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Patents Act 1952

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Form 1
Regulation 9

APPLICATION FOR A STANDARD PATENT OR A STANDARD PATENT OF ADDITION

598957

Insert full name(s) of applicant(s)

(71) I/We SEALAND TECHNOLOGY, INC.

Insert address(es) of applicant(s)

of Fourth Street, Big Prairie, Ohio 44611, United States of America

Insert title of invention

(54) hereby apply for the grant of a ☑ standard patent ☐ patent of addition for an invention entitled VACUUM TOILET SYSTEM

(tick appropriate box)

which is described in the accompanying ☐ provisional ☑ complete specification.

Insert name of actual inventor

(72) The actual inventor(s) of the said invention is/are James A. SIGLER, Richard W. SPRANG, Edward MC KIERNAN and Ronald J. BAILEY

Insert address for service of notices in Australia

(74) My/our address for service is SANDERCOCK, SMITH & BEADLE, 207 Riversdale Road, (P.O. Box 410) Hawthorn, Victoria, 3122 Attorney Code SA

for Convention cases only

(ONLY TO BE USED IN THE CASE OF A CONVENTION APPLICATION)

Details of basic application(s) —

NUMBER	COUNTRY	DATE OF APPLICATION	ISO Code
07/101,788	United States of America	28th September 1987	US

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 26-4-90

Insert day, month and year form signed

Dated this 26th day of September, 1988

SEALAND TECHNOLOGY, INC.

Signature of applicant or Australian attorney

TO

M003110 26/09/88

(Signature)

SANDERCOCK, SMITH & BEADLE
Patent Attorneys for the Applicant.

THE COMMISSIONER OF PATENTS

This form must be accompanied by either a provisional specification (Form 9 and true copy) or by a complete specification (Form 10 and true copy).

PATENT DECLARATION FORM
(CONVENTION OR NON-CONVENTION)

DECLARATION IN SUPPORT OF APPLICATION FOR A PATENT

Insert name of applicant.

In support of the application made by SEALAND TECHNOLOGY, INC.

Insert title of invention.

for a patent for an invention entitled: VACUUM TOILET SYSTEM

Insert full name(s) and address(es) of person(s) making declaration. If applicant a company person must be authorised to make declaration.

I, Edward McKIERNAN of ~~xxxx~~ Sealand Technology, Inc., a corporation of the state of Ohio, U.S.A., Fourth Street, P.O. Box 38, Big Prairie, Ohio 44611

do solemnly and sincerely declare as follows:

* ~~XXXX

(12) PATENT ABRIDGMENT (11) Document No. AU-B-22816/88
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(54) Title
VACUUM TOILET SYSTEM

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(56) Prior Art Documents
US 4521925
US 3811135
US 4672690

(57) Claim

1. A vacuum toilet system for a vehicle comprising :

a vacuum toilet including a valve;

a vacuum tank operatively connected to said vacuum toilet below said valve;

a vacuum pump operatively connected to said vacuum tank; and

a holding tank operatively connected to said vacuum pump;

said vacuum tank comprising a plastic tank including at least three ports, each of said ports being substantially identical to the other ports to allow interchangeability of the connection between said ports and other components;

an inlet conduit operatively connected to one of said

.../2

ports;

an outlet conduit operatively connected to another of said ports; and

a vacuum sensor operatively connected to a third of said ports;

at least one of said ports defined by a continuation of a wall of said tank so that said port can be operatively connected to an outlet conduit so that no accumulation of sewage material within said tank take place.

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Form 10

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COMPLETE SPECIFICATION

(ORIGINAL)

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The following contains the amendments made under Section 49 and is correct for printing.

Related Art:

TO BE COMPLETED BY APPLICANT

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Complete Specification for the invention entitled: VACUUM TOILET SYSTEM

The following statement is a full description of this invention, including the best method of performing it known to me:—

The invention relates to vacuum toilet systems, particularly for use on vehicles such as boats, planes, trains, recreational vehicles, and the like, and to component parts for such systems.

Vacuum toilet systems, such as those sold for many years under the "Vacu-Flush" trademark have had many practical advantages including being able to flush without using large amounts of precious clean water, low energy use per flush, excellent system flexibility, and the avoidance of using macerators or other accessory pieces of equipment to break up the sewage. While the Vacu-Flush system has been very commercially successful, there are some aspects thereof that can be improved upon as far of ease of construction, optimization of functionality, and minimization of the number of components is concerned. According to the present invention a vacuum toilet system is provided which retains the numerous advantages of the Vacu-Flush system, yet improve upon it.

The vacuum tank in conventional vacuum toilet systems has had a number of practical difficulties. The ports extending to and from the tank are of widely different construction, minimizing the flexibility of connection of various components to it. Also, the tank has been mounted utilizing a mounting base and clamping strap system that is less than desirable, and because that system that is less than desirable, and because of the cooperation of the outlet from the tank and the tank itself, liquid (which includes sewage particles) can collect at the bottom of the tank. The provision of sewage constantly in the tank is

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undesirable for many reasons.

According to the invention there is provided a vacuum toilet system for a vehicle comprising :

a vacuum toilet including a valve;

a vacuum tank operatively connected to said vacuum toilet below said valve;

a vacuum pump operatively connected to said vacuum tank; and

a holding tank operatively connected to said vacuum pump;

said vacuum tank comprising a plastic tank including at least three ports, each of said ports being substantially identical to the other ports to allow interchangeability of the connection between said ports and other components;

an inlet conduit operatively connected to one of said ports;

an outlet conduit operatively connected to another of said ports; and

a vacuum sensor operatively connected to a third of said ports;

at least one of said ports defined by a continuation of a wall of said tank so that said port can be operatively connected to an outlet conduit so that no accumulation of sewage material within said tank take place.

The tank is preferably formed so that it has no seams.

In a preferred form, ribs are integrally molded on the outside of the tank extending in the direction of elongation of the tank, the ribs including a plurality of through extending openings which are substantially tangential to the

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tank and adapted to directly connect to a bracket for bolting of the tank to the bracket. By providing four equally circumferentially spaced longitudinal ribs on the tank maximum flexibility in the mounting of the tank and orientation of the various ports is provided.

The vacuum toilet system according to the invention have numerous advantages over the prior art while retaining the desirable features of the commercially successful prior "Vacu-Flush" system. This and other objects of the invention will become clear from an inspection of the detailed description of the invention and from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of an exemplary vacuum toilet system, which utilizes a single pump for filling and emptying the holding tank;

Figure 2 is a side schematic view of an exemplary vacuum toilet system which allows flexibility of use, and operation even if one pump becomes temporarily inoperative;

Figure 3 is a side cross sectional view of an exemplary flexible sealing element utilized in the vacuum toilet of FIGURE 1;

Figure 4 is a top plan view of the sealing element of FIGURE 3;

Figure 5 is a side view of the sealing element of FIGURE 3;

Figure 6 is a side partial cross sectional view of an exemplary vacuum toilet which maximizes macerating operations by taking into account the point where the

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majority of fragmentation occurs;

Figure 7 is a side schematic view of portions of toilet like that of Figure 6 only showing a reciprocal valve element instead of a rotary one;

Figure 8 is a side view, partly in cross section and partly in elevation, of an exemplary anti-siphon valve with spray nozzle utilized in the vacuum toilet system according to the embodiment;

Figure 9 is a perspective view of the anti-siphon valve and spray nozzle of Figure 8 shown in exploded relationship with respect to a conventional toilet bowl;

Figure 10 is a side view, partly in cross section and partly in elevation, illustrating an exemplary funnel and the interconnection between the funnel and various conduit components;

Figure 11 is a side cross sectional view of a prior art vacuum toilet funnel construction;

Figure 12 is an opposite side cross sectional view of a vacuum tank according to the invention;

Figure 13 is a side view of the tank of Figure 12;

Figure 14 is an end view of the tank of Figures 12 and 13, shown in operative association with the mounting bracket, which bracket is in cross section;

Figure 15 is a top plan view of an exemplary plug adaptor for connection of a vacuum switch to a port of the vacuum tank;

Figure 16 is a side view of the plug adaptor of Figure 15;

Figure 17 is a cross sectional view of the plug of

Figure 15 taken along lines 17-17 thereof;

Figure 18 is a cross sectional view of the plug of Figure 16 taken along lines 18-18 thereof;

Figure 19 is a side view of an electrical switch support mount for use with the plug adaptor of Figure 15, and shown in association with an electrical switch;

Figure 20 is a top plan view of the switch mount, per se, of Figure 19;

Figure 21 is a side cross sectional view of the switch mount of Figure 20 taken along lines 21-21 thereof;

Figure 22 is a side cross sectional view of the switch mount of Figure 20 taken along lines 22-22 thereof, and shown in cooperation with fasteners and a plug adaptor which plug adaptor is shown in cross section;

