NASA TECHNICAL MEMORANDUM

MSC-05813
NASA TM X-58085
February 1972

ZERO-GRAVITY OPEN-TYPE URINE RECEPTACLE

Presented to the Conference on Body Waste Systems for Spacecraft at the NASA Langley Research Center Hampton, Virginia, May 17, 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

NASA TM X-58085

ZERO-GRAVITY OPEN-TYPE URINE RECEPTACLE

Anthony S. Girala
Manned Spacecraft Center
Houston, Texas 77058

CONTENTS

TABLE

FIGURES

Figure		Page

ZERO-GRAVITY OPEN-TYPE URINE RECEPTACLE

By Anthony S. Girala
Manned Spacecraft Center

SUMMARY

The development of the zero-gravity open-type urine receptacle (now called the urine-receptacle assembly) that is used in the Apollo command module is described in this report. The receptacle design is unique because it eliminates the need for contact of the penis with the device and allows the user to urinate in a manner similar to that encountered for a standup urinal in earth gravity. The urine-receptacle assembly may be used in a gravity environment that varies from zero to earth gravity, such as may be experienced in a spacecraft or space station. An innovation, incorporated in the urine-receptacle assembly, consists of an integral rinse device. The device was used in a 90-day manned test conducted for the NASA Langley Research Center and is also described in this report.

INTRODUCTION

After the Apollo 8 flight, the crewmen reported during debriefing that the urine collection system used in the Apollo command module (CM) was not satisfactory. Specifically, the objections and complaints involved the urine receptacle and not the overall waste management system (WMS). The receptacle used at this time was the same collector used in Project Mercury and the Gemini Program, and it consisted of a penis roll-on cuff, a collector bag, and a urine-transfer hose.

As an aid to the reader, where necessary the original units of measure have been converted to the equivalent value in the Systȅme International d' Unites (SI). The SI units are written first, and the original units are written parenthetically thereafter.

PROBLEM DEFINITION

The roll-on cuff was not desirable because it required circumferential contact with the penis; also, after several cycles it became contaminated with urine and made subsequent use of the cuff uncomfortable. The residual urine contaminated the inner cuff surface and eventually caused it to become sticky and smelly. Therefore, an obvious problem existed and a concerted effort, based on recommendations made by the crewmen, was made to arrive at a solution.

PROPOSED SOLUTIONS

In the debriefing, the crewmen suggested that more effort should be put forth to develop an open urinal for spacecraft applications, a urinal such as may be found in any lavatory on earth. Another suggestion was to consider the relief-tube approach; that is, to develop an open-type urine receptacle similar to a relief tube used in airplanes, in which an in-rush of air pulls the urine stream into the collector without contact between the penis and the urinal.

Because there were no requirements in the medical operation plan to collect inflight samples during the Apollo Program, the urine collection and disposal problem was simplified greatly.

URINE-RECEPTACLE DESIGN

Before starting to design an open-type urine receptacle, feasibility studies were made using informative material on the present urine collection system, the proposed concepts, and other possible alternatives. The basic receptacle-envelope configuration and initial absorbent-material selection resulted from these studies. The design constraints were established using the receptacle-design criteria and spacecraft-environment criteria. The receptacle-design criteria and the spacecraft-environment criteria are given as follows.

1. Receptacle-design criteria

   a. Open-ended cylindrical configuration

   b. 4.0×10^{-5} m^3/sec (40 ml/sec) maximum urine flow rate

   c. 7.0×10^{-4} m^3 (700 milliliter) volumetric capacity

   d. Retain fluid in zero gravity

   e. Eliminate splashback

   f. Absorbent material insert

   g. Sealing cap with vent

   h. Vacuum dry

   i. Rinse device

2. Spacecraft-environment criteria

   a. 3.447×10^4 N/m^2 (5.0 psia) (max.) pressure differential between cabin and space

b. 1.88×10^{-4} m^3/sec (6.67×10^{-3} ft^3/sec) (max.) gas flow rate out of cabin to space

c. 9.45×10^{-3} kg/sec (2.083×10^{-2} lb/sec) (max.) urine flow rate out of cabin to space

d. Dump line outlet, 1.397×10^{-3} meter (0.055 inch) orifice nozzle capacity

e. Urine-dump line: 4.11×10^{-4} m^3 (411 milliliter) volumetric capacity, 5.334-meter (210 inch) urine-dump line, 8.51×10^{-3}-meter (0.335 inch) urine-dump line inside diameter

Prototype Fabrication

Basically, the first prototype receptacles were cylindrical containers made of plexiglass material that provided a transparent envelope through which the flow characteristics of the fluid and behavior of the insert materials could be viewed. The 4.0×10^{-4} m^3 (400 milliliter) receptacle (fig. 1) has an absorbent-material insert. An improved concept is shown in figure 2. The improved concept is basically similar but has a larger target area and is easier to handle.

