JC330 09/713892 PTO 11/16/00

ISSUE CLASSIFICATION	Class	Subclass
	004	431

PATENT NUMBER

6353942

6353942

U.S. UTILITY Patent Application

O.I.P.E.	PATENT DATE
SCANNED TC Q.A. LA	MAR 12 2002

T6

APPLICATION NO.	CONT/PRIOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
09/713892		004	431	3751	Nguyen

APPLICANTS

Mark Pondelick
Jay Stradinger
William Anderson
Arthur McGowan

TITLE

Modular vacuum toilet

PTO-2040
12/99

ISSUING CLASSIFICATION

ORIGINAL CLASS	ORIGINAL SUBCLASS	CROSS REFERENCE(S) CLASS	CROSS REFERENCE(S) SUBCLASS (ONE SUBCLASS PER BLOCK)					
004	431	4	434	435				
INTERNATIONAL CLASSIFICATION		137	588	595				
E03D 11/00								

☐ Continued on Issue Slip Inside File Jacket

☐ TERMINAL DISCLAIMER

☐ The term of this patent subsequent to _____ (date) has been disclaimed.

☐ The term of this patent shall not extend beyond the expiration date of U.S Patent. No. _____

☐ The terminal ____ months of this patent have been disclaimed.

DRAWINGS			CLAIMS ALLOWED	
Sheets Drwg.	Figs. Drwg.	Print Fig.	Total Claims	Print Claim for O.G.
8	12	1B & 4	26	1

TUAN NGUYEN (Assistant Examiner) 8/30/01 (Date)

GREGORY L. HUSON
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3700

(Primary Examiner) 8/31/01 (Date)

(Legal Instruments Examiner) 9-2-01 (Date)

NOTICE OF ALLOWANCE MAILED: 8.31.01

ISSUE FEE

Amount Due	Date Paid
$1240.00	11-20-01

ISSUE BATCH NUMBER: L41

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FILED WITH: ☐ DISK (CRF) ☐ FICHE ☐ CD-ROM
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ISSUE FEE IN FILE

Formal Drawings (____ shts)

B/E Exhibit 1002, p. 1

(FACE)

PATENT APPLICATION

09713892

[redacted]

INITIALS ____

CONTENTS

No.		Date Received (Incl. C. of M.) or Date Mailed	No.		Date Received (Incl. C. of M.) or Date Mailed
1.	Application ____ papers.	7/31/01	42.		
2.	Ltr; RES Decl	8-2-01	43.		
3.	IDS	05-16-01	44.		
4.	Dec and Fee	06-22-01	45.		
5.	Interview Summary		46.		
6.	~~Ex. Amdt~~ NOA	8-31-01	47.		
7.	Change of add.	1-7-02	48.		
8.	Formal Drawings (8 shts) set 1	12-3-01	49.		
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(margin notes: 8/31, 2/7/02, 2-8)

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PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

11/20/2000 HLE333 00000006 09713892

01 FC:101 710.00 OP
02 FC:102 [illegible] OP
03 FC:103 360.00 OP

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*U.S. GPO: 1999-459-082/19144

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

Bib Data Sheet

CONFIRMATION NO. 9452

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/713,892	11/16/2000 RULE	004	3751	05007/36585

APPLICANTS

Mark A. Pondelick, Roscoe, IL;
Jay D. Stradinger, Roscoe, IL;
William Bruce Anderson, Rockford, IL;
Arthur J. McGowan JR., Thornton, CO;
Douglas M. Wallace, Roscoe, IL;
Ian Tinkler, Rockford, IL;
Michael B. Hancock, Rockford, IL;

** CONTINUING DATA **********

NONE, JAV

** FOREIGN APPLICATIONS **********

NONE, JAV

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 02/22/2001

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☑ no	IL	9	40	4
35 USC 119 (a-d) conditions met ☐ yes ☑ no ☐ Met after Allowance				
Verified and Acknowledged Examiner's Signature Initials JAV				

#7 ADDRESS ~~4743~~ MARSHALL, GERSTEIN & BORUN
6300 SEARS TOWER 233 SOUTH WACKER DR. CHICAGO, IL 60606-6402

TITLE

Modular vacuum toilet with lone replaceable units

FILING FEE RECEIVED	FEES: Authority has been given in Paper
1280	No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:

☐ All Fees
☐ 1.16 Fees (Filing)
☐ 1.17 Fees (Processing Ext. of time)
☐ 1.18 Fees (Issue)
☐ Other _____
☐ Credit

11.17.

A

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No: 05007/36585

PATENT APPLICATION TRANSMITTAL UNDER 37 C.F.R. 1.53

Box Patent Application
Commissioner for Patents
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of

Inventor(s): Mark A. Pondelick, Jay D. Stradinger, William Bruce Anderson, Arthur J. McGown, Jr., Douglas M. Wallace, Ian Tinkler and Michael B. Hancock

Title: MODULAR VACUUM TOILET

1. **Type of Application**

☒ This is a new application for a

- ☒ utility patent.
- ☐ design patent.

☐ This is a continuation-in-part application of prior application no.

2. **Application Papers Enclosed**

1	Title Page
14	Pages of Specification (excluding Claims, Abstract, Drawings & Sequence Listing)
7	Page(s) of Claims
1	Page(s) of Abstract
9	Sheet(s) of Drawings (Figs. 1A to 7D)
	☐ Formal
	☒ Informal
0	Page(s) of Sequence Listing

CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this Patent Application Transmittal and the documents referred to as enclosed therewith are being deposited with the United States Postal Service on **November 16, 2000**, in an envelope addressed to the Commissioner for Patents, Washington, D.C. 20231 utilizing the "Express Mail Post Office to Addressee" service of the United States Postal Service under Mailing Label No. EM 099 904 446 US.

Richard Zimmermann

3. Declaration or Oath

☐ Enclosed

☐ Executed by (check all applicable boxes)

☐ Inventor(s)

☐ Legal representative of inventor(s) (37 CFR 1.42 or 1.43)

☐ Joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached

☐ The petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 are enclosed. See Item 5D below for fee.

☒ Not enclosed - the undersigned attorney or agent is authorized to file this application on behalf of the applicant(s). An executed declaration will follow.

4. **Small Entity Status**

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A small entity statement is(are) attached.

5. **Additional Papers Enclosed**

☐ Preliminary Amendment

☐ Information Disclosure Statement

☐ Declaration of Biological Deposit

☐ Computer readable copy of sequence listing containing nucleotide and/or amino acid sequence

☐ Microfiche computer program

☐ Associate Power of Attorney

☐ Verified translation of a non-English patent application

☐ An assignment of the invention

☒ Return receipt postcard

☐ Other

6. **Priority Applications Under 35 USC 119**

Certified copies of applications from which priority under 35 USC 119 is claimed are listed below and

☐ are attached.

☐ will follow.

COUNTRY	APPLICATION NO.	FILED

7. **Filing Fee Calculation (37 CFR 1.16)**

A. ☒ **Utility Application**

CLAIMS AS FILED - INCLUDING PRELIMINARY AMENDMENT (IF ANY)						
			SMALL ENTITY		OTHER THAN A SMALL ENTITY	
	NO. FILED	NO. EXTRA	RATE	FEE	RATE	FEE
BASIC FEE				$355.00		$710.00
TOTAL	40 -20	= 20	X 9 =	$	X 18 =	$360.00
INDEP.	4 - 3	= 1	X 40 =	$	X 80 =	$80.00
☐ First Presentation of Multiple Dependent Claim			+ 135 =	$	+ 270 =	$
			Filing Fee:	$	**OR**	$1150.00

B. ☐ **Design Application ($160.00/$320.00)** Filing Fee: $ _____

C. ☐ **Plant Application ($245.00/$490.00)** Filing Fee: $ _____

D. **Other Fees**

☐ Recording Assignment [Fee -- **$40.00** per assignment] $ _____

☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached [Fee -- **$130.00**] $ _____

☐ Other $ _____

Total Fees Enclosed **$1150.00**

8. **Method of Payment of Fees**

☒ Enclosed check in the amount of: $1150.00

☐ Charge Deposit Account No. 13-2855 in the amount of: $_____
A copy of this Transmittal is enclosed.

☐ Not enclosed

9. **Deposit Account and Refund Authorization**

The Commissioner is hereby authorized to charge any deficiency in the amount enclosed or any additional fees which may be required during the pendency of this application under 37 CFR 1.16 or 37 CFR 1.17 or under other applicable rules (except payment of issue fees), to Deposit Account No. 13-2855. A copy of this Transmittal is enclosed.

Please refund any overpayment to Marshall, O'Toole, Gerstein, Murray & Borun at the address below.

10. **Correspondence Address**

Customer No.: 04743

Respectfully submitted,

MARSHALL, O'TOOLE, GERSTEIN,
MURRAY & BORUN
6300 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6402
(312) 474-6300
(312) 474-0448 (Telefacsimile)

By: Brent E. Matthias
Brent E. Matthias
Reg. No: 41,974

November 16, 2000

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No: 05007/36585

PATENT APPLICATION TRANSMITTAL UNDER 37 C.F.R. 1.53

Box Patent Application
Commissioner for Patents
Washington, D.C. 20231

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Transmitted herewith for filing is the patent application of

Inventor(s): Mark A. Pondelick, Jay D. Stradinger, William Bruce Anderson, Arthur J. McGown, Jr., Douglas M. Wallace, Ian Tinkler and Michael B. Hancock

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Chicago, Illinois 60606-6402
(312) 474-6300
(312) 474-0448 (Telefacsimile)

By: Brent E. Matthias

Brent E. Matthias
Reg. No: 41,974

November 16, 2000

JOINT INVENTORS

APPLICATION FOR
UNITED STATES LETTERS PATENT

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that we, MARK A. PONDELICK, a citizen of the United States of America, residing at 10848 Hamborg Rd., Roscoe 61073, in the County of Winnebago and State of Illinois and JAY D. STRADINGER, a citizen of the United States of America, residing at 12742 Bellmawr Lane, Roscoe 61073, in the County of Winnebago and State of Illinois and WILLIAM BRUCE ANDERSON, a citizen of the United States of America, residing at 128 N. Vale Ave., Rockford 61109, in the County of Winnebago and State of Illinois and ARTHUR J. McGOWN, JR., a citizen of the United States of America, residing at 6122 Weeping Willow Lane, Roscoe 61073, in the County of Winnebago and State of Illinois and DOUGLAS M. WALLACE, a citizen of the United States of America, residing at 9343 Forest Ridge Drive, Roscoe 61073, in the County of Winnebago and State of Illinois and IAN TINKLER, a citizen of Great Britain, residing at 3345 Gunflint Trail, Rockford 61109, in the County of Winnebago and State of Illinois and MICHAEL B. HANCOCK, a citizen of the United States of America, residing at1464 Randall Drive, Rockford 61108, in the County of Winnebago and State of Illinois have invented a new and useful MODULAR VACUUM TOILET, of which the following is a specification.

Ins. a1 ~~MODULAR VACUUM TOILET~~

FIELD OF THE INVENTION

The present invention generally relates to toilets and, more particularly, to vacuum toilet systems.

BACKGROUND OF THE INVENTION

Vacuum toilet systems are generally known in the art for use in both vehicle and stationary applications. A vacuum toilet system typically comprises a bowl for receiving waste having an outlet connected to a vacuum sewer line. A discharge valve is disposed between the bowl outlet and vacuum sewer line to selectively establish fluid communication therebetween. The vacuum sewer line is connected to a collection tank that is placed under partial vacuum pressure by a vacuum source, such as a vacuum blower. When the discharge valve is opened, material in the bowl is transported to the sewer pipe as a result of the pressure difference between the interior of the bowl and the interior of the sewer line. Conventional vacuum toilet systems also include a source of rinse fluid and a rinse fluid valve for controlling introduction of rinse fluid into the bowl.

The components of a conventional vacuum toilet are typically provided separately and are overly difficult to assemble. The discharge valve is typically mounted in a first position, while the rinse valve is mounted in a second, separate position. A flush control unit (FCU) is mounted remote from both valves and provides control signals to the discharge and rinse valve actuators. Accordingly, various mounting brackets, tubing, and wires are needed to interconnect the various components, making assembly overly complicated and time-consuming.

In addition, the separate components used in conventional vacuum toilets make repair and maintenance overly time consuming and labor intensive. Maintenance concerns are particularly significant in aircraft applications, in which a number of sub-systems are installed on board. According to general practice in the airline industry, each sub-system includes one or more components which must be replaced in the event of failure, such replacement components being commonly referred to as line replaceable units (LRUs). Presently, the entire vacuum toilet is defined as the LRU for the vacuum

toilet system. As a result, an airline must stock one or more replacement toilets in the event of a toilet failure, so that the replacement toilet may be swapped in for the faulty toilet. A "bench test" is then performed on the faulty toilet to determine which components have failed in the toilet. The faulty components are then repaired or replaced (which may include significant disassembly and reassembly of the toilet) so that the toilet may be reused on another aircraft.

Each of the steps performed during a toilet repair is overly difficult and time consuming. To remove an entire toilet assembly from an aircraft requires disassembly of at least four self-locking mounting fasteners, an electrical connection, a grounding strap, a potable water line connection, and a waste discharge pipe connection. Each connection may be difficult to access, and may require a particular tool in order to loosen and disconnect. The same connections must then be reconnected for the replacement toilet.

Even if it were possible to remove and replace a single toilet component, it would be overly difficult and time consuming to do so. Removal of a component would require disconnection of several wires and pipes, and the components are often located in areas which are difficult to access. Furthermore, it would be difficult to diagnose whether one component or several components had failed. There exists a multitude of combinations of simultaneous component failures, which may lead to trouble-shooting errors and the replacement or repair of non-faulty components.

In view of the foregoing, it is apparent that the replacement and repair of conventional toilets is overly time consuming, and requires an airline to maintain a large stock of replacement toilets in the event of equipment failure.

Other repairs, which may not require substantial amounts of trouble shooting to identify the failed components, still require significant amounts of disassembly and reassembly. The toilet bowl, for example, is typically formed of stainless steel covered with a non-stick coating that is subject to failure. In conventional toilets, the bowl is a structural, load bearing component that is attached to a base support. In some toilets, the base support is permanently attached to the bowl and therefore the entire toilet must be removed to replace the coating. In other toilets, the bowl is removable from the support base, and therefore fasteners must be removed and the bowl

must be disconnected from the rinse fluid and discharge lines. In addition, the rinse ring or nozzle used to direct rinse fluid into the bowl must be removed. Furthermore, if the non-stick coating fails, the bowl must be removed from all of the other toilet components for a re-coating process, steps of which are performed at high temperature to remove the old coating and apply a new coating to the toilet bowl surface. Accordingly, the replacement of a conventional bowl is overly complicated and time consuming.

From the foregoing, it will be appreciated that a number of toilets must be kept in stock for replacement in the event of a faulty toilet. The number of stock toilets is further increased due to the left-handed and right-handed discharge configurations of conventional vacuum toilets. Typically, the component layout of a conventional vacuum toilet must be modified according to the type of discharge configuration desired. In addition, different components may be required, such as a toilet bowl with a left-handed or right-handed discharge. As a result, an airline must have both left- and right-handed discharge replacement toilets on hand, thereby increasing the number of stock parts required.

From the above, it will be appreciated that a need exists for a vacuum toilet that is easier to maintain and which reduces the number of stock parts required.

SUMMARY OF THE INVENTION

In accordance with certain aspects of the present invention, a modular vacuum toilet is provided for use in a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid. The modular vacuum toilet comprises a support structure, and a removable bowl supported by the support structure, the bowl defining an outlet and having a rinse fluid dispenser associated therewith. A valve set module is provided having a discharge valve with an inlet in fluid communication with the bowl outlet, an outlet in fluid communication with the sewer line, and a movable discharge valve member disposed between the discharge valve inlet and outlet; a rinse fluid valve having an inlet in fluid communication with the source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a movable rinse fluid valve member disposed between the rinse fluid valve inlet and outlet; and a flush control unit having a circuit board operably connected to the discharge valve and

rinse fluid valve for controlling actuation of the discharge valve member and rinse fluid valve member.

In accordance with additional aspects of the present invention, a method of servicing a vacuum toilet is provided, in which the vacuum toilet is attached to a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid, and in which the vacuum toilet includes a waste receptacle defining an outlet and having a rinse fluid dispenser associated therewith. The method comprises providing a first valve set module having a discharge valve with an inlet adapted to engage the receptacle outlet and an outlet adapted for releasable connection to the sewer line, a rinse fluid valve with an inlet adapted for releasable connection to the source of rinse fluid and an outlet adapted for releasable connection to the rinse fluid dispenser, and a flush control unit adapted to control operation of the discharge valve and rinse fluid valve. The discharge valve is detached from the bowl outlet, discharge valve outlet from the sewer line, the rinse fluid valve inlet from the rinse fluid source, and the rinse fluid valve outlet from the rinse fluid line, and the valve set module is removed from the vacuum toilet. A second valve set module is inserted into the vacuum toilet, the second valve set module including a discharge valve with an inlet adapted to engage the receptacle outlet and an outlet adapted for releasable connection to the sewer line, a rinse fluid valve with an inlet adapted for releasable connection to the source of rinse fluid and an outlet adapted for releasable connection to the rinse fluid dispenser, and a flush control unit adapted to control operation of the discharge valve and rinse fluid valve. The second valve set discharge valve inlet is then attached to the bowl outlet, the discharge valve outlet to the sewer line, the rinse fluid valve inlet to the rinse fluid source, and the rinse fluid valve outlet to the rinse fluid line.

In accordance with further aspects of the present invention, a method of servicing a vacuum toilet is provided wherein the toilet has a receptacle for receiving waste defining an outlet and includes a rinse fluid dispenser associated therewith. A discharge valve has an inlet in fluid communication with the receptacle outlet, an outlet in fluid communication with a sewer line placeable under partial vacuum pressure, and a moveable discharge valve member disposed between the discharge valve inlet and the discharge valve outlet. A rinse fluid valve has an inlet in fluid communication with a

source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a moveable rinse fluid valve member disposed between the rinse fluid valve inlet and the rinse fluid valve outlet. A flush control unit is adapted to control actuation of the discharge valve member and rinse fluid valve member, in which at least one of the discharge valve, rinse fluid valve, flush control unit, and waste receptacle is a line replaceable unit. The method comprises removing the faulty line replaceable unit from the toilet, and installing a new line replaceable unit into the toilet.

In accordance with still further aspects of the present invention, a valve set is provided for use in a vacuum toilet system having a sewer pipe placeable under partial vacuum pressure. The valve set comprises a discharge valve having an outlet, and an outlet pipe attached to the discharge valve outlet and defining a branch. A discharge pipe has a first end adapted to releasably engage the sewer pipe and a second end releasably attachable to the branch in at least a first position corresponding to a left-handed discharge configuration and a second position corresponding to a right-handed discharge configuration.

Other features and advantages are inherent in the apparatus claimed and disclosed or will become apparent to those skilled in the art from the following detailed description and its accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are front and rear perspective views, respectively, of a modular vacuum toilet in accordance with the present invention.

FIG. 2 is a schematic diagram of the vacuum toilet of FIG. 1.

FIG. 3 is an enlarged view of a tab used to secure a bowl to the frame.

FIG. 4 is an enlarged perspective view of the valve set incorporated into the vacuum toilet of FIG. 1.

FIG. 5A and 5B are perspective views of a discharge valve and actuator incorporated into the valve set.

FIG. 6 is a side elevation view, in cross-section, of a rinse valve assembly incorporated into the valve set.

FIGS. 7A-D are side elevation views, in cross-section, of the rinse valve

assembly showing the various stages of a rinse cycle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. 1A, 1B, and 2, a modular vacuum toilet suitable for use in a vehicle, in accordance with the present invention, is generally referred to with reference numeral 10. The modular vacuum toilet 10 generally includes a valve set 8, a frame 20, and a bowl 36. The vehicle is provided with a sewer line 11, a vacuum tank 13 connected to the sewer line 11, and a vacuum source (not shown) for placing the vacuum tank 13 under partial vacuum pressure. The vehicle further includes a source of rinse fluid 15 connected to a rinse fluid supply line 19.

The frame 20 is provided for supporting the components of the vacuum toilet 10. As best shown with reference to FIGS. 1A and 1B, the frame 20 includes a bottom member 24 adapted for attachment to a support surface of the vehicle. Vertical supports 26 extend upwardly from the bottom member 24, and a top member 28 is attached to the vertical supports 26. The top member 28 is formed with an opening 30 near the front and two slots 29 near the rear thereof. In the illustrated embodiment, an intermediate support 32 is attached between adjacent vertical supports 26, and a bracket 27 is attached to the bottom member 24. The bottom member 24, top member 28, and bracket 27 are preferably formed of sheet metal, while the vertical supports 26 and intermediate support 32 are preferably formed of tube steel, both of which are readily available and inexpensive. Other materials having sufficient rigidity, however, may also be used.

The bowl 36 is provided for receiving waste material. The bowl 36 has a curved sidewall 38 and an out-turned flange 40 extending about an upper edge of the sidewall (FIGS. 1A and 1B). The out-turned flange 40 further includes tabs 39 sized for insertion through the slots 29 formed in the frame top member 28, as best shown in FIG. 3. A bottom of the sidewall is formed in an outlet 42, and the sidewall 38 is sized for insertion into the opening 30 of the frame top member 28. The outlet 42 fluidly communicates with a discharge valve 70 through a transfer pipe 44. The transfer pipe 44 preferably includes a collar 47 sized to frictionally engage and seal with the outlet 42.

To attach the bowl 36 to the frame 20, the bowl 36 is inserted through the

opening 30 and positioned so that the tabs 39 are aligned with the slots 29 and the outlet 42 is aligned with the collar 47. The bowl 36 is lowered so that the tabs 39 pass through and lock with the slots 29. Simultaneously, the outlet 42 is inserted into and engages the collar 47. In this position, the out-turned flange 40 closely overlies the frame top member 28 so that downward forces applied to the bowl 36 are transferred to the frame 20. As a result, the bowl 36 is not a load-bearing component, and may be made of non-structural materials such as plastic, thin-walled metal (defined herein as less than approximately 0.040" thick), or other known alternatives. In addition, the bowl 36 is separable from the frame 20 and therefore may be replaced independently from the rest of the toilet 10. Still further, the tabs 39 may be manipulated manually, and therefore no tools are required to install or remove the bowl 36.

At least one rinse fluid dispenser, such as nozzles 46, is provided inside the bowl 36 for directing rinse fluid over the surface of the bowl. As best shown in FIGS. 1A and 1B, a plurality of nozzles 46 are spaced about the bowl sidewall 38 and are oriented to direct rinse fluid over portions of the bowl surface. The number of nozzles may be more or less than that shown, depending on the size of the bowl surface to be rinsed. As used herein, the phrase "rinse fluid dispenser" includes the illustrated nozzles 46, as well as known substitutes, such as spray rings.

A vacuum breaker 33 is positioned above the top edge of the bowl 36, and a first rinse fluid pipe 35a extends from the nozzles 46 to the vacuum breaker 33. A second rinse fluid pipe 35b extends from the vacuum breaker 33 to a rinse valve 72. Quick-disconnect couplings 108a, 108b are provided to connect the first and second rinse fluid pipes 35a, 35b to the vacuum breaker 33.

The separate frame 20 advantageously allows the bowl 36 to be a line replaceable unit (LRU). When the bowl 36 becomes worn or otherwise needs replacement, a maintenance person may simply disconnect the first rinse fluid pipe 35a using the quick disconnect coupling 108a, manipulate the tabs 39 so that the are disengaged from the slots 29, and pull upward on the bowl 36 to remove the bowl 36 from the frame 20. A new bowl 36 may then be inserted into the frame 20 as described above, and the first rinse fluid pipe 35a may be connected to the vacuum breaker 33 using the quick-disconnect coupling 108a. As a result, the entire toilet need not be removed

and serviced. In addition to facilitating bowl removal and replacement, the frame 20 allows a wider range of materials to be used for the bowl 36, since the frame 20, rather than the bowl 36, supports the load.

As best shown in FIG. 1A, the valve set 8 is mounted to the frame bracket 27. The valve set 8 is preferably attached to the bracket 27 using fasteners that may be manipulated by hand, such as knurled screws 37. The valve set 8 includes four sub-components: a discharge valve 70, a rinse valve 72, a flush control unit (FCU) 74, and an actuator 76 (FIG. 4). The discharge valve 70 includes a discharge valve housing 78 divided into two halves 78a, 78b. As best shown in FIGS. 5A and 5B, the housing 78 includes a pair of inlets 79, 80 formed in the housing half 78a aligned with a pair of outlets 81, 82 formed in the housing half 78b.

The housing 78 further defines a chamber for receiving a discharge valve member, such as valve disk 83. An axle 84 is attached to the valve disk 83 and has two ends 84a, 84b. Holes are formed in the housing halves 78a, 78b sized to receive the axle ends 84a, 84b, respectively, so that the disk 83 is supported for rotation about the axle 84. The periphery of the disk 83 is formed with gear teeth 85, and a pair of apertures 86, 87 are formed through the disk 83. The apertures 86, 87 are spaced so that both register simultaneously with the associated inlet/outlet pairs 79/81, 80/82 as the disk 83 rotates. In the illustrated embodiment, the apertures 86, 87 and associated inlet/outlet pairs 79/81, 80/82 are spaced 180 degrees apart.

According to the illustrated embodiment, the inlet 79 is connected to one end of the transfer pipe 44, with the other end of the transfer pipe 44 being attached to the bowl outlet 42. An air intake check valve 45 is attached to the other inlet 80, and is oriented to allow fluid to flow into the inlet 80 while preventing fluid from discharging out of the check valve 45 (FIGS. 1A and 2). A U-shaped outlet pipe 12 (FIG. 1B) has a first end connected to the outlet 81 and a second end connected to the outlet 82. The outlet pipe 12 further has a branch 17 leading to a discharge pipe 21.

In accordance with certain aspects of the present invention, the branch 17 and discharge pipe 21 are adapted to provide both right- and left-handed discharge configurations. As best shown in Fig. 1B, the branch 17 includes a pair of spaced pins 160 (only one shown in Fig. 1B) and the discharge pipe 21 a pair of spaced J-shaped slots

162 (only one shown in Fig. 1B) positioned to engage the pins, so that the discharge pipe 21 is removably attached to the branch 17. The pins 160 and J-shaped slots 162 are preferably spaced 180 degrees apart, so that the discharge pipe 21 may be positioned for either right- or left-handed discharge simply by rotating the discharge pipe 21 before attachment, without requiring changes to the other toilet components. The free end of the discharge pipe 21 is adapted for releasable connection to the sewer line 11, such as with a clam shell coupling (not shown).

In operation, when the disk apertures 86, 87 are aligned with the inlet/outlet pairs 79/81, 80/82, the discharge valve 70 not only transfers waste from the transfer pipe 44 to the sewer line 11, but also pulls additional air into the sewer line 11 through the air intake check valve 45. The additional air intake reduces noise that is normally generated during a flush.

The actuator 76 is provided for driving the valve disk 83. As best shown in FIG. 5A, the actuator 76 includes a spur gear 90 enmeshed with the gear teeth 85 formed about the periphery of the disk 83. The spur gear 90 is mounted to a rotatable shaft 92, and a drive is provided for rotating the shaft 92. The FCU 74 is operably coupled to the actuator 76 to control operation of the actuator. According to the illustrated embodiment, the disk 83 may be rotated in a single direction by ninety degree increments to open and close the discharge valve 70. Alternatively, the disk 83 may also be reciprocated back and forth across a ninety degree arc to open and close the valve 70, or the disk 83 may be controlled in other manners according to other disk designs and layouts.

The rinse valve 72 is provided for controlling flow of rinse fluid to the bowl 36. As best shown in FIG. 6, the rinse valve 72 comprises a housing block 100 formed with an inlet bore 101, defining an inlet 102, and an outlet bore 103. The inlet bore ~~103~~ 102 is adapted for connection to the rinse fluid line 19 via a quick-disconnect coupling (not shown). An insert 104 is positioned in a downstream portion of the outlet bore 103 and defines an outlet 105. The outlet end of the insert 104 is barbed to secure one end of the second rinse fluid pipe 35b thereto, while the opposite end of the second rinse fluid pipe 35b has the quick-disconnect coupling 108b (FIGS. 1A and 1B). A poppet valve bore 106 is also formed in the housing block 100, and fluidly communicates

with the inlet bore 101. An annular recess 107 is formed in the housing block 100 concentric with the poppet valve bore 106 to establish fluid communication between the poppet valve bore 106 and the outlet bore 103.

The rinse valve 72 includes a rinse valve member, such as a ball valve 110, which is disposed in the outlet bore 103 for selectively establishing fluid communication between the outlet bore 103 and the outlet 105. The ball valve 110 includes a shaft 111 and a valve member 112 having a flow passage 113 extending therethrough. A seal 114 is provided downstream of the valve member 112 for preventing leakage between the valve member 112 and the downstream portion of the outlet bore 103. As shown in FIG. 6, the flow passage 113 is perpendicular to the outlet bore 103, thereby preventing fluid flow. The ball valve 110 is rotatable, however, to align the flow passage 113 with the outlet bore 103, thereby establishing fluid communication between the upstream portion of the outlet bore 103 and outlet 105.

In the preferred embodiment, the top of the shaft 111 is adapted to mechanically engage the axle end 84a, as best shown in FIG. 4, so that rotation of the disk 83 also rotates the ball valve 110. In the illustrated embodiment, the shaft 111 is formed with a key 115, while the axle end 84a has a slot 116 sized to receive the key 115. As a result, a separate actuator is not required to actuate the ball valve 110, thereby reducing cost and space requirements for the toilet.

The rinse valve 72 further includes a fuse valve 120 for metering rinse fluid flow through the rinse valve when the ball valve 110 is open. As used herein, the phrase "fuse valve" indicates a valve that actuates after a set value of fluid has passed therethrough. As best shown in FIG. 6, a bonnet 121 is attached to the housing block 100 to close off the poppet valve bore 106 and the recess 107. A flexible diaphragm 122 is attached between the housing block 100 and the bonnet 121 to define a pilot chamber 117 above the diaphragm 122 and a flow chamber 118 below the diaphragm 122. As illustrated at FIG. 6, the diaphragm 122 is in a closed position, in which the diaphragm 122 engages an annular intermediate wall 123 extending between the poppet valve bore 106 and recess 107, thereby closing off fluid communication between the poppet valve bore 106 and recess 107. A poppet valve 124 is disposed inside the poppet valve bore 106 and is attached to the diaphragm 122, so that the poppet valve 124 moves with the

diaphragm 122. The top of the poppet valve 124 is formed with a pilot port 125, and flow ports 126 extend radially through a sidewall of the poppet valve 124. A spring 127 is disposed in the poppet valve port for biasing the diaphragm 122 away from the intermediate wall 123 toward an open position, in which fluid communication is established between the poppet valve bore 106 and the recess 107.

The fuse valve 120 limits the amount of rinse fluid allowed to flow through the rinse valve 72 when the ball valve 110 is open. During operation, the ball valve 110 is normally in a closed position to prevent flow of rinse fluid through the rinse valve 72. The rinse fluid flows through both the pilot port 125 to register at the pilot chamber 117, and through the flow ports 126 to register in the flow chamber 118. Because there is no rinse fluid flow, the rinse fluid pressure is the same in both the pilot chamber 117 and the flow chamber 118, so that the spring 127 urges the diaphragm 122 and poppet valve 124 to the open position, as shown in FIG. 7A.