Figure 23 is an exploded perspective view of an exemplary vacuum pump;

Figure 24 is a side view, partly in cross section and partly in elevation, of just the pumping components of the pump of Figure 23; and

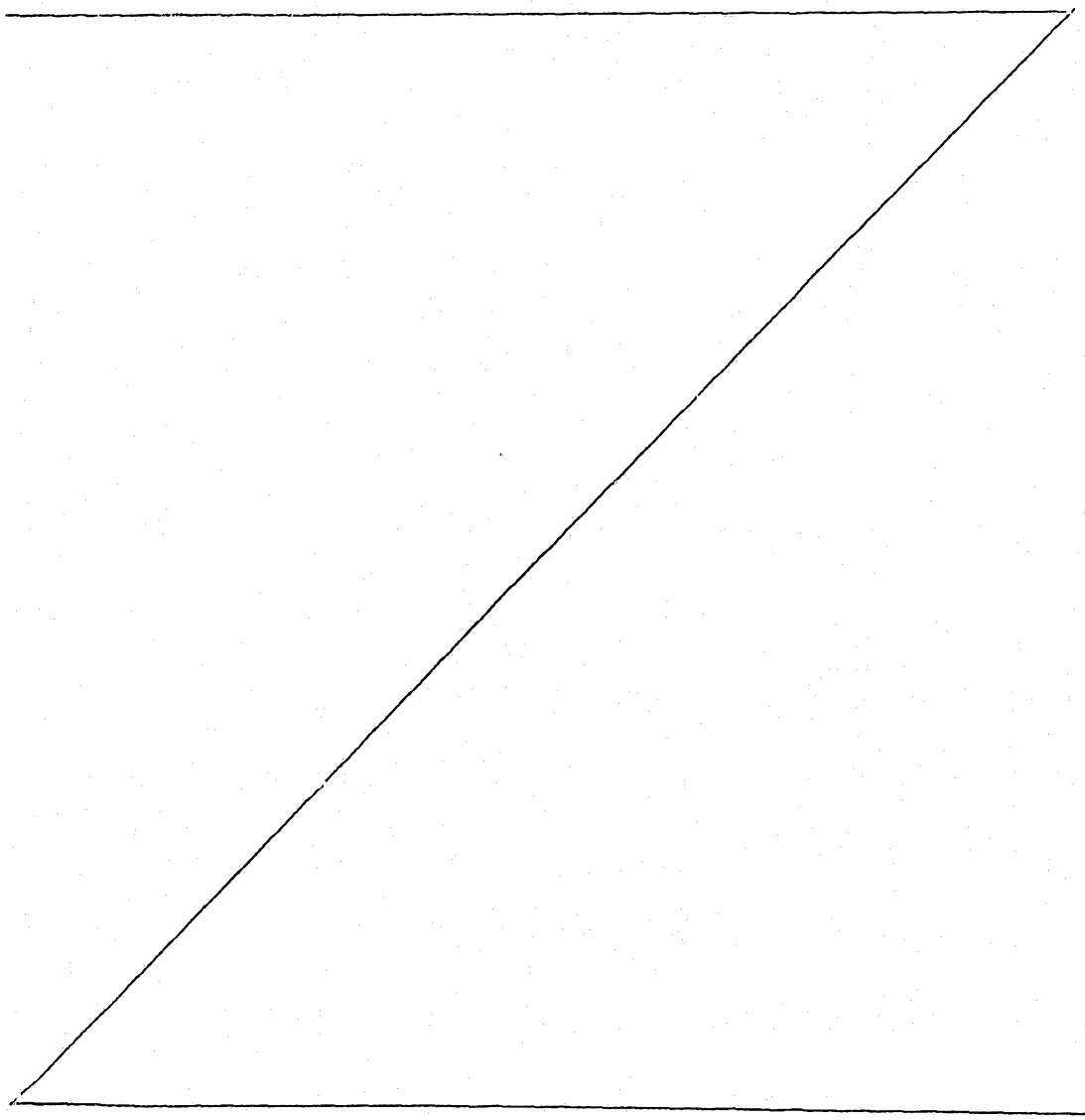
Figure 25 is a detail side view, partly in cross section and partly in elevation, of the interconnection between a desirable pump stem and movable pump element of a vacuum pump that can be utilized according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows most of the major components of a conventional vacuum toilet system for a vehicle, such as a boat, but interconnected in a particularly advantageous system according to the invention and utilizing advantageous

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component parts according to the invention. The basic components of the system include a vacuum toilet 10 which includes a movable valve element interior thereof, shown in dotted line at 11, and an anti-siphon valve 12 with a spray nozzle 13 associated therewith and connected to an on-board source of fresh water 14. The toilet 10 is operatively connected, below the toilet valve 11, to a vacuum tank 15, to be described further in relation to Figures 12 to 14 which is an accumulator of vacuum, and has a vacuum switch assembly 16 operatively



associated therewith, as well as a vacuum pump 17 and a holding (or treatment) tank 18. Sewage may ultimately be discharged from the system through discharge conduit 19.

According to the system of the invention of FIGURE 1, filling or emptying of the holding tank is accomplished utilizing a single pump 17 rather than requiring two pumps as is conventional in the prior art, by utilizing a pair of three-way valves 20, 21 which are preferably solenoid operated valves or the like which are controlled from a common control console 22 or the like. When first valve 20 and second valve 21 are in respective first positions thereof, the vacuum pump 17 will pump sewage from vacuum tank 15 through valve 20, through it, and then through valve 21 to holding tank 18. In a second position of valves 20, 21, the pump 17 will pump sewage from holding tank 18, through valve 20, to pump 17, through valve 21, and to discharge conduit 19.

FIGURE 2 illustrates a multiple head system such as would be used in train cars or the like which will allow continued operation even if one of the vacuum pumps breaks down. A first plurality of vacuum toilets 10 and associated vacuum tanks 11 is associated with each of the lines 22a-22c, connected to a header 23 or the like and passing in first conduit 24 to first vacuum pump 25 and then to a holding tank 26. A first valve 27 is provided in conduit 24 between header 23 and pump 25. A second plurality of lines 28a-28c are connected to a second plurality of heads, to header 29, second conduit 30, and second vacuum pump 31. A second valve 32 is



disposed in conduit 30 between header 29 and pump 31. A third conduit 33 is provided connected between the valves 27, 32, so that with the valves 27, 32 in the appropriate position--as well as third valve 34 in the appropriate position--all the sewage from the first header 23 may pass to the vacuum pump 31 in addition to that from lines 28a-28c; or alternatively the sewage from header 29 may pass to first pump 25. The fourth and fifth valves 35, 36 also may be provided between the pumps 25, 31 and holding tank 26. The holding tank 26 is connected to a discharge in any conventional manner. All the valves may be manually operated valves as indicated in the drawing, or may be solenoid operated. Valves 35, 36 may be check valves in the appropriate circumstances.

FIGURES 3-5 show a sealing element for the toilet valve 11 ~~pursuant to the invention~~. The sealing element illustrated in FIGURES 3-5 is substituted for the sealing element 10 in the toilet of the U.S. Patent 3599248 (the disclosure of which is hereby incorporated by reference herein), and may also be seen in FIGURE 6 the sealing element 37 comprises an annular one-piece sealing element of resilient material having a body 38 of a first material (preferably synthetic rubber) and radially spaced concentric rings 39, 40 upstanding from the body 38. As is conventional in such sealing elements a positioning peg-engaging slot 41 is provided in the periphery of the element 37 including in the concentric ring 40. Also, means defining an overflow opening 42 is integrally molded into the sealing element 37. The sealing element also includes an inner annular flap portion 43 which is of a second

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material having greater anti-friction and lubricity properties than the first material, preferably synthetic rubber blended with Teflon® (polytetraflouroethylene). The upstanding radially spaced rings 39, 40 engage a bottom surface 44 of toilet bowl 10 (see FIGURE 6) and provide effective sealing despite the inherent irregularities of the bowl 10 when it is formed of china (ceramic) as is desirable.

The inner flap 43, which must have a minimum thickness of about .062 inches, actually engages the movable valve element (e.g. hemispherical element 45 in FIGURE 6) to effect sealing. The durometer of the sealing element 37 is about 55-65, preferably about 60, and thus entire element 37 can be molded in a single mold. For example the inner flap 43 may be white buna-n synthetic composition number 2653, mixed with Teflon, while the body 38 (and rings 39, 40) could be black buna-n synthetic rubber, composition number 2319.

FIGURE 6 illustrates a toilet 10 with a conventional toilet bowl 46 with downwardly sloping sides 47 defining a drain opening 48 with the bottom surface 44 surrounding the drain opening 48. The valve element 45 is rotatable about axis 49 to move into and out of sealing engagement with an entire periphery of the inner flap 43 of the sealing element 37 to open or close the drain opening 48. In the FIGURE 6 embodiment, the components are located in such a way as to optimize the macerating action that inherently results in vacuum toilet systems (without the need for an accessory macerating device).

