

[54] **MULTIPLE RECIRCULATING TOILET**[75] Inventor: **Michael R. Molus**, Chatsworth, Calif.[73] Assignee: **Monogram Industries, Inc.**, Santa Monica, Calif.[22] Filed: **June 8, 1972**[21] Appl. No.: **260,738**[52] U.S. Cl. **4/11, 4/67 R, 4/89, 4/DIG. 3, 137/567, 210/167, 417/7**[51] Int. Cl. **E03d 1/22, E03d 5/016**[58] Field of Search **4/8, 10, 11, 12, DIG. 3, 4/26, 18, 30, 52, 67 A, 67 R, 90, 100, 114, 115; 222/52, 63; 137/567; 417/7, 8, 12, 33; 210/167**[56] **References Cited****UNITED STATES PATENTS**

2,797,846	7/1957	Reed	222/63
2,812,110	11/1957	Romanowski	417/8
2,817,091	12/1957	Painter	4/11
2,945,445	7/1960	Smith et al.	417/7
3,005,411	10/1961	Metz	417/12

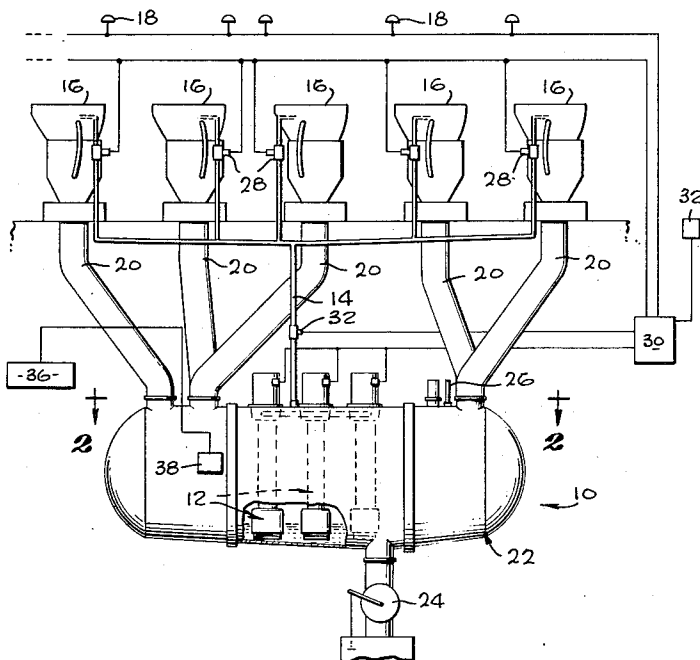
3,079,612	3/1963	Corliss	4/10
3,229,639	1/1966	Hignutt et al.	417/12
3,247,864	4/1966	Conery	417/7
3,343,178	9/1967	Palmer	4/115
3,478,690	11/1969	Helke et al.	4/90

Primary Examiner—John W. Huckert*Assistant Examiner*—Stuart S. Levy*Attorney, Agent, or Firm*—Miketta, Glenn, Poms & Smith

[57]

ABSTRACT

A pumping system for a plurality of recirculating toilets sharing a common tank is described. A variable volume pump has an internal by-pass valve which is controlled by the fluid pressure in the output line, to prevent excessive fluid pressure at the toilets. More than one pump is provided in the system for increased reliability. When a pump is operated, a time delay circuit is connected to a pressure switch which energizes the "next" pump if the fluid pressure in the line does not exceed a predetermined pressure within a set time interval.