In response to a flush command, the ball valve 110 is rotated to the open position so that the ball valve flow passage 113 communicates the outlet bore 103 to the outlet 105, thereby creating fluid flow through the valve 72 (FIG. 7B). During fluid flow, the rinse fluid experiences a pressure drop as it passes through the flow ports 126, thereby reducing the fluid pressure in the flow chamber 118 while the pressure in the pilot chamber 117 stays substantially the same. The resulting pressure differential across the diaphragm 122 ultimately overcomes the force of the spring 127 so that the diaphragm 122 and poppet valve 124 move to the closed position, as shown in FIG. 7C. When the diaphragm is in the closed position, fluid flow through the rinse valve 72 is again cut off, this time by the engagement of the diaphragm 122 with the intermediate wall 123. Because of the fuse valve 120, the volume of rinse fluid passing through the open ball valve 110 is substantially constant from flush to flush, regardless of the rinse fluid pressure supplied to the rinse valve 72. It will also be appreciated that the fuse valve 120 provides a redundant shut-off, so that the ball valve 110 or the fuse valve 120 may be used to stop rinse fluid flow should the other fail.

The rinse valve 72 further includes a face valve 130 for returning the diaphragm 122 back to the open position after the ball valve 110 is subsequently closed. Referring to FIG. 7A, a bypass bore 131 is formed in the housing block 100 that connects

the inlet bore 101 to an auxiliary bore 132. A reset bore 134 intersects the bypass bore 131 and communicates with a ball valve bore 135 formed in the housing block 100. A reset insert 136 is inserted in the reset bore 134 and has a top surface adapted to engage a bottom of the ball valve 110. The ball valve 110 is formed with reset passages 137 extending into the ball valve 110 to a transverse passage 138 extending entirely through the ball valve 110. The reset passages 137 are located on the ball valve 110 so that they align with the reset insert 136 only when the ball valve 110 is in the closed position. The seal 114 prevents rinse fluid from leaking from the transverse passage 138 to the outlet 105. No seal is provided upstream of the ball valve 110 so that, when one of the reset passages 137 is aligned with the insert 136, fluid communication is established from the inlet bore 101, through the bypass and reset bores 131, 134 and one of the reset passages 137 to the flow chamber 118.

According to the illustrated embodiment, the rinse valve 72 also includes a drain valve 133 disposed in the auxiliary bore 132 to provide freeze protection, as is well known in the art.

In operation, the diaphragm ~~121~~ 122 moves to the closed position while the ball valve 110 is open, thereby stopping rinse fluid flow through the rinse valve 72 (FIG. 7C). With the ball valve 110 in the open position, neither reset passage 137 is aligned with the reset insert 136. The ball valve 110 is subsequently closed, thereby aligning one of the reset passages 137 with the insert 136 and establishing fluid communication from the inlet bore 101 to the flow chamber 118 (FIG. 7D). The incoming rinse fluid pressure registers at the flow chamber 118, so that the flow chamber reaches the same pressure as the pilot chamber 117. With the differential pressure across the diaphragm 121 removed, the spring 127 is again allowed to urge the diaphragm 121 to the open position, thereby resetting the fuse valve 120 to the position shown in FIG. 7A.

In the preferred embodiment, a position sensor is used to provide feedback regarding poppet valve position feedback. In the illustrated embodiment, a magnet 140 is attached to the poppet valve 124, and a hall effect switch 141 is located outside of the bonnet 121 in a switch enclosure 142 attached to the bonnet 121 (FIG. 6). The hall effect switch 141 provides a signal that varies according to the position of the magnet 140 to indicate the position of the poppet valve 124. The poppet valve position signal may be

used for diagnostic purposes such as fault detection by comparing the position signal to the position of the disk 83 or ball valve 110.

The FCU 74 comprises a housing 150 attached to the discharge valve housing half 78b opposite the rinse valve 72 (FIG. 4). The housing 150 encloses one or more circuit boards (not shown) for controlling operation of the toilet 10. In addition to the typical inputs and outputs, the FCU 74 also receives feedback from the poppet valve position sensor 141.

The FCU housing 150 further houses a position sensor for determining the position of the disk 83. As best shown in FIG. 5A, magnets 152 are attached to the axle end 84b of the disk 83. The axle end 84b extends into the FCU housing 150, so that the magnets 152 are positioned proximal the control board. Hall effect switches 154 are provided directly on the circuit board for sensing the magnets 152 and thus determining the rotational position of the disk 83. In the illustrated embodiment, a pair of magnets 152 are attached to the axle end 84b, and a pair of hall effect switches 154 are attached to the circuit board. The switches 154 actuate between on and off positions depending on the proximity of the magnets, thereby indicating the position of the disk 83. As a result, the position of the disk 83 is directly sensed rather than inferring disk position based on actuator position. In addition, the switches 154 are located inside the FCU housing 150 and are therefore isolated from contamination due to lubrication or other material.

With the above construction, the valve set 8 is quickly and easily removed and replaced. To remove the valve set 8, the discharge pipe 21 is disconnected from the sewer line 11, the rinse valve inlet 102 is disconnected from the rinse supply line 19, and the quick-disconnect coupling 108b of the second rinse fluid pipe 35b is disconnected from the vacuum breaker 33. The knurled screws 37 are then removed from the bracket 27 and the valve set 8 with attached transfer pipe 44 is lowered so that the transfer pipe disengages the bowl outlet 42. Thus the valve set 8 is removed with the transfer pipe 44, outlet pipe 12, discharge pipe 21, and second rinse pipe 35b. A new valve set 8, also having a new transfer pipe 44, outlet pipe 12, discharge pipe 21, and second rinse pipe 35b may then be attached to the bracket 27 and reconnected.

From the foregoing, it will be appreciated that the valve set 8 of the

present invention incorporates all of the valve and control apparatus. The rinse valve 72, FCU 74, and actuator 76 are all mounted to the discharge valve 70 to create an LRU, wherein a single module may be targeted for maintenance in the event of a valve or control failure. The wiring between the components may remain in place so that, in the event of a valve or control failure, only the piping connections between the valve set 8 and the drain, sewer, and rinse water piping need be undone to remove the valve set 8.

Maintenance of the modular vacuum toilet 10 is entirely different from that of conventional vacuum toilets. Instead of defining the entire toilet as an LRU, the toilet 10 defines individual components or groups of components as LRUs. The bowl 36 may be independently removed from the toilet 10 and replaced. Similarly, the valve set 8 may be separately removed from the toilet 10. Furthermore, the individual components may be quickly removed with the use of few or no tools.

The branch 17 and discharge pipe 21 of the valve set 8 are adapted to provide both right- and left-handed discharge configurations without additional modifications to the other toilet components, thereby further reducing the number of parts needed in stock

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications would be obvious to those skilled in the art.

IN THE CLAIMS

1. A modular vacuum toilet for use in a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid, the modular vacuum toilet comprising:

a ~~support structure~~;

a removable bowl ~~supported by~~ the support structure, the bowl defining an outlet and having a rinse fluid dispenser associated therewith; and

a valve set module including:

a discharge valve having an inlet in fluid communication with the bowl outlet, an outlet in fluid communication with the sewer line, and a movable discharge valve member disposed between the discharge valve inlet and outlet;

a rinse fluid valve having an inlet in fluid communication with the source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a movable rinse fluid valve member disposed between the rinse fluid valve inlet and outlet; and

a flush control unit having a circuit board operably connected to the discharge valve and rinse fluid valve for controlling actuation of the discharge valve member and rinse fluid valve member.

2. The modular vacuum toilet of claim 1, in which the ~~support structure~~ comprises a frame.

3. The modular vacuum toilet of claim 2, in which the frame defines an opening, and in which the bowl includes a sidewall sized for insertion into the opening.

~~4~~ 2. The modular vacuum toilet of claim 1, in which the support structure includes slots, and in which the bowl includes tabs adapted to lockingly engage the slots, thereby to secure the bowl in place.

~~5~~ 3. The modular vacuum toilet of claim ~~4~~ 2, in which the tabs are manually releasable to disengage from the slots.

6. The modular vacuum toilet of claim 1, in which a rinse fluid pipe communicates between the rinse fluid valve outlet and the rinse fluid dispenser, wherein the rinse fluid pipe is releasably attached to the rinse fluid valve outlet with a coupling.

7. The modular vacuum toilet of claim 6, in which the coupling is manually releasable.

8. The modular vacuum toilet of claim 1, in which a transfer pipe has a first end connected to the discharge valve inlet, and a second end adapted to releasably engage the bowl outlet.

9. The modular vacuum toilet of claim 8, in which the second end of the transfer pipe includes a collar sized to releasably engage and seal with the bowl outlet.

10. The modular vacuum toilet of claim 1, in which a rinse fluid line communicates between the rinse fluid valve inlet and the source of rinse fluid, wherein the rinse fluid valve inlet is releasably connected to the rinse fluid line with a coupling.

11. The modular vacuum toilet of claim 10, in which the coupling is manually releasable.

12. The modular vacuum toilet of claim 1, in which a discharge pipe communicates between the discharge valve outlet and the sewer line, wherein the discharge pipe is adapted for releasable connection to the sewer line.

13. The modular vacuum toilet of claim 1, in which the support structure includes a bracket, and in which fasteners are provided for releasably securing the valve set module to the bracket.

14. The modular vacuum toilet of claim 13, in which the fasteners comprise knurled screws.

24. A method of servicing a vacuum toilet having a receptacle for receiving waste defining an outlet and having a rinse fluid dispenser associated therewith, a discharge valve having an inlet in fluid communication with the receptacle outlet, an outlet in fluid communication with a sewer line placeable under partial vacuum pressure, and a moveable discharge valve member disposed between the discharge valve inlet and the discharge valve outlet, a rinse fluid valve having an inlet in fluid communication with a source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a moveable rinse fluid valve member disposed between the rinse fluid valve inlet and the rinse fluid valve outlet, and a flush control unit adapted to control actuation of the discharge valve member and rinse fluid valve member, in which at least one of the discharge valve, rinse fluid valve, flush control unit, and waste receptacle is a line replaceable unit, the method comprising:

removing the faulty line replaceable unit from the toilet; and

installing a new line replaceable unit into the toilet.

25. The method of claim 24, ~~in which the vacuum toilet comprises a stationary support structure, and in which the bowl is adapted to releasably engage the support structure, the bowl being a~~ line replaceable unit.

26. The method of claim 25, in which the support structure includes slots, and in which the ~~bowl~~ waste receptacle includes tabs adapted to lockingly engage the slots, thereby to secure the ~~bowl~~ waste receptacle in place.

27. The method of claim 26, in which the tabs are manually releasable to disengage from the slots.

28. The method of claim 24, in which the discharge valve, rinse fluid valve, and flush control unit are integrally provided in a valve set, the valve set being a line replaceable unit.

18 13
29. The method of claim 24, in which a rinse fluid pipe communicates between the rinse fluid valve outlet and the rinse fluid dispenser, wherein the rinse fluid pipe is releasably attached to the rinse fluid dispenser with a coupling.

19 18
30. The method of claim 29, in which the coupling is manually releasable.

20 13
31. The method of claim 24, in which a transfer pipe has a first end connected to the discharge valve inlet, and a second end adapted to releasably engage the ~~bowl~~ waste receptacle outlet.

21 20
32. The method of claim 31, in which the second end of the transfer pipe includes a collar sized to releasably engage and seal with the ~~bowl~~ waste receptacle outlet.

22 13
33. The method of claim 24, in which a rinse fluid line communicates between the rinse fluid valve inlet and the source of rinse fluid, wherein the rinse fluid valve inlet is releasably connected to the rinse fluid line with a coupling.

23 22
34. The method of claim 33, in which the coupling is manually releasable.

24 13
35. The method of claim 24, in which a discharge pipe communicates between the discharge valve outlet and the sewer line, wherein the discharge pipe is adapted for releasable connection to the sewer line.

25 13
36. The method of claim 24, in which the vacuum toilet includes a support structure having a bracket, and in which fasteners are provided for releasably securing the valve set to the bracket.

26 25
37. The method of claim 36, in which the fasteners comprise knurled screws.

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15. A method of servicing a vacuum toilet attached to a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid, the vacuum toilet including a waste receptacle defining an outlet and having a rinse fluid dispenser associated therewith, the method comprising:

providing a first valve set module having a discharge valve with an inlet adapted to engage the receptacle outlet and an outlet adapted for releasable connection to the sewer line, a rinse fluid valve with an inlet adapted for releasable connection to the source of rinse fluid and an outlet adapted for releasable connection to the rinse fluid dispenser, and a flush control unit adapted to control operation of the discharge valve and rinse fluid valve;

detaching the discharge valve inlet from the bowl outlet, discharge valve outlet from the sewer line, the rinse fluid valve inlet from the rinse fluid source, and the rinse fluid valve outlet from the rinse fluid line;

removing the valve set module from the vacuum toilet;

inserting a second valve set module into the vacuum toilet, the new valve set module including a discharge valve with an inlet adapted to engage the receptacle outlet and an outlet adapted for releasable connection to the sewer line, a rinse fluid valve with an inlet adapted for releasable connection to the source of rinse fluid and an outlet adapted for releasable connection to the rinse fluid dispenser, and a flush control unit adapted to control operation of the discharge valve and rinse fluid valve; and

attaching the second valve set discharge valve inlet to the bowl outlet, the discharge valve outlet to the sewer line, the rinse fluid valve inlet to the rinse fluid source, and the rinse fluid valve outlet to the rinse fluid line.

16. The method of claim 15, in which the first and second valve sets comprise a transfer pipe attached to the discharge valve inlet, the transfer pipe including a collar adapted to releasable engage and seal with the bowl outlet.

17. The method of claim 15, in which the first and second valve sets comprise a rinse fluid pipe communicating between the rinse fluid valve outlet and the rinse fluid dispenser, wherein the rinse fluid pipe is releasably attached to the rinse fluid dispenser with a coupling.

18. The method of claim 17, in which the coupling is manually releasable.

19. The method 15, in which the first and second valve sets comprise a rinse fluid line communicating between the rinse fluid valve inlet and the source of rinse fluid, wherein the rinse fluid valve inlet is releasably connected to the rinse fluid line with a coupling.

20. The method of claim 19, in which the coupling is manually releasable.

21. The method of claim 15, in which the first and second valve set comprise a discharge pipe communicating between the discharge valve outlet and the sewer line, wherein the discharge pipe is adapted for releasable connection to the sewer line.

22. The method of claim 15, in which the vacuum toilet further comprises a support structure having a bracket, and in which fasteners are provided for releasably securing the first and second valve set modules to the bracket.

23. The method of claim 22, in which the fasteners comprise knurled screws.

38. A valve set for use in a vacuum toilet system having a sewer pipe placeable under partial vacuum pressure, the valve set comprising:

a discharge valve having an outlet;

an outlet pipe attached to the discharge valve outlet and defining a branch;

a discharge pipe having a first end adapted to releasably engage the sewer pipe and a second end releasably attachable to the branch in at least a first position corresponding to a left-handed discharge configuration and a second position corresponding to a right-handed discharge configuration.

39. The valve set of claim 38, in which the branch includes a pair of spaced pins and the discharge pipe includes a pair of spaced J-shaped slots sized to receive and engage with the pins.

40. The valve set of claim 39, in which the pins and J-shaped slots are spaced 180 degrees.

ABSTRACT

A modular vacuum toilet, and a method of servicing such a toilet, are disclosed. The toilet is used with a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid. The modular vacuum toilet comprises a frame and a removable bowl engaging and supported be the frame, the bowl defining an outlet and having a rinse fluid dispenser associated therewith. The modular vacuum toilet also has a valve set module. The valve set module includes a discharge valve having an inlet in fluid communication with the bowl outlet, an outlet in fluid communication with the sewer line, and a movable discharge valve member disposed between the discharge valve inlet and outlet. A rinse fluid valve is also incorporated into the valve set module and has an inlet in fluid communication with the source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a movable rinse fluid valve member disposed between the rinse fluid valve inlet and outlet. The valve set module further includes a flush control unit having a circuit board operably connected to the discharge valve and rinse fluid valve for controlling actuation of the discharge valve member and rinse fluid valve member.

FIG. 1A

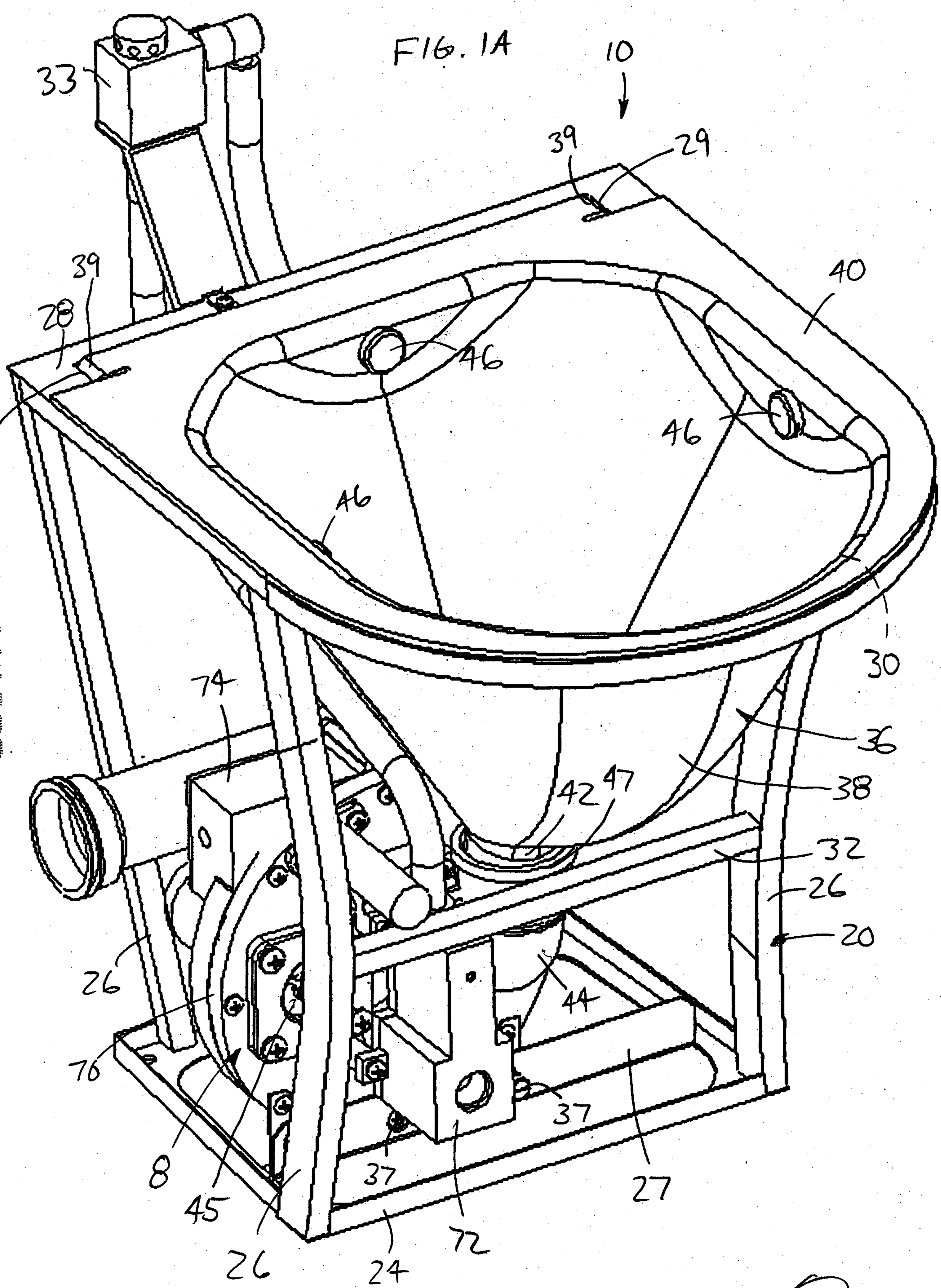

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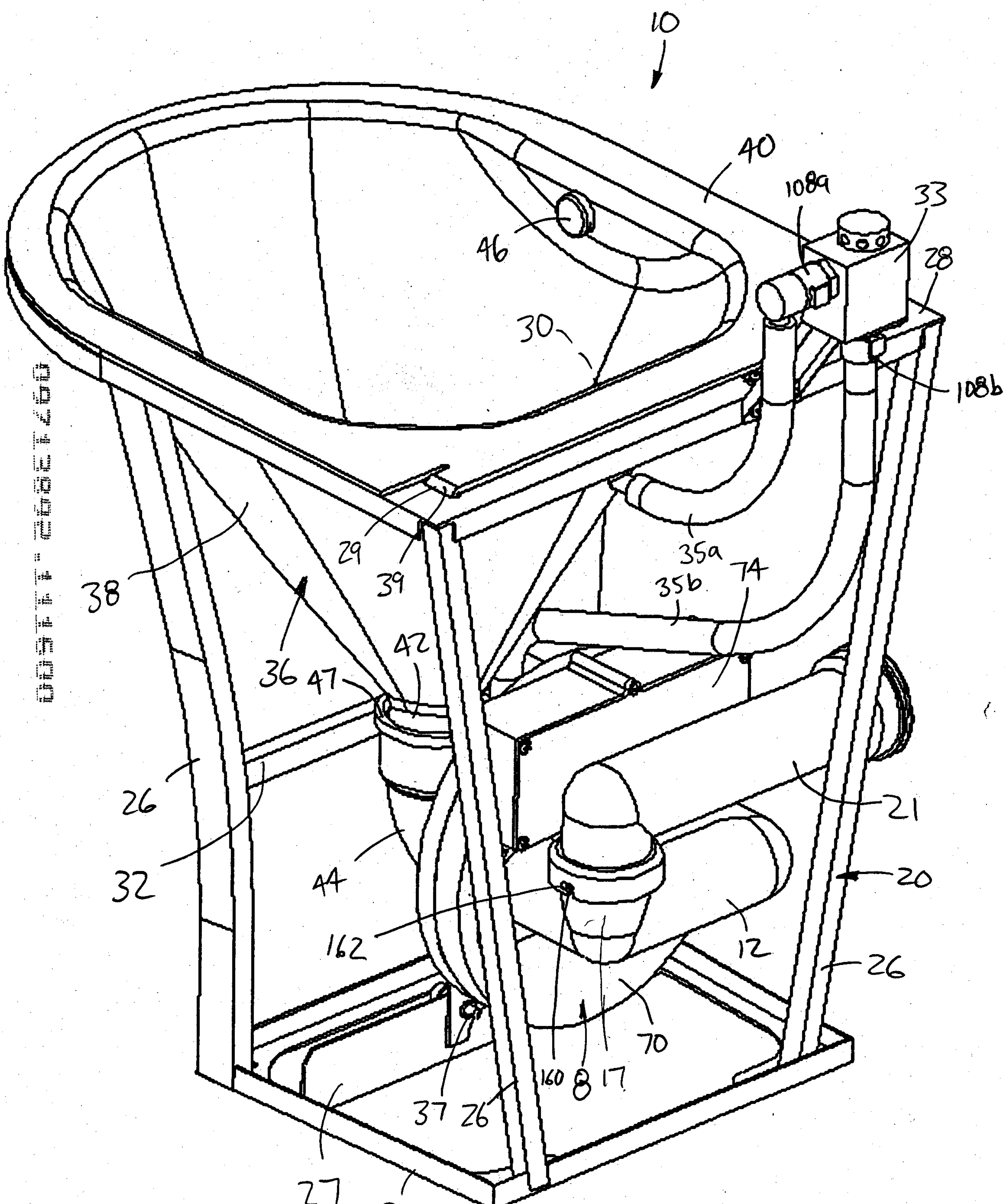
FIG. 1B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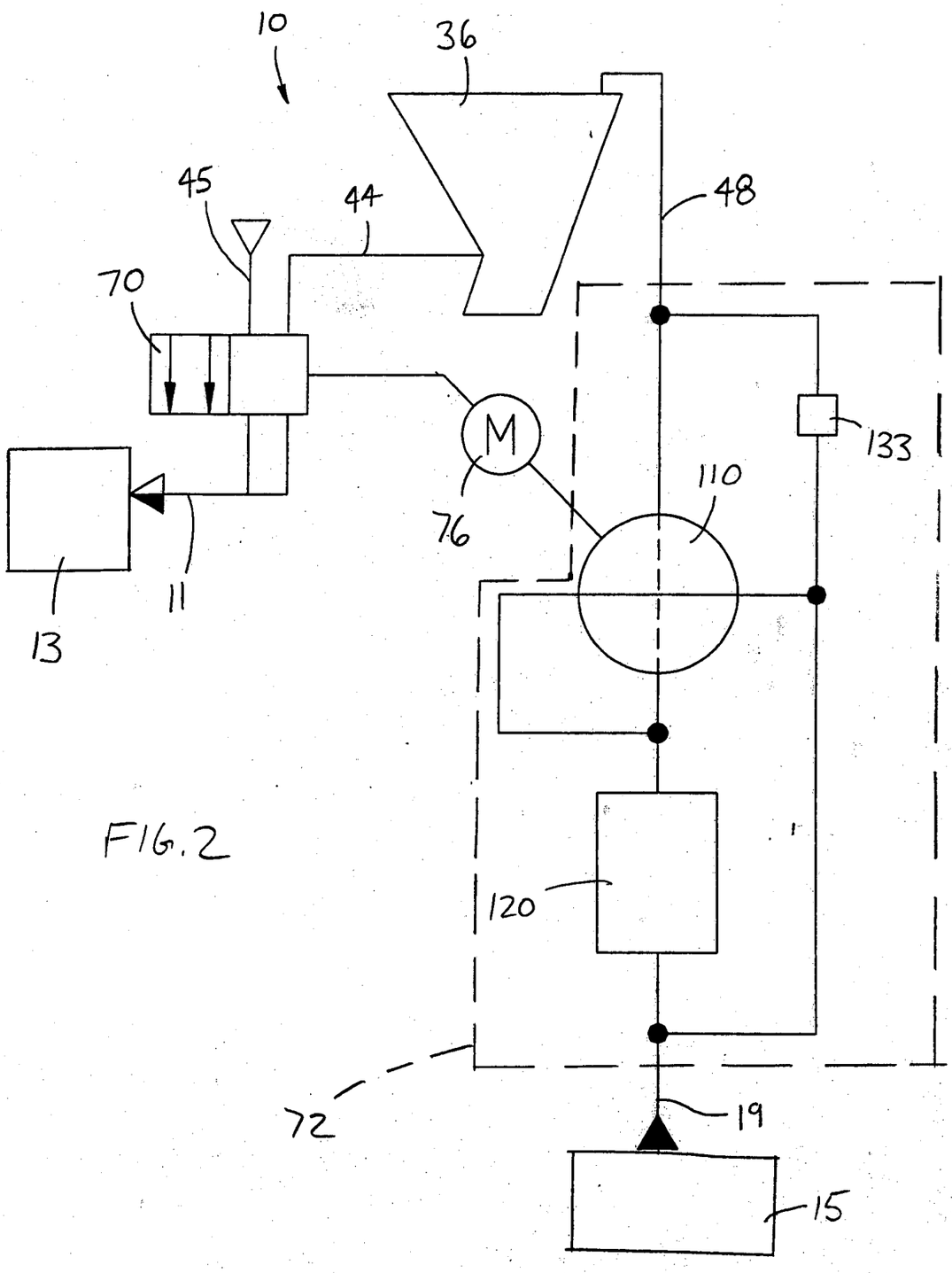