As previously stated, it has been recognized

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according to the invention that instead of the majority of the macerating action taking place at an orifice--such as at the orifice 50 located below the drain opening 48 at the bottom of the converging walls of the funnel means 51--it takes place at the point where the valve is initially "cracked open" and the waste material is initially exposed to the force of the vacuum on the opposite side of valve element 45 from the bowl 46. Upon rotation of the valve element 45 about axis 49, an initial passageway or opening 52 is provided and this is where the macerating action takes place, or at least significant fragmentation occurs there so as to enhance any subsequent fragmentation that occurs. In view of this recognition, according to the invention, in the vacuum toilet of FIGURE 6 the components are located so as to take maximum advantage of this condition. In particular, the orifice 50 and particularly the center line thereof, is disposed so that it is disposed directly below (in vertical alignment with) the initial passageway 52 so that the waste material does not change direction in moving to orifice 50 and need not follow any unnecessarily long path. This facilitates the fragmenting action.

In the schematic embodiment of FIGURE 7, the valve element 45' is a linearly reciprocal valve element operated by a linear actuator 49' or the like, cooperating with the sealing element 37'. Here, again, the orifice 50' at the bottom of funnel means 51' is disposed so that it is directly below and in vertical alignment with the initial passageway that is created when the movable valve element 45' is first reciprocated to the right in FIGURE 7.

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In the construction of vacuum toilet systems, typically the orifice 50, 50' would be about one inch in diameter and that would be the smallest diameter portion of any part of the system so that if a piece of waste material makes it past the orifice 50, 50' (which preferably comprises a knife-edge orifice), it will be able to move throughout the rest of the system.

The improved anti-siphon valve 12, with hand spray nozzle 13, according to the invention is best seen in FIGURES 8 and 9. The structure ~~according to the invention~~ achieves simplicity of design, simplicity in the manufacture of components, and minimal use of material (plastic) while additionally providing a hand spray nozzle so as to provide flexibility in directing flush liquid into the bowl to facilitate complete removal of waste material.

The anti-siphon valve 12 includes a housing 53 body portion having means defining a first valve seat 54 (see FIGURE 8) and a second valve seat 55, with first and second legs 56, 57 respectively extending from the same side of the housing 53, generally parallel to each other and preferably connected by a small web of plastic 58 to facilitate stabilization thereof. Indicia indicating the direction of flow of liquid through the valve 12 may be provided on the exterior of the legs 56, 57 as shown by the arrows in FIGURE 9.

Means are provided defining an anti-siphon air passage 59 associated with the second valve seat 55. This comprises a continuation of the tubular interior of the of second valve seat 55 to the exterior environment with a cap support 60 preferably molded

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on the housing 53 for supporting a removable cap 61 which prevents entry of foreign material into the valve 12, but does not restrict passage of air from the environment to the valve when breaking of a siphon effect is necessary.

The first leg 56 is connected to the source of fresh water 14, as by hose 62 (see FIGURE 9) and is in alignment with the air passage 59. The second leg is operatively connected to the toilet bowl 46, as through the elbow connection 63 (see FIGURE 9) and associated fitting 64, which connects to the back of the toilet bowl 46 in a per se conventional manner. However, according to the invention the leg 57 also includes a downwardly extending portion 65 which is connected to the flexible tube 66 and ultimately to the hand spray nozzle 13.

A poppet 69 is mounted in the valve 12 so that the flexible material in the valve portion 67 (e.g. rubber washer) thereof moves between the first valve seat 54 and the second valve seat 55. The interior of the first leg 56 including the enlarged diameter upper portion 68 thereof immediately adjacent the body portion 53 of the housing, guides the poppet 69 for up and down movement. The poppet 69 preferably is elongated in the dimension of leg 56, and includes means for guiding the valve portion 67 thereof during movement between the valve seats 54, 55, while still allowing free flow of water. Preferably four lobes are provided, three of the lobes seen in FIGURE 8, circumferentially spaced 90 degrees from from each other. The width of the top portion 70 of the poppet 69 is substantially the same as the interior diameter of the upper cavity 68 of the leg 56, while the

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maximum width portion 71 of the poppet 69 bottom is approximately the same as the interior diameter of the leg 56.

The spray nozzle 13 preferably is conveniently mounted by bracket 72, which is connected by screws 73 or the like to the side or back of toilet bowl 46.

In use, the anti-siphon valve 12 operates as follows: when the toilet is flushed by operation of the movable valve element in a conventional manner (e.g. as in U.S. Patent 3663970, the disclosure of which is incorporated by reference herein) and/or by lifting up on the actuator for flushing the toilet, fresh water flows from reservoir 14 through first leg 56 to move the poppet 69 upwardly so that there is no seal made between valve portion 67 and valve seal 54, the water causing the poppet 69 to move up completely so that valve portion 67 is in sealing relationship with valve seat 55. Water then flows from first leg 56 through the interior of housing body 53 and to second leg 57 and through fitting 63, 64 into the interior of the toilet. If it is desirable to direct a portion of this flow at a particular point within the toilet bowl 46, the user removes the spray nozzle 13 from the bracket 72 and actuates it so that a portion of the water flows through conduit 66 through spray nozzle 13 into the bowl 46. Once operation of the fresh water flow to the bowl has terminated it is necessary to insure that a siphon effect does not take place which would continue to draw water from the reservoir 14, and/or allow possible contamination of fresh water source 14 by back up through the valve 12. This is automatically taken care of by the air passage-way 59 which--when water pressure (as under

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the pressure of a pump) is no longer applied to the poppet 69--allows air to flow through passageway 59 causing the poppet 69 to move downwardly so that the valve portion 67 thereof sealingly engages stationary seal 55.

A conventional prior art funnel means is illustrated in FIGURE 4 by reference numeral 74, comprising an insert terminating in an orifice 75 with at least one solid portion 76 below the orifice 75. According to another aspect of the present invention, enhanced flexibility of the connection of the funnel and orifice to the vacuum tank is provided as illustrated in FIGURE 10. In this embodiment the funnel means 77 terminating in knife-edge orifice 78 has an annular collar 79 extending downwardly therefrom, the collar having a large diameter with respect to the orifice 78, and there being a significant "lip" portion 80 of the funnel 77 extending inwardly of the collar 79 so that the orifice 78 is truly "within" the collar 79. The upper portion 81 of the funnel 77 may be suspended or supported from the floor or deck by pedestals or a large annular pedestal (not shown).

FIGURE 10 illustrates the interconnection of different components that may be provided utilizing the funnel means with collar 79. For example, 1.5 inch rigid plastic pipe 82 may act as a male element and may be inserted into the interior of the collar (which acts as the female element). Note the bevelled entryway 83 to the collar 79 and the slightly inwardly tapering interior 84 thereof. Alternatively, 1.5 inch inside diameter flexible hose 85 may be connected to the funnel 77 utilizing

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adaptor 86, which adaptor 86 is inserted into the collar 79. Sill further, an L 87 my be inserted into operative association with the collar 79, the L, in turn, either being connected directly to rigid pipe or through an adaptor to flexible hose. 1.5 inch pipe or hose is typically desirable where the diameter of the orifice 78 is optimized at about 1 inch.

Conventional vacuum tanks in marine vacuum toilet systems have a seam at the middle, comprising two cylindrical portions with rounded ends which are joined at the seam. An inlet nipple of one diameter is connected to one end, and a vacuum switch is operatively connected to the other end, with the outlet extending downwardly from the nipple in the side wall of the tank. Adjustable metal straps strap the tank support pedestals. The improved vacuum tank illustrated in FIGURES 12-14 overcomes the disadvantages associated with such conventional vacuum tanks.

The vacuum tank of FIGURES 12-14 may be blow molded from plastic so that it has no seams. The tank is primarily circular in cross-section, and elongated in a dimension 88. The tank has first and second ends 89, 90 and has at least three universal ports. By "universal ports" it is meant that the ports are substantially identical in configuration so that the ports are uniform and may be used to cooperate with each of a wide variety of connecting components so as to provide maximum flexibility for interconnecting tank 15 to other components. For example as illustrated in the drawings a first port 91, a second port 92, and a third port 93 are

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provided, and preferably also an optional fourth port 94 illustrated in dotted line in figure 12. At least one of the ports (e.g. preferably both ports 93, 94) is formed by a continuation portion 95 of the side wall of the tank 15. In this way, if that port (e.g. 93) is used as the outlet from the tank no accumulation of sewage within the tank 15 occurs because there stagnant or "sump" portion.