7 Claims, 15 Drawing Figures

SHEET 1 OF 5

Fig. 1

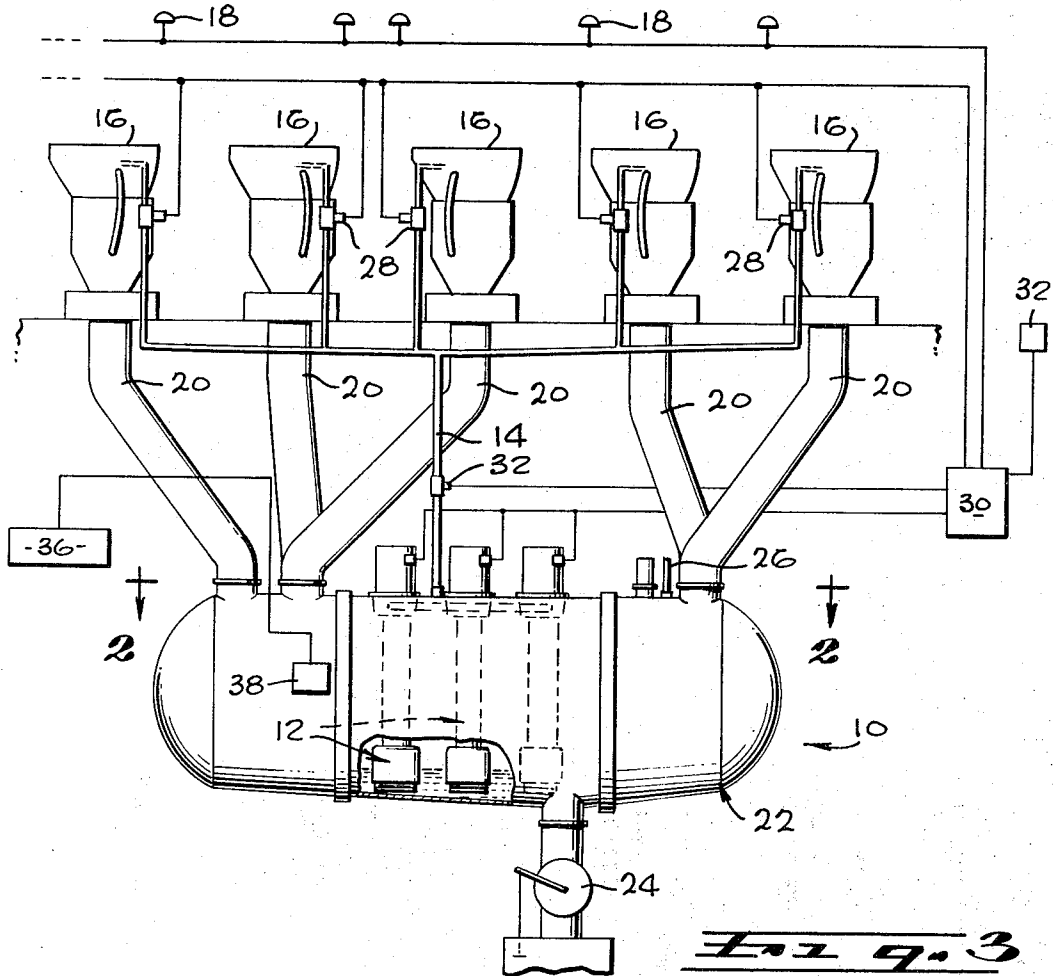


Fig. 3

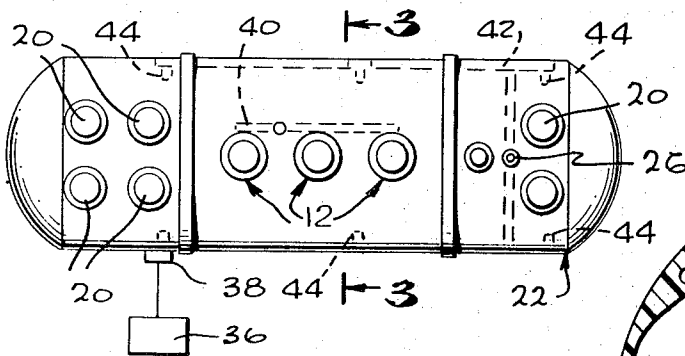
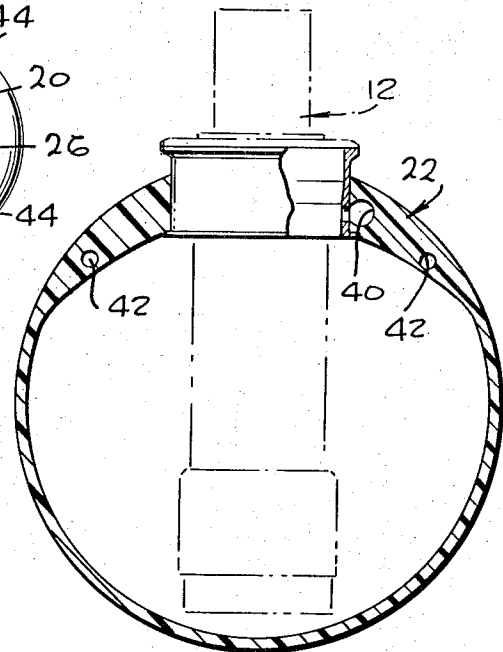