FIG. 2

FIG. 3

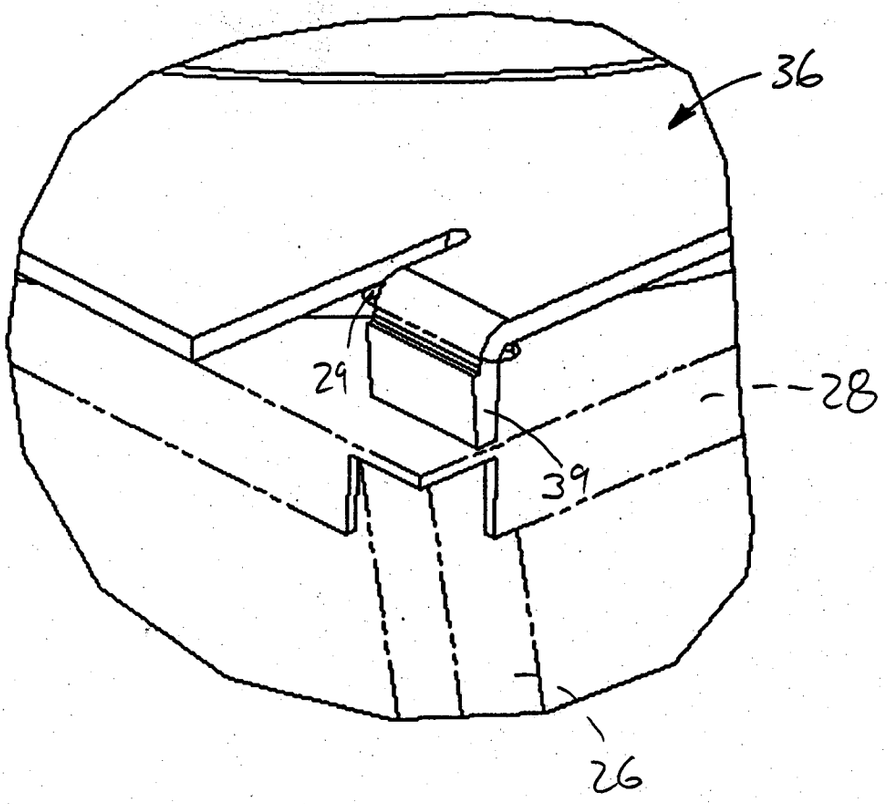


FIG. 4

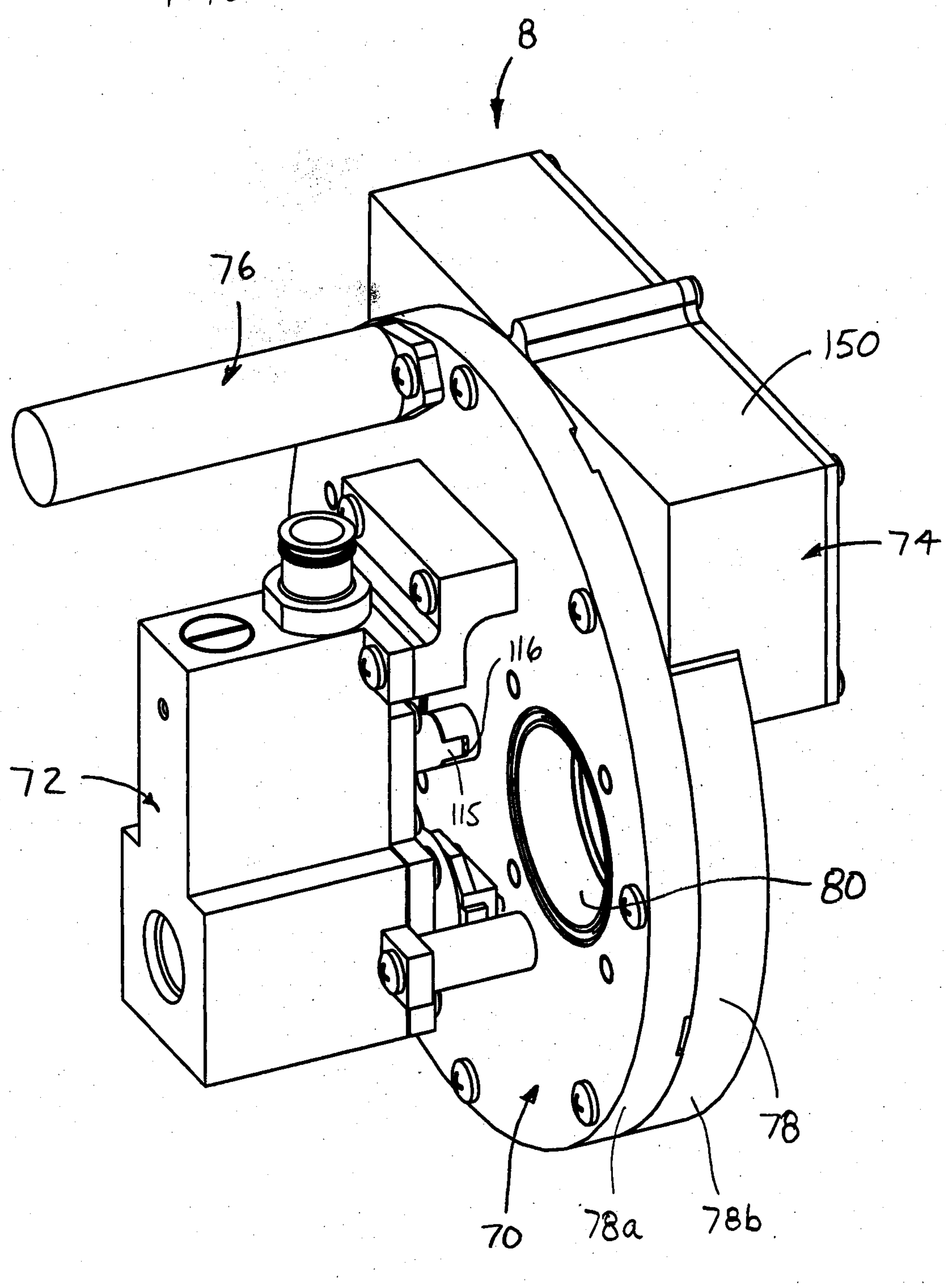
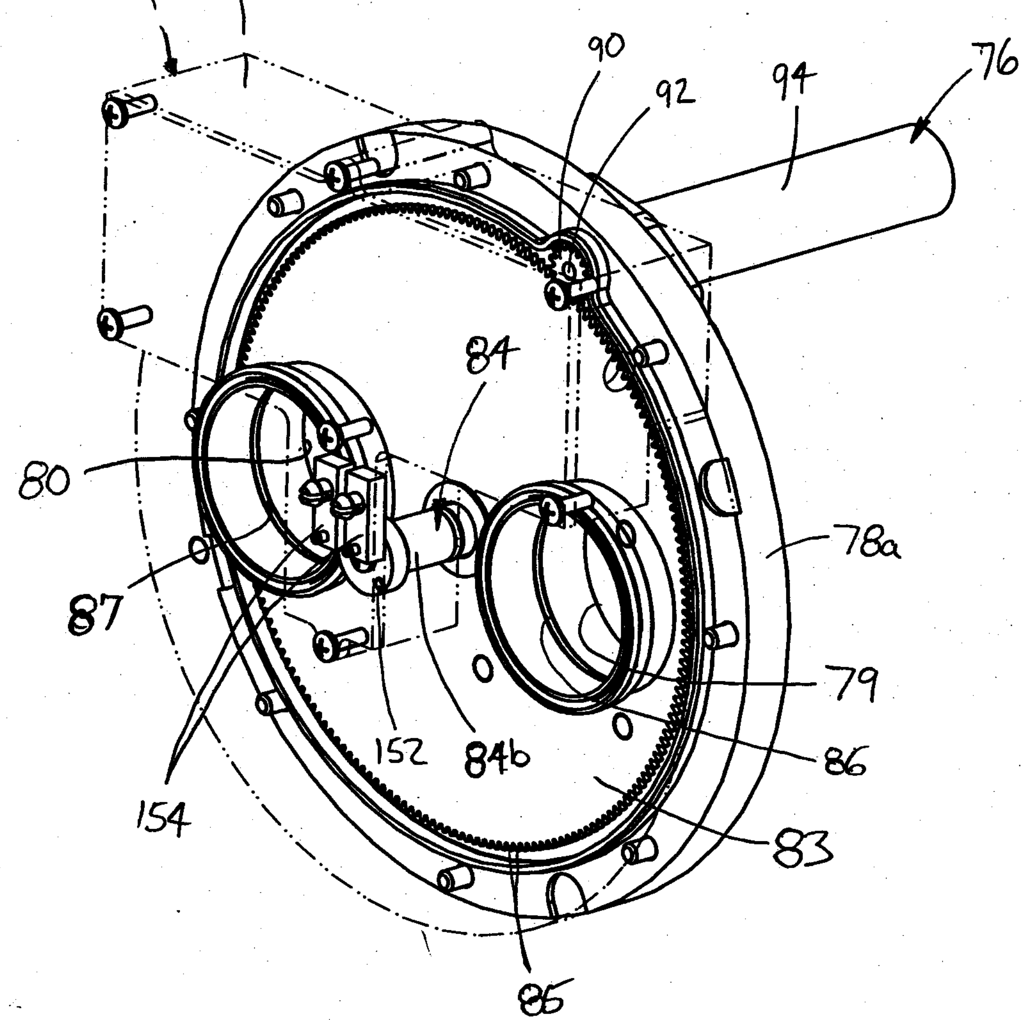


FIG. 5A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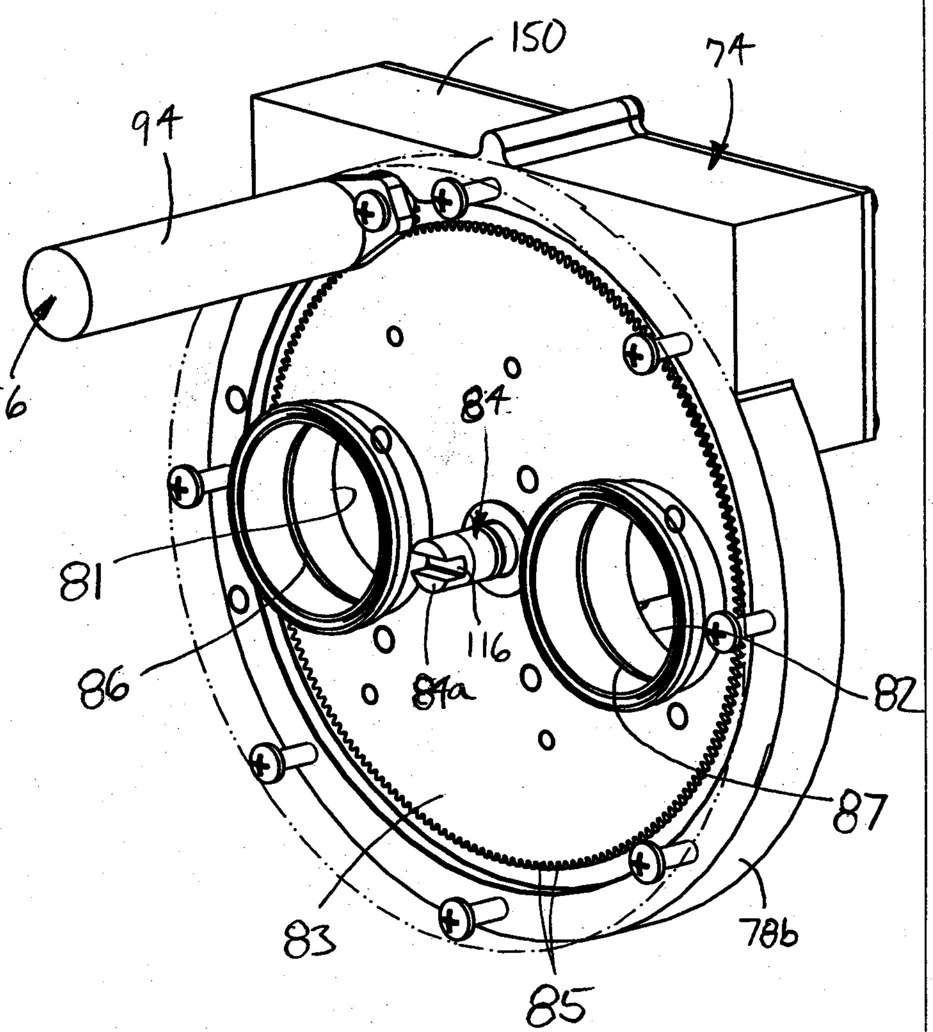
87
78a
79
86
83
152
84b
154
85

FIG. 5B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83
78b
85

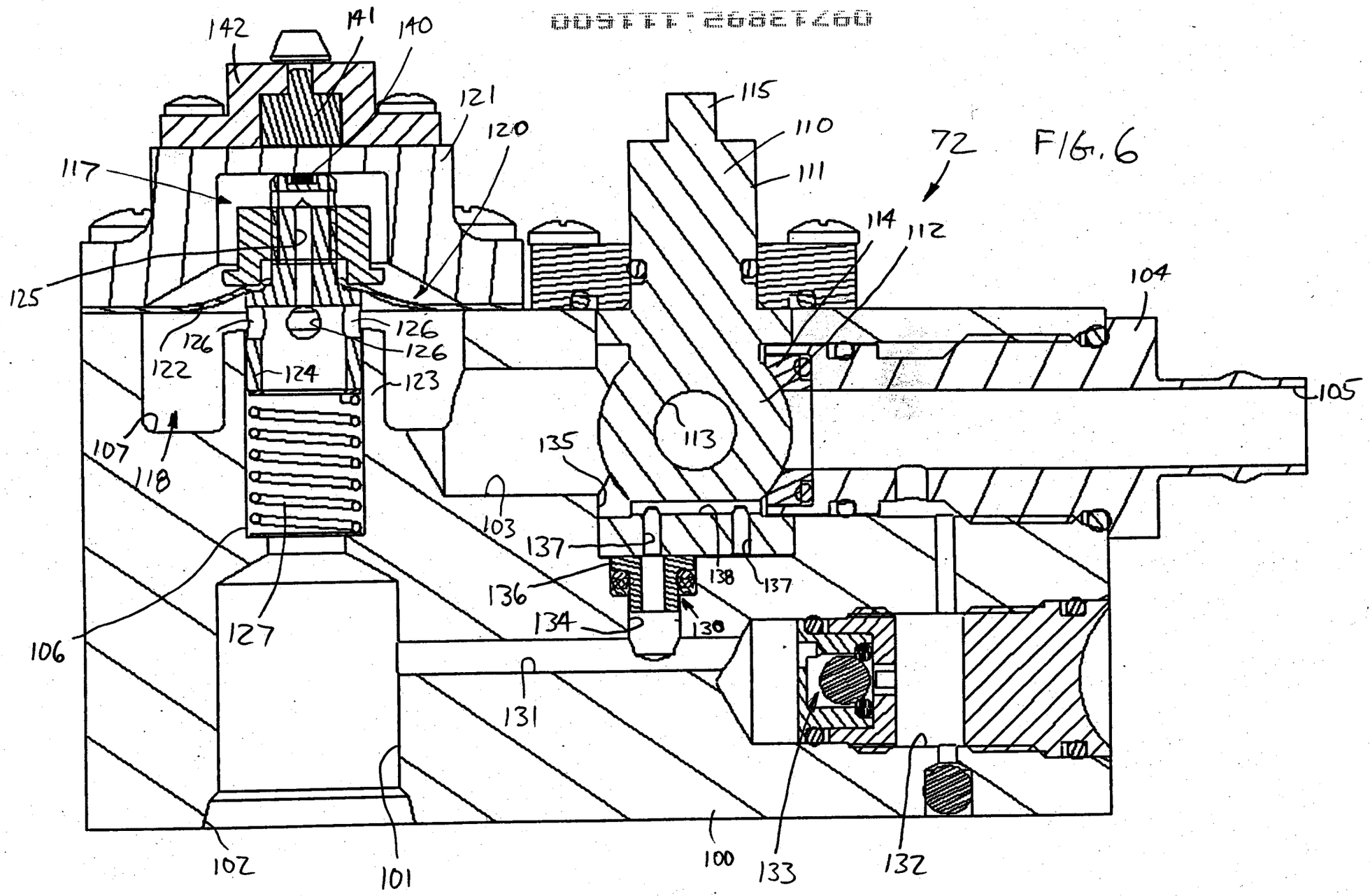

FIG. 6

FIG. 7A

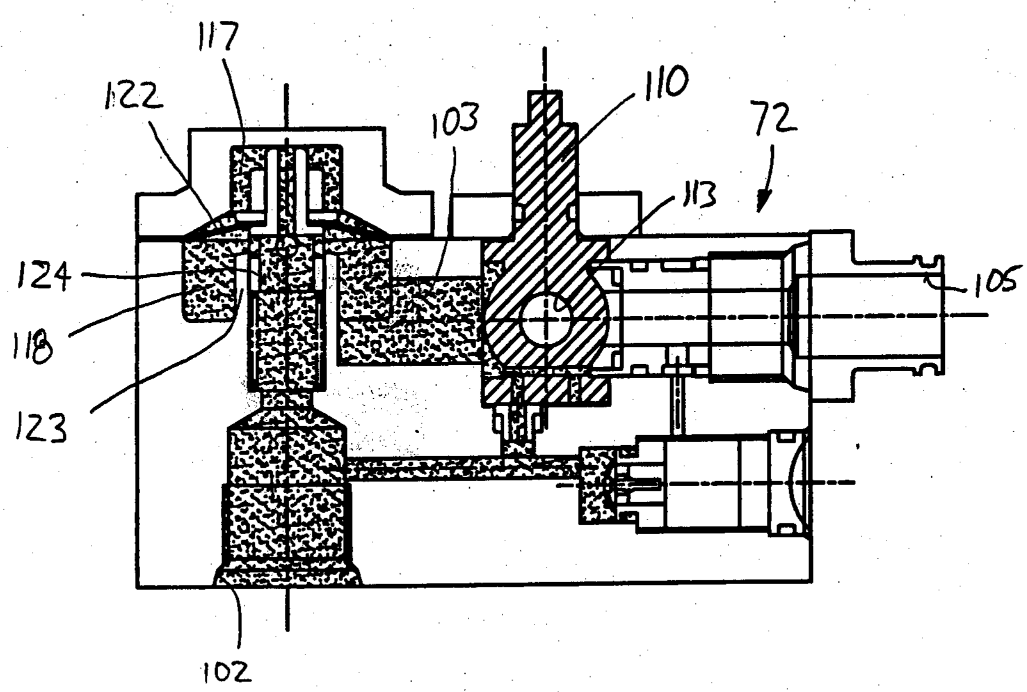
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FIG. 7C

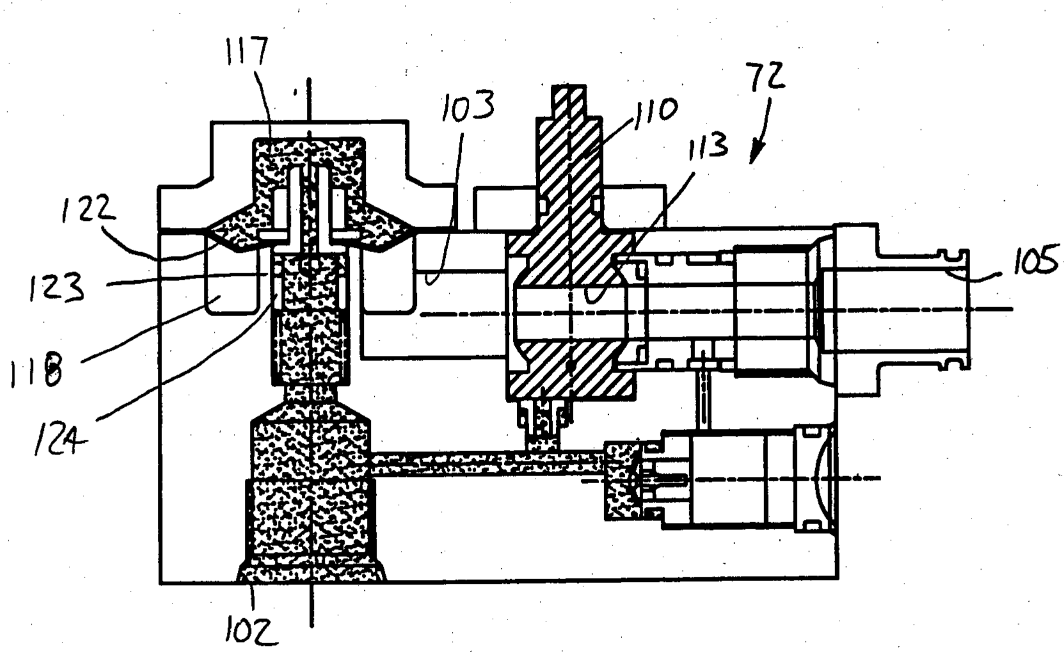
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FIG. 7B

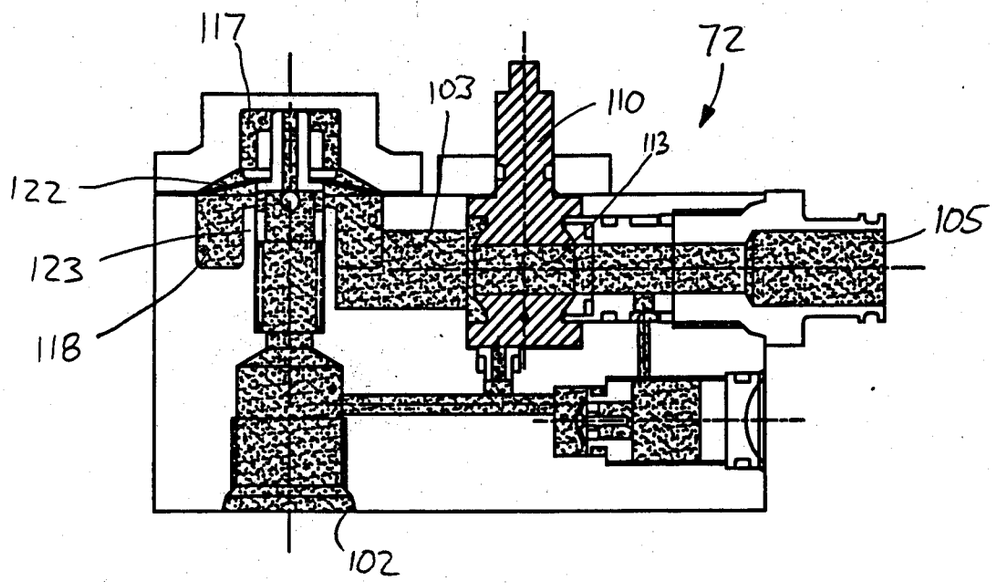
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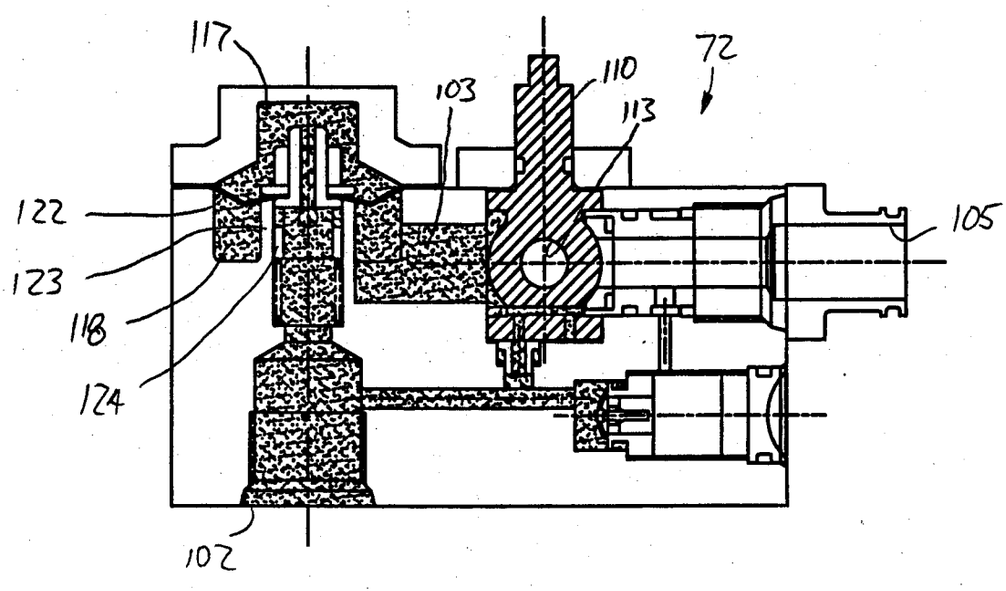
FIG. 7D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PRINT OF DRAWINGS
AS ORIGINALLY F)

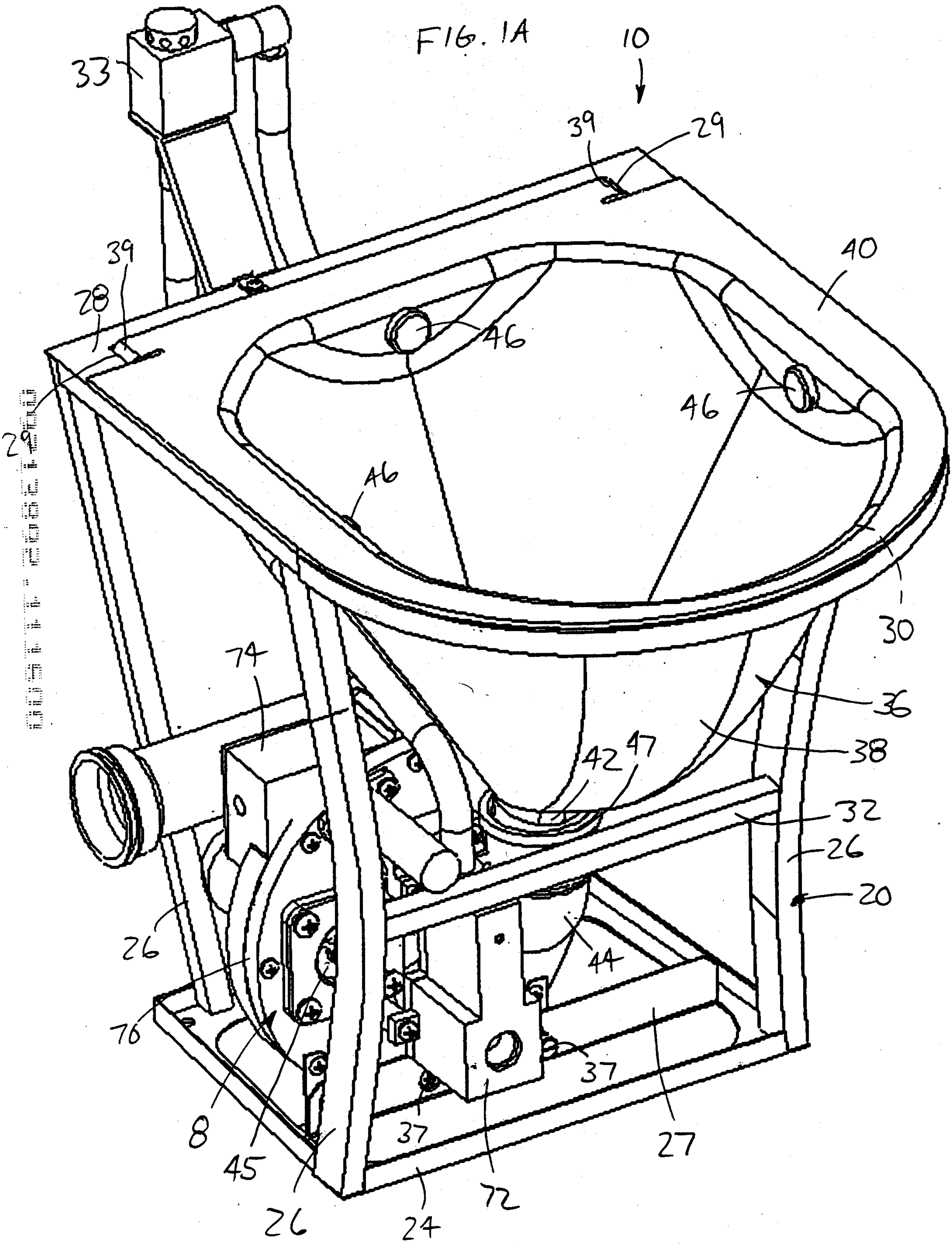
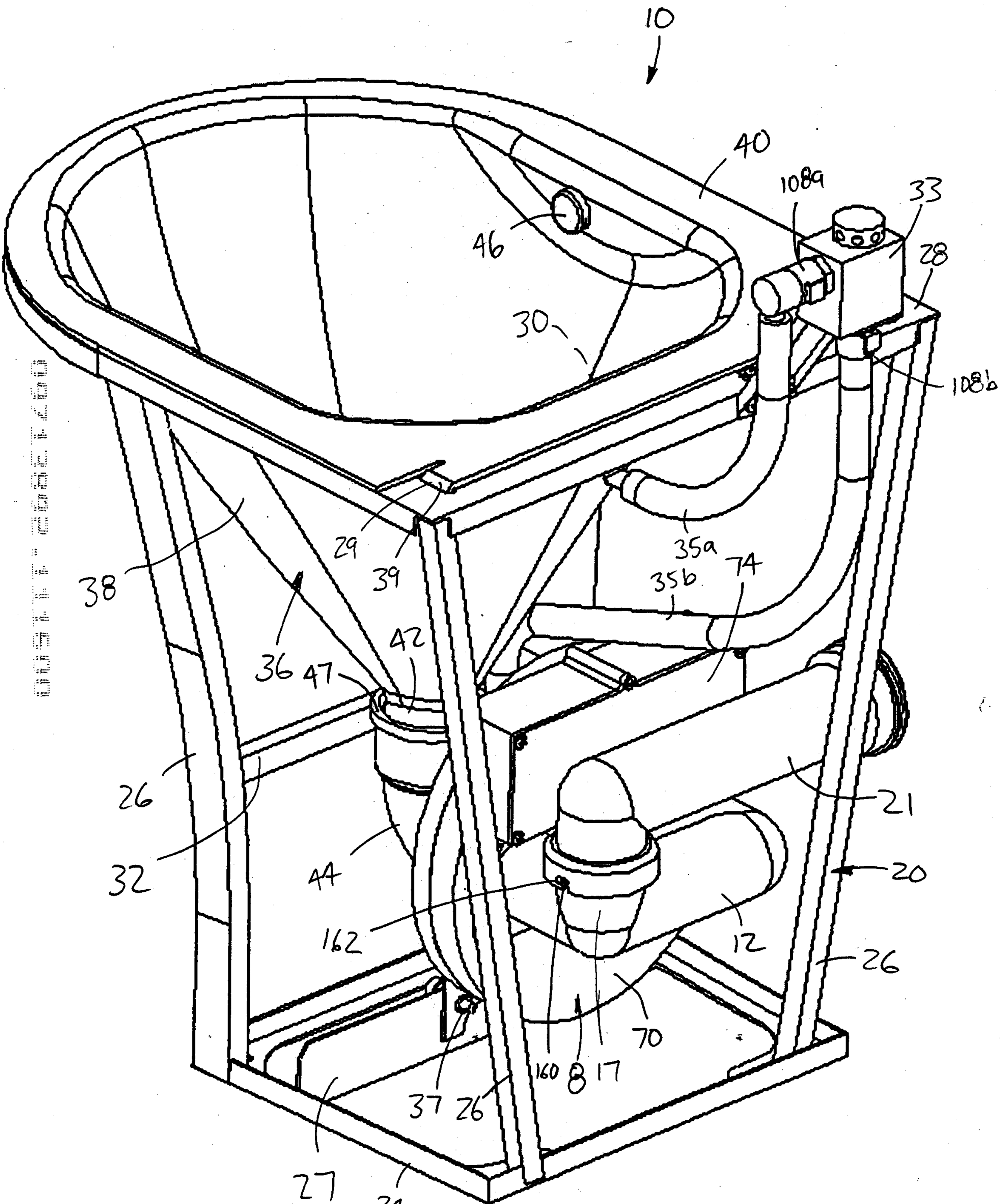


FIG. 1A

PRINT OF DRAWINGS
AS ORIGINALLY F   D

FIG. 1B



PRINT OF DRAWINGS
AS ORIGINALLY F)