FIGURE 12 shows connection of the first port 91 to an adaptor 96 and providing the inlet to the tank, port 92 is connected to a vacuum switch unit 16 for sensing the vacuum within the tank 15 and operating the pump 17 in response thereto; and connection of third port 93 is connected to an adaptor 97 for connection to the outlet conduit which passes to pump 17.

As seen most clearly in FIGURES 13 and 14, the tank 15 also preferably includes longitudinally extending ribs 98 on the exterior thereof. The ribs 98 preferably extend in the dimension of elongation 88 of the tank 15 and are integrally molded with the rest of the tank 15, and include means defining a plurality of through extending openings 99 therein. The openings 99 extend essentially tangential to the tank 15 at the points at which they are provided. At least two opposite ribs 98 are provided and preferably four are provided as illustrated in FIGURE 14. The ribs 98 greatly facilitate interconnection of the tank 15 to a stationary support, such as the bracket 100 (see FIGURE 14). The bracket 100 itself preferably has a pair of ribs 101 each with at least one opening, and preferably with a plurality of openings cooperating with openings 99 so that bolts

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secured by nuts can be passed through the ribs 98, 100 to hold them securely together. It will thus be seen that with such a configuration of the tank and associated mounting bracket, a wide variety of different mounting orientations and connection of diverse components to the tank may be readily provided.

FIGURES 15-22 show various components to facilitate connection of the vacuum switch assembly 16 to a tank 15. FIGURES 15-18 show a plug adaptor ~~according to the invention~~ while FIGURES 19-22 show primarily an electrical switch support mount, although the plug adaptor is also shown in FIGURE 22. In these FIGURES it is assumed the tank will have interiorly threaded ports for connection of the components thereto, however that is not necessary and the ports of the tank could equally well be exteriorly threaded (as in FIGURES 12-14) and the threads on the plug adaptor FIGURES 15-18 adjusted accordingly.

The plug 103 includes threaded collar portion 104 for engaging the tank 15 port with which it will be associated and includes a body 105 which is basically annular and includes a plurality of blind holes 106 for receiving fasteners (see FIGURES 15 and 18), preferably four such holes are spaced from each other so that they are on the corners of a square or other quadrate. Access to the holes 106 is provided from the side of the body 105 opposite the threaded collar 104. Upstanding bosses 107 are provided on the body 105 opposite the threaded collar 104. The plug adaptor preferably is formed of nylon or like plastic material.

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The electrical switch support mount is shown generally by reference numeral 108 in FIGURES 19-22, and it mounts a conventional electrical switch, such as a micro-switch 109 (see FIGURE 19). It includes a base portion 110 with a plurality of through-extending openings 111 defined therein, through which fasteners--such as the fasteners 112 of FIGURE 22--might pass. The openings 111 (see FIGURES 20) are preferably disposed in the corners of a square or like quadrate, having the same spacing from each other as the blind openings 106 and adaptor 103 so that when the openings 111, 106 are in alignment the fasteners 112 may pass therethrough and connect the base 110 to the plug adaptor 103. Note that with such a construction the fasteners 112 will be exterior of the tank environment and therefore need not be made of stainless steel, but may be made of any other desirable, less expensive material that performs a connecting function, such as conventional screw steel.

Note that the mount 108 also includes a centrally located guide bushing 113 for guiding a switch actuator plunger 114 which reciprocates therein, and a recess 115 (see FIGURE 22) is provided for a coil spring 116 (see FIGURES 19 and 22) that will surround the plunger 114 and bias the head 117 thereof toward the switch 109. The opposite end of the plunger 114 from head 117, as seen in FIGURE 19, is connected up to a stiff diaphragm 118, or other conventional vacuum level responsive material such as is used in conventional vacuum switches in conventional Vacu-Flush® systems. The mount 108 also includes upstanding posts 119 which are in

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alignment with the central bushing 113 (see FIGURE 20) and are at the mid points of the sides of the quadrate base 110 opposite each other and between a pair of holes 111. These posts also include blind openings 120 (see FIGURE 21) which receive fasteners which connect the electrical switch 109 thereto.

The inside face of the base 110 is formed with a plurality of concentric grooves 122 (see FIGURE 22)--or alternatively it may be considered that a plurality of upstanding lands 123 are provided therein. In any event, these concentric surface manifestations 122,123 provide sealing engagement with the plug 103 so the necessity for an O-ring in such a structure (necessary in the prior art) is overcome.

The pump 17 conventionally utilized in a system according to the invention is shown in one or more of U.S. Patents 3529908, 3597517, 3714536, and 3774461, the disclosures of which are incorporated by reference herein. However, those pumps contain bellows between the movable pump element and the housing, and are subject to the paper compaction problem discussed above and therefore the improved pump according to the invention, as illustrated in FIGURES 23 and 24 is preferably provided.

The pump 17 illustrated in FIGURES 23 and 24 includes a housing 126 which has an inlet 127 and an outlet 128 (preferably connected to check valves as is conventional in present vacuum toilet systems) with a sump area 129 (see FIGURE 24) provided in the housing 126 below the inlet and outlet 127, 128. The provision of the sump volume 129 allows the pump to practically and effectively pump sewage slurries and

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the like even though there may be particles therein with a diameter or effective maximum exterior dimension of about one half inch. The pump 17 also includes a movable pump element 130 (sometimes called a piston) which is connected to a stem 131 (sometimes called a rod). The end 132 of the housing containing the sump 129 is closed, however, the end 133 opposite end 132 is open. According to the invention a rolling diaphragm 134 is connected between the pump movable element 130 and the open end 133 of the housing. A cover, shown in dotted line at 135 in FIGURE 24, may be utilized to close the open end 133.

The stem 131 is reciprocated up and down to effect the pumping action by a motor crank assembly which includes a bushing-connector 136 which fits at one end thereof into opening 137 in stem 131, and receives a pin 138 from a crank arm 139 on the other end thereof. The crank arm 139 is connected to shaft 140 of a motor/gear reducer assembly 141. Rotation of shaft 140 from the gear reducer connected to a motor effects rotation of crank arm 139 which in turn effects movement of the stem 131 and movable pump element 130 in dimension 132 (see FIGURE 24) to effect the pumping action. The rolling diaphragm does not suffer the same disadvantages as a bellows with respect to paper compaction and thus can be expected to have longer life.

Also ~~according to the invention~~ it is desirable to minimize the cost of the pump 17 by forming the crank 139 of powdered metal. In addition to minimizing costs this provides the crank arm 139--which is a relatively inexpensive component (compared to the elements 130, 131 assembly, gear

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reducer, or motor)--as the first component to break and thus the fail-safe mechanism.

~~According to the invention it~~ It is also possible to reduce the cost of the pump 17 by forming the stem of plastic. For example in the embodiment illustrated in FIGURE 25, the movable valve element 144 is connected to an injection molded plastic stem 145 with the rolling diaphragm 134 (or bellows) received between the components 144, 145. Interconnection between the components 144, 145 preferably is facilitated by a plurality of integral pegs or pins 146 which extend outwardly from the stem 145, and are staked, ultrasonically welded, or otherwise attached to the movable pump element 144 (which preferably also is of plastic).

The operation of the basic vacuum toilet system according to the invention is the same as for the conventional Vacu-Flush® marine toilet system, except that the components thereof are improved and the system advantages such as illustrated in FIGURES 1 and 2 can be obtained. It will thus be seen that an advantageous vacuum toilet system, and component parts therefor, have been provided.

While the invention has been herein shown and described in what is presently considered to be the most practical and preferred embodiment, it will be apparent to those of ordinary skill in the art that many modifications may be made thereof within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all the equivalent structures and devices.

The claims form part of the disclosure of this specification.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS :

1. A vacuum toilet system for a vehicle comprising :

a vacuum toilet including a valve;

a vacuum tank operatively connected to said vacuum toilet below said valve;

a vacuum pump operatively connected to said vacuum tank; and

a holding tank operatively connected to said vacuum pump;

said vacuum tank comprising a plastic tank including at least three ports, each of said ports being substantially identical to the other ports to allow interchangeability of the connection between said ports and other components;

an inlet conduit operatively connected to one of said ports;

an outlet conduit operatively connected to another of said ports; and

a vacuum sensor operatively connected to a third of said ports;

at least one of said ports defined by a continuation of a wall of said tank so that said port can be operatively connected to an outlet conduit so that no accumulation of sewage material within said tank take place.

2. A vacuum toilet system as recited in claim 1 wherein said tank comprises a plastic material tank circular in cross-section over the majority of the length thereof, and the walls defining the circular cross-section thereof including a wall portion which defines said continuation for said at least one port for connection to said outlet

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conduit.