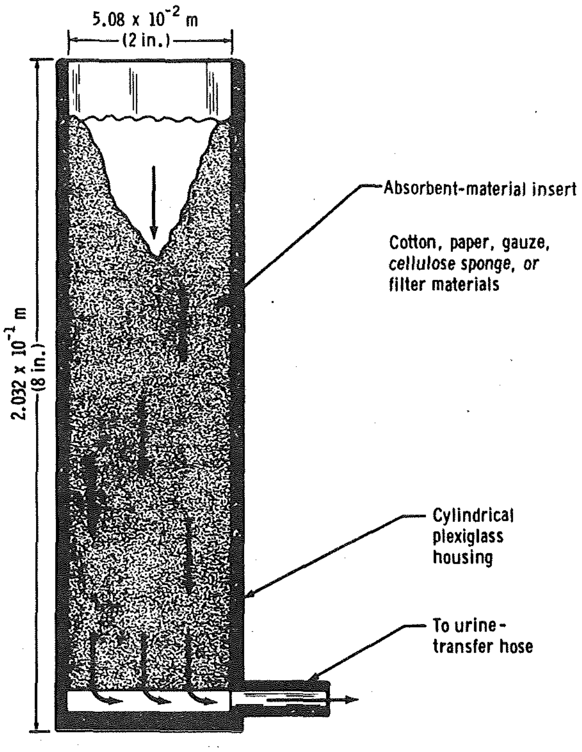

Figure 1. - Prototype 4.0×10^{-4} m^3 (400 milliliter) open-type urine receptacle.

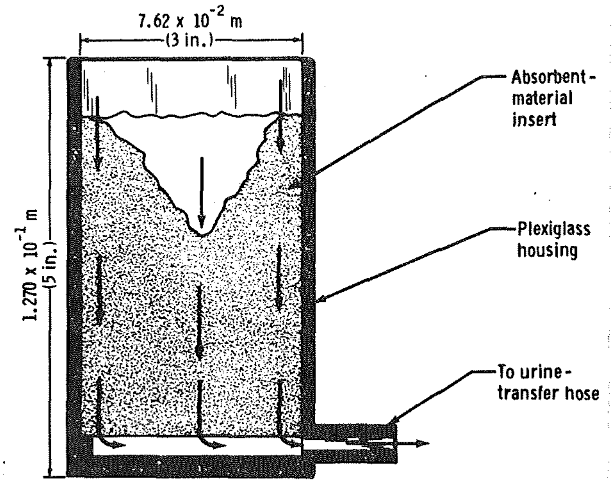

Figure 2. - Prototype open-type urine receptacle (improved concept).

Absorbent-Material Inserts

The purpose of the absorbent-type insert was to absorb the urine directed into the receptacle and to provide a wicking action for the last few drops of urine that invariably cling to the penis at the conclusion of a urination. Inserts of absorbent material such as cotton, paper, cellulose sponge, gauze, and a combination of these materials were made and incorporated into the prototype receptacles for test and evaluation. Polyurethane foam sandwiched between absorbent paper, acrylic fibers, and a variety of filter papers and filter cloths were tested also.

EARTH-ENVIRONMENT TEST

The equipment used to test and evaluate the initial urine-receptacle concepts in earth environment was set up to simulate the CM urine-drain line and overboard-dump nozzle (fig. 3). The receptacle to be tested was connected, by means of a urine-transfer hose, to the simulated dump line, which had a 1.397×10^{-3} meter (0.055 inch) diameter orifice and a length of line similar to the line in the CM.

During the initial testing, although the absorbent characteristics of the insert materials were good, splashback occurred when the urine stream impinged on these materials. Even after shaping and contouring the target profile in the shape of a cone, parabola, and combinations of both, the splashback problem persisted. To lessen the effect of gravity in some of the tests, the receptacle was held in a horizontal position. The splashback was more pronounced in this position than when held in an upright position, which indicated that it would be a problem in a zero-gravity environment.

The results of the initial tests indicated that the fluid flow was impeded sufficiently to back up in the receptacle and almost overflow. Also, splashback was significant when the absorbent-type material was used.