Fig. 2



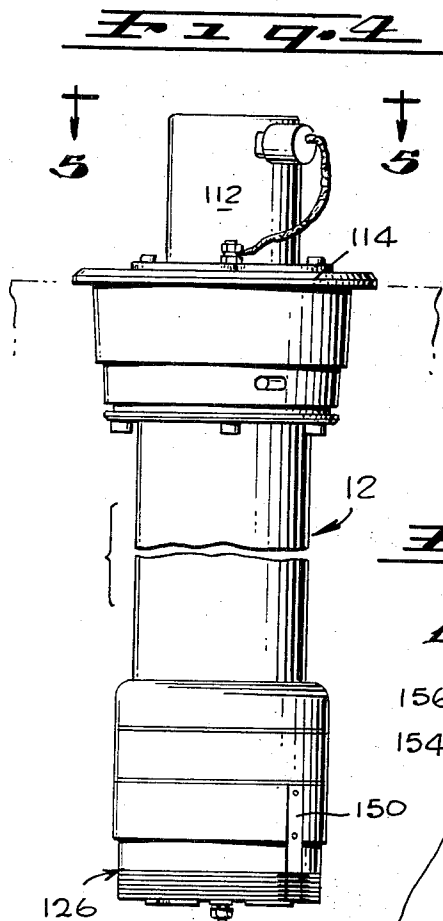
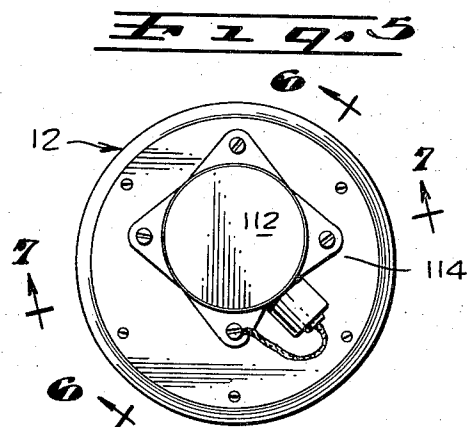
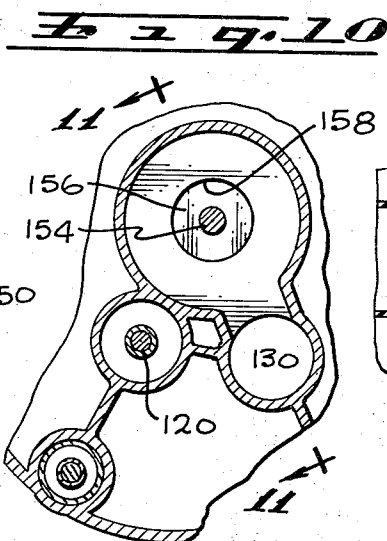
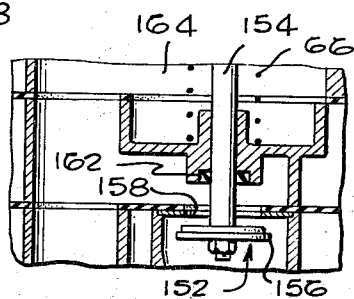