3. A vacuum toilet system as recited in claim 2 wherein said tank is formed without seams.

4. A vacuum toilet system as recited in claim 2 or 3 wherein said tank includes at least two longitudinal ribs integral therewith and extending along the exterior thereof in the dimension of elongation of said tank, and means defining a plurality of openings in said ribs, said openings being substantially tangential to said tank.

5. A vacuum toilet system as recited in claim 4 wherein four of said ribs are provided evenly spaced from each other around the circumference of said tank.

6. A vacuum toilet system as recited in claim 5 wherein said vacuum tank comprises four ports, so that the opposite ends of said tank are symmetrical, all of said ports being universal ports.

7. A vacuum toilet system as recited in claim 4, 5 or 6 further comprising a support bracket for mounting said tank, said support bracket including arcuate portions for engaging the tank wall and ribbed portions for engaging the longitudinal ribs on said tank, said ribbed portions having at least one opening therein which is alignable with one of said plurality of openings in said tank ribs.

8. A vacuum toilet system as recited in any preceding claim wherein connection of said vacuum tank, through a universal port, to said vacuum sensor is provided by a plug with connector portions operatively engaging said port, and an electrical switch support mount, said electrical switch support mount having a base with a plurality of through-

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extending fastener receiving openings therein, a centrally located plunger guide and a pair of peripherally located support posts; and wherein said plug comprises a plurality of blind fastener receiving openings in alignment with said fastener receiving openings in said support mount base so that fasteners may be passed from the exterior of said base through said base into engagement with said adaptor plug blind openings to hold said electrical switch support mount to said plug adaptor and ultimately said vacuum tank.

9. A vacuum toilet system as recited in claim 8 wherein said base of said electrical switch support mount comprises a plurality of concentric grooves formed therein and cooperating with said adaptor plug so that there is no necessity for an O-ring.

10. A vacuum toilet system as recited in claim 9 wherein said electrical switch support mount base is substantially quadrate in plan, and wherein one of said fastener receiving openings is disposed at each of the corners of said quadrate; and wherein said support posts are disposed along opposite sides of said quadrate in line with said plunger guide, each of said support posts being substantially equidistant between fastener receiver openings.

DATED THIS 2nd April 1990

SMITH SHELSTON BEADLE

Fellows Institute of Patent

Attorneys of Australia.

Patent Attorneys for the Applicant

SEALAND TECHNOLOGY, INC.

FIG. 1

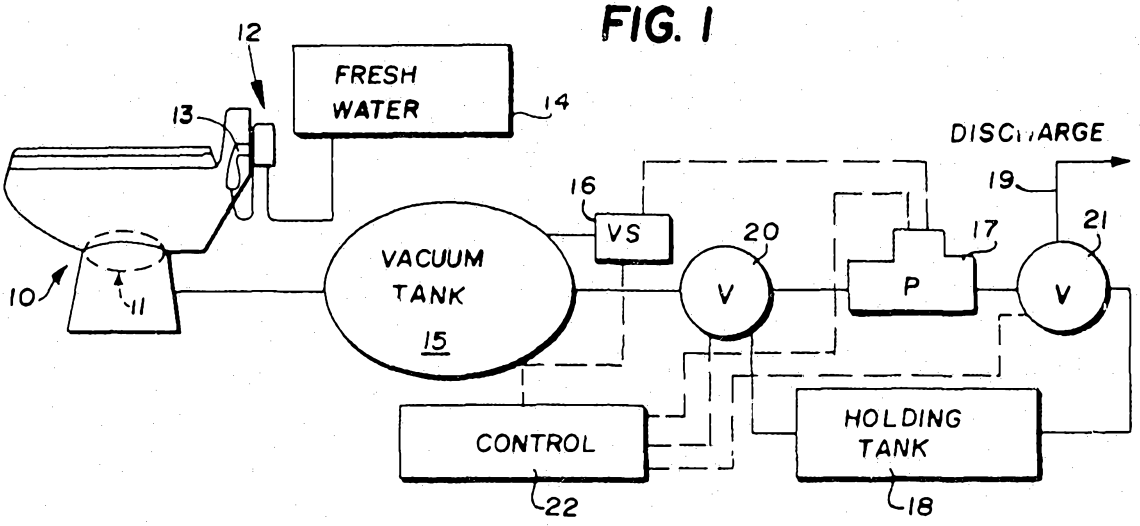
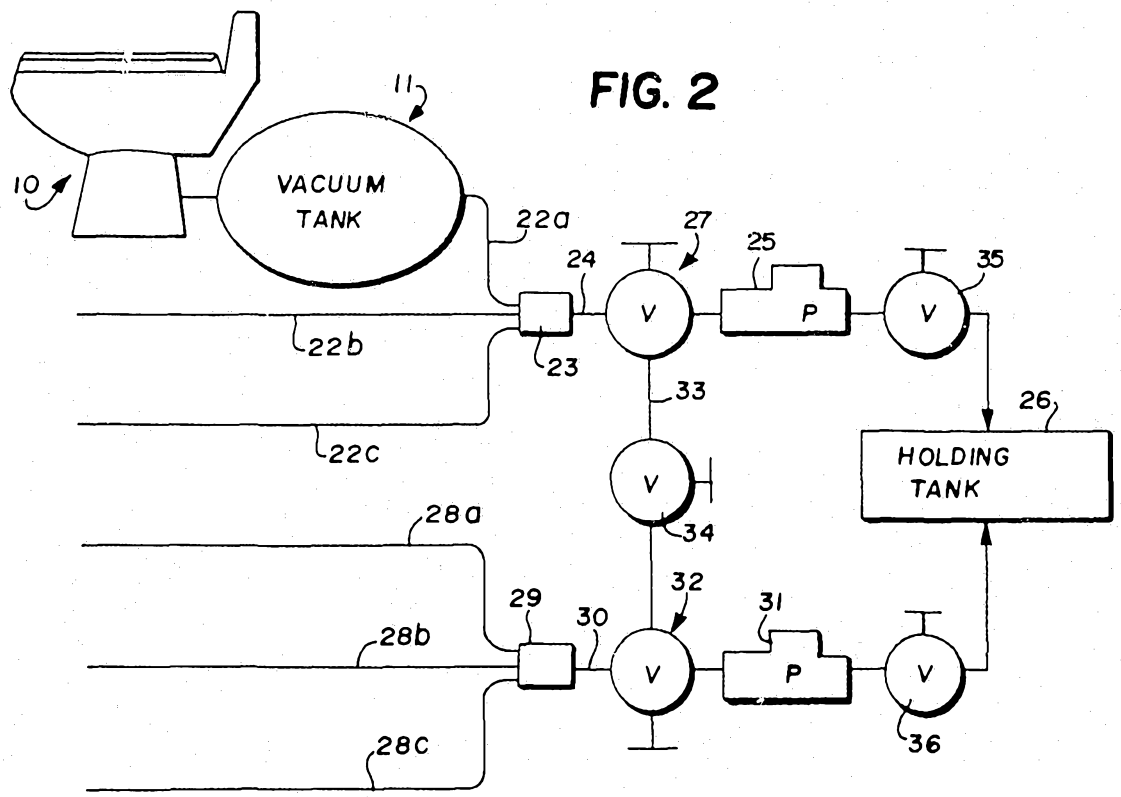

