adjust the water level in the toilet bowl **24** after each selection of a water flow volume. Continuing with the above description of using the "economy" volume of water flow, the timing circuit instructs powered valve **35** to displace valve face **30** a second distance from valve seat **32**. The second distance is generally substantially less than the aforementioned first distance thereby lowering the rate at which water flows through the aperture. The timing circuit subsequently instructs powered valve **35** to close after a predetermined time lapse necessary for obtaining the desired toilet bowl water level **34**. Adjuster(s) **50** may be used to establish the time lapse following one or both of the "economy" and "power" volumes of water flow. It is envisioned that toilet bowl water level **34** may be established before or after powered valve **35** is closed to complete either the "economy" or "power" volumes of water flow. That is to say, the powered valve **35** may or may not be fully closed between flushing and establishing the toilet bowl level **34**.

A preferred embodiment of a timing circuit according to the present invention will now be discussed with reference to FIG. **6**. Upon selecting a flush cycle on control panel **46**, i.e. "power" or "economy", actuator **42** is initially powered through a first integrated circuit **52**. A second integrated circuit **54** or a third integrated circuit **56** establish the length of time necessary to obtain the "power" or "economy" water flow volumes, respectively. After the established time has lapsed for the desired water flow volume, actuator **42** is reversely powered through a fourth integrated circuit **58**.

In order to obtain toilet bowl water level **34**, fourth integrated circuit **58** also initiates the fill cycle by powering actuator **42** through a fifth integrated circuit **60**. However, operation of fifth integrated circuit **60** is delayed by a sixth integrated circuit **62** while toilet tank **14** is refilled. This ensures a uniform pressure head so that measured times may be consistently related to water flow volumes. A seventh integrated circuit **64** or an eighth integrated circuit **66** establish the length of time necessary to obtain the "power" or "economy" toilet bowl water levels **34**, respectively. After the established time has lapsed for obtaining the desired toilet bowl water level, actuator **42** is reversely powered through a ninth integrated circuit **68**.

An adjuster **50** may be associated with one or more of the second **54**, third **56**, sixth **62**, seventh **64**, and eighth **66** integrated circuits. A separate adjuster **50** is shown for each of the aforementioned integrated circuits in FIG. **6**, however, it is noted that a single potentiometer could be used to establish a common range of adjustment for the "power" and "economy" water flow volumes, as well as "power" and "economy" toilet bowl water levels **34**. It is envisioned that a single potentiometer would be useful for establishing optimum water flow volumes given the available pressure at water supply **16**.

What is claimed is:

1. A toilet flush system for regulating flow of water out of a toilet tank into a toilet bowl, said flush system comprising:

powered valve means for positioning a valve face with respect to a valve seat, said valve seat defines an aperture between said toilet tank and said toilet bowl, said valve face is adapted to close said aperture when said valve face is contiguous with said valve seat;

toilet tank water volume means for establishing an economy volume of water flow from said toilet tank through said aperture, and aperture, and establishing a power volume of water flow from said toilet tank through said aperture, said economy flow volume being substantially less than said power flow volume and being accomplished by said valve face being separated a given distance from said valve seat for a period of time to establish said economy flow volume and a greater period of time to establish said power flow volume; and

toilet bowl water level means for establishing one of a first and second water level in said toilet bowl, said first and second water levels in said toilet bowl are achieved by water transfer from said toilet tank, through said aperture, to said toilet bowl by moving said valve face from said valve seat a distance substantially less than said given distance for one period of time for said first water level and a longer period of time for said second water level.

2. The toilet flush system according to claim 1, wherein said powered valve means includes guide means for aligning said valve face with said valve seat.

3. The toilet flush system according to claim 1, wherein said powered valve means includes closure means for pressing said valve facing toward said valve seat.

4. The toilet flush system according to claim 1, wherein said powered valve means includes an electric actuator.

5. The toilet flush system according to claim 4, wherein said electric actuator is an electric motor.

6. The toilet flush system according to claim 4, wherein said electric actuator is an electromechanical actuator.

7. The toilet flush system according to claim 1, further comprising:

selection means for electing one of said first volume of water flow and said second volume of water flow, as well as electing one of said first water level and said second water level.

8. The toilet flush system according to claim 7, wherein said selection means includes a battery, an electric switch and a control circuit for electing between said first volume of water flow corresponding with said first water level and said second volume of water flow corresponding with said second water level.

9. The toilet flush system according to claim 8, wherein said control circuit includes timing means for determining water flow through said aperture.

10. The toilet flush system according to claim 8, wherein said selection means further includes an indicator of minimum electrical power for operating the toilet flush system.

11. The toilet flush system according to claim 8, wherein said electric switch is relatively remote with respect to said toilet flush system.

12. The toilet flush system according to claim 1, further comprising:

manual override means for mechanically bypassing said powered valve means.

13. The toilet flush system according to claim 12, wherein said manual override means is operationally interposed between said powered valve means and said valve face.

14. The toilet flush system according to claim 13, wherein said powered valve means includes a screw threadably engaging a nut such that relative rotation causes relative axial displacement, and said manual override means permits relative axial displacement between said powered valve means and said valve face.

15. The toilet flush system according to claim 1, wherein said selection means simultaneously actuates an accessory which is relatively remote with respect to said toilet flush system.

16. The toilet flush system according to claim 15, wherein said accessory is a chemical dispenser.

17. The toilet flush system according to claim 15, wherein said accessory is a fan.

* * * * *