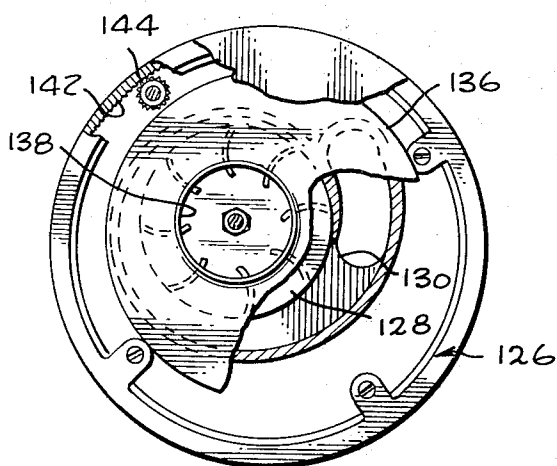
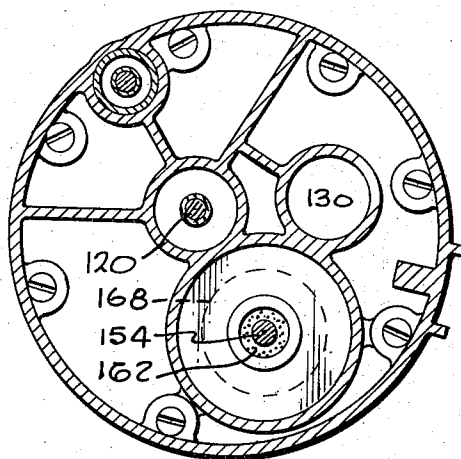
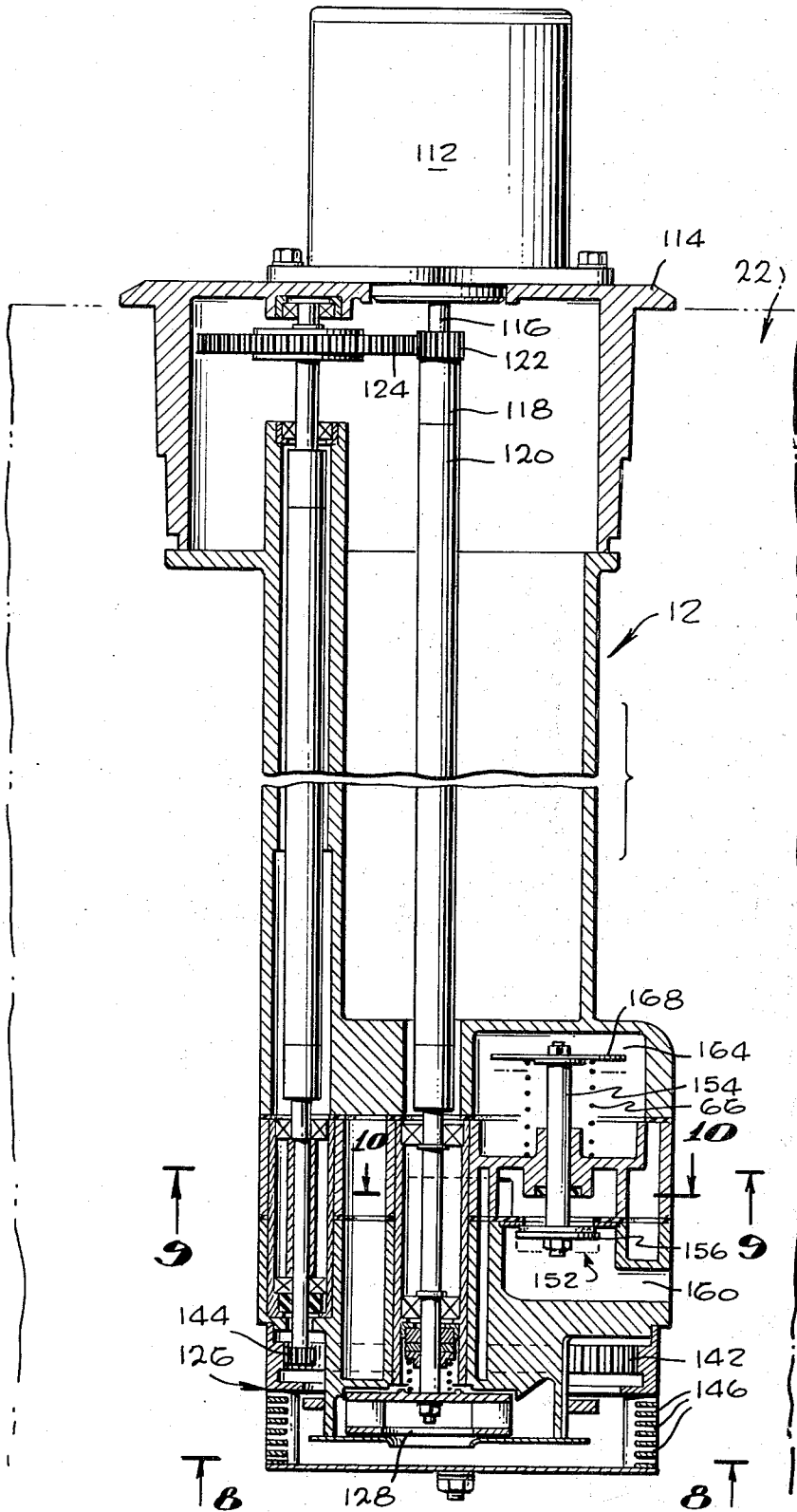
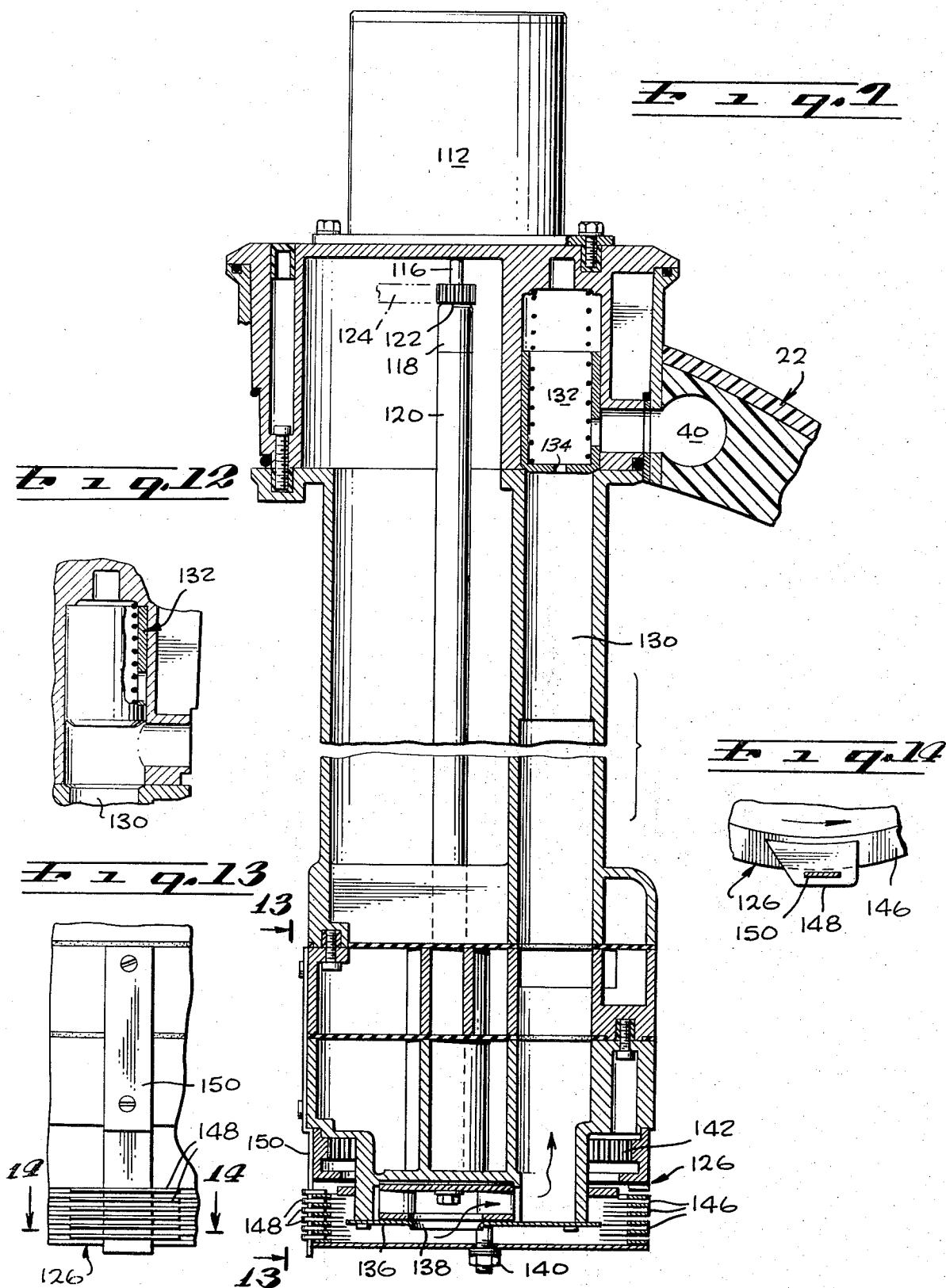