12
FRESH WATER
14
13
DISCHARGE
19
16
VS
20
17
21
VACUUM TANK
15
V
P
V
10
11
CONTROL
22
HOLDING TANK
18

FIG. 2


11
10
VACUUM TANK
22a
27
25
35
24
V
P
V
22b
23
33
26
22c
V
HOLDING TANK
34
28a
32
29
30
31
28b
V
P
V
36
28c

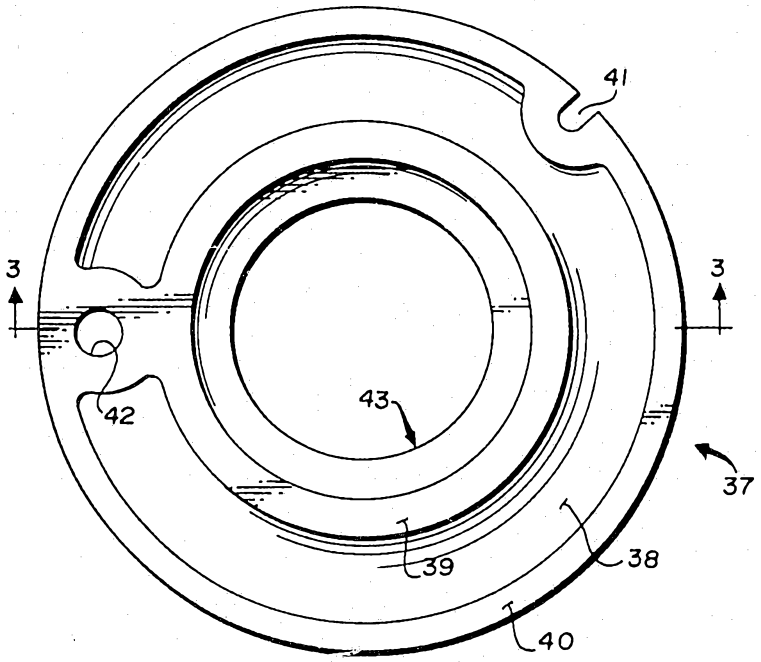


FIG. 4

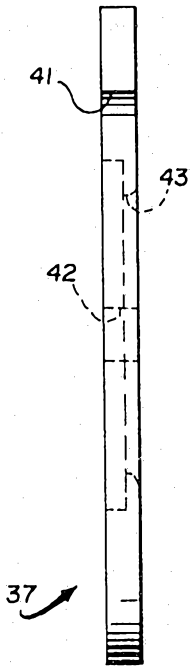
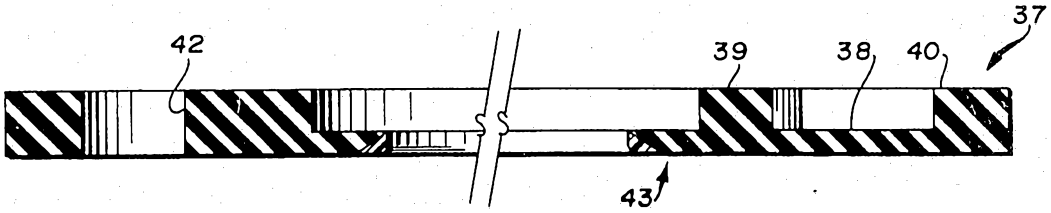


FIG. 5

FIG. 3



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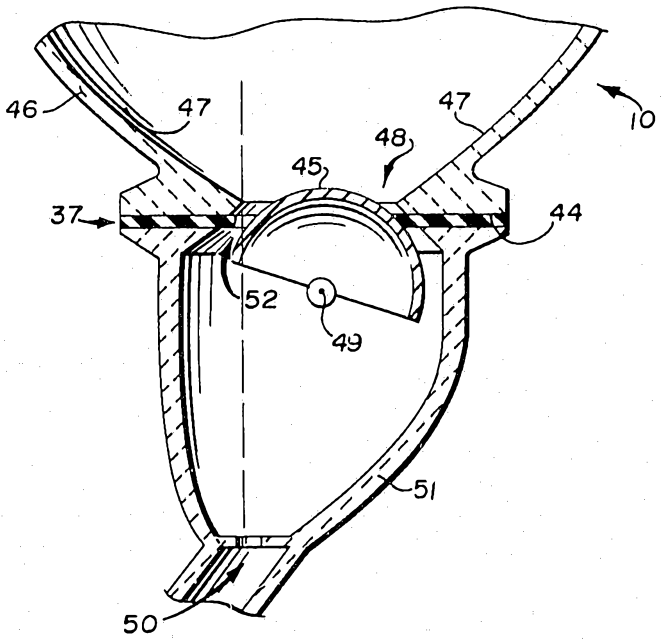


FIG. 6

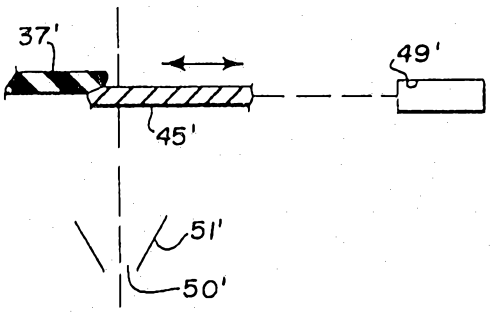
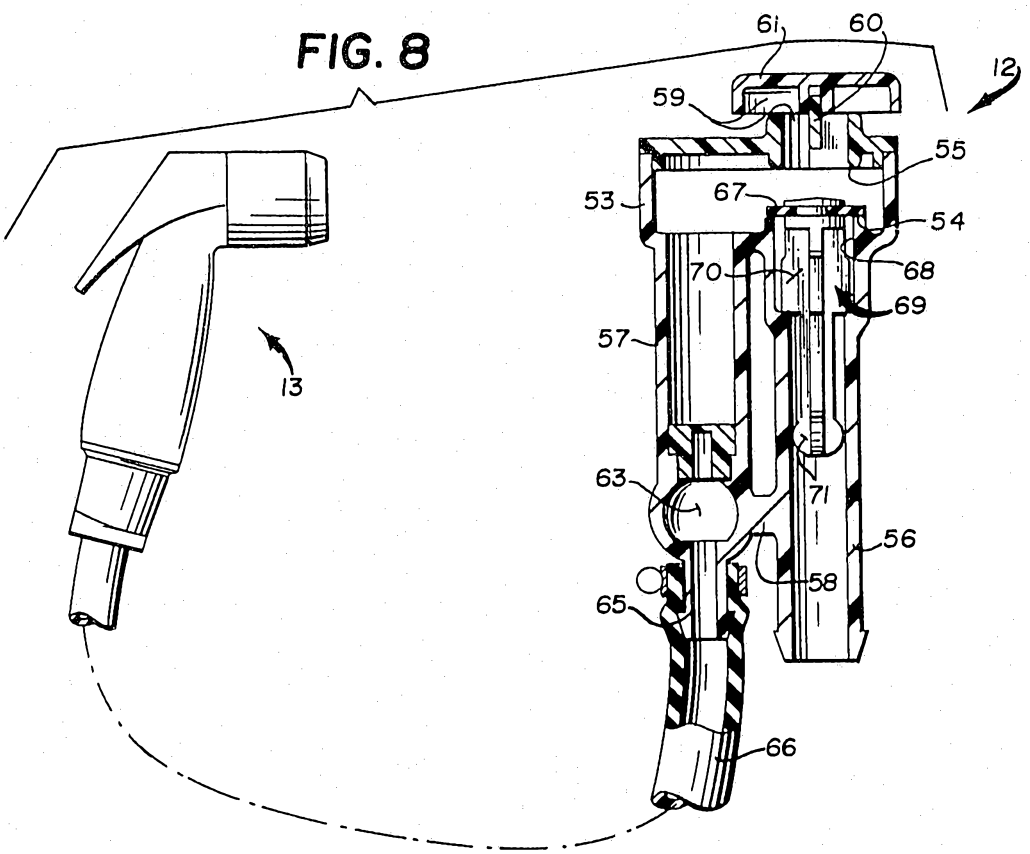


FIG. 7

FIG. 8



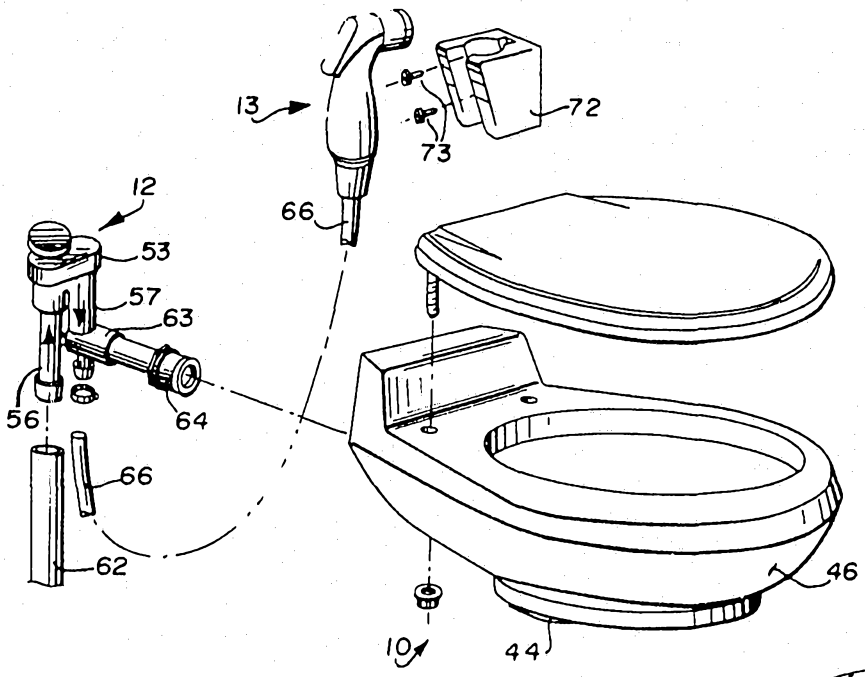
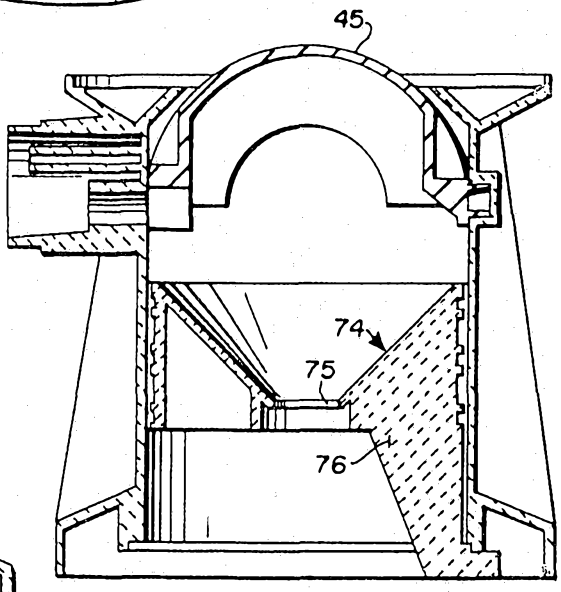