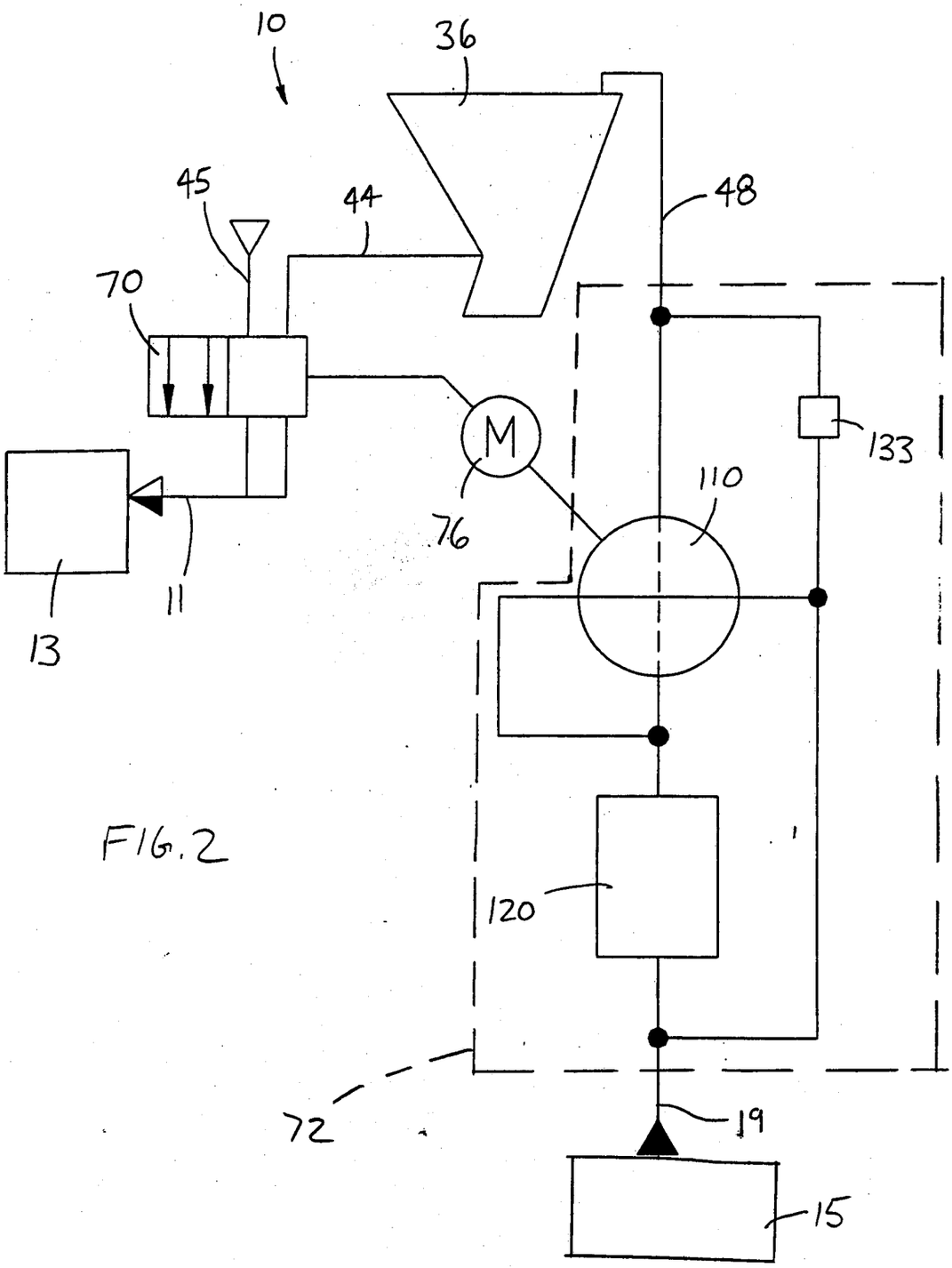
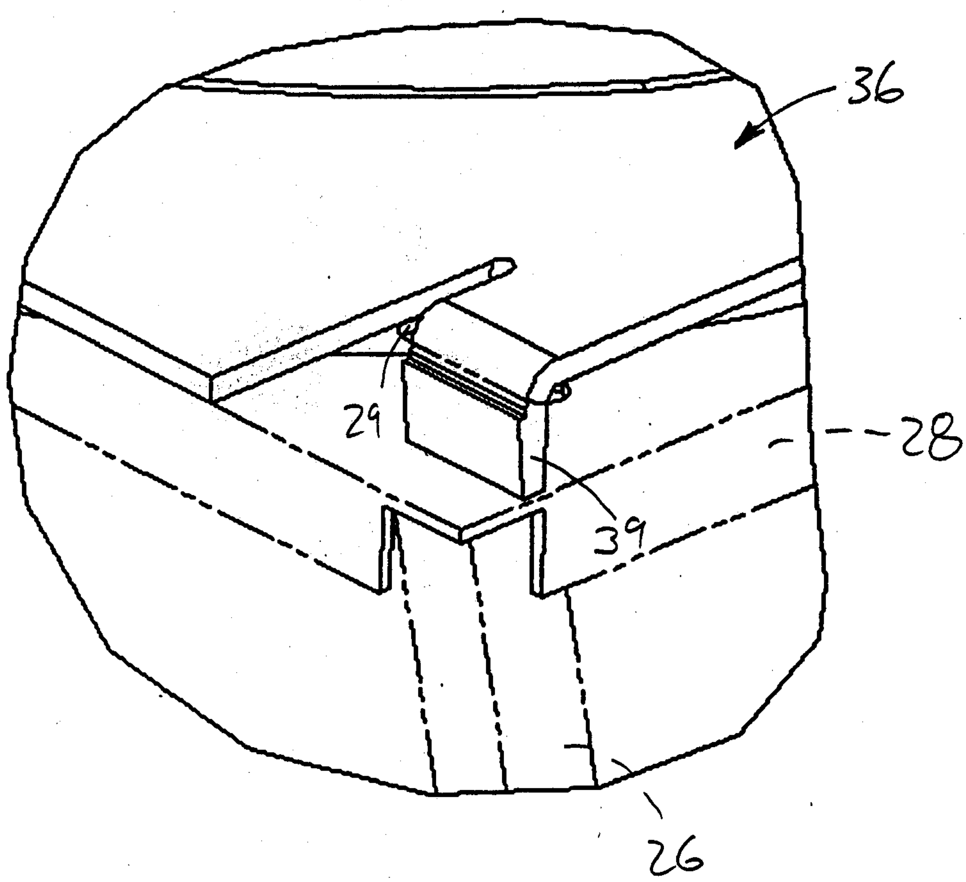


FIG. 2

F/G. 3



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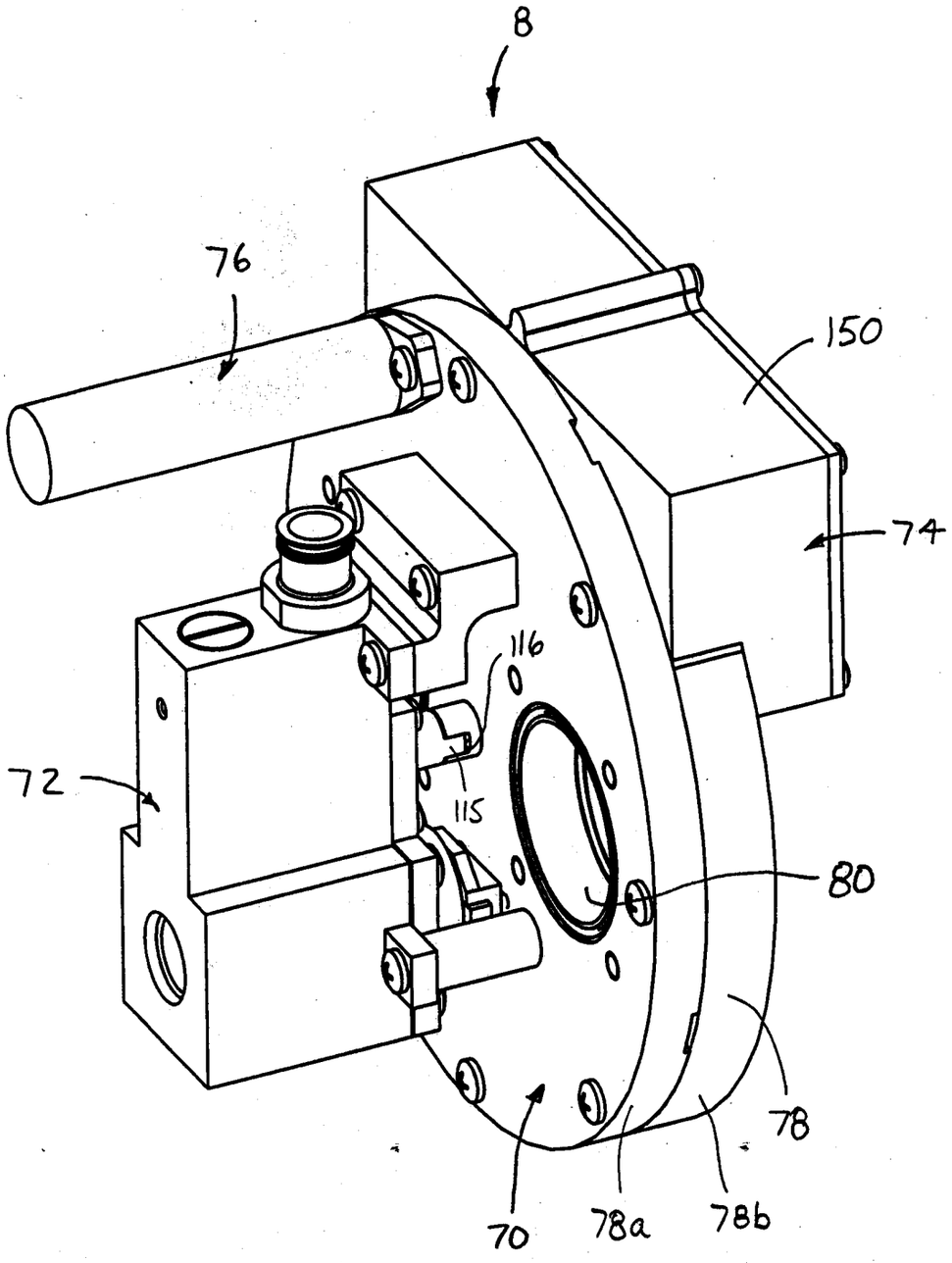
AS ORIGINALLY F D

FIG. 4



PRINT OF DRAWINGS
AS ORIGINALLY F D

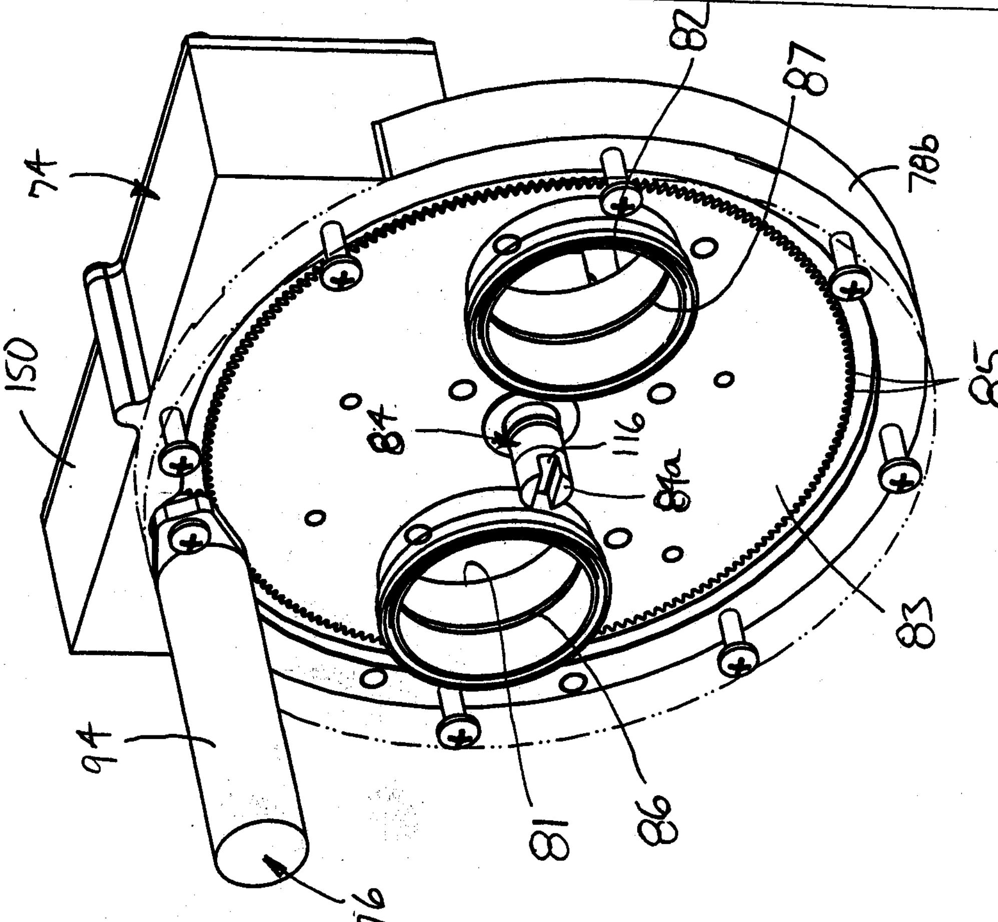


FIG. 5B

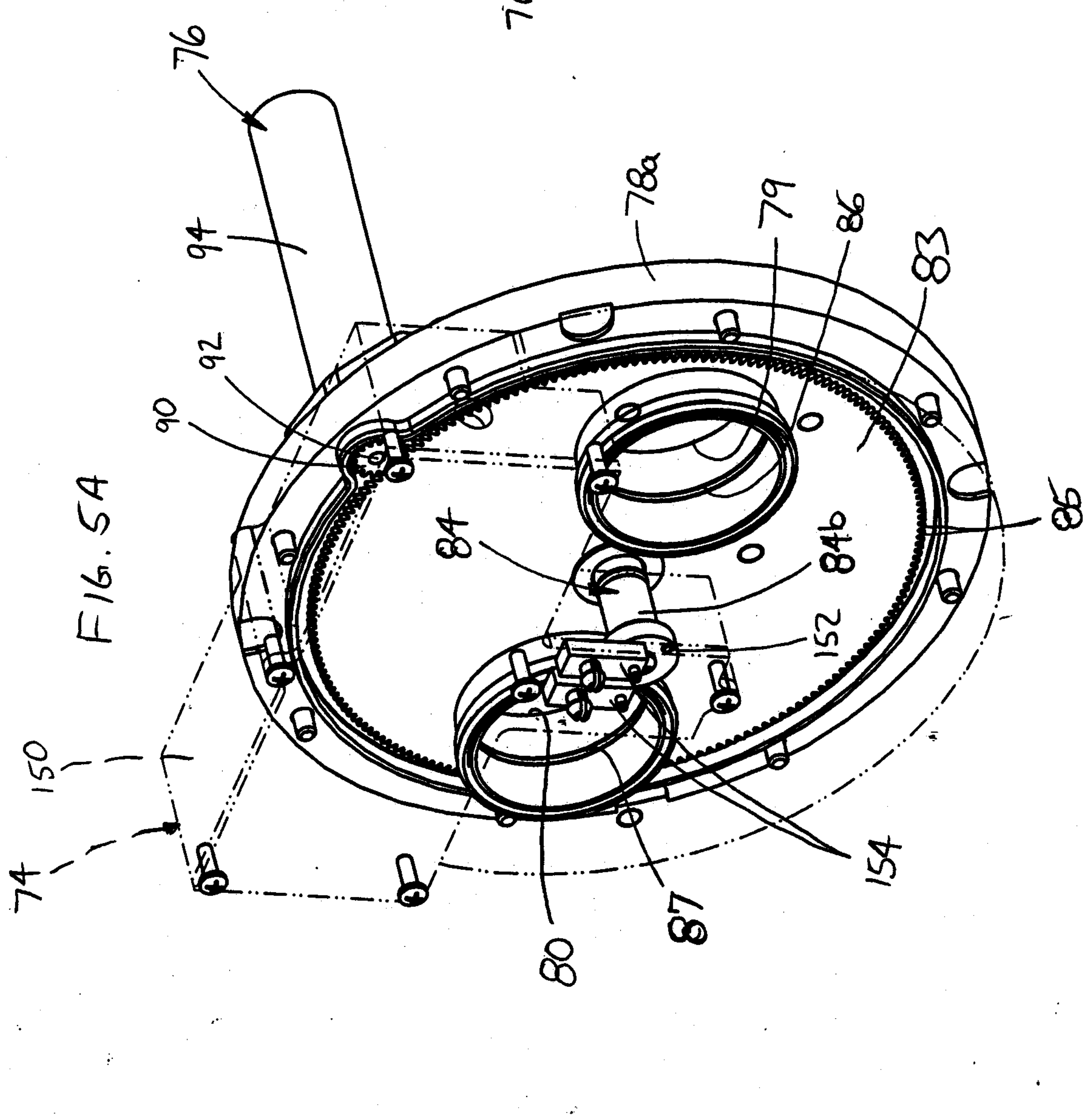
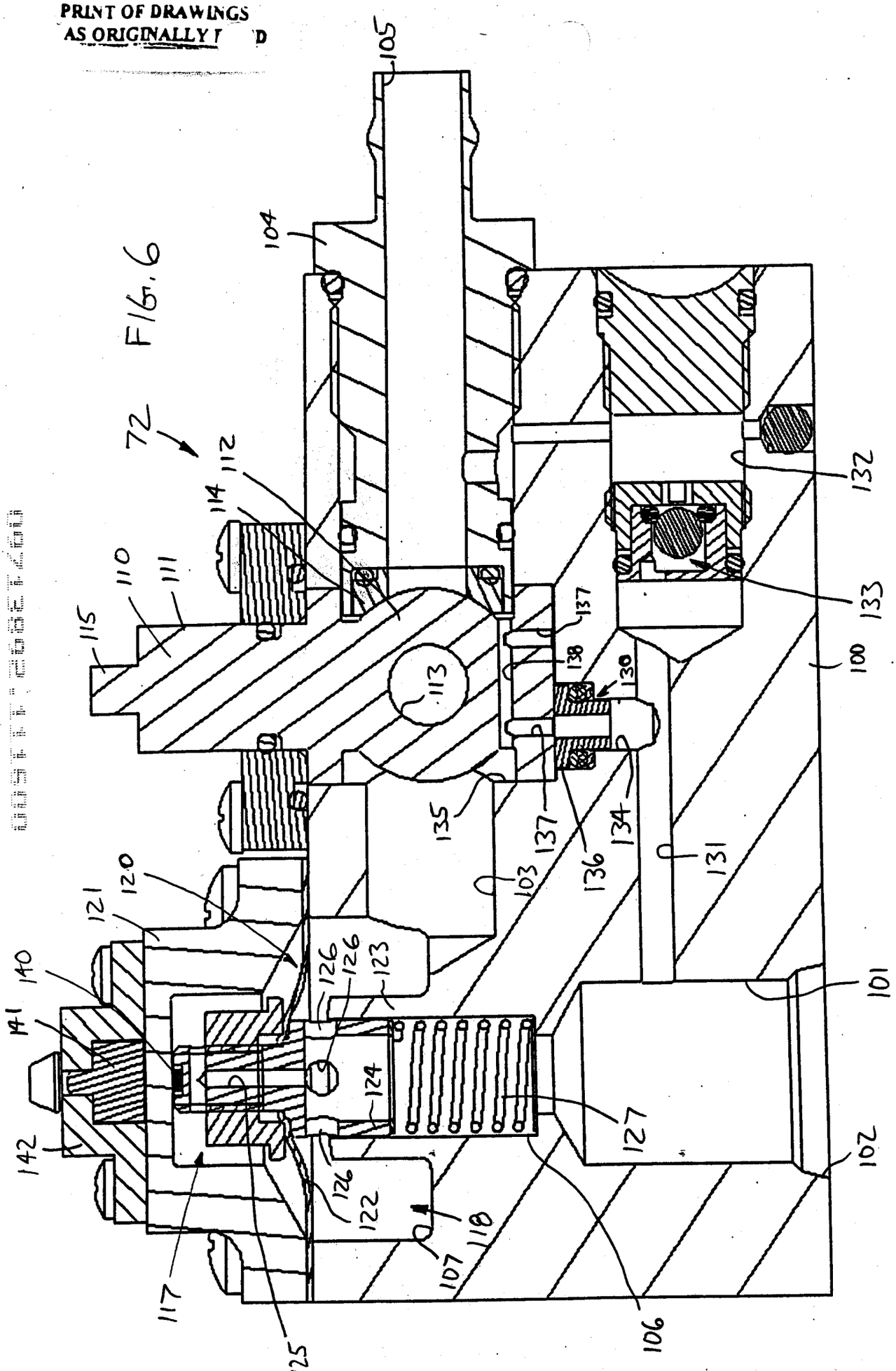


FIG. 5A

PRINT OF DRAWINGS
AS ORIGINALLY FILED

FIG. 6



PRINT OF DRAWINGS
AS ORIGINALLY F)

FIG. 7A

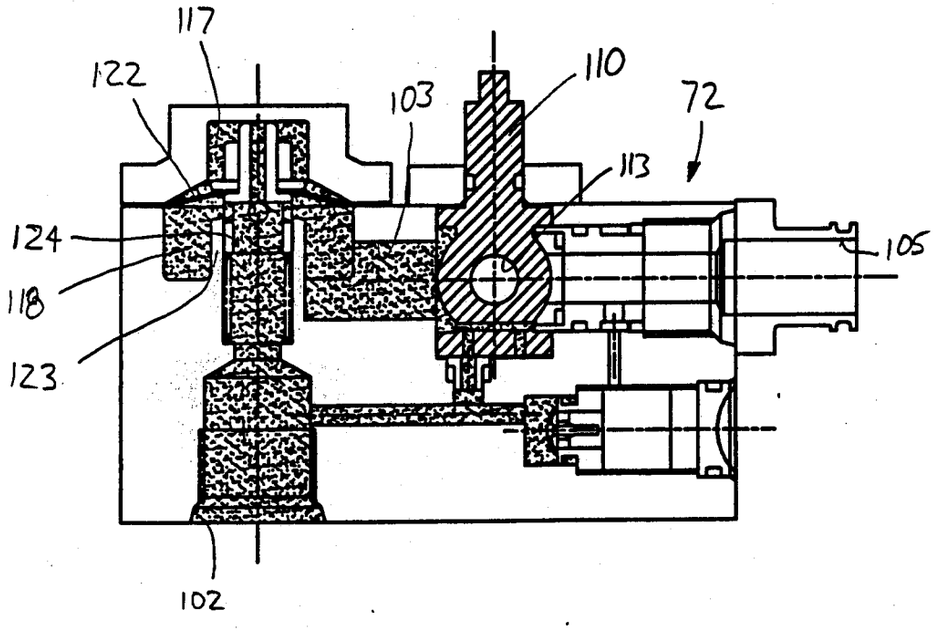
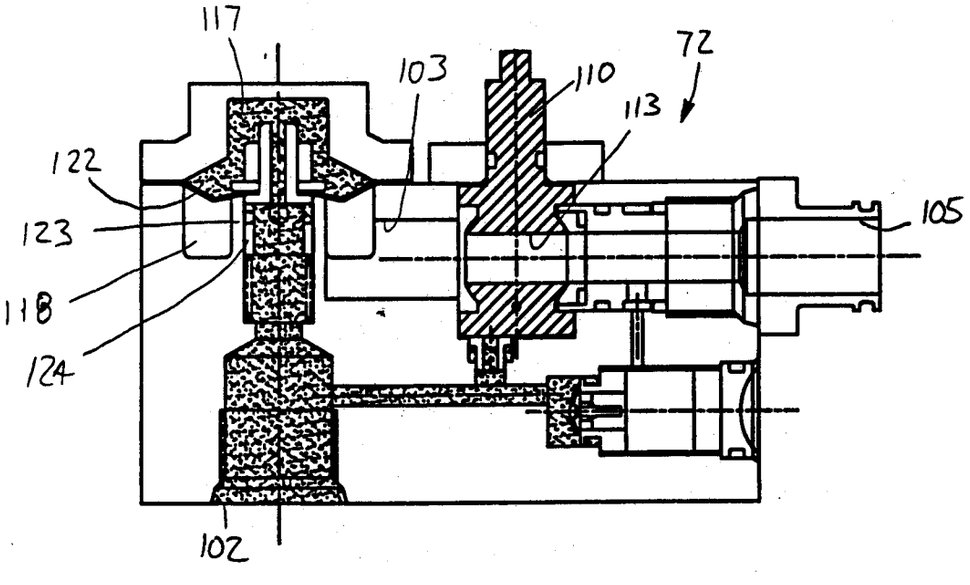


FIG. 7C



PRINT OF DRAWINGS
AS ORIGINALLY F)

FIG. 7B

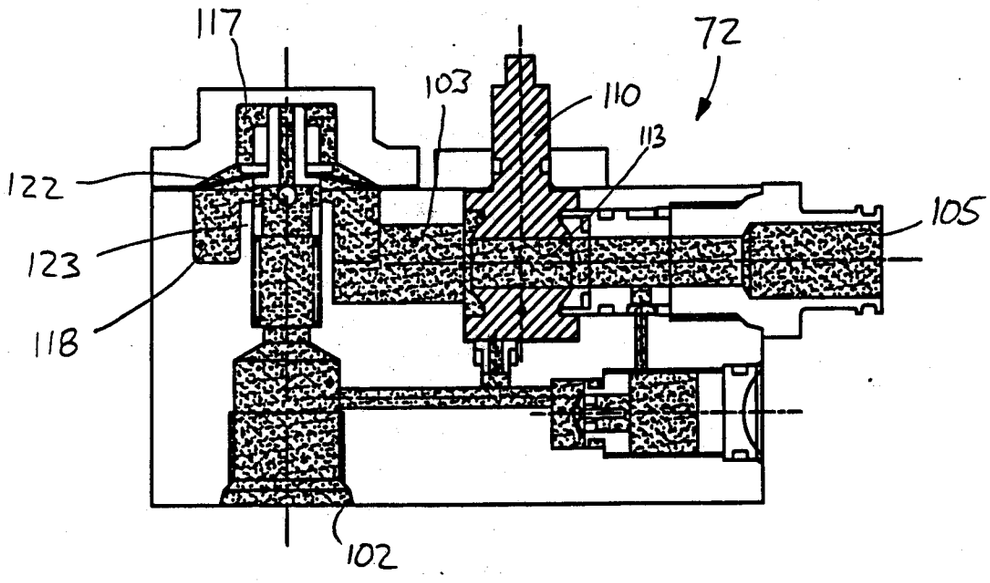
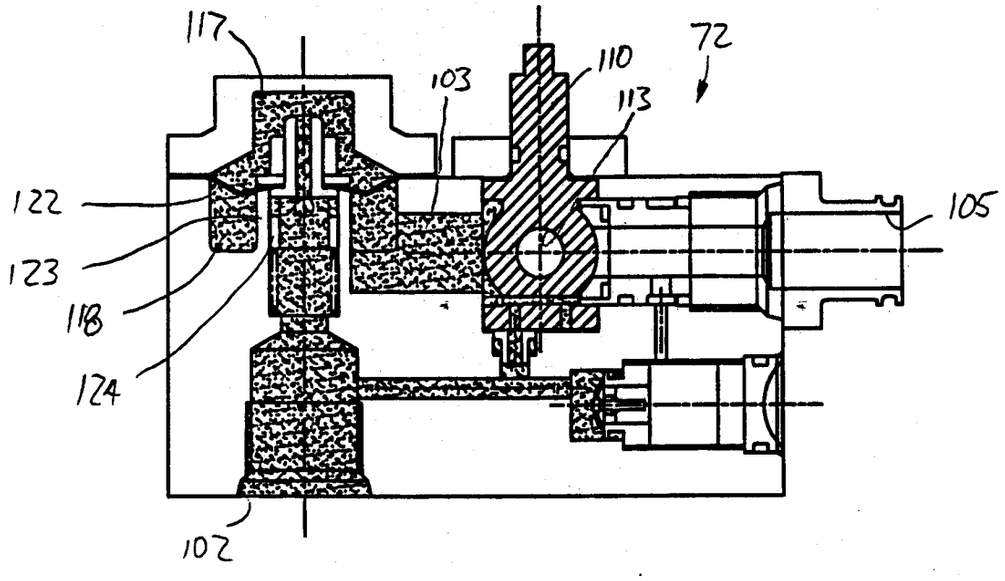


FIG. 7D



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/713,892	11/16/2000	Mark A. Pondelick	05007/36585

4743
MARSHALL, O'TOOLE, GERSTEIN, MURRAY & BORUN
6300 SEARS TOWER
233 SOUTH WACKER DRIVE
CHICAGO, IL 60606-6402

FORMALITIES LETTER

OC000000005791337

Date Mailed: 02/22/2001

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

- **The balance due by applicant is $ 130.**

A copy of this notice MUST be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

3751

#3

PATENT
Attorney Docket No. 05007/36585

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):

Mark A. Pondelick *et al.*

Serial No.: 09/713,892

Filed: November 16, 2000

For: MODULAR VACUUM TOILET

Group Art Unit: 3751

Examiner: Not yet assigned

I hereby certify that this paper is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, Washington, D.C. 20231 on this date:

May 14, 2001

Brent E. Matthias
Registration No. 41,974
Attorney for Applicants

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

The patents and/or publications listed on the enclosed PTO Form-1449 are submitted pursuant to 37 CFR §§ 1.56, 1.97, and 1.98. Copies of the patents or publications are enclosed as necessary.

This information disclosure statement is being filed with the application or within three months of the filing date of the application or date of entry into the national stage of an international application or, to the best of the undersigned's knowledge, before the mailing date of a first Office Action on the merits, whichever event occurs last. In accordance with 37 CFR §1.97(b), no certification or fee is required.

The Commissioner is authorized to charge any fee deficiency required by this paper, or credit any overpayment, to Deposit Account No. 13-2855. A copy of this paper is enclosed.

Respectfully submitted,

MARSHALL, O'TOOLE, GERSTEIN,
MURRAY & BORUN
6300 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6402
(312) 474-6300

By: Brent E. Matthias

Brent E. Matthias
Reg. No: 41,974

May 14, 2001

PATENT
Attorney Docket No. 05007/36585

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):

Mark A. Pondelick *et al.*

Serial No.: 09/713,892

Filed: November 16, 2000

For: MODULAR VACUUM TOILET

Group Art Unit: 3751

Examiner: Not yet assigned

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May 14, 2001

Brent E. Matthias
Registration No. 41,974
Attorney for Applicants

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
Washington, D.C. 20231

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MURRAY & BORUN
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233 South Wacker Drive
Chicago, Illinois 60606-6402
(312) 474-6300

By: Brent E. Matthias

Brent E. Matthias
Reg. No: 41,974

May 14, 2001

#3

Form PTO-1449 (Modified)

U.S. Department of Commerce
Patent and Trademark Office

INFORMATION DISCLOSURE STATEMENT

(Use several sheets if necessary)

Atty. Docket No.	Serial No.
05007/36585	09/713,892
Applicant: Mark A. Pondelick et al.	
Filing Date: 11/16/00	Group: 3751

U.S. PATENT DOCUMENTS

*Examiner Initials		Document Number	Issue Date	Name	Class	Subclass	Filing Date If Appropriate
	A1	3,239,849	03/15/66	S.A.J. Liljendahl	4	77	
	A2	3,922,730	12/02/75	Kemper	4	10	
	A3	3,995,328	12/07/76	Carolan et al.	4	10	
	A4	4,063,315	12/20/77	Carolan et al.	4	10	
	A5	4,184,506	01/22/80	Varis et al.	137	205	
	A6	4,246,925	01/27/81	Oldfelt	137	205	
	A7	4,275,470	06/30/81	Badger et al.	4	316	
	A8	4,357,719	11/09/82	Badger et al.	4	316	
	A9	4,521,925	06/11/85	Chen et al.	4	362	
	A10	4,713,847	12/22/87	Oldfelt et al.	4	316	
	A11	5,007,117	04/16/91	Oldfelt et al.	4	432	
	A12	5,133,853	07/28/92	Mattsson et al.	210	104	
	A13	5,604,938	02/25/97	Tyler	4	321	
	A14	5,732,417	03/31/98	Pondelick	4	427	
	A15	6,131,596	10/27/00	Monson	137	14	
	A16	6,152,160	11/28/00	Bowden Wilcox et al.	137	15.01	
	A17	US 6,216,285B1	04/17/01	Olin	4	431	

EXAMINER [signature] DATE CONSIDERED 8/15/01

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PATENT
Attorney Docket No. 05007/36585

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	)	
	)	
Mark A. Pondelick et al.	)	Title: MODULAR VACUUM
	)	TOILET
Serial No: 09/713,892	)	
	)	
Filed: November 16, 2000	)	

TRANSMITTAL OF EXECUTED DECLARATION

Commissioner for Patents
Washington, D.C. 20231

Attention: BOX MISSING PART

Sir:

Submitted herewith is an executed Declaration for filing in the above-identified application, in response to the Notice to File Missing Parts issued by the Patent and Trademark Office on February 22, 2001.

CERTIFICATE OF MAILING (37 CFR 1.8)

I hereby certify that this paper and the documents referred to as enclosed therewith are being deposited with the United States Postal Service as first class mail, postage prepaid, on June 18, 2001, in an envelope addressed to Commissioner for Patents, Washington, D.C. 20231.

Brent E. Matthias

Brent E. Matthias, Reg. No. 41,974

Also enclosed is a copy of the Notice together with our check in the amount of $130.00 in payment of the fee.

The Commissioner is hereby authorized to charge any deficiency in the amount enclosed or any additional fees which may be required under 37 CFR 1.16 or 1.17 to Deposit Account No. 13-2855. A copy of this request is enclosed.

Please refund any overpayment to Marshall, O'Toole, Gerstein, Murray & Borun at the address below.