FIG. 6





MULTIPLE RECIRCULATING TOILET

This invention relates to circulating toilet systems and, more particularly to an improved recirculating toilet system having a plurality of pumping devices.

In self-contained, recirculating sanitation systems, of the type currently in use on large aircraft, and, to some extent on trains and other vehicles, it has been the practice to use a plurality of substantially independent, recirculating toilet systems, each with its own filter and pump assembly and storage tank.

Typical self-contained recirculating toilet systems have been shown, for example in the patent to J. W. Deitz, et al, U.S. Pat. No. 3,067,433, or in the patents to N. J. Palmer, U.S. Pat. Nos. 3,458,049 and 3,473,171, among others. An improved system which provided a common tank and filter connected to a pair of independent toilets, each with its own pump has been disclosed in the patent to Corliss, U.S. Pat. No. 3,079,612.

As the size of aircraft and other vehicles increase to accommodate greater numbers of passengers for journeys of substantial duration, sanitation facilities must be provided in sufficient numbers to serve the expected usage. However, an important consideration for the proprietor of the aircraft or vehicle, is the time required to perform maintenance on the sanitation systems, and the time required for vehicle "turn around," during which the sanitation system must be serviced, and when necessary, drained and recharged with fresh fluid.

With systems of the prior art, the provision of individual tanks for each toilet unit is less than satisfactory because of the servicing time required. The system described by Corliss, represented an improvement in that only a single tank need be drained and recharged for each pair of toilets.

Yet other problems arise in systems employing a plurality of toilet units, each with its own pump. If, for any reason, a pump becomes disabled, then its toilet is inoperable and out of service, thereby limiting the facilities available for use. Because space on a vehicle is at a premium, it is uneconomical to provide extra facilities and any failure is likely to result in substantial passenger inconvenience.

Further, the additional usage imposed upon the remaining toilets may, in fact, accelerate any incipient failures which would then compound the problem. It is also to be noted that the task of maintaining toilet systems is not the most desirable one, and it has been deemed preferable to limit, wherever possible, the number of elements requiring repair, service, or maintenance.

Other systems have been suggested in which a single, high volume pump is connected to serve several toilet units all of which share a common storage tank. Each toilet has a 3-way valve which by-passes unwanted flush water back to the waste tank when the toilet is not being flushed. In order to flush a particular toilet, the 3-way valve is operated to divert flush water into the bowl instead of the drain line. Such a system has several disadvantages. For example, with this system, the entire output of the pump must recirculate throughout the entire fluid system whether needed or not.

In accordance with the present invention, it has been discovered that an "oversize," high volume pump can be modified to serve a plurality of toilet units. In a pre-

ferred embodiment of the invention, a high volume pump is provided with an internal by-pass relief valve, that returns fluid from the outlet side of the pump to the tank, thus by-passing the output line. The relief valve is controlled by a pressure spring loaded diaphragm. When a toilet flush valve is actuated, the pump is energized and any rise in pressure over the spring rate setting operates the valve to return fluid to the tank. The bleed check valve permits all fluid in the system to drain back into the waste tank.

Each flush valve has a flush timing circuit which holds the valve open for a preset interval, during which flushing liquid is applied to the toilet. Therefore, the water volume going through the flush output line is only that volume required to flush the toilets being used, even though the pump operates at full capacity.

Should a second toilet be actuated during the operation of the first toilet, change in fluid pressure adjusts the relief valve to increase the flow in the line to the toilets. Further, a timing circuit associated with the second toilet extends the operation of the pump to assure a full flushing interval for the second toilet. When the timing circuit of the first toilet closes the first toilet flush valve, the increase in back pressure at the relief valve, increases the by-pass flow, thereby maintaining the pressure.

In an alternative embodiment, a partly redundant system is provided which includes a pair of substantially similar, high volume pumps, connected in parallel to the several toilets. Each pump is equipped with a controllable relief valve. An electronic cycling circuit is provided to select the pumps for alternate operation. A second timing circuit is provided which is connected to a pressure sensor and the cycling circuit. If, after a preset time interval, the fluid pressure at the sensor has not reached a preset magnitude, the other pump is started.

In yet alternative embodiments, three or more high volume pumps are provided to increase reliability and to avoid catastrophic failures in the system. In these embodiments, a cycling circuit energizes each of the pumps, in turn. If a second toilet, or other utilization device is operated while a first toilet is flushing, the timing circuit merely extends the operation of the pump.

An improved waste tank has been provided in conjunction with the present invention which includes internal manifolds to facilitate cleaning and filling of the tank. Because the manifolds are placed within the walls of the tank, the interior surface of the tank is perfectly smooth. A plurality of nozzles are provided at various parts within the tank so that high-speed fluid streams can be introduced into the tank interior for cleaning purposes and for precharging with a fresh fluid charge. This is accomplished through a connection located at the service panel at the outside of the aircraft.

The novel features which are believed to be characteristic of the invention, both as to organization and method of operation, together with further objects and advantages thereof will be better understood from the following description considered in connection with the accompanying drawings in which several preferred embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and de-

scription only and are not intended as a definition of the limits of the invention.