FIG. 9

FIG. 11 PRIOR ART



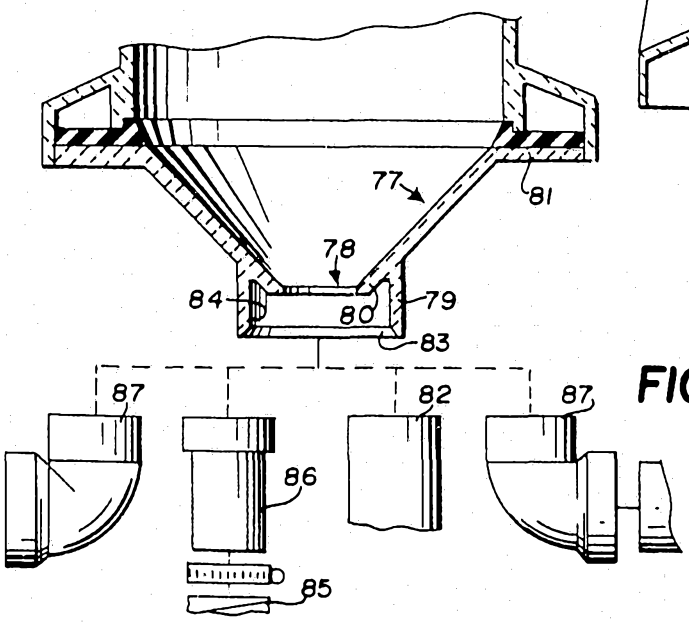


FIG. 10

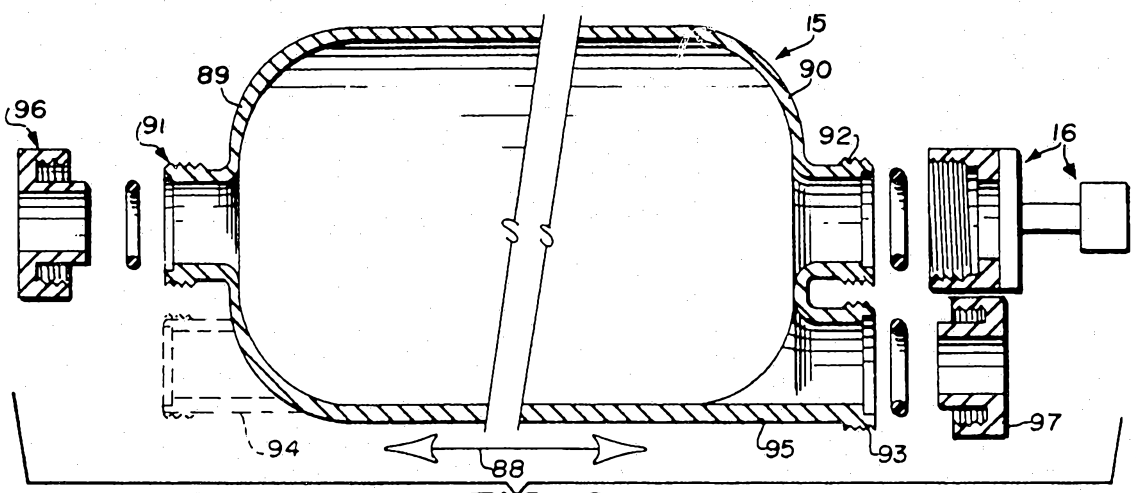


FIG. 12

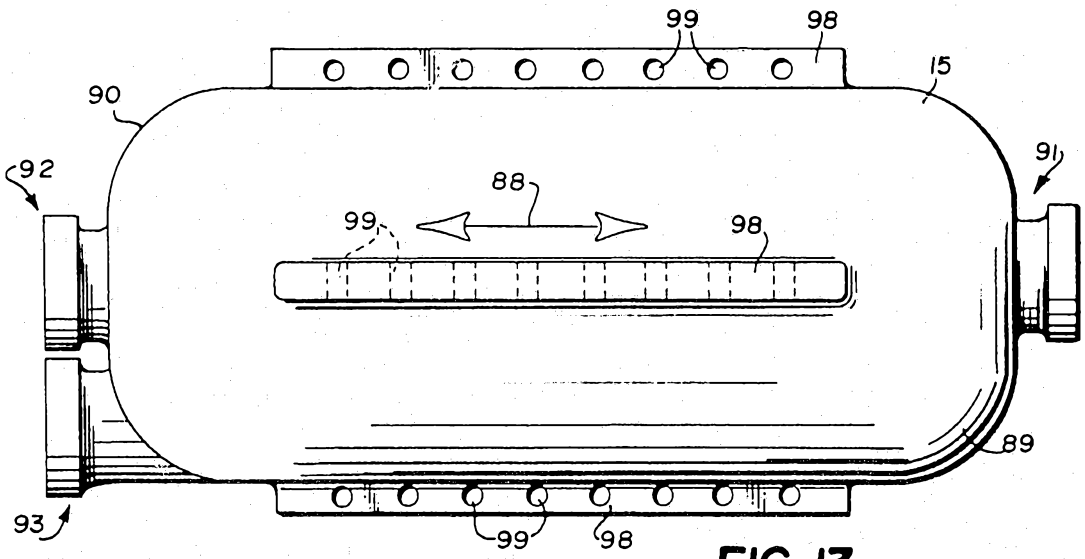


FIG. 13

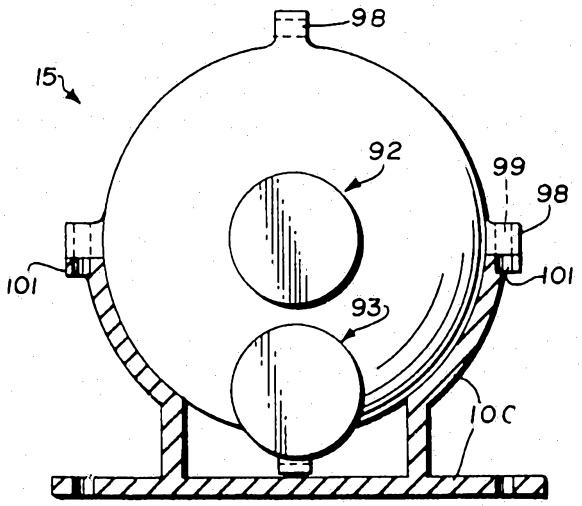


FIG. 14

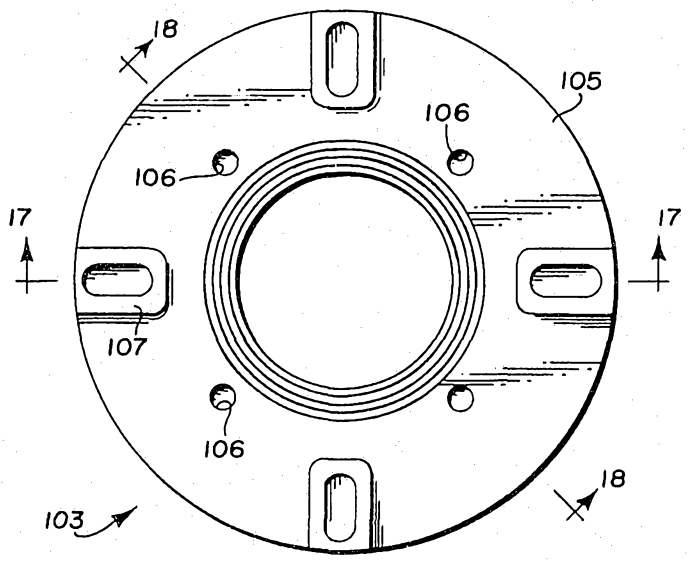


FIG. 15

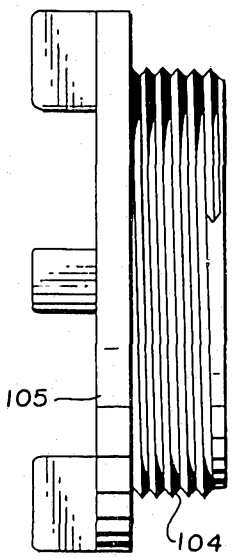


FIG. 16

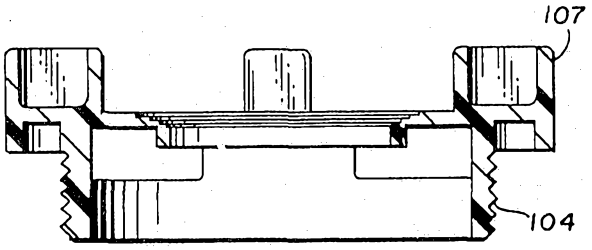


FIG. 17