Respectfully submitted,

MARSHALL, O'TOOLE, GERSTEIN,
MURRAY & BORUN
6300 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6402
(312) 474-6300

By: Brent E Matthias

Brent E. Matthias
Reg. No: 41,974

June 18, 2001

PATENT
Attorney Docket No. 05007/36585

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	)	Title: MODULAR VACUUM TOILET
Mark A. Pondelick et al.	)	
	)	Group Art Unit: 3751
Serial No: 09/713,892	)	
	)	Examiner: Not yet assigned
Filed: November 16, 2000	)	
	)	

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicant(s) hereby petition(s) pursuant to 37 CFR 1.136(a) for a two month extension of time in order to respond to a Notice to File Missing Parts mailed by the U.S. Patent Office on February 22, 2001.

CERTIFICATE OF MAILING (37 CFR 1.8)

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Brent E. Matthias

Brent E. Matthias, Reg. No. 41,974

1. **Small Entity Status**

☐ Verified statement(s) claiming small entity status is(are) attached.

☐ Small entity status has been established and is still effective.

☒ Has not been established.

2. **Extension of Time**

☒ This is a petition for an extension of time under 37 CFR 1.136 for the total number of months checked below:

EXTENSION (Months)	FEE FOR LARGE ENTITY		FEE FOR SMALL ENTITY	
One Month		$110.00		$55.00
Two Months	x	$390.00		$195.00
Three Months		$890.00		$445.00
Four Months		$1,390.00		$695.00
Five Months		$1,890.00		$945.00

If an additional Extension of Time is required, please consider this a petition therefor.

Extension Fee: $390.00

☐ An extension for _____ month(s) has already been secured and the fee paid therefor of $ _____ is deducted from the total fee due for the total months of extension now requested.

Deduction: $

Extension Fee Due With This Request: $390.00

3. **Method of Payment of Fees**

☒ Attached is a check in the amount of $390.00

☐ Charge Deposit Account No. 13-2855 in the amount of: $_____
A copy of this Petition is enclosed.

4. **Deposit Account and Refund Authorization**

The Commissioner is hereby authorized to charge any deficiency in the amount enclosed or any additional fees which may be required during the pendency of this application under 37 CFR 1.16 or 37 CFR 1.17 to Deposit Account No. 13-2855. A copy of this Petition is enclosed.

Please refund any overpayment to Marshall, O'Toole, Gerstein, Murray & Borun at the address below.

Respectfully submitted,

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MURRAY & BORUN
6300 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6402
(312) 474-6300

By: 

Brent E. Matthias
Reg. No: 41,974

June 18, 2001

PATENT
Attorney Docket No. 05007/36585

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	)	
	)	
Mark A. Pondelick et al.	)	Title: MODULAR VACUUM TOILET
	)	
Serial No: 09/713,892	)	
	)	
Filed: November 16, 2000	)	

TRANSMITTAL OF EXECUTED DECLARATION

Commissioner for Patents
Washington, D.C. 20231

Attention: BOX MISSING PART

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(312) 474-6300

By: Brent E Matthias

Brent E. Matthias
Reg. No: 41,974

June 18, 2001

Sector 5

PATENT
Attorney Docket No. 05007/36585

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	)	Title: MODULAR VACUUM TOILET
Mark A. Pondelick et al.	)	
	)	Group Art Unit: 3751
Serial No: 09/713,892	)	
	)	Examiner: Not yet assigned
Filed: November 16, 2000	)	
	)	

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06/26/2001 JADD01 00000059 09713892
01 FC:116 390.00 OP

Brent E. Matthias, Reg. No. 41,974

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MARSHALL, O'TOOLE, GERSTEIN,
MURRAY & BORUN
6300 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6402
(312) 474-6300

By: 

Brent E. Matthias
Reg. No: 41,974

June 18, 2001

Atty. Docket No: 05007/36585

DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled "**MODULAR VACUUM TOILET**," the specification of which was filed on November 16, 2000 as Application Serial No. 09/713,892. I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

			Priority Claimed	
(Application Serial Number)	(Country)	(Day/Month/Year Filed)	☐ Yes	☐ No
(Application Serial Number)	(Country)	(Day/Month/Year Filed)	☐ Yes	☐ No

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

(Application Serial Number)	(Day/Month/Year Filed)
(Application Serial Number)	(Day/Month/Year Filed)

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

(Application Serial Number)	(Day/Month/Year Filed)	(Status-Patented, Pending or Abandoned)
(Application Serial Number)	(Day/Month/Year Filed)	(Status-Patented, Pending or Abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: I hereby appoint as my attorneys, with full power of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

John B. Lungmus(18,566)	Patrick D. Ertel (26,877)	Jeffrey S. Sharp (31,879)	Anthony G. Sitko (36,278)
Allen H. Gerstein (22,218)	Richard B. Hoffman(26,910)	Martin J. Hirsch (32,237)	James A. Flight (37,622)
Nate F. Scarpelli (22,320)	James P. Zeller (28,491)	James J. Napoli (32,361)	Roger A. Heppermann (37,641)
Edward M. O'Toole (22,477)	William E. McCracken (30,195)	Richard M. La Barge (32,254)	David A. Gass (38,153)
Michael F. Borun (25,447)	Richard A. Schnurr (30,890)	Li-Hsien Rin-Laures, M.D. (33,547)	Gregory C. Mayer (38,238)
Trevor B. Joike (25,542)	Anthony Nimmo (30,920)	Douglass C. Hochstetler (33,710)	Michael R. Weiner (38,359)
Carl E. Moore, Jr. (26,487)	Christine A. Dudzik (31,245)	Robert M. Gerstein (34,824)	William K. Merkel (40,725)
Richard H. Anderson (26,526)	Kevin D. Hogg (31,839)		Brent E. Matthias (41,974)

Send correspondence to: Brent E. Matthias, Esq.

FIRM NAME	PHONE NO.	STREET	CITY & STATE	ZIP CODE
Marshall, O'Toole, Gerstein, Murray & Borun	312-474-6300	6300 Sears Tower 233 South Wacker Drive	Chicago, Illinois	60606-6402

Full Name of First or Sole Inventor Mark A. Pondelick	Citizenship USA
Residence Address - Street 10848 Hamborg Rd.	Post Office Address - Street 10848 Hamborg Rd.
City (Zip) Roscoe 61073	City (Zip) Roscoe 61073
State or Country Illinois	State or Country Illinois
Date ☒ 4/30/2001	Signature ☒ Mark A. Pondelick

Second Joint Inventor, if any Jay D. Stradinger	Citizenship USA
Residence Address - Street 12742 Bellmawr Lane	Post Office Address - Street 12742 Bellmawr Lane
City (Zip) Roscoe 61073	City (Zip) Roscoe 61073
State or Country Illinois	State or Country Illinois
Date ☒ 5/02/01	Signature ☒ Jay Stradinger

Third Joint Inventor, if any William Bruce Anderson	Citizenship USA
Residence Address - Street 128 N. Vale Avenue	Post Office Address - Street 128 N. Vale Avenue
City (Zip) Rockford 61109	City (Zip) Rockford 61109
State or Country Illinois	State or Country Illinois
Date ☒ 5-2-01	Signature ☒ William Bruce Anderson

Fourth Joint Inventor, if any Arthur J. McGowan, Jr.	Citizenship USA
Residence Address - Street 604 East 130th Way	Post Office Address - Street 604 East 130th Way
City (Zip) Thornton 80241	City (Zip) Thornton 80241
State or Country Colorado	State or Country Colorado
Date ☒ ~~5/2/01~~ 6/4/01	Signature ☒ ~~Arthur J. McGowan, Jr.~~ Arthur J. McGowan, Jr.

Fifth Joint Inventor, if any Douglas M. Wallace	Citizenship USA
Residence Address - Street 9343 Forest Ridge Drive	Post Office Address - Street 9343 Forest Ridge Drive
City (Zip) Roscoe 61073	City (Zip) Roscoe 61073
State or Country Illinois	State or Country Illinois
Date ☒ June 12 '01	Signature ☒

Sixth Joint Inventor, if any Ian Tinkler	Citizenship Great Britain
Residence Address - Street 3345 Gunflint Trail	Post Office Address - Street 3345 Gunflint Trail
City (Zip) Rockford 61109	City (Zip) Rockford 61109
State or Country Illinois	State or Country Illinois
Date ☒ 4-30-01	Signature ☒

Seventh Joint Inventor, if any Michael B. Hancock	Citizenship USA
Residence Address - Street 1464 Randall Drive	Post Office Address - Street 1464 Randall Drive
City (Zip) Rockford 61108	City (Zip) Rockford 61108
State or Country Illinois	State or Country Illinois
Date ☒ 4/30/2001	Signature ☒

Eighth Joint Inventor, if any	Citizenship
Residence Address - Street	Post Office Address - Street
City (Zip)	City (Zip)
State or Country	State or Country
Date ☒	Signature ☒

APPLICABLE RULES AND STATUTES

37 CFR 1.56. DUTY OF DISCLOSURE - INFORMATION MATERIAL TO PATENTABILITY (Applicable Portion)

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and
(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentability defines, to make sure that any material information contained therein is disclosed to the Office.

Information relating to the following factual situations enumerated in 35 USC 102 and 103 may be considered material under 37 CFR 1.56(a).

35 U.S.C. 102. CONDITIONS FOR PATENTABILITY: NOVELTY AND LOSS OF RIGHT TO PATENT

A person shall be entitled to a patent unless --

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

(c) he has abandoned the invention, or

(d) the invention was first patented or caused to be patented, or was the subject of an inventor's certificate, by the applicant or his legal representatives or assigns in a foreign country prior to the date of the application for patent in this country on an application for patent or inventor's certificate filed more than twelve months before the filing of the application in the United States, or

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraph (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent, or

(f) he did not himself invent the subject matter sought to be patented, or

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

35 U.S.C. 103. CONDITIONS FOR PATENTABILITY; NON-OBVIOUS SUBJECT MATTER (Applicable Portion)

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

35 U.S.C. 112. SPECIFICATION (Applicable Portion)

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/713,892	11/16/2000	Mark A. Pondelick	05007/36585

4743
MARSHALL, O'TOOLE, GERSTEIN, MURRAY & BORUN
6300 SEARS TOWER
233 SOUTH WACKER DRIVE
CHICAGO, IL 60606-6402

FORMALITIES LETTER

OC000000005791337

Date Mailed: 02/22/2001

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing. Docketed: 4/22/01
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

- **The balance due by applicant is $ 130.**

A copy of this notice MUST be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202
PART 2 - COPY TO BE RETURNED WITH RESPONSE

06/26/2001 JADD01 00000059 09713892
02 FC:105 130.00 OP

Interview Summary	Application No.	Applicant(s)	
	09/713,892	PONDELICK ET AL.	
	Examiner	Art Unit	
	Tuan N. Nguyen	3751	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Tuan N. Nguyen*. (3)_____.

(2) *Brent Matthias*. (4)_____.

Date of Interview: *29 August 2001* .

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____ .

Claim(s) discussed: *1 and 24* .

Identification of prior art discussed: *as cited on form PTO-892* .

Agreement with respect to the claims f)☒ was reached. g)☐ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *it was agreed to amend claims 1 and 24 as indicated on the attached Examiner's Amendment to avoid the application of prior art* .

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

i)☒ It is not necessary for applicant to provide a separate record of the substance of the interview(if box is checked).

Unless the paragraph above has been checked, THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

_____
Examiner's signature, if required

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/713,892	11/16/00	PONDELICK	05007/36585

004743 QM01/0831
MARSHALL, O TOOLE, GERSTEIN, MURRAY & BO
6300 SEARS TOWER
233 SOUTH WACKER DRIVE
CHICAGO IL 60606-6402

EXAMINER	
NGUYEN, T	
ART UNIT	**PAPER NUMBER**
3751	

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

THE PATENT TERM ADJUSTMENT TO DATE IS 00 DAYS. IF THE PATENT ISSUE FEE IS PAID ON THE DATE THAT IS THREE MONTHS AFTER THE MAILING DATE OF THIS NOTICE AND THE PATENT ISSUES ON THE TUESDAY BEFORE THE DATE THAT IS 28 WEEKS (SIX AND A HALF MONTHS) AFTER THE MAILING DATE OF THIS NOTICE, THE TERM ADJUSTMENT WILL BE 00 DAYS.

6/A

Notice of Allowability	Application No. 09/713,892	Applicant(s) PONDELICK ET AL.	
	Examiner Tuan N. Nguyen	Art Unit 3751	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the application filed 11/16/00*.
2. ☒ The allowed claim(s) is/are *1,4-14 and 24-37*.
3. ☐ The drawings filed on _____ are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
   (a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

8. ☒ CORRECTED DRAWINGS must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No. _____.
   (b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the Examiner.
   (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the top margin (not the back) of each sheet. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1☒ Notice of References Cited (PTO-892)
3☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
5☒ Information Disclosure Statements (PTO-1449), Paper No. 3.
7☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
2☐ Notice of Informal Patent Application (PTO-152)
4☒ Interview Summary (PTO-413), Paper No. 5.
6☒ Examiner's Amendment/Comment
8☒ Examiner's Statement of Reasons for Allowance
9☐ Other

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

   I. Claims 1-14 and 24-37, drawn to a modular vacuum toilet, classified in class 4, subclass 431.

   II. Claims 15-23 and 38-40, drawn to a valve set, classified in class 137, subclass 588.

The inventions are distinct, each from the other because of the following reasons:

Inventions (I) and (II) are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombination as claimed because the modular vacuum toilet does not require a valve set having an outlet pipe defining a branch that is attachable to a discharge pipe in a left-handed discharge configuration and a right-handed discharge configuration. The subcombination has separate utility such as a valve set for a sink.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art because of their recognized divergent subject matter, restriction for examination purposes as indicated is proper.

2. During a telephone conversation with Mr. Brent Matthias on August 29, 2001, a provisional election was made without traverse to prosecute the invention (I), claims 1-14 and 24-37.

3. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a petition under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

EXAMINER'S AMENDMENT

4. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Mr. Brent Matthias on August 29, 2001.

The application has been amended as follows:

On page 1 of the specification,

line 1: the title "MODULAR VACUUM TOILET" has been replaced with --MODULAR VACUUM TOILET WITH LINE REPLACEABLE UNITS--.

On page 8 of the specification,

line 13: "80" has been replaced with --83--; and

line 19: "85, 86" has been replaced with --86, 87--.

On page 9 of the specification,

line 26: "103" has been replaced with --102--.

On page 11 of the specification,

line 30: "121" has been replaced with --122--; and

line 31: "5" has been replaced with --6--.

On page 12 of the specification,

line 16: "121" has been replaced with --122--.

Claims 2, 3, 15-23 and 38-40 have been canceled.

In claim 1 (patent claim 1),

line 4: "support structure" has been replaced with --frame support structure having a top with an opening therethrough--; and

a2

line 5: "supported by" has been replaced with --including a sidewall sized for insertion into the opening and having an out-turned flange supported by the top of--.

a3

In claim 24 (patent claim 13),

line 1: --waste-- has been inserted before "receptacle"; and

line 2: --, a stationary frame support structure having a top with an opening therethrough, the waste receptacle including a sidewall sized for insertion into the opening and having an out-turned flange supported by the top of the support structure-- has been inserted after "therewith".

a4

In claim 25 (patent claim 14),

lines 1-3: "in which the vacuum... the bowl being a" has been replaced with --the waste receptacle is the--.

a5

In claim 26 (patent claim 15),

line 2: "bowl" has been replaced with --waste receptacle--; and

line 3: "bowl" has been replaced with --waste receptacle--.

In claim 31 (patent claim 20),

line 2: "bowl" has been replaced with --waste receptacle--.

In claim 32 (patent claim 21),

line 2: "bowl" has been replaced with --waste receptacle--.

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Olin et al. discloses another vacuum toilet having a valve set including a discharge valve, a rinse fluid valve, and a control unit. Tyler discloses a vacuum flush toilet assembly having a frame support structure for supporting a bowl therein. Uyeda et al. discloses a toilet construction having a valve set including a discharge valve, a rinse fluid valve, and a control unit.

6. Claims 1, 4-14 and 24-37 are allowed.

7. The following is an examiner's statement of reasons for allowance: none of the prior art alone or in combination teaches a vacuum toilet comprising a frame support structure having a top with an opening therethrough, a waste receptacle (removable bowl) including a sidewall sized for insertion into the opening and having an out-turned flange supported by the top of the support structure, the bowl defining an outlet and having a rinse fluid dispenser, and a valve set module including a discharge valve connected to the bowl outlet, a rinse fluid valve connected the rinse fluid dispenser and a flush control unit for controlling actuation of the discharge valve and rinse fluid valve.

8. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tuan N. Nguyen whose telephone number is 703-306-9046. The examiner can normally be reached on Monday-Friday (10:00-6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Gregory L. Huson can be reached on 703-308-2580. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7766 for regular communications and 703-308-7766 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0858.

TN
August 29, 2001

GREGORY L. HUSON
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3700

Attachment for PTO-948 (Rev. 03/01, or earlier)
6/18/01

The below text replaces the pre-printed text under the heading, "Information on How to Effect Drawing Changes," on the back of the PTO-948 (Rev. 03/01, or earlier) form.

INFORMATION ON HOW TO EFFECT DRAWING CHANGES

1. Correction of Informalities -- 37 CFR 1.85

New corrected drawings must be filed with the changes incorporated therein. Identifying indicia, if provided, should include the title of the invention, inventor's name, and application number, or docket number (if any) if an application number has not been assigned to the application. If this information is provided, it must be placed on the front of each sheet and centered within the top margin. If corrected drawings are required in a Notice of Allowability (PTOL-37), the new drawings **MUST** be filed within the **THREE MONTH** shortened statutory period set for reply in the Notice of Allowability. Extensions of time may NOT be obtained under the provisions of 37 CFR 1.136(a) or (b) for filing the corrected drawings after the mailing of a Notice of Allowability. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

2. Corrections other than Informalities Noted by Draftsperson on form PTO-948.

All changes to the drawings, other than informalities noted by the Draftsperson, **MUST** be made in the same manner as above except that, normally, a highlighted (preferably red ink) sketch of the changes to be incorporated into the new drawings **MUST** be approved by the examiner before the application will be allowed. No changes will be permitted to be made other than correction of informalities, unless the examiner has approved the proposed changes.

Timing of Corrections

Applicant is required to submit the drawing corrections within the time period set in the attached Office communication. See 37 CFR 1.85(a).

Failure to take corrective action within the set period will result in **ABANDONMENT** of the application.

Notice of References Cited	Application/Control No. 09/713,892	Applicant(s)/Patent Under Reexamination PONDELICK ET AL.	
	Examiner Tuan N. Nguyen	Art Unit 3751	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification	
X	A	US-5,909,968	06-1999	Olin et al.	4	431
X	B	US-5,271,105	12-1993	Tyler	4	431
X	C	US-3,860,973	01-1975	Uyeda et al.	4	431
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification	
	N						
	O						
	P						
	Q						
	R						
	S						
	T						

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

004743 QM01/0831
MARSHALL, O TOOLE, GERSTEIN, MURRAY & BO
6300 SEARS TOWER
233 SOUTH WACKER DRIVE
CHICAGO IL 60606-6402

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
09/713,892	11/16/00	026	NGUYEN, T	3751	08/31/01

First Named Applicant: PONDELICK, 35 USC 154(b) term ext. = 0 Days.

TITLE OF INVENTION: MODULAR VACUUM TOILET WITH LINE REPLACEABLE UNITS

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2 05007/36585	004-431.000	L41	UTILITY	NO	$1240.00	11/30/01

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.
If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is changed, pay twice the amount of the FEE DUE shown above and notify the Patent and Trademark Office of the change in status, or
B. If the status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:

A. Pay FEE DUE shown above, or

B. File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.

II. Part B-Issue Fee Transmittal should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B Issue Fee Transmittal should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "4b" of Part B-Issue Fee Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give application number and batch number.
Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PATENT AND TRADEMARK OFFICE COPY

PTOL-85 (REV. 10-96) Approved for use through 06/30/99. (0651-0033)

Bc,

PART B—ISSUE FEE TRANSMITTAL

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Washington, D.C. 20231

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Brent E. Matthias (Depositor's name)
Brent E. Matthias (Signature)
November 20, 2001 (Date)

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

004743 QM01/0831
MARSHALL, XXXXXXXX, GERSTEIN, XXXXXX & BO
6300 SEARS TOWER
233 SOUTH WACKER DRIVE
CHICAGO IL 60606-6402

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
09/713,892	11/16/00	026	NGUYEN, T 3751	08/31/01

First Named Applicant PONDELICK, 35 USC 154(b) term ext. = 0 Days.

TITLE OF INVENTION: MODULAR VACUUM TOILET WITH LINE REPLACEABLE UNITS

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2 05007/36585	004-431.000	L41	UTILITY	NO	$1240.00	11/30/01

1. Change of correspondence address or indication of " Fee Address" (37 CFR 1.363). Use of PTO form(s) and Customer Number are recommended, but not required.
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47) attached.

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 Marshall,
   2 Gerstein,
   3 & Borun

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)
PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.
(A) NAME OF ASSIGNEE EVAC INTERNATIONAL OY
(B) RESIDENCE: (CITY & STATE OR COUNTRY) Helsinki, Finland
Please check the appropriate assignee category indicated below (will not be printed on the patent)
☐ Individual ☒ corporation or other private group entity ☐ government

4a. The following fees are enclosed (make check payable to Commissioner of Patents and Trademarks):
- ☒ Issue Fee
- ☒ Advance Order - # of Copies 4

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- ☐ Advance Order - # of Copies

The COMMISSIONER OF PATENTS AND TRADEMARKS IS requested to apply the Issue Fee to the application identified above.

(Authorized Signature) Brent E. Matthias Reg. # 41,974 (Date) 11/20/01

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01/10/2002 MBIZUNE2 00000179 09713892
01 FC:142 1240.00 BP
02 FC:561 12.00 BP

TRANSMIT THIS FORM WITH FEE

PATENT
Attorney Docket No. 05007/36585

B
#8

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	)	Title: MODULAR VACUUM TOILET WITH LINE REPLACEABLE UNITS
Mark A. Pondelick *et al.*	)	
Serial No: 09/713,892	)	Batch #L41
Filed: November 16, 2000	)	Group Art Unit: 3751
	)	Examiner: T. Nguyen

TRANSMITTAL OF FORMAL DRAWINGS

Assistant Commissioner for Patents
Washington, D.C. 20231
Attention: Official Draftsman

Sir:

This application was allowed on August 21, 2001 and is assigned to Batch No. L41.

Enclosed herewith are eight (8) sheets of formal drawings for substitution in the above-referenced application.

Respectfully submitted,

MARSHALL, GERSTEIN & BORUN
6300 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606-6357
(312) 474-6300

By: Brent E. Matthias
Brent E. Matthias, Reg. No. 41,974

CERTIFICATE OF MAILING (37 CFR 1.8)

I hereby certify that this paper and the documents referred to as enclosed therewith are being deposited with the United States Postal Service as first class mail, postage prepaid, on **November 20, 2001**, in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Brent E. Matthias
Brent E. Matthias, Reg. No. 41,974

08/01

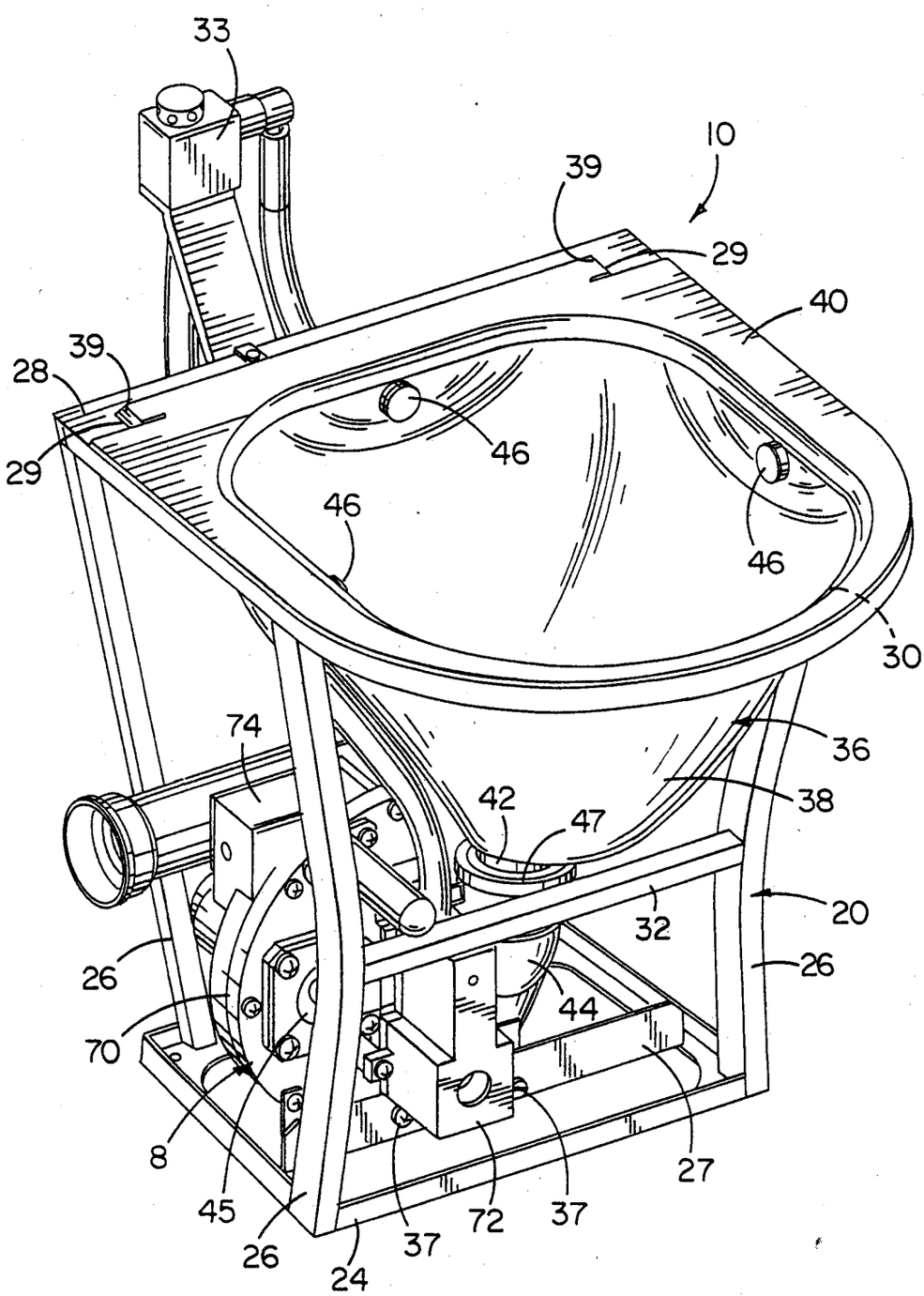
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FIG. 1A

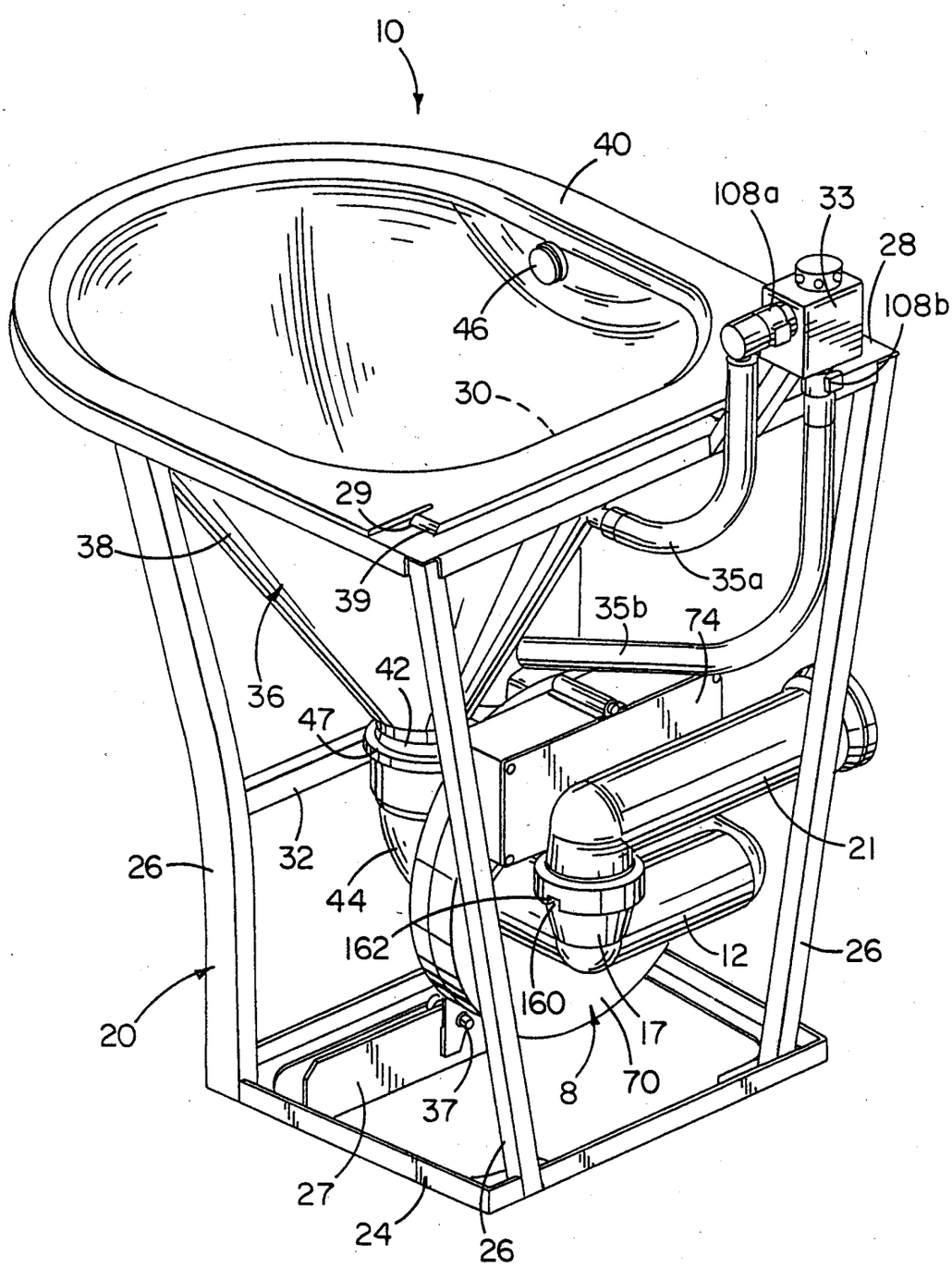
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FIG. 1B

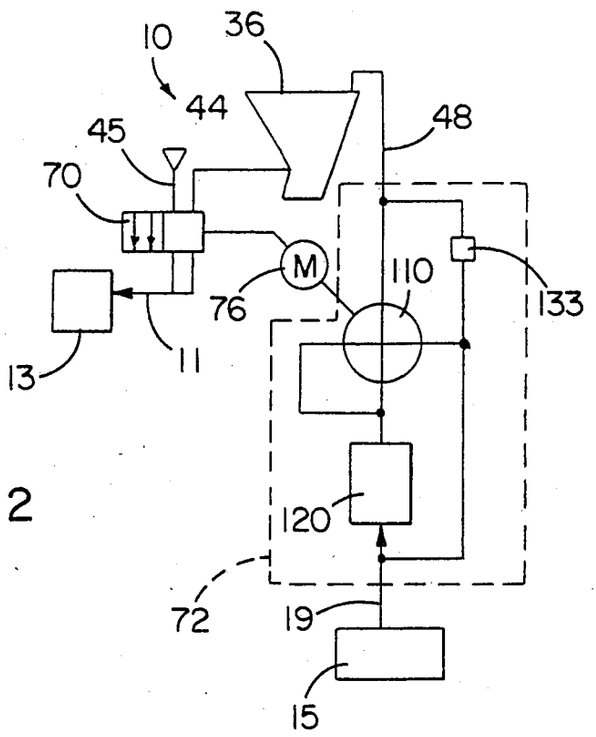

FIG. 2

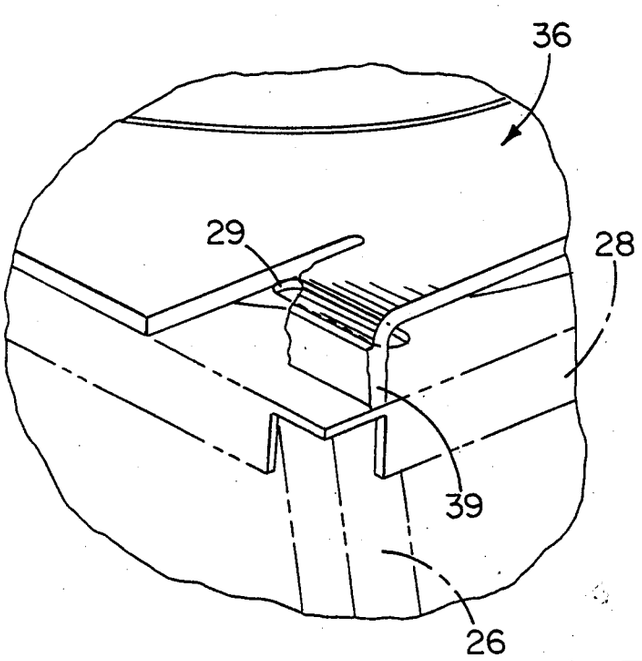

FIG. 3

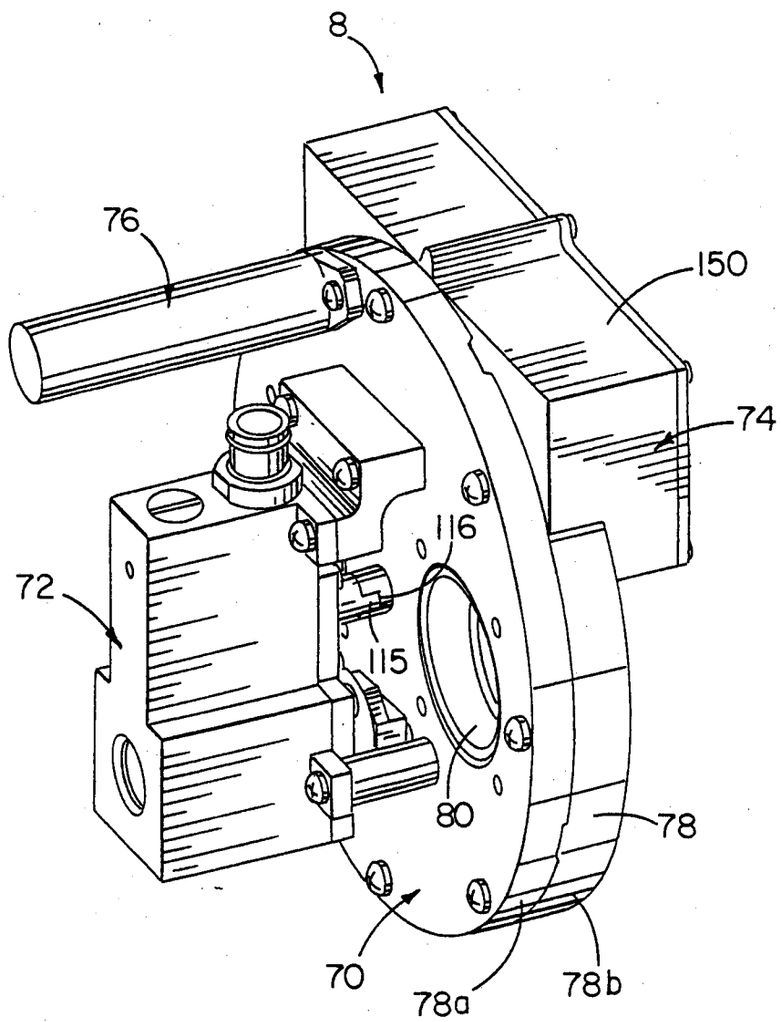

FIG. 4

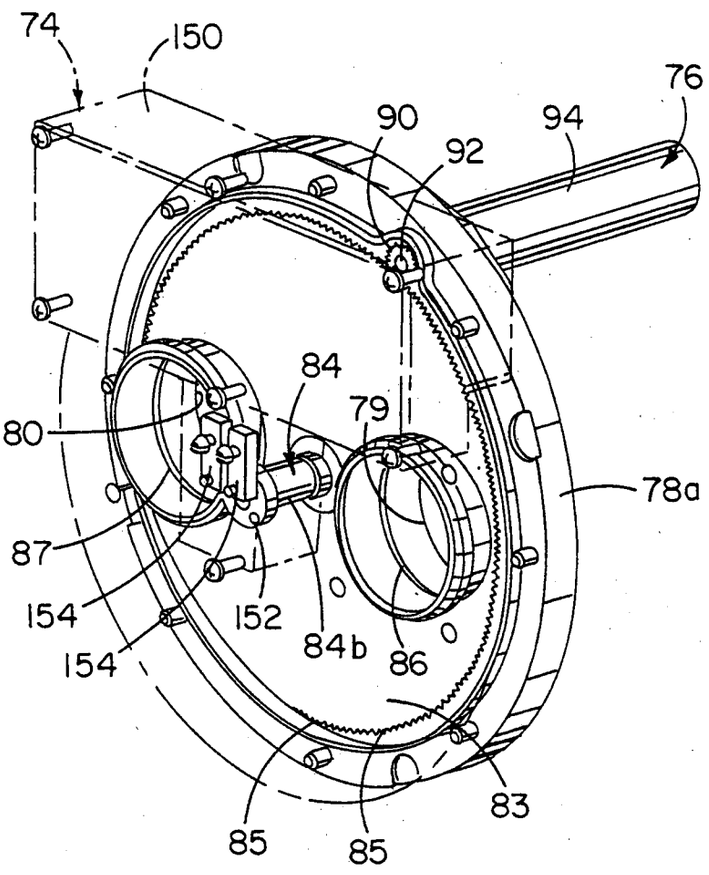
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FIG. 5A

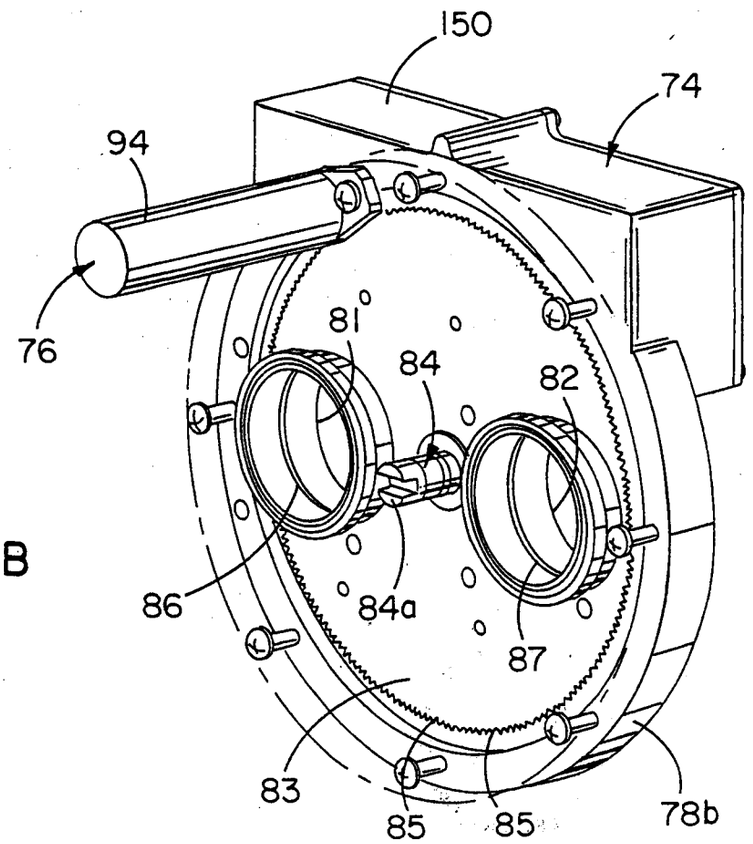
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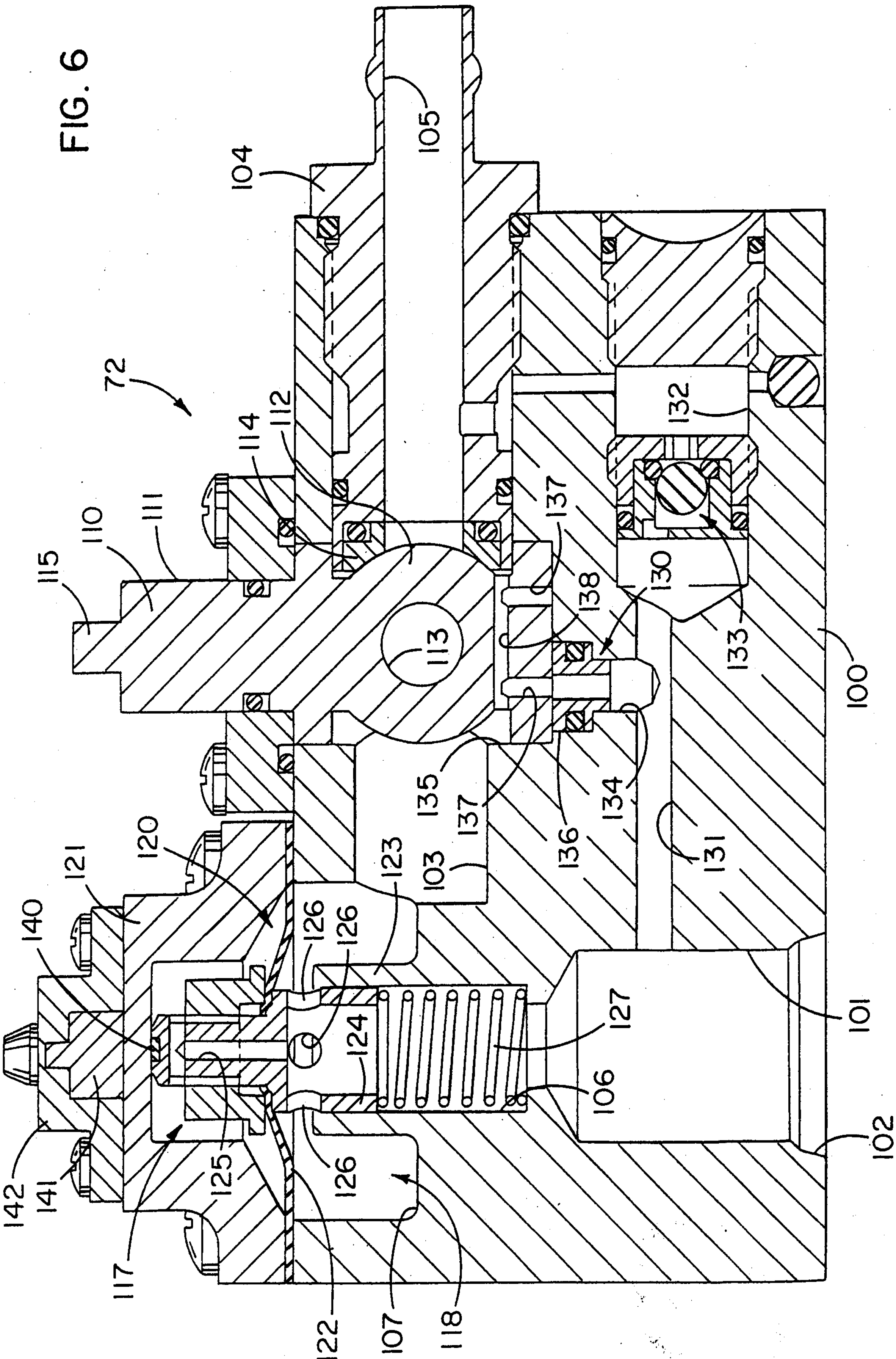
FIG. 5B

USSN 09/713,892 - Mark A. Pondeli[illegible] et al.
"Modular Vacuum Toilet With Line Replaceable Units"

FIG. 6



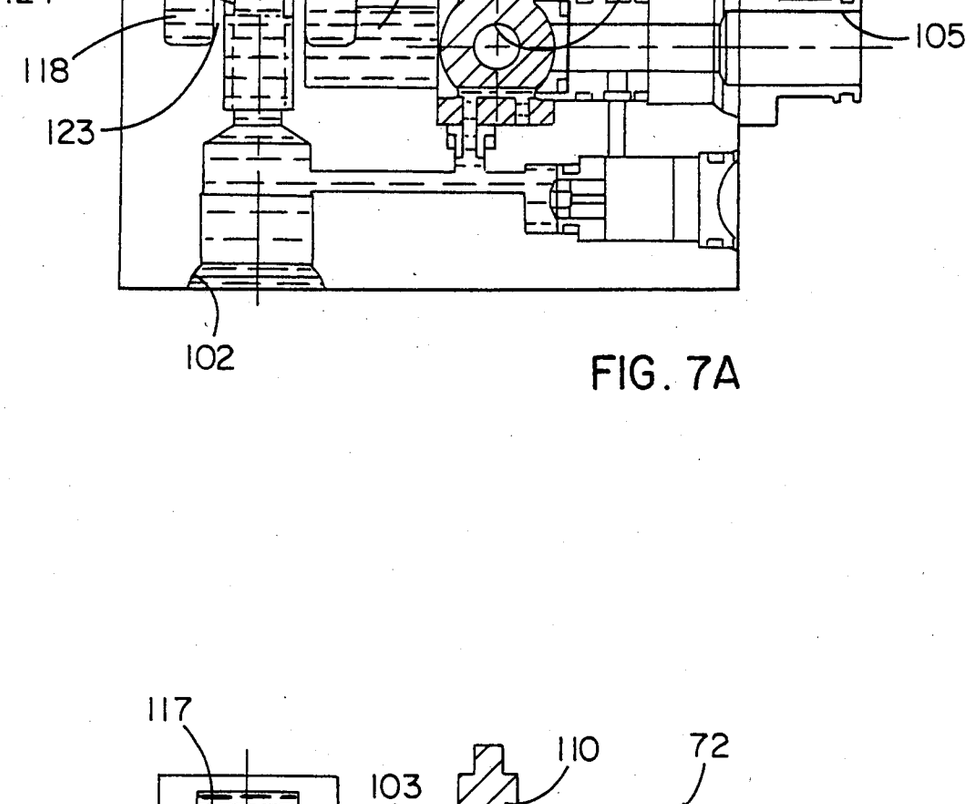

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FIG. 7A

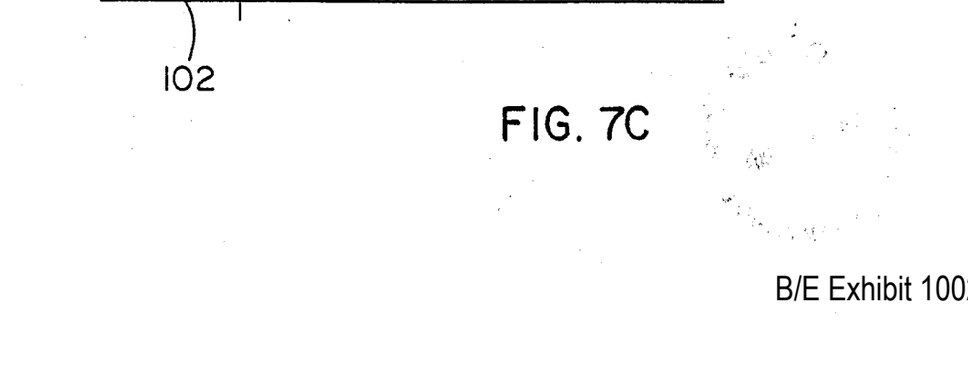
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FIG. 7C

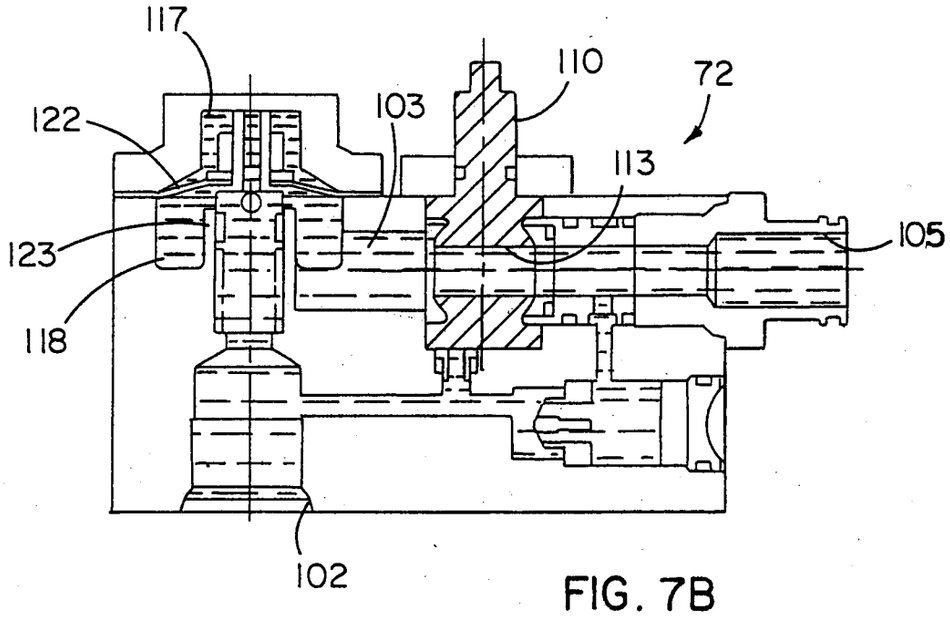
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FIG. 7B

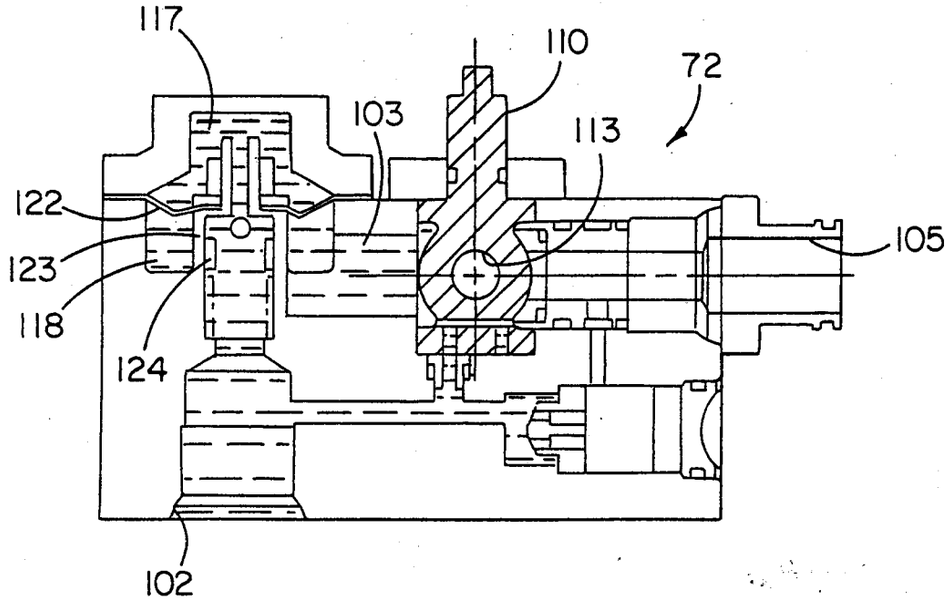
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FIG. 7D

	Type	Hits	Search Text	DBs	Time Stamp
1	BRS	259	(4/$.ccls. and toilet and frame) and valve	USPAT; EPO; JPO; DERWENT	2001/08/15 18:45
2	BRS	165	((4/$.ccls. and toilet and frame) and valve) and flush	USPAT; EPO; JPO; DERWENT	2001/08/16 18:45
3	IS&R	138	("4/431").CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/16 18:45
4	BRS	9	("3591868" | "4041554" | "5231706").PN.	USPAT; EPO; JPO; DERWENT	2001/08/16 18:47
5	BRS	44	("3239849" | "3355139" | "3727877" | "3811135" | "3860973" | "3878569" | "4275470" | "4306321" | "4357719" | "4376315" | "4521925" | "4585207" | "4713847" | "4783859").PN.	USPAT; EPO; JPO; DERWENT	2001/08/16 18:50
6	IS&R	70	("4/458").CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/16 19:02

	Type	L #	Hits	Search Text	DBs	Time Stamp
1	BRS	L1	68	sewer adj valve	USPAT; EPO; JPO; DERWENT	2001/08/23 02:07
2	BRS	L2	30501	(gear teeth) with valve	USPAT; EPO; JPO; DERWENT	2001/08/23 02:08
3	BRS	L3	204	2 and (sewer toilet)	USPAT; EPO; JPO; DERWENT	2001/08/23 02:08
4	BRS	L4	272	1 3	USPAT; EPO; JPO; DERWENT	2001/08/23 02:08
5	BRS	L5	27	valve adj disc and sewage and outlet	USPAT; EPO; JPO; DERWENT	2001/08/23 03:09

	Type	Hits	Search Text	DBs	Time Stamp
1	BRS	259	(4/$.ccls. and toilet and frame) and valve	USPAT; EPO; JPO; DERWENT	2001/08/15 18:45
2	BRS	165	((4/$.ccls. and toilet and frame) and valve) and flush	USPAT; EPO; JPO; DERWENT	2001/08/22 18:21
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4	BRS	9	("3591868" | "4041554" | "5231706").PN.	USPAT; EPO; JPO; DERWENT	2001/08/16 18:47
5	BRS	44	("3239849" | "3355139" | "3727877" | "3811135" | "3860973" | "3878569" | "4275470" | "4306321" | "4357719" | "4376315" | "4521925" | "4585207" | "4713847" | "4783859").PN.	USPAT; EPO; JPO; DERWENT	2001/08/16 18:50
6	IS&R	70	("4/458").CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/16 19:02
7	IS&R	374	("4/300").CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/21 19:28
8	IS&R	751	(("4/300") or ("4/316,420")).CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/21 19:29
9	IS&R	1059	(("4/300,431,432,433,434,435") or ("4/316,420")).CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/21 19:32
10	BRS	339	((("4/300,431,432,433,434,435") or ("4/316,420")).CCLS.) and valve	USPAT; EPO; JPO; DERWENT	2001/08/22 17:27
11	BRS	17	("4156297" | "4713847" | "4811754" | "4841578" | "5245711" | "5692250" | "B000001").PN.	USPAT; EPO; JPO; DERWENT	2001/08/21 19:41
12	BRS	68	valve and disk and sewage and outlet and toilet	USPAT; EPO; JPO; DERWENT	2001/08/22 17:34
13	BRS	27	valve adj disk and sewage and outlet	USPAT; EPO; JPO; DERWENT	2001/08/23 02:57
14	IS&R	1249	("137/588,595").CCLS.	USPAT; EPO; JPO; DERWENT	2001/08/22 18:16
15	BRS	3	"5271105" and bowl and (removable replac$)	USPAT; EPO; JPO; DERWENT	2001/08/22 18:23
16	BRS	394	(("137/588,595").CCLS.) and valve	USPAT; EPO; JPO; DERWENT	2001/08/22 18:25

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2000

Application or Docket Number: 09713892

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	40 minus 20=	* 20
INDEPENDENT CLAIMS	4 minus 3 =	* 1
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	355.00	OR	BASIC FEE	710.00
X$ 9=		OR	X$18=	360
X40=		OR	X80=	80
+135=		OR	+270=	
TOTAL		OR	TOTAL	1150

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

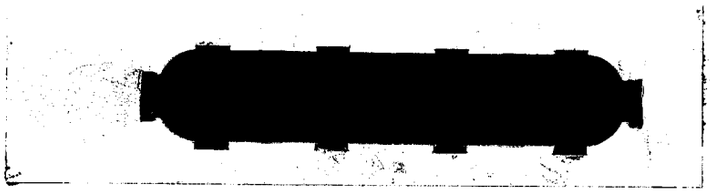
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.



SEARCHED

Class	Sub.	Date	Exmr.
4	300	8/15/01	~~DR~~
	316		
	420		
	431		
	1		
	435		
	458	8/15/01	
137	588	8/20/01	
	595	8/20/01	~~DR~~

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
4	431		
	1		
	435	8/29/01	~~DR~~

SEARCH NOTES
(INCLUDING SEARCH STRATEGY)

	Date	Exmr.
CONSULTED W/PRIMARY FETSUGA/CLASS 4	8/16/01	~~DR~~
CONSULTED W/PRIMARY RIVELL/CLASS 137 and 251	8/20/01	~~DR~~
~~EAST~~ BRS TEXT SEARCH	8/23/01	~~DR~~

(RIGHT OUTSIDE)

ISSUE SLIP STAPLE AREA (for additional cross references)

POSITION	INITIALS	ID NO.	DATE
FEE DETERMINATION			
O.I.P.E. CLASSIFIER			12-4-01
FORMALITY REVIEW	SDW	72346	2-22-01
RESPONSE FORMALITY REVIEW	Tequest	925	07-11-01

INDEX OF CLAIMS

✔ ..... Rejected
= ..... Allowed
— (Through numeral)... Canceled
÷ ..... Restricted
N ..... Non-elected
I ..... Interference
A ..... Appeal
O ..... Objected

Claim Final	Claim Original	Date
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If more than 150 claims or 10 actions staple additional sheet here

(LEFT INSIDE)

US006353942B1

(12) **United States Patent**
Pondelick et al.

(10) **Patent No.: US 6,353,942 B1**
(45) **Date of Patent: Mar. 12, 2002**

(54) **MODULAR VACUUM TOILET WITH LINE REPLACEABLE UNITS**

(75) Inventors: **Mark A. Pondelick**; **Jay D. Stradinger**, both of Roscoe; **William Bruce Anderson**, Rockford, all of IL (US); **Arthur J. McGowan, Jr.**, Thornton, CO (US); **Douglas M. Wallace**, Roscoe, IL (US); **Ian Tinkler**; **Michael B. Hancock**, both of Rockford, IL (US)

(73) Assignee: **Evac International OY**, Helsinki (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/713,892**

(22) Filed: **Nov. 16, 2000**

(51) **Int. Cl.**[7] **E03D 11/00**

(52) **U.S. Cl.** **4/431**; 4/434; 4/435; 137/588; 137/595

(58) **Field of Search** 4/300, 316, 420, 4/431–435, 458; 137/588, 595

(56) **References Cited**

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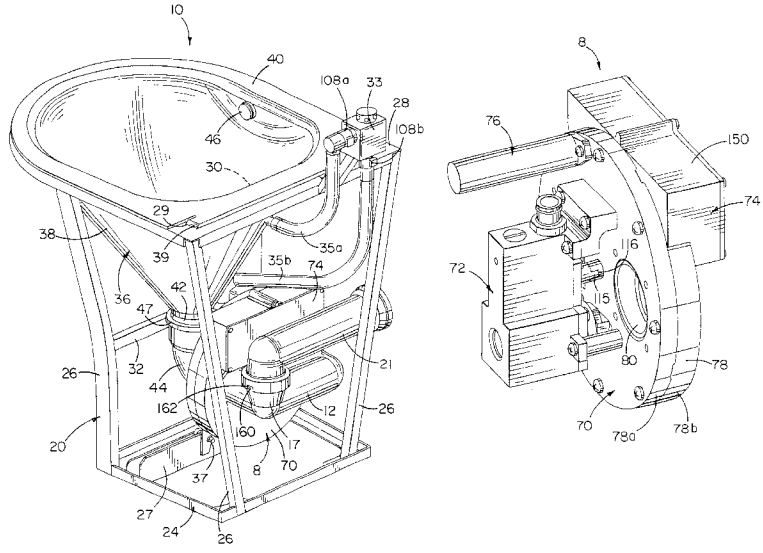
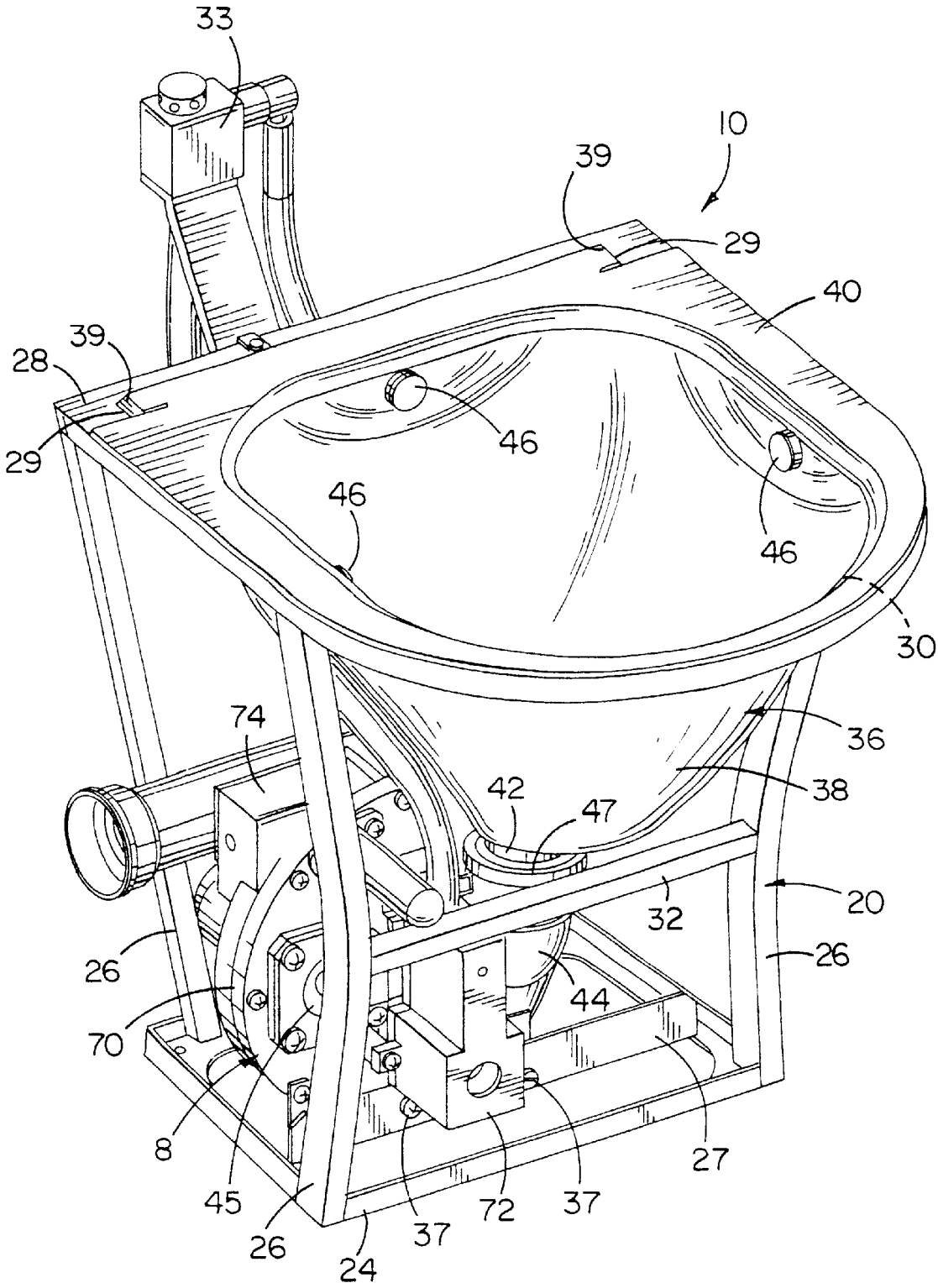
Primary Examiner—Gregory L. Huson
Assistant Examiner—Tuan Nguyen
(74) *Attorney, Agent, or Firm*—Marshall, Gerstein, & Borun

(57) **ABSTRACT**

A modular vacuum toilet, and a method of servicing such a toilet, are disclosed. The toilet is used with a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid. The modular vacuum toilet comprises a frame and a removable bowl engaging and supported be the frame, the bowl defining an outlet and having a rinse fluid dispenser associated therewith. The modular vacuum toilet also has a valve set module. The valve set module includes a discharge valve having an inlet in fluid communication with the bowl outlet, an outlet in fluid communication with the sewer line, and a movable discharge valve member disposed between the discharge valve inlet and outlet. A rinse fluid valve is also incorporated into the valve set module and has an inlet in fluid communication with the source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a movable rinse fluid valve member disposed between the rinse fluid valve inlet and outlet. The valve set module further includes a flush control unit having a circuit board operably connected to the discharge valve and rinse fluid valve for controlling actuation of the discharge valve member and rinse fluid valve member.

26 Claims, 8 Drawing Sheets

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72
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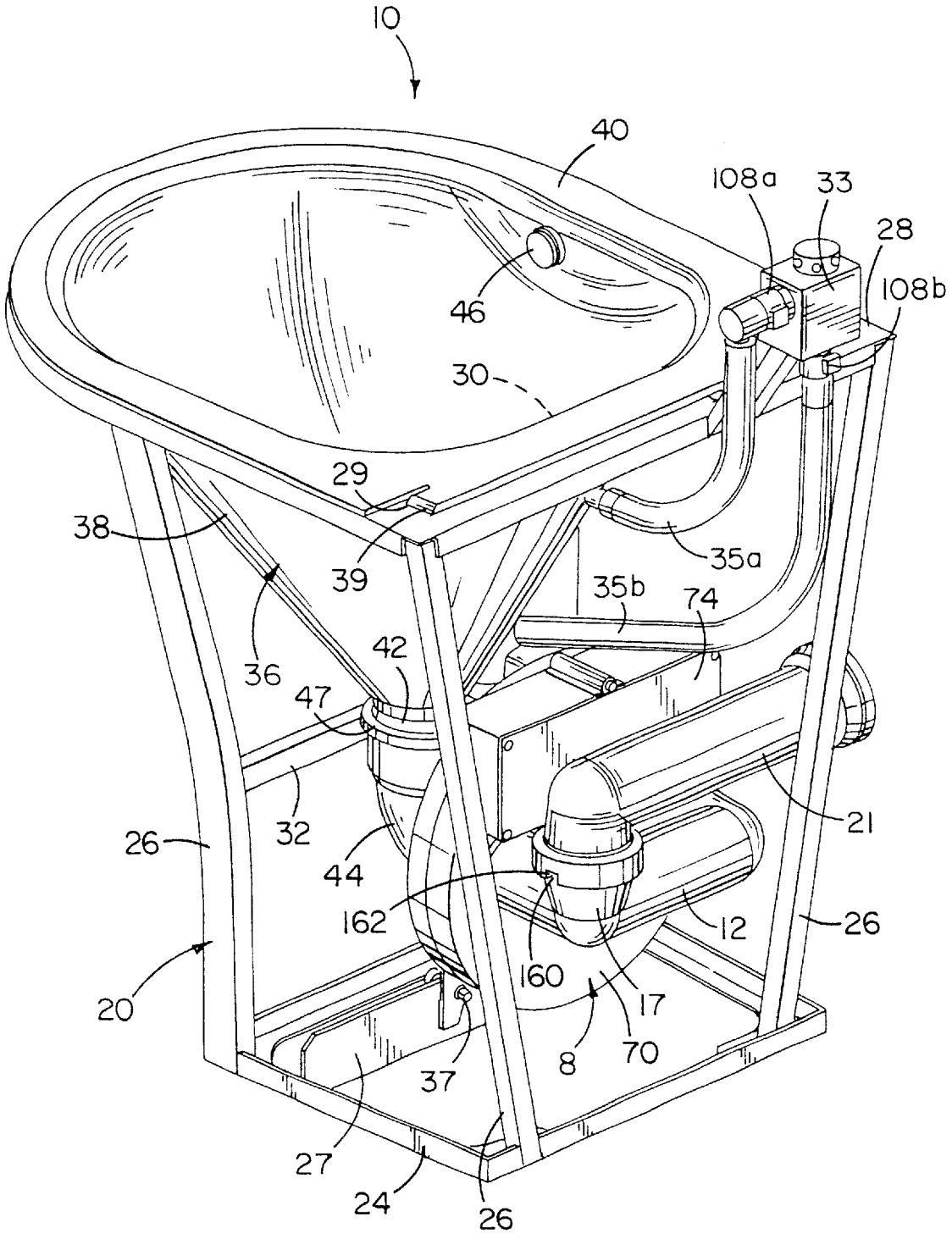
27

FIG. 1A


10
40
108a
33
28
108b
46
30
29
38
39
35a
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74
36
42
47
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162
12
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160
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FIG. 1B

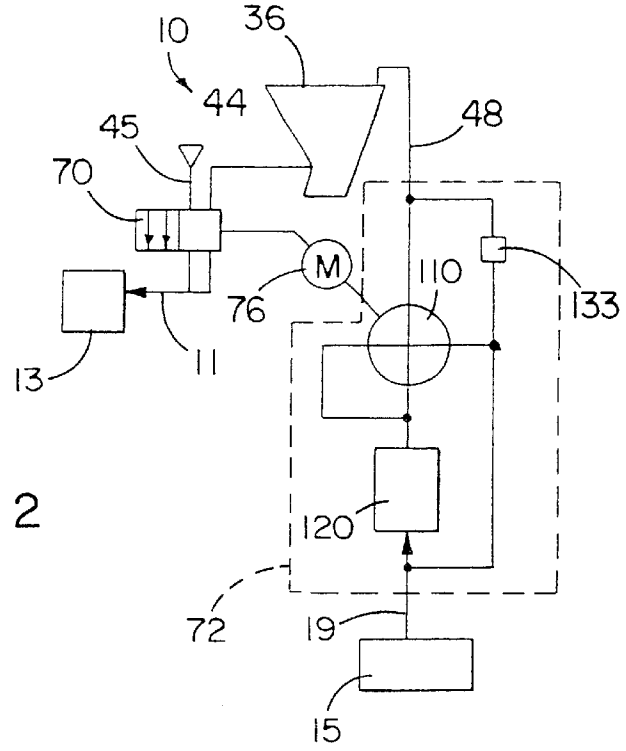


FIG. 2

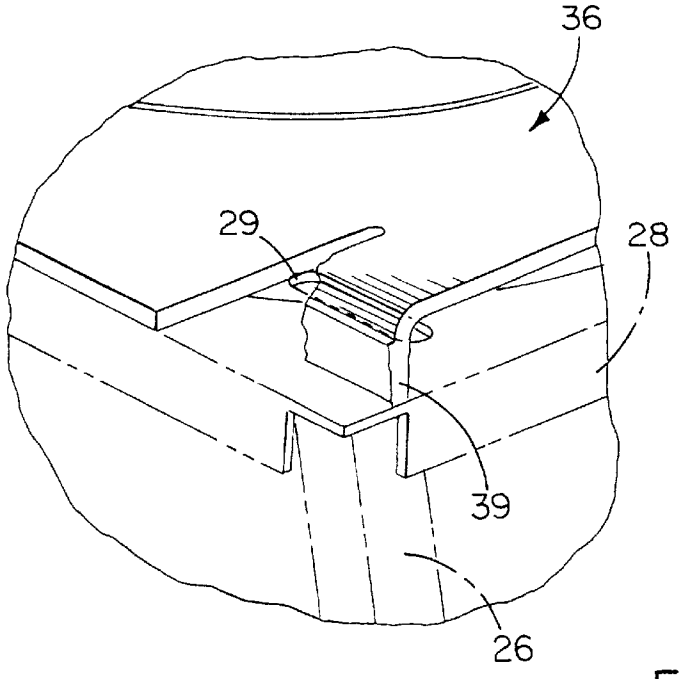


FIG. 3

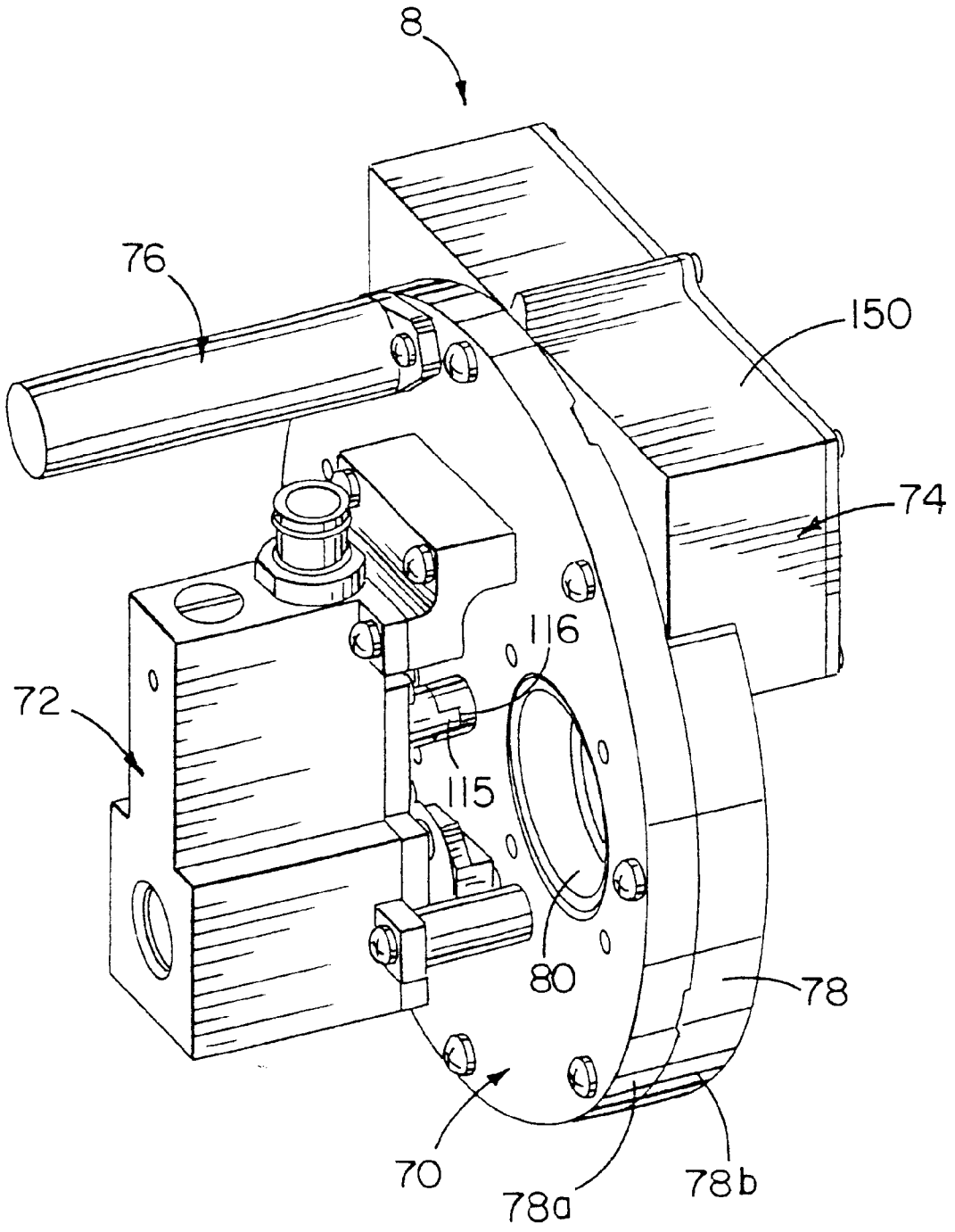


FIG. 4

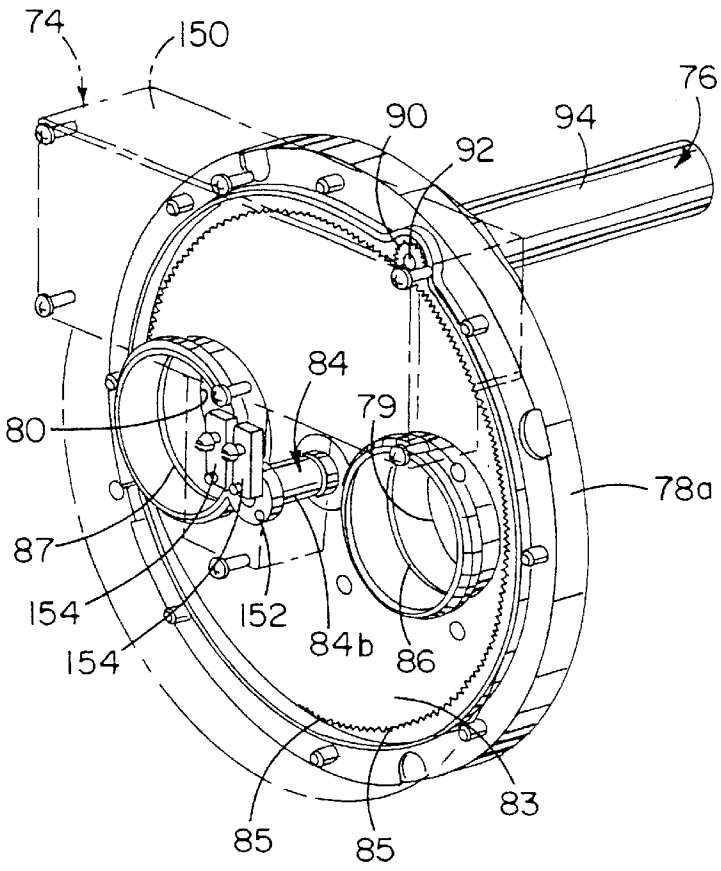
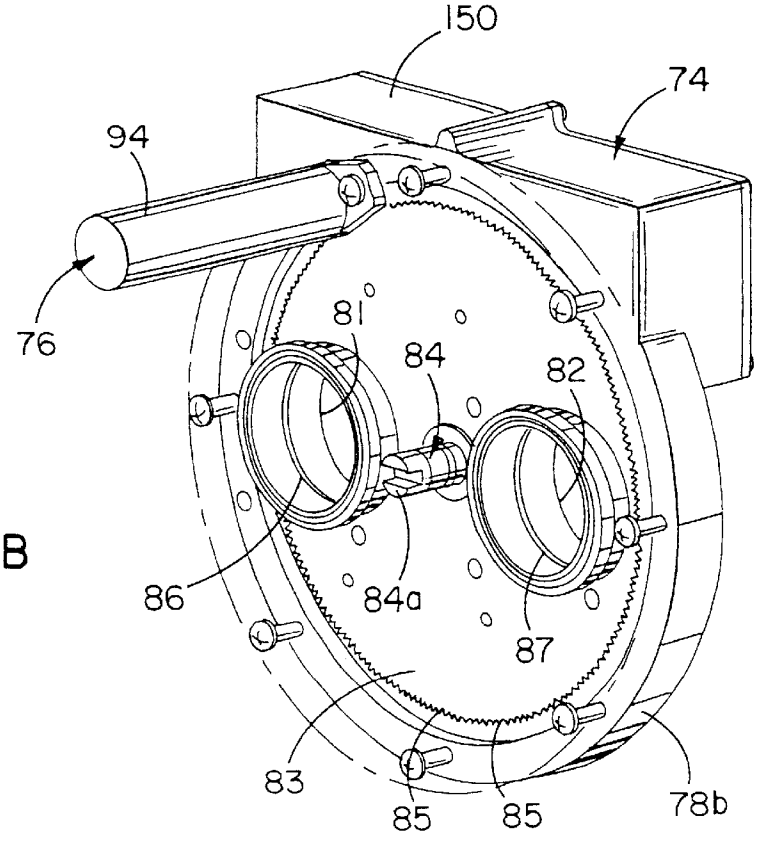

74
150
76
90
92
94
84
80
79
78a
87
154
152
84b
86
154
83
85
85

FIG. 5A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84a
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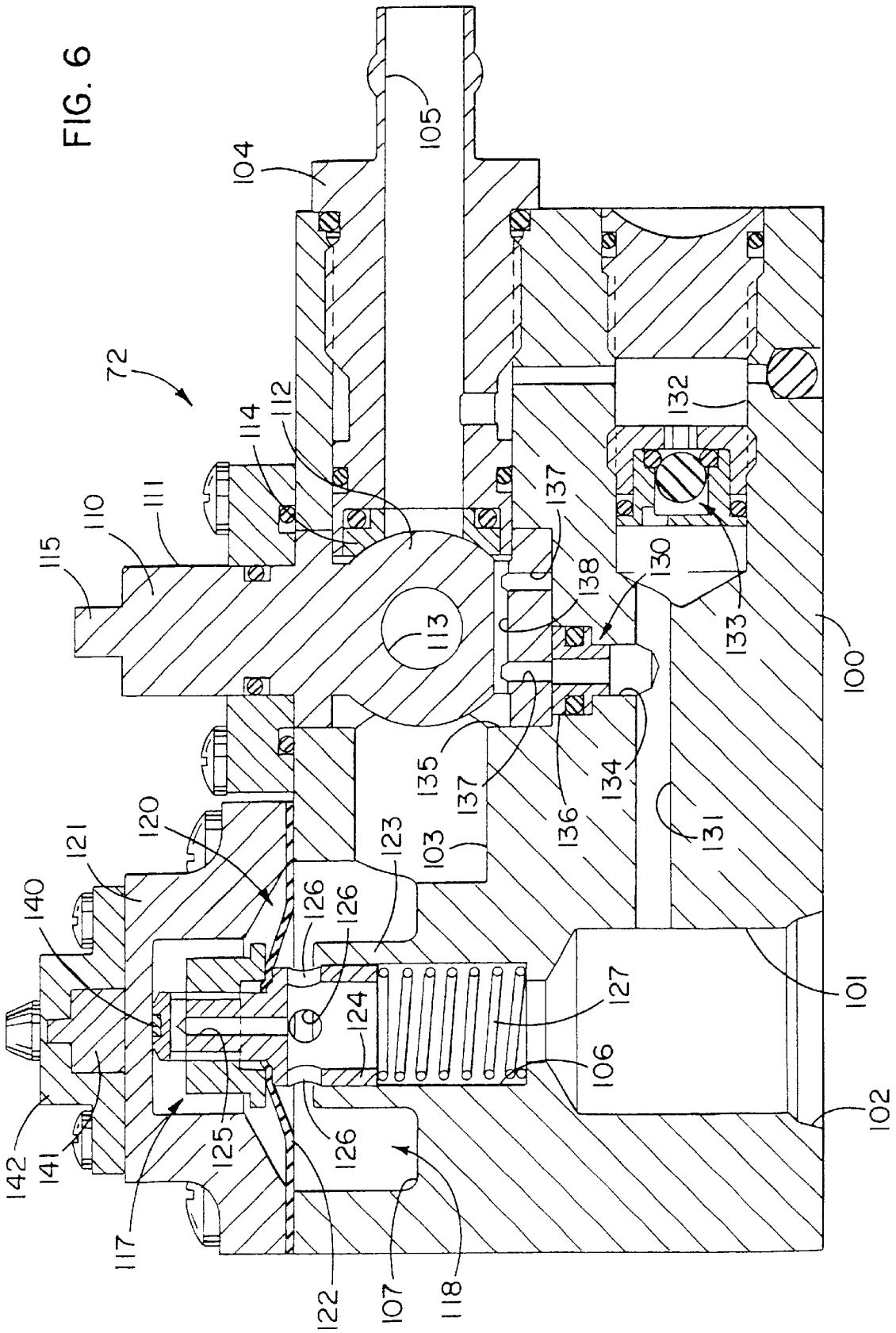
78b

FIG. 5B

FIG. 6


72
104
105
112
114
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132
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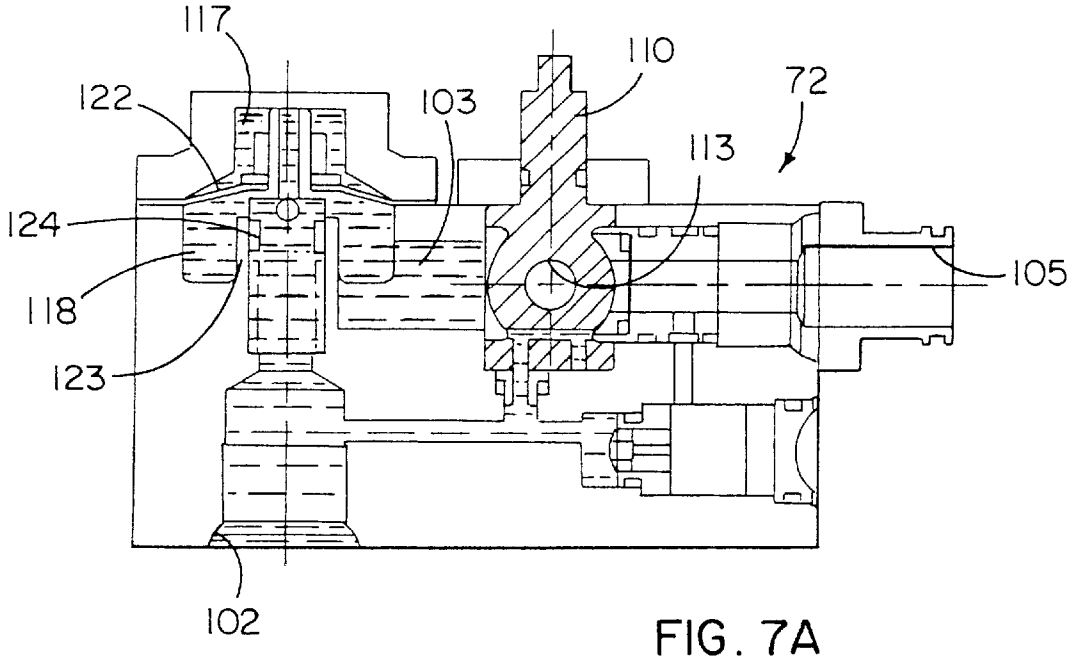
117
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103
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FIG. 7A

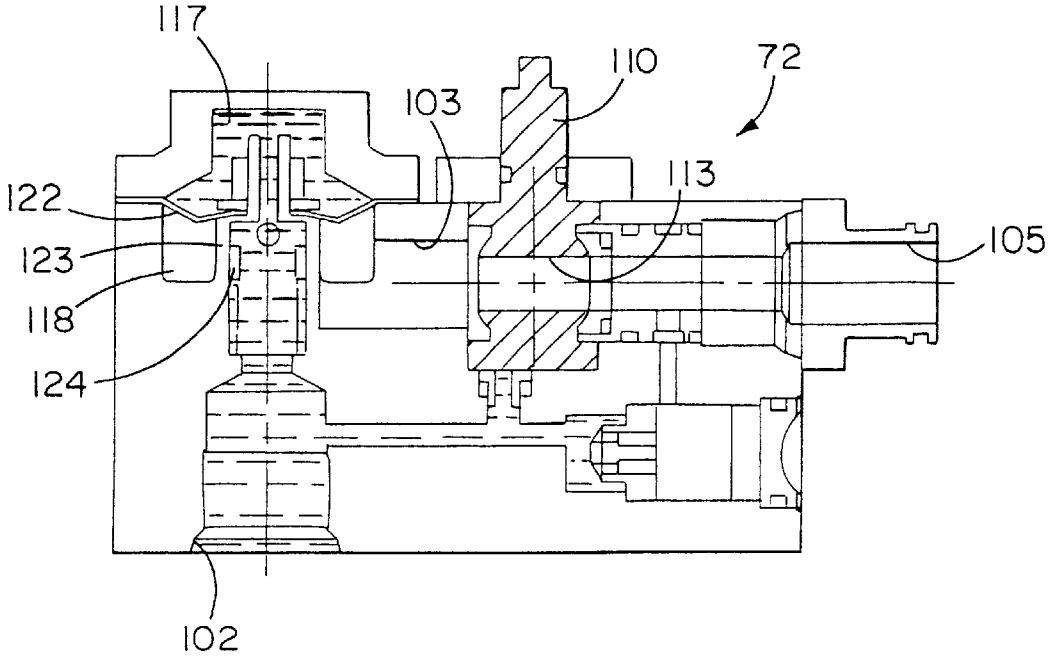
117
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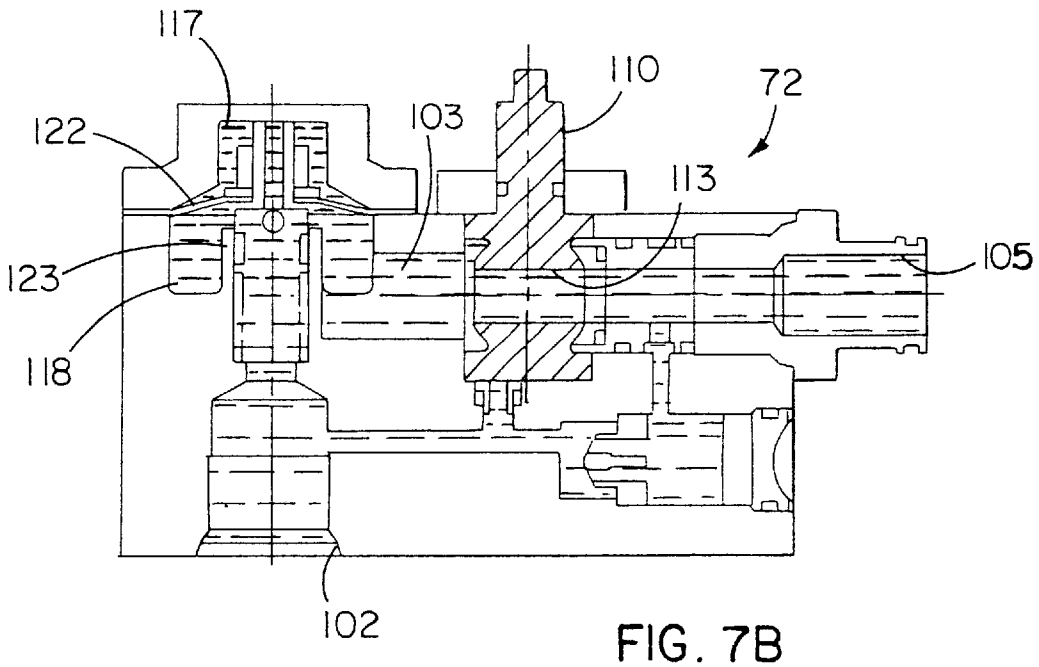
FIG. 7C


117
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72
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103
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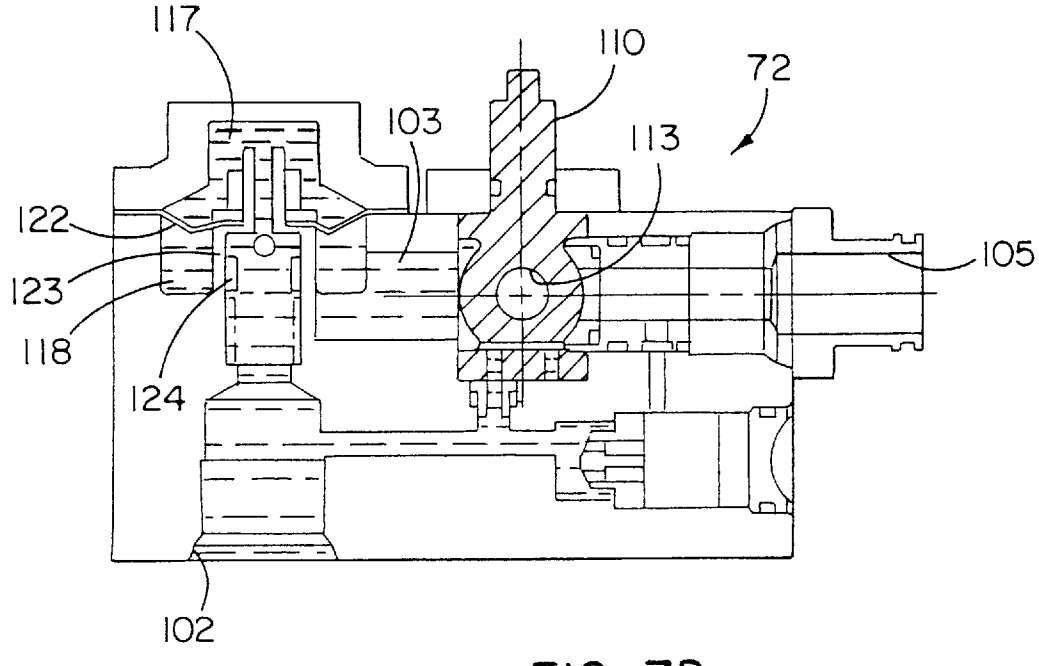
102

FIG. 7B


117
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124
102

FIG. 7D

MODULAR VACUUM TOILET WITH LINE REPLACEABLE UNITS

FIELD OF THE INVENTION

The present invention generally relates to toilets and, more particularly, to vacuum toilet systems.

BACKGROUND OF THE INVENTION

Vacuum toilet systems are generally known in the art for use in both vehicle and stationary applications. A vacuum toilet system typically comprises a bowl for receiving waste having an outlet connected to a vacuum sewer line. A discharge valve is disposed between the bowl outlet and vacuum sewer line to selectively establish fluid communication therebetween. The vacuum sewer line is connected to a collection tank that is placed under partial vacuum pressure by a vacuum source, such as a vacuum blower. When the discharge valve is opened, material in the bowl is transported to the sewer pipe as a result of the pressure difference between the interior of the bowl and the interior of the sewer line. Conventional vacuum toilet systems also include a source of rinse fluid and a rinse fluid valve for controlling introduction of rinse fluid into the bowl.

The components of a conventional vacuum toilet are typically provided separately and are overly difficult to assemble. The discharge valve is typically mounted in a first position, while the rinse valve is mounted in a second, separate position. A flush control until (FCU) is mounted remote from both valves and provides control signals to the discharge and rinse valve actuators. Accordingly, various mounting brackets, tubing, and wires are needed to interconnect the various components, making assembly overly complicated and time-consuming.

In addition, the separate components used in conventional vacuum toilets make repair and maintenance overly time consuming and labor intensive. Maintenance concerns are particularly significant in aircraft applications, in which a number of sub-systems are installed on board. According to general practice in the airline industry, each sub-system includes one or more components which must be replaced in the event of failure, such replacement components being commonly referred to as line replaceable units (LRUs). Presently, the entire vacuum toilet is defined as the LRU for the vacuum toilet system. As a result, an airline must stock one or more replacement toilets in the event of a toilet failure, so that the replacement toilet may be swapped in for the faulty toilet. A "bench test" is then performed on the faulty toilet to determine which components have failed in the toilet. The faulty components are then repaired or replaced (which may include significant disassembly and reassembly of the toilet) so that the toilet may be reused on another aircraft.

Each of the steps performed during a toilet repair is overly difficult and time consuming. To remove an entire toilet assembly from an aircraft requires disassembly of at least four self-locking mounting fasteners, an electrical connection, a grounding strap, a potable water line connection, and a waste discharge pipe connection. Each connection may be difficult to access, and may require a particular tool in order to loosen and disconnect. The same connections must then be reconnected for the replacement toilet.

Even if it were possible to remove and replace a single toilet component, it would be overly difficult and time consuming to do so. Removal of a component would require disconnection of several wires and pipes, and the components are often located in areas which are difficult to access. Furthermore, it would be difficult to diagnose whether one component or several components had failed. There exists a multitude of combinations of simultaneous component failures, which may lead to trouble-shooting errors and the replacement or repair of non-faulty components.

In view of the foregoing, it is apparent that the replacement and repair of conventional toilets is overly time consuming, and requires an airline to maintain a large stock of replacement toilets in the event of equipment failure.

Other repairs, which may not require substantial amounts of trouble shooting to identify the failed components, still require significant amounts of disassembly and reassembly. The toilet bowl, for example, is typically formed of stainless steel covered with a non-stick coating that is subject to failure. In conventional toilets, the bowl is a structural, load bearing component that is attached to a base support. In some toilets, the base support is permanently attached to the bowl and therefore the entire toilet must be removed to replace the coating. In other toilets, the bowl is removable from the support base, and therefore fasteners must be removed and the bowl must be disconnected from the rinse fluid and discharge lines. In addition, the rinse ring or nozzle used to direct rinse fluid into the bowl must be removed. Furthermore, if the non-stick coating fails, the bowl must be removed from all of the other toilet components for a re-coating process, steps of which are performed at high temperature to remove the old coating and apply a new coating to the toilet bowl surface. Accordingly, the replacement of a conventional bowl is overly complicated and time consuming.

From the foregoing, it will be appreciated that a number of toilets must be kept in stock for replacement in the event of a faulty toilet. The number of stock toilets is further increased due to the left-handed and right-handed discharge configurations of conventional vacuum toilets. Typically, the component layout of a conventional vacuum toilet must be modified according to the type of discharge configuration desired. In addition, different components may be required, such as a toilet bowl with a left-handed or right-handed discharge. As a result, an airline must have both left- and right-handed discharge replacement toilets on hand, thereby increasing the number of stock parts required.

From the above, it will be appreciated that a need exists for a vacuum toilet that is easier to maintain and which reduces the number of stock parts required.

SUMMARY OF THE INVENTION

In accordance with certain aspects of the present invention, a modular vacuum toilet is provided for use in a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid. The modular vacuum toilet comprises a support structure, and a removable bowl supported by the support structure, the bowl defining an outlet and having a rinse fluid dispenser associated therewith. A valve set module is provided having a discharge valve with an inlet in fluid communication with the bowl outlet, an outlet in fluid communication with the sewer line, and a movable discharge valve member disposed between the discharge valve inlet and outlet; a rinse fluid valve having an inlet in fluid communication with the source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a movable rinse fluid valve member disposed between the rinse fluid valve inlet and outlet; and a flush control unit having a circuit board operably connected to the discharge valve and rinse fluid valve for

controlling actuation of the discharge valve member and rinse fluid valve member.

In accordance with additional aspects of the present invention, a method of servicing a vacuum toilet is provided, in which the vacuum toilet is attached to a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid, and in which the vacuum toilet includes a waste receptacle defining an outlet and having a rinse fluid dispenser associated therewith. The method comprises providing a first valve set module having a discharge valve with an inlet adapted to engage the receptacle outlet and an outlet adapted for releasable connection to the sewer line, a rinse fluid valve with an inlet adapted for releasable connection to the source of rinse fluid and an outlet adapted for releasable connection to the rinse fluid dispenser, and a flush control unit adapted to control operation of the discharge valve and rinse fluid valve. The discharge valve is detached from the bowl outlet, discharge valve outlet from the sewer line, the rinse fluid valve inlet from the rinse fluid source, and the rinse fluid valve outlet from the rinse fluid line, and the valve set module is removed from the vacuum toilet. A second valve set module is inserted into the vacuum toilet, the second valve set module including a discharge valve with an inlet adapted to engage the receptacle outlet and an outlet adapted for releasable connection to the sewer line, a rinse fluid valve with an inlet adapted for releasable connection to the source of rinse fluid and an outlet adapted for releasable connection to the rinse fluid dispenser, and a flush control unit adapted to control operation of the discharge valve and rinse fluid valve. The second valve set discharge valve inlet is then attached to the bowl outlet, the discharge valve outlet to the sewer line, the rinse fluid valve inlet to the rinse fluid source, and the rinse fluid valve outlet to the rinse fluid line.

In accordance with further aspects of the present invention, a method of servicing a vacuum toilet is provided wherein the toilet has a receptacle for receiving waste defining an outlet and includes a rinse fluid dispenser associated therewith. A discharge valve has an inlet in fluid communication with the receptacle outlet, an outlet in fluid communication with a sewer line placeable under partial vacuum pressure, and a moveable discharge valve member disposed between the discharge valve inlet and the discharge valve outlet. A rinse fluid valve has an inlet in fluid communication with a source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a moveable rinse fluid valve member disposed between the rinse fluid valve inlet and the rinse fluid valve outlet. A flush control unit is adapted to control actuation of the discharge valve member and rinse fluid valve member, in which at least one of the discharge valve, rinse fluid valve, flush control unit, and waste receptacle is a line replaceable unit. The method comprises removing the faulty line replaceable unit from the toilet, and installing a new line replaceable unit into the toilet.

In accordance with still further aspects of the present invention, a valve set is provided for use in a vacuum toilet system having a sewer pipe placeable under partial vacuum pressure. The valve set comprises a discharge valve having an outlet, and an outlet pipe attached to the discharge valve outlet and defining a branch. A discharge pipe has a first end adapted to releasably engage the sewer pipe and a second end releasably attachable to the branch in at least a first position corresponding to a left-handed discharge configuration and a second piston corresponding to a right-handed discharge configuration.

Other features and advantages are inherent in the apparatus claimed and disclosed or will become apparent to those skilled in the art from the following detailed description and its accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1A** and **1B** are front and rear perspective views, respectively, of a modular vacuum toilet in accordance with the present invention.

FIG. **2** is a schematic diagram of the vacuum toilet of FIG. **1**.

FIG. **3** is an enlarged view of a tab used to secure a bowl to the frame.

FIG. **4** is an enlarged perspective view of the valve set incorporated into the vacuum toilet of FIG. **1**.

FIGS. **5A** and **5B** are perspective views of a discharge valve and actuator incorporated into the valve set.

FIG. **6** is a side elevation view, in cross-section, of a rinse valve assembly incorporated into the valve set.

FIGS. **7A–D** are side elevation views, in cross-section, of the rinse valve assembly showing the various stages of a rinse cycle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. **1A**, **1B**, and **2**, a modular vacuum toilet suitable for use in a vehicle, in accordance with the present invention, is generally referred to with reference numeral **10**. The modular vacuum toilet **10** generally includes a valve set **8**, a frame **20**, and a bowl **36**. The vehicle is provided with a sewer line **11**, a vacuum tank **13** connected to the sewer line **11**, and a vacuum source (not shown) for placing the vacuum tank **13** under partial vacuum pressure. The vehicle further includes a source of rinse fluid **15** connected to a rinse fluid supply line **19**.

The frame **20** is provided for supporting the components of the vacuum toilet **10**. As best shown with reference to FIGS. **1A** and **1B**, the frame **20** includes a bottom member **24** adapted for attachment to a support surface of the vehicle. Vertical supports **26** extend upwardly from the bottom member **24**, and a top member **28** is attached to the vertical supports **26**. The top member **28** is formed with an opening **30** near the front and two slots **29** near the rear thereof. In the illustrated embodiment, an intermediate support **32** is attached between adjacent vertical supports **26**, and a bracket **27** is attached to the bottom member **24**. The bottom member **24**, top member **28**, and bracket **27** are preferably formed of sheet metal, while the vertical supports **26** and intermediate support **32** are preferably formed of tube steel, both of which are readily available and inexpensive. Other materials having sufficient rigidity, however, may also be used.

The bowl **36** is provided for receiving waste material. The bowl **36** has a curved sidewall **38** and an out-turned flange **40** extending about an upper edge of the sidewall (FIGS. **1A** and **1B**). The out-turned flange **40** further includes tabs **39** sized for insertion through the slots **29** formed in the frame top member **28**, as best shown in FIG. **3**. A bottom of sidewall is formed in an outlet **42**, and the sidewall **38** is sized for insertion into the opening **30** of the frame top member **28**. The outlet **42** fluidly communicates with a discharge valve **70** through a transfer pipe **44**. The transfer pipe **44** preferably includes a collar **47** sized to frictionally engage and seal with the outlet **42**.

To attach the bowl **36** to the frame **20**, the bowl **36** is inserted through the opening **30** and positioned so that the tabs **39** are aligned with the slots **29** and the outlet **42** is

aligned with the collar **47**. The bowl **36** is lowered so that the tabs **39** pass through and lock with the slots **29**. Simultaneously, the outlet **42** is inserted into and engages the collar **47**. In this position, the out-turned flange **40** closely overlies the frame top member **28** so that the downward forces applied to the bowl **36** are transferred to the frame **20**. As a result, the bowl **36** is not a load-bearing component, and may be made of non-structural materials such as plastic, thin-walled metal (defined herein as less than approximately 0.040" thick), or other known alternatives. In addition, the bowl **36** is separable from the frame **20** and therefore may be replaced independently from the rest of the toilet **10**. Still further, the tabs **39** may be manipulated manually, and therefore no tools are required to install or remove the bowl **36**.

At least one rinse fluid dispenser, such as nozzles **46**, is provided inside the bowl **36** for directing rinse fluid over the surface of the bowl. As best shown in FIGS. **1**A and **1**B, a plurality of nozzles **46** are spaced about the bowl sidewall **38** and are oriented to direct rinse fluid over portions of the bowl surface. The number of nozzles may be more or less than that shown, depending on the size of the bowl surface to be rinsed. As used herein, the phrase "rinse fluid dispenser" includes the illustrated nozzles **46**, as well as known substitutes, such as spray rings.

A vacuum breaker **33** is positioned above the top edge of the bowl **36**, and a first rinse fluid pipe **35***a* extends from the nozzles **46** to the vacuum breaker **33**. A second rinse fluid pipe **35***b* extends from the vacuum breaker **33** to a rinse valve **72**. Quick-disconnect couplings **108***a*, **108***b* are provided to connect the first and second rinse fluid pipes **35***a*, **35***b* to the vacuum breaker **33**.

The separate frame **20** advantageously allows the bowl **36** to be a line replaceable unit (LRU). When the bowl **36** becomes worn or otherwise needs replacement, maintenance person may simply disconnect the first rinse fluid pipe **35***a* using the quick disconnect coupling **108***a*, manipulate the tabs **39** so that the are disengaged from the slots **29**, and pull upward on the bowl **36** to remove the bowl **36** from the frame **20**. A new bowl **36** may then be inserted into the frame **20** as described above, and the first rinse fluid pipe **35***a* may be connected to the vacuum breaker **33** using the quick-disconnect coupling **108***a*. As a result, the entire toilet need not be removed and serviced. In addition to facilitating bowl removal and replacement, the frame **20** allows a wider range of materials to be used for the bowl **36**, since the frame **20**, rather than the bowl **36**, supports the load.

As best shown in FIG. **1**A, the valve set **8** is mounted to the frame bracket **27**. The valve set **8** is preferably attached to the bracket **27** using fasteners that may be manipulated by hand, such as knurled screws **37**. The valve set **8** includes four sub-components: a discharge valve **70**, a rinse valve **72**, a flush control unit (FCU) **74**, and an actuator **76** (FIG. **4**). The discharge valve **70** includes a discharge valve housing **78** divided into two halves **78***a*, **78***b*. As best shown in FIGS. **5**A and **5**B, the housing **78** includes a pair of inlets **79**, **80** formed in the housing half **78***a* aligned with a pair of outlets **81**, **82** formed in the housing half **78***b*.

The housing **78** further defines a chamber for receiving a discharge valve member, such as valve disk **83**. An axle **84** is attached to the valve disk **83** and has two ends **84***a*, **84***b*. Holes are formed in the housing halves **78***a*, **78***b* sized to receive the axle ends **84***a*, **84***b*, respectively, so that the disk **83** is supported for rotation about the axle **84**. The periphery of the disk **83** is formed with gear teeth **85**, and a pair of apertures **86**, **87** are formed through the disk **83**. The apertures **86**, **87** are spaced so that both register simultaneously with the associated inlet/outlet pairs **79**/**81**, **80**/**82** as the disk **83** rotates. In the illustrated embodiment, the apertures **86**, **87** and associated inlet/outlet pairs **79**/**81**, **80**/**82** are spaced 180 degrees apart.

According to the illustrated embodiment, the inlet **79** is connected to one end of the transfer pipe **44**, with the other end of the transfer pipe **44** being attached to the bowl outlet **42**. An air intake check valve **45** is attached to the other inlet **80**, and is oriented to allow fluid to flow into the inlet **80** while preventing fluid from discharging out of the check valve **45** (FIGS. **1**A and **2**). A U-shaped outlet pipe **12** (FIG. **1**B) has a first end connected to the outlet **81** and a second end connected to the outlet **82**. The outlet pipe **12** further has a branch **17** leading to a discharge pipe **21**.

In accordance with certain aspects of the present invention, the branch **17** and discharge pipe **21** are adapted to provide both right- and left-handed discharge configurations. As best shown in FIG. **1**B, the branch **17** includes a pair of spaced pins **160** (only one shown in FIG. **1**B) and the discharge pipe **21** a pair of spaced J-shaped slots **162** (only one shown in FIG. **1**B) positioned to engage the pins, so that the discharge pipe **21** is removably attached to the branch **17**. The pins **160** and J-shaped slots **162** are preferably spaced 180 degrees apart, so that the discharge pipe **21** may be positioned for either right- or left-handed discharge simply by rotating the discharge pipe **21** before attachment, without requiring changes to the other toilet components. The free end of the discharge pipe **21** is adapted for releasable connection to the sewer line **11**, such as with a clam shell coupling (not shown).

In operation, when the disk apertures **86**, **87** are aligned with the inlet/outlet pairs **79**/**81**, **80**/**82**, the discharge valve **70** not only transfers waste from the transfer pipe **44** to the sewer line **11**, but also pulls additional air into the sewer line **11** through the air intake check valve **45**. The additional air intake reduces noise that is normally generated during a flush.

The actuator **76** is provided for driving the valve disk **83**. As best shown in FIG. **5**A, the actuator **76** includes a spur gear **90** enmeshed with the gear teeth **85** formed about the periphery of the disk **83**. The spur gear **90** is mounted to a rotatable shaft **92**, and a drive is provided for rotating the shaft **92**. The FCU **74** is operably coupled to the actuator **76** to control operation of the actuator. According to the illustrated embodiment, the disk **83** may be rotated in a single direction by ninety degree increments to open and close the discharge valve **70**. Alternatively, the disk **83** may also be reciprocated back and forth across a ninety degree arc to open and close the valve **70**, or the disk **83** may be controlled in other manners according to other disk designs and layouts.

The rinse valve **72** is provided for controlling flow of rinse fluid to the bowl **36**. As best shown in FIG. **6**, the rinse valve **72** comprises a housing block **100** formed with an inlet bore **101**, defining an inlet **102**, and an outlet bore **103**. The inlet bore **102** is adapted for connection to the rinse fluid line **19** via a quick-disconnect coupling (not shown). An insert **104** is positioned in a downstream portion of the outlet bore **103** and defines an outlet **105**. The outlet end of the insert **104** is barbed to secure one end of the second rinse fluid pipe **35***b* thereto, while the opposite end of the second rinse fluid pipe **35***b* has the quick-disconnect coupling **108***b* (FIGS. **1**A and **1**B). A poppet valve bore **106** is also formed in the housing block **100**, and fluidly communicates with the inlet bore **101**. An annular recess **107** is formed in the housing block **100**

concentric with the poppet valve bore **106** to establish fluid communication between the poppet valve bore **106** and the outlet bore **103**.

The rinse valve **72** includes a rinse valve member, such as a ball valve **110**, which is disposed in the outlet bore **103** for selectively establishing fluid communication between the outlet bore **103** and the outlet **105**. The ball valve **110** includes a shaft **111** and a valve member **112** having a flow passage **113** extending therethrough. A seal **114** is provided downstream of the valve member **112** for preventing leakage between the valve member **112** and the downstream portion of the outlet bore **103**. As shown in FIG. **6**, the flow passage **113** is perpendicular to the outlet bore **103**, thereby preventing fluid flow. The ball valve **110** is rotatable, however, to align the flow passage **113** with the outlet bore **103**, thereby establishing fluid communication between the upstream portion of the outlet bore **103** and outlet **105**.

In the preferred embodiment, the top of the shaft **111** is adapted to mechanically engage the axle end **84***a*, as best shown in FIG. **4**, so that rotation of the disk **83** also rotates the ball valve **110**. In the illustrated embodiment, the shaft **111** is formed with a key **115**, while the axle end **84***a* has a slot **116** sized to receive the key **115**. As a result, a separate actuator is not required to actuate the ball valve **110**, thereby reducing cost and space requirements for the toilet.

The rinse valve **72** further includes a fuse valve **120** for metering rinse fluid flow through the rinse valve when the ball valve **110** is open. As used herein, the phrase "fuse valve" indicates a valve that actuates after a set value of fluid has passed therethrough. As best shown in FIG. **6**, a bonnet **121** is attached to the housing block **100** to close off the poppet valve bore **106** and the recess **107**. A flexible diaphragm **122** is attached between the housing block **100** and the bonnet **121** to define a pilot chamber **117** above the diaphragm **122** and a flow chamber **118** below the diaphragm **122**. As illustrated at FIG. **6**, the diaphragm **122** is in a closed position, in which the diaphragm **122** engages an annular intermediate wall **123** extending between the poppet valve bore **106** and recess **107**, thereby closing off fluid communication between the poppet valve bore **106** and recess **107**. A poppet valve **124** is disposed inside the poppet valve bore **106** and is attached to the diaphragm **122**, so that the poppet valve **124** moves with the diaphragm **122**. The top of the poppet valve **124** is formed with a pilot port **125**, and flow ports **126** extend radially through a sidewall of the poppet valve **124**. A spring **127** is disposed in the poppet valve port for biasing the diaphragm **122** away from the intermediate wall **123** toward an open position, in which fluid communication is established between the poppet valve bore **106** and the recess **107**.

The fuse valve **120** limits the amount of rinse fluid allowed to flow through the rinse valve **72** when the ball valve **110** is open. During operation, the ball valve **110** is normally in a closed position to prevent flow of rinse fluid through the rinse valve **72**. The rinse fluid flows through both the pilot port **125** to register at the pilot chamber **117**, and through the flow ports **126** to register in the flow chamber **118**. Because there is no rinse fluid flow, the rinse fluid pressure is the same in both the pilot chamber **117** and the flow chamber **118**, so that the spring **127** urges the diaphragm **122** and poppet valve **124** to the open position, as shown in FIG. **7**A.

In response to a flush command, the ball valve **110** is rotated to the open position so that the ball valve flow passage **113** communicates the outlet bore **103** to the outlet **105**, thereby creating fluid flow through the valve **72** (FIG. **7**B). During fluid flow, the rinse fluid experiences a pressure drop as it passes through the flow ports **126**, thereby reducing the fluid pressure in the flow chamber **118** while the pressure in the pilot chamber **117** stays substantially the same. The resulting pressure differential across the diaphragm **122** ultimately overcomes the force of the spring **127** so that the diaphragm **122** and poppet valve **124** move to the closed position, as shown in FIG. **7**C. When the diaphragm is in the closed position, fluid flow through the rinse valve **72** is again cut off, this time by the engagement of the diaphragm **122** with the intermediate wall **123**. Because of the fuse valve **120**, the volume of rinse fluid passing through the open ball valve **110** is substantially constant from flush to flush, regardless of the rinse fluid pressure supplied to the rinse valve **72**. It will also be appreciated that the fuse valve **120** provides a redundant shut-off, so that the ball valve **110** or the fuse valve **120** may be used to stop rinse fluid flow should the other fail.

The rinse valve **72** further includes a face value **130** for returning the diaphragm **122** back to the open position after the ball valve **110** is subsequently closed. Referring to FIG. **6**, a bypass bore **131** is formed in the housing block **100** that connects the inlet bore **101** to an auxiliary bore **132**. A reset bore **134** intersects the bypass bore **131** and communicates with a ball valve bore **135** formed in the housing block **100**. A reset insert **136** is inserted in the reset bore **134** and has a top surface adapted to engage a bottom of the ball valve **110**. The ball valve **110** is formed with reset passages **137** extending into the ball valve **110** to a transverse passage **138** extending entirely through the ball valve **110**. The reset passages **137** are located on the ball valve **110** so that they align with the reset insert **136** only when the ball valve **110** is in the closed position. The seal **114** prevents rinse fluid from leaking from the transverse passage **138** to the outlet **105**. No seal is provided upstream of the ball valve **110** so that, when one of the reset passages **137** is aligned with the insert **136**, fluid communication is established from the inlet bore **101**, through the bypass and reset bores **131**, **134** and one of the reset passages **137** to the flow chamber **118**.

According to the illustrated embodiment, the rinse valve **72** also includes a drain valve **133** disposed in the auxiliary bore **132** to provide freeze protection, as is well known in the art.

In operation, the diaphragm **122** moves to the closed position while the ball valve **110** is open, thereby stopping rinse fluid flow through the rinse valve **72** (FIG. **7**C). With the ball valve **110** in the open position, neither reset passage **137** is aligned with the reset insert **136**. The ball valve **110** is subsequently closed, thereby aligning one of the reset passages **137** with the insert **136** and establishing fluid communication from the inlet bore **101** to the flow chamber **118** (FIG. **7**D). The incoming rinse fluid pressure registers at the flow chamber **118**, so that the flow chamber reaches the same pressure as the pilot chamber **117**. With the differential pressure across the diaphragm **121** removed, the spring **127** is again followed to urge the diaphragm **121** to the open position, thereby resetting the fuse valve **120** to the position shown in FIG. **7**A.

In the preferred embodiment, a position sensor is used to provide feedback regarding poppet valve position feedback. In the illustrated embodiment, a magnet **140** is attached to the poppet valve **124**, and a hall effect switch **141** is located outside of the bonnet **121** in a switch enclosure **142** attached to the bonnet **121** (FIG. **6**). The hall effect switch **141** provides a signal that varies according to the position of the magnet **140** to indicate the position of the poppet valve **124**. The poppet valve position signal may be used for diagnostic

purposes such as fault detection by comparing the position signal to the position of the disk **83** or ball valve **110**.

The FCU **74** comprises a housing **150** attached to the discharge valve housing half **78***b* opposite the rinse valve **72** (FIG. **4**). The housing **150** encloses one or more circuit boards (not shown) for controlling operation of the toilet **10**. In addition to the typical inputs and outputs, the FCU **74** also receives feedback from the poppet valve position sensor **141**.

The FCU housing **150** further houses a position sensor for determining the position of the disk **83**. As best shown in FIG. **5**A, magnets **152** are attached to the axle end **84***b* of the disk **83**. The axle end **84***b* extends into the FCU housing **150**, so that the magnets **152** are positioned proximal the control board. Hall effect switches **154** are provided directly on the circuit board for sensing the magnets **152** and thus determining the rotational position of the disk **83**. In the illustrated embodiment, a pair of magnets **152** are attached to the axle end **84***b*, and a pair of hall effect switches **154** are attached to the circuit board. The switches **154** actuate between on and off positions depending on the proximity of the magnets, thereby indicating the position of the disk **83**. As a result, the position of the disk **83** is directly sensed rather than inferring disk position based on actuator position. In addition, the switches **154** are located inside the FCU housing **150** and are therefore isolated from contamination due to lubrication or other material.

With the above construction, the valve set **8** is quickly and easily removed and replaced. To remove the valve set **8**, the discharge pipe **21** is disconnected from the sewer line **11**, the rinse valve inlet **102** is disconnected from the rinse supply line **19**, and the quick-disconnect coupling **108***b* of the second rinse fluid pipe **35***b* is disconnected from the vacuum breaker **33**. The knurled screws **37** are then removed from the bracket **27** and the valve set **8** with attached transfer pipe **44** is lowered so that the transfer pipe disengages the bowl outlet **42**. Thus the valve set **8** is removed with the transfer pipe **44**, outlet pipe **12**, discharge pipe **21**, and second rinse pipe **35***b*. A new valve set **8**, also having a new transfer pipe **44**, outlet pipe **12**, discharge pipe **21**, and second rinse pipe **35***b* may then be attached to the bracket **27** and reconnected.

From the foregoing, it will be appreciated that the valve set **8** of the present invention incorporates all of the valve and control apparatus. The rinse valve **72**, FCU **74**, and actuator **76** are all mounted to the discharge valve **70** to create an LRU, wherein a single module may be targeted for maintenance in the event of a valve or control failure. The wiring between the components may remain in place so that, in the event of a valve or control failure, only the piping connections between the valve set **8** and the drain, sewer, and rinse water piping need be undone to remove the valve set **8**.

Maintenance of the modular vacuum toilet **10** is entirely different from that of conventional vacuum toilets. Instead of defining the entire toilet as an LRU, the toilet **10** defines individual components or groups of components as LRUs. The bowl **36** may be independently removed from the toilet **10** and replaced. Similarly, the valve set **8** may be separately removed from the toilet **10**. Furthermore, the individual components may be quickly removed with the use of few or no tools.

The branch **17** and discharge pipe **21** of the valve set **8** are adapted to provide both right- and left-handed discharge configurations without additional modifications to the other toilet components, thereby further reducing the number of parts needed in stock

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications would be obvious to those skilled in the art.

What is claimed is:

1. A modular vacuum toilet for use in a vacuum toilet system having a sewer line placeable under partial vacuum pressure and a source of rinse fluid, the modular vacuum toilet comprising:

a frame support structure having a top with an opening therethrough;

a removable bowl including a sidewall sized for insertion into the opening and having an out-turned flange supported by the top of the support structure, the bowl defining an outlet and having a rinse fluid dispenser associated therewith; and

a valve set module including:

a discharge valve having an inlet in fluid communication with the bowl outlet, an outlet in fluid communication with the sewer line, and a moveable discharge valve member disposed between the discharge valve inlet and outlet;

a rinse fluid valve having an inlet in fluid communication with the source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a movable rinse fluid valve member disposed between the rinse fluid valve inlet and outlet; and

a flush control unit having a circuit board operably connected to the discharge valve and rinse fluid valve for controlling actuation of the discharge valve member and rinse fluid valve member.

2. The modular vacuum toilet of claim **1**, in which the support structure includes slots, and in which the bowl includes tabs adapted to lockingly engage the slots, thereby to secure the bowl in place.

3. The modular vacuum toilet of claim **2**, in which the tabs are manually releasable to disengage from the slots.

4. The modular vacuum toilet of claim **1**, in which a rinse fluid pipe communicates between the rinse fluid valve outlet and the rinse fluid dispenser, wherein the rinse fluid pipe is releasably attached to the rinse fluid valve outlet with a coupling.

5. The modular vacuum toilet of claim **4**, in which the coupling is manually releasable.

6. The modular vacuum toilet of claim **1**, in which a transfer pipe has a first end connected to the discharge valve inlet, and a second end adapted to releasably engage the bowl outlet.

7. The modular vacuum toilet of claim **6**, in which the second end of the transfer pipe includes a collar sized to releasably engage and seal with the bowl outlet.

8. The modular vacuum toilet of claim **1**, in which a rinse fluid line communicates between the rinse fluid valve inlet and the source of rinse fluid, wherein the rinse fluid valve inlet is releasably connected to the rinse fluid line with a coupling.

9. The modular vacuum toilet of claim **8**, in which the coupling is manually releasable.

10. The modular vacuum toilet of claim **1**, in which a discharge pipe communicates between the discharge valve outlet and the sewer line, wherein the discharge pipe is adapted for releasable connection to the sewer line.

11. The modular vacuum toilet of claim **1**, in which the support structure includes a bracket, and in which fasteners are provided for releasably securing the valve set module to the bracket.

12. The modular vacuum toilet of claim **11**, in which the fasteners comprise knurled screws.

13. A method of servicing a vacuum toilet having a waste receptacle for receiving waste defining an outlet and having a rinse fluid dispenser associated therewith, a stationary frame support having a top with an opening therethrough, the waste receptacle including a sidewall sized for insertion into the opening and having an out-turned flange supported by the top of the support structure, a discharge valve having an inlet in fluid communication with the receptacle outlet, an outlet in fluid communication with a sewer line placeable under partial vacuum pressure, and a moveable discharge valve member disposed between the discharge valve inlet and the discharge valve outlet, a rinse fluid valve having an inlet in fluid communication with a source of rinse fluid, an outlet in fluid communication with the rinse fluid dispenser, and a moveable rinse fluid valve member disposed between the rinse fluid valve inlet and the rinse fluid valve outlet, and a flush control unit adapted to control actuation of the discharge valve member and rinse fluid valve member, in which at least one of the discharge valve, rinse fluid valve, flush control unit, and waste receptacle is a line replaceable unit, the method comprising:

removing the faulty line replaceable unit from the toilet; and

installing a new line replaceable unit into the toilet.

14. The method of claim 13, the waste receptacle is the line replaceable unit.

15. The method of claim 14, in which the support structure includes slots, and in which the waste receptacle includes tabs adapted to lockingly engage the slots, thereby to secure the waste receptacle in place.

16. The method of claim 15, in which the tabs are manually releasable to disengage from the slots.

17. The method of claim 13, in which the discharge valve, rinse fluid valve, and flush control unit are integrally provided in a valve set, the valve set being a line replaceable unit.

18. The method of claim 13, in which a rinse fluid pipe communicates between the rinse fluid valve outlet and the rinse fluid dispenser, wherein the rinse fluid pipe is releasably attached to the rinse fluid dispenser with a coupling.

19. The method of claim 18, in which the coupling is manually releasable.

20. The method of claim 13, in which a transfer pipe has a first end connected to the discharge valve inlet, and a second end adapted to releasably engage the waste receptacle outlet.

21. The method of claim 20, in which the second end of the transfer pipe includes a collar sized to releasably engage and seal with the waste receptacle outlet.

22. The method of claim 13, in which a rinse fluid line communicates between the rinse fluid valve inlet and the source of rinse fluid, wherein the rinse fluid valve inlet is releasably connected to the rinse fluid line with a coupling.

23. The method of claim 22, in which the coupling is manually releasable.

24. The method of claim 13, in which a discharge pipe communicates between the discharge valve outlet and the sewer line, wherein the discharge pipe is adapted for releasable connection to the sewer line.

25. The method of claim 13, in which the vacuum toilet includes a support structure having a bracket, and in which fasteners are provided for releasably securing the valve set to the bracket.

26. The method of claim 25, in which the fasteners comprise knurled screws.

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