FIG. 1 is a side view of a multiple toilet recirculating system according to the present invention;

FIG. 2 is a top view of the improved waste tank of FIG. 1, taken along line 2—2 in the direction of the appended arrows;

FIG. 3 is an end section view of the tank of FIG. 2 taken along the line 3—3 in the direction of the appended arrows;

FIG. 4 is a side view of a variable volume pump according to the present invention;

FIG. 5 is a top view of the pump of FIG. 4;

FIG. 6 is a side section view of the pump of FIGS. 4 and 5 taken along lines 6—6 in the direction of the appended arrows;

FIG. 7 is a similar side section view of the pump of FIGS. 4 and 5, taken along lines 7—7 in the direction of the appended arrows;

FIG. 8 is a bottom view, partly broken away of the pump of FIG. 6 taken along the line 8—8 in the direction of the appended arrows;

FIG. 9 is a second bottom section view of the pump of FIG. 6 taken along the line 9—9 in the direction of the appended arrows;

FIG. 10 is a fragmentary top section view of a portion of the pump of FIG. 6 taken along line 10—10 of the direction of the appended arrows;

FIG. 11 is a fragmentary side sectional view of the pump of FIG. 6 taken along line 11—11 of FIG. 10 in the direction of the appended arrows;

FIG. 12 is a broken away sectional view of the outward portion of the pump of FIG. 7 showing the anti-backflow valve in position for normal pump operation;

FIG. 13 is a view of the exterior of the filter basket portion of the recirculating pump of FIG. 7 taken along lines 13—13 in the direction of the appended arrows;

FIG. 14 is a view of one of the scraper blades of the filter basket shown in FIG. 13 taken along lines 14—14 in the direction of the appended arrows; and

FIG. 15 is a system block diagram of the system of FIG. 1.

Turning now to FIG. 1, there is shown as a preferred embodiment, such as is in use on large, multi-passenger vehicles, for example, commercial air transports. A plurality of substantially identical pumps 12, in this embodiment, three, is commonly connected to a single flush manifold 14 which serves several, substantially identical, toilet assemblies 16.

A switch 18 is provided for each of the toilet assemblies 16, which controls the initiation of a toilet flush cycle. A waste return line 20 couples each toilet assembly 16 to a single holding tank 22 in which the several pumps 12 are located. For servicing purposes the tank 22 is provided with a drain valve 24 and a tank cleaning line 26. These are utilized for draining, cleaning, and refilling the tank 22 as a part of a routine service or maintenance operation on the vehicle.

Each of the toilet assemblies 16 is coupled to the flush manifold 14 through a solenoid flush valve 28 which is operated by an electrical control assembly 30. A pressure switch 32 is electrically coupled to the control assembly 30.

In the event of the failure of any of the pumps 12, a failure warning indicator panel is provided at a remote

location, so that repair crews can be alerted to repair or replace the failed pump or other faulty component. A second, fluid level indicator panel 36 is provided in the vicinity of the drain valve 24 and the tank cleaning line 26, so that service personnel can determine fluid level within the tank 22. A liquid level sensor 38 is provided to drive the fluid level indicator panel 36.

When a flush cycle is to be initiated at a toilet assembly 16, the switch 18 which may be a lever or push button is depressed, signalling the control assembly 30. A pump 12 is then selected and power is applied to its motor. If operable, the selected pump 12 will begin pumping fluid into the flush manifold 14 and the fluid pressure in the line will rise. The solenoid flush valve 28 corresponding to the selected switch 18 is also energized to open.

As the fluid pressure in the flushing manifold 14 increases, pressure switch 32 is operated, signalling to the control assembly 30 that the pressure has reached a predetermined minimum. The fluid is then applied to the appropriate toilet assembly 16 through the open flush valve 28, and that toilet is flushed.

A timing circuit within the control assembly 30 maintains the flush valve 28 open for a timed flushing interval. At the expiration of that interval, the flush valve 28 is closed and the pump motor is de-energized.

If, during the flushing interval of a first toilet assembly 16, a second toilet push button 18 is actuated, a second, independent, time interval is initiated and the associated flush valve 28 is opened. Since a pump is already operating, fluid in the flush manifold 14 is available to the second toilet assembly. At the conclusion of the timed interval for the first toilet assembly, its flush valve 28 closes.

In the case of a pump failure, a switch 18 is energized but the pump fails to operate. If at the expiration of the first short timed interval, the pressure switch 32 has not been energized, the power to the pump is electrically disconnected and a second pump is called into service, and a failure light of the warning panel is energized to signal that the initially selected pump is inoperable. A second timed interval is also initiated in the event that the second pump is also inoperable. In this case, the third pump is then energized and remains energized to the end of the flushing cycle. The next or fourth command will start back to the first pump 12.

If pump failure should be experienced during a flushing cycle, the dropping pressure in the flush manifold 14 will be signalled by the pressure switch 32 to the control assembly 30. In this event, a pump energizing signal will be applied to activate another of the pumps.

Turning next to FIG. 2, there is shown the waste tank 22 of FIG. 1. A plurality of waste drains 20 returns the contents of recirculating toilets 16 to the tank 22 and, as shown, three variable volume pumps 12 are mounted in communication with an output manifold 40 which connects to the flush manifold 14.

As can be seen in FIG. 1, the individual pumps 12 extend substantially to the bottom of the tank 22 from where the fluid is filtered and pumped into the output manifold 40 which is common to all pumps 12.