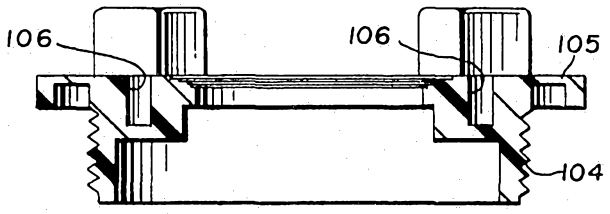


FIG. 18

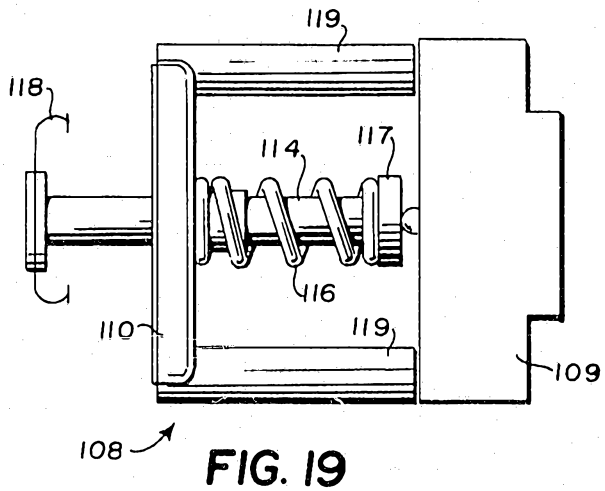


FIG. 19

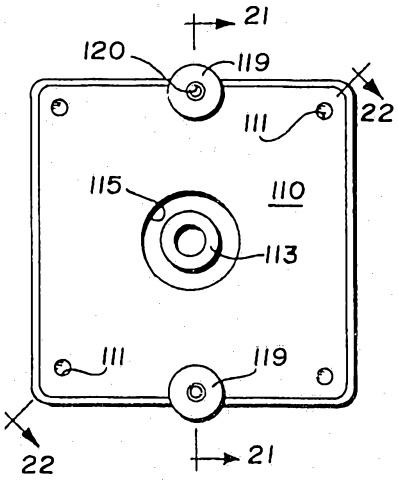


FIG. 20

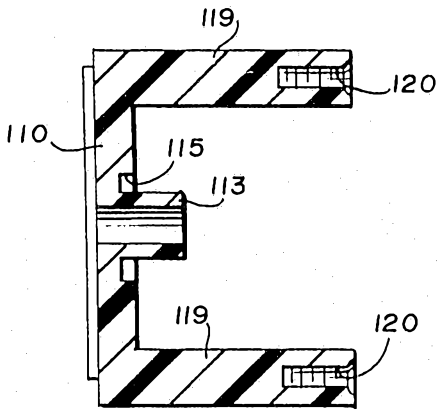


FIG. 21

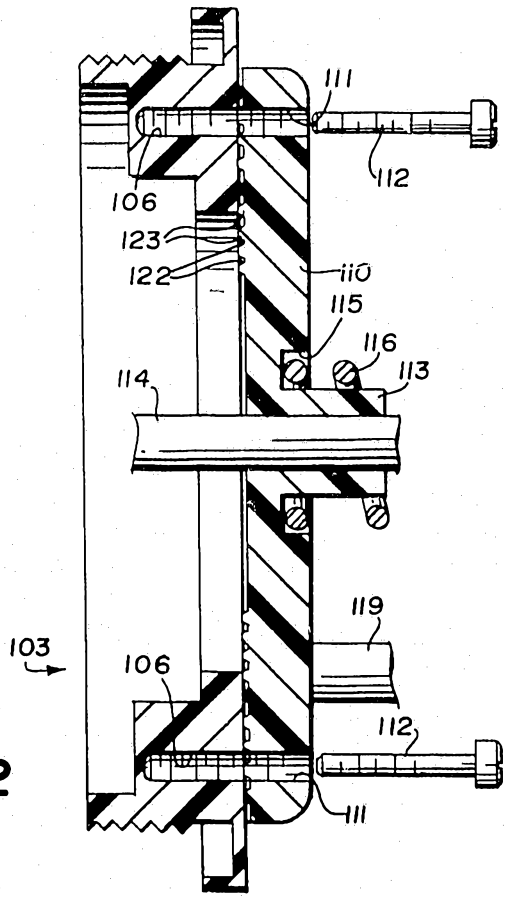


FIG. 22

FIG. 23

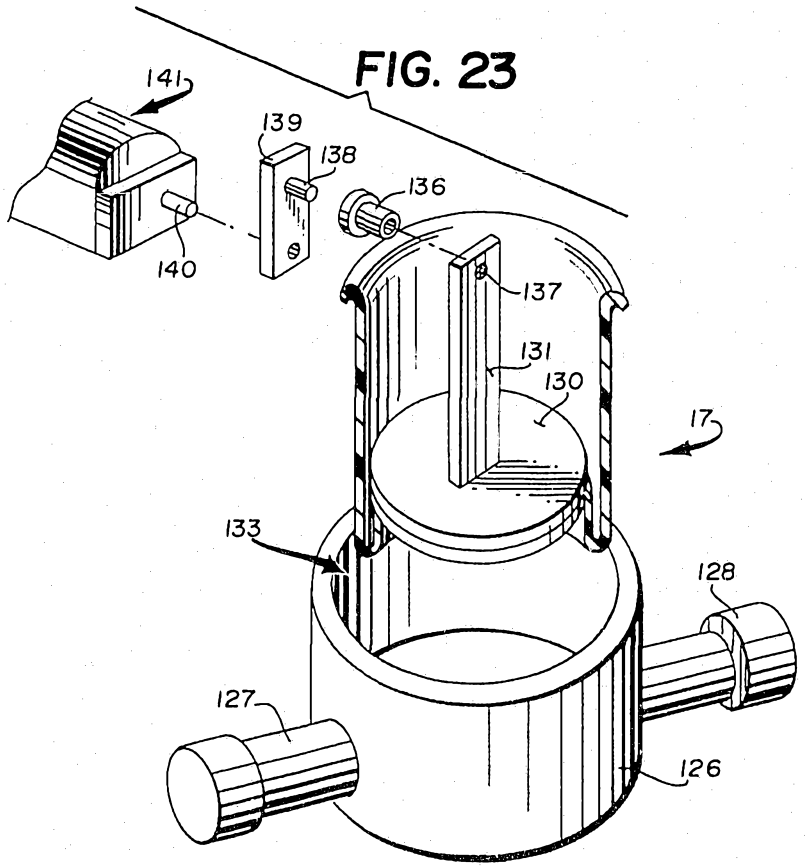
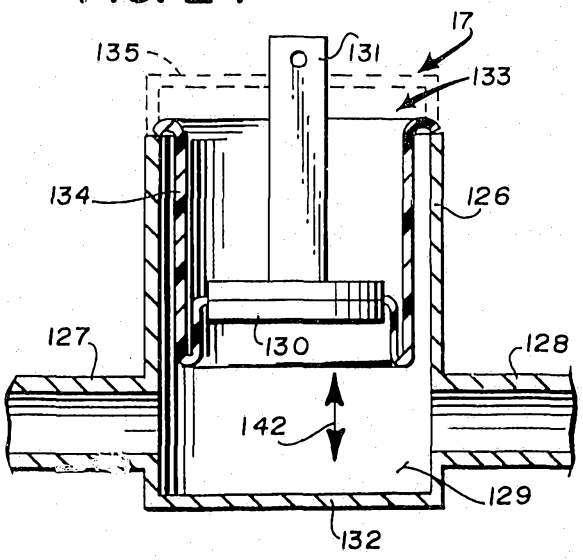


FIG. 24



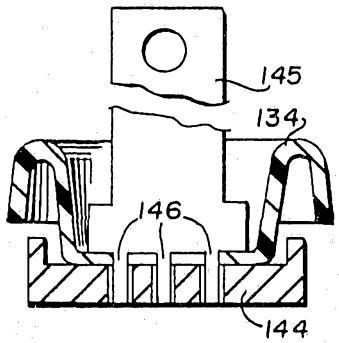


FIG. 25