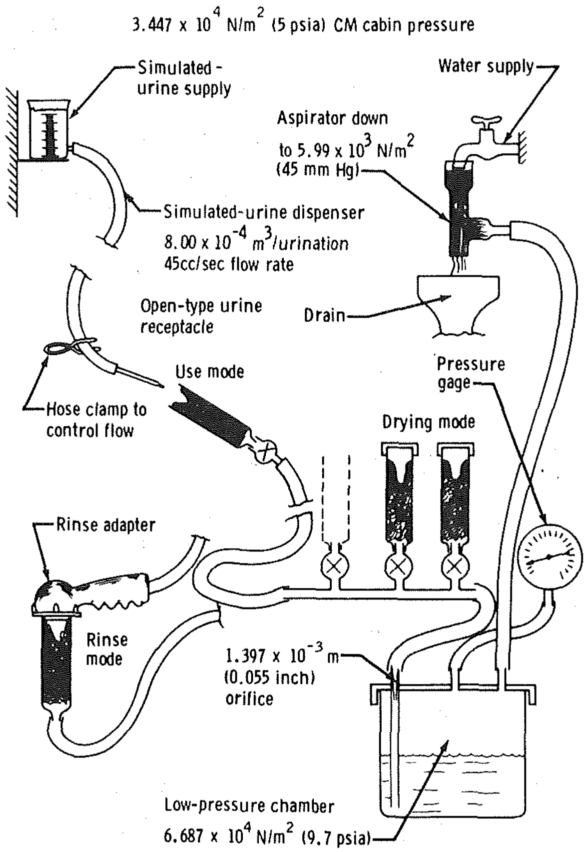

Figure 3. - Earth-gravity test equipment.

Honeycomb-Insert Concept

Obviously, some means had to be devised to capture the stream without splashback (that is, to provide a means for absorbing the energy contained by the moving stream). The impingement of a stream on a series of knife edges seemed to be the most logical method, particularly because this method would tend to polarize the stream and eliminate splashback. Also, it was established that a capillary-tube-insert concept would store the fluid in zero gravity. Ideally then, it would be desirable to find a medium that would satisfy both conditions. In searching for an insert material to meet both requirements, the idea to use a piece of honeycomb seemed plausible because it was anticipated that the individual cells would act as a temporary storage medium for the fluid and that the insert face would provide a multiplicity of knife edges. Tests were conducted to evaluate the performance of an insert made of aluminum-honeycomb material. The tests results revealed that the honeycomb polarized the urine stream, reduced splashback to a minimum, and stored the fluid (acting as a capillary-tube matrix) until it drained through the dump line. Also, the angle of the urine stream to honeycomb cell axes could be varied to as much as 25° without splashback.

Combination Insert

Earth-environment tests indicated that a combination insert of honeycomb and cellulose sponge yielded the best results. The honeycomb insert polarized the urine stream, eliminated splashback, and supported the absorbent upper insert (fig. 4). The cellulose sponge, placed at the open end, provided a wicking action to collect the last few urine drops that cling to the penis. Inserts of cotton and polyurethane foam sandwiched in paper also gave satisfactory results.

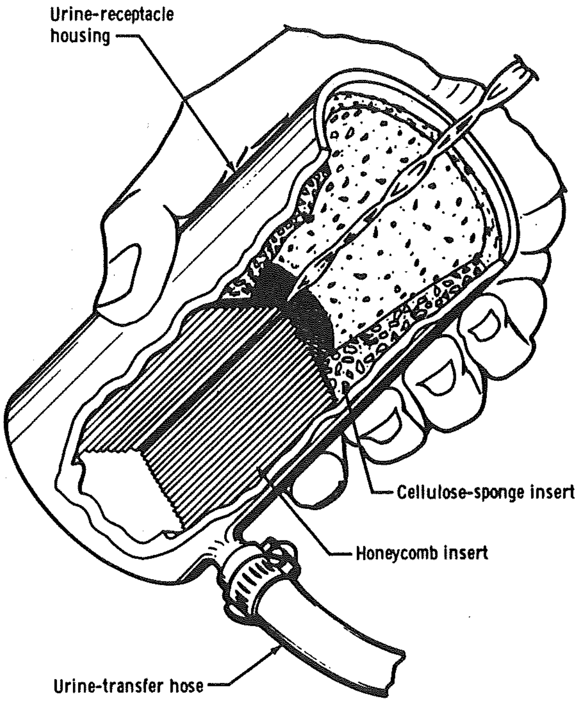

Figure 4. - Urine receptacle with combination insert.

Tests were conducted in an earth environment to determine the vacuum-drying characteristics of the inserts and the urinal. These tests were accomplished by covering the open receptacle with a sealing-type cover and exposing the drain line to a vacuum source. To enhance the performance and sanitary qualities of the urinal, a fresh-water-rinse device was incorporated into the cover (fig. 5) to flush the unit after each urination. This innovation has not been used on any Apollo flight because of the lack of a rinse-water source separate from the drinking water. The receptacle configuration, although designed primarily as a hand-held unit, may be wall-mounted rigidly or may be attached to a