The tank cleaning line 26 is coupled through an integral distribution line 42 to a plurality of spray nozzles 44 which provide a cleaning spray of liquid to the interior of the tank 22 for cleaning and precharging purposes. As can be noted in FIG. 3, the interior of the

tank is perfectly smooth without seams or other projections. The output manifold 40 and the cleaning lines 42 are formed wholly within the body of the tank 22. Since there are no projections or seams, the interior surface does not tend to retain waste material and a high velocity cleaning spray applied through the spray nozzle 44 can effectively clean the tank. Further, when the tank is clean, a measured precharge of liquid for flushing purposes is provided through the nozzles 44.

Turning next to FIGS. 4 and 5, there is shown a side and top view, respectively, of a recirculating pump 12 according to the present invention. FIGS. 4 and 5 provide a better view of the exterior of the pump 12. The structural details are explained in greater detail in connection with FIG. 6 and follows which are sectional views of the pump 12. FIGS. 4 and 5 when taken in conjunction with the remaining FIGS. 6-14, give a better understanding of the structure of the variable volume pump 12 of the present invention.

A detailed description of the pump is best commenced by reference first to FIGS. 6 and 7.

FIGS. 6 and 7 are side sectional views of the variable volume pump 12, developed from the side view of FIG. 4. The pump 12 includes a motor 112 which is fastened to a flange body housing 114. A motor drive shaft 116 passes through the plate 114 and is coupled, by a shear coupling member 118, to a pump drive shaft 120.

The motor drive shaft 116 includes a pinion drive gear 122 which meshes with a transmission assembly 124, to rotationally drive a filter basket 126. The pump drive shaft 120 terminates in a pump impeller 128 which draws fluid from the pump interior and drives the fluid through an outlet duct 130. A check valve 132 in the duct 130 permits unidirectional flow of fluid from the pump to an output manifold 40, which is coupled to the several utilization devices (not shown). A small by-pass orifice 134 is provided in the the check valve 132 to facilitate self-draining of the output lines and to preclude freezing of the lines 14 in low temperatures (See FIG. 7).

The filter basket 126 is rotatably attached to a pump impeller plate 136, which includes a pump inlet orifice 138, by fastening means, here shown as a bolt 140. The filter basket 126 itself has a ring gear 142, integral with the inner periphery of the basket 126 at its upper, open end. A filter basket drive gear 144 is driven from the gear train of the transmission assembly 124.

The filter basket 126 includes a plurality of parallel circumferential slots 146 which serve to filter the fluid taken into the pump 12. A plurality of scraper blades 148 is carried by a suitable support 150. The blades 148 protrude through the slots 146 to dislodge any solid matter as the basket 126 rotates.

Thus far, the pump 12 is generally similar to pumps of the prior art which have been employed in similar systems. The pump 12, in addition, includes a by-pass valve 152 which is controlled by the pressure in the output line 40. The by-pass valve assembly 152 includes a valve stem 154 which carries a valve head 156 that seats against a by-pass opening 158 in the pump outlet conduit 130. When opened, the by-pass valve 152 permits fluid to flow through the by-pass opening 158 to a return line 160 which is opened to the tank.

The by-pass valve stem 154 extends through a fluid impermeable seal member 162. In a separate chamber 164 which is in the path of flush fluid travel and which

communicates with the outlet conduit 130 the valve stem 154 is biased into the closed position by a spring member 66 (See FIG. 6).

A piston member 168 couples to the stem 154 and responds to pressure in the line to open and close by-pass valve 152. When the pressure in the output line 40 rises above a predetermined setting, approximately 17 PSIG, the fluid pressure in the valve chamber 164, exceeds the bias spring 66 pressure and the valve stem 154 is moved downwardly as viewed in FIGS. 6 and 11 opening the valve proportional to the pressure gradient.

Fluid then by-passes the excess pressure in outlet conduit 130, and returns through the by-pass line 160 to the tank. The low "impedance" return path reduces the pressure in the output line 40. If more than one utilization device is "on-line," the pressure in the output line 40 will drop. A reduction of pressure enables the bias spring 166 to move the valve stem 154 upwardly, closing the by-pass valve 152 and increasing the pressure and volumetric flow in the output line 40.

The control circuits for operating the system 10 as described above, are illustrated schematically in FIG. 15. It will be understood by those skilled in the art that the particular arrangement of FIG. 15 is illustrative only and that other, equivalent mechanizations are available to accomplish the desired operation.

FIG. 15 has been generalized to cover a system having N toilet assemblies and M pumps. This is indicated by applying to the reference numerals of the several switches 18 a subscript 1 through n. Similarly, the flush valves 28 are also suitably subscripted 1 through n.

Connected to each switch 18, is a relatively long, interval timer circuit 240. The long timer circuit 240 is intended to be energized for a predetermined, adjustable time interval and provides a continuous output during the timed interval. One output of the timer circuit 240 is applied to energize the flush valve 28 and a second output is applied through an "or" GATE circuit 242, which applied its output to a ring counter 244 and to the contacts of the pressure switch 32.

The "or" circuit 242 receives substantially similar inputs from each of the long interval timers 240 and provides a single output to the remaining elements of the control circuit 30.

The counter 244 may be a ring counter or any other conventional, addressing circuit which sequentially selects, in turn, M different output lines, all of which are applied to a selection logic circuit 248 which ultimately determines which of the M pumps 12 to energize.

The pressure switch 32 can be provided with a pair of normally closed switch contacts 32a and 32b which are directly controlled by the pressure sensed in the line. In this embodiment, the pressure switch 32 is arranged to maintain switches in the closed configuration so long as the pressure detected is less than a preset magnitude. When the pressure exceeds the limit, the switch 32a and 32b are opened.

The output of energized timer 240 through the "or" gate 242 is applied on a first line through the normally closed set of switch contacts 32a to the selection logic circuit 248, and, on a second line through a first short interval timer 246 and to a second short interval timer 250 through a solid state device 232b controlled by switch 32. The output of both short interval timers are applied to the selection logic block 248.

As is well known in the design and construction of data processing equipment, the operation of the control circuit 30 can be represented by a series of logical equations which define the conditions under which an output is provided. Once these equations have been formulated, then it is routine to design the appropriate structural elements that operate in accordance with these logical equations.

In operation, it will be seen that as a push button 18 is actuated, the relatively long timer 240 is energized, which times the flush cycle. A counting impulse is applied to the ring counter 244 to select one of the pumps. The selection is signalled on the appropriate output line to the selection logic block 248, which immediately energizes the selected pump motor 112 and pump 12.

The first relatively short interval timer 246 is energized for an interval, in the preferred embodiment, 4 seconds, which is believed adequate to permit the selected pump to come to full pressure in the line. The pressure switch 32, switch contact 232a and the solid state device 232b will be opened by the pressure increase and, at the time that a signal output is provided by the first interval timer 246, the circuit will be open.

If the pressure in the line is not adequate, then a signal is applied to the selection logic 248 and to the second short interval timer 250. The selection logic 248 then energizes a second motor. If the pressure in the line is still insufficient to affect the switch, then the output of the second short interval timer 250, when applied to the selection logic 248, energizes the third motor of the group.

During a flush cycle, if the pressure drops sufficiently to reclose the switch contacts 232a and the solid state device, a second pump is immediately energized, and, if pressure is not restored within the interval timed by the second timer 250, a third pump is energized. If, for any reason, the long timers fail to operate, the switch 18 can be operated in a manual override mode by holding in the "ON" position.

It is not believed essential to described the detailed logic required to select the appropriate failure warning lights. It will be obvious to those skilled in the art that the circumstances dictating the lighting of the failure lamps can be easily expressed in logical terms which can be simply mechanized.

The successive energization of more than one switch 18 will not affect the state of the counter 244 so long as a pump is running. However, as soon as the latest flush cycle is concluded, and the pumps de-energized, the next energization of a switch 18 will advance the counter 244.

What is claimed as new is:

1. A fluid recirculating sanitary system for selectively supplying flushing fluid to a plurality of toilets wherein fluid is present in said system under pressure, each of said toilets having a waste outlet, comprising in combination:

- a single flushing manifold operatively connected to all of said toilets;
- a single waste holding tank operatively connected to the waste outlets of all of said toilets;
- a plurality of controllable volume pumping means

mounted internally of said tank adapted to respond to the fluid pressure in the system to maintain a predetermined fluid pressure in said system, each of said pumping means having an outlet connected in parallel through said flushing manifold to supply flushing fluid selectively to the toilets, each of said pumping means having an inlet in fluid communication with waste in said tank;

pressure sensing means connected to said flushing manifold for providing a first signal when sensed fluid pressure in said manifold is less than a predetermined magnitude;

control means, connected to said pumping means and said pressure sensing means, and operable in response to applied first signals for energizing one of said pumping means for supplying flushing fluid to the flushing manifold;

by-pass means, located internally of each of said pumping means and in fluid communication with the waste in said tank, each of said by-pass means being independently operable from each other and operable in response to sensed fluid pressure in said flushing manifold for diverting sufficient fluid from each of said pumping means outlet back into said tank to maintain the fluid pressure at the toilets at a desired pressure; and

volume and pressure monitoring means operatively connected to both said flushing manifold and said control means for monitoring the volume and pressure of flushing fluid admitted into said toilets.

2. The system of claim 1, further including a switch at each of the toilets connected to said control means, said control means being responsive to switch actuations for energizing at least one of said pumping means to supply flushing fluid to the toilets, said control means being further operable in response to said first signals for energizing another of said pumping means and deenergizing said at least one said pumping means.

3. The system of claim 1, wherein said control means further include selecting means for alternately selecting said pumping means for operation.

4. The system of claim 1, wherein said control means further include selecting means for alternately selecting said pumping means for operation, said system further including a switch at each toilet, coupled to said control means for energizing one of said pumping means, said control means being further operable in response to first signals for energizing one of the non-selected pumping means and deenergizing said one of said pumping means.

5. The system of claim 1 wherein said control means is operable to select each of said pumping means alternatively in a predetermined cyclical order.

6. The system of claim 5, wherein said control means are operable in response to applied first signals to energize the next pumping means in the predetermined cyclical order and to deenergize the initially selected pumping means.

7. The system of claim 1 further including alarm means coupled to said pressure sensing means and responsive to applied first signals for generating a remote visual alarm signal.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,835,478
DATED : 09/17/74
INVENTOR(S) : Michael R. Molus

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, line 18, before "by-pass", insert - - spring-
biased - -; line 18, after "by-pass", insert - - valve - -;
lines 22 and 23, change "in said flushing manifold" to
- - at said outlets - -; line 24, change "outlet" to
- - outlets - -.

Signed and sealed this 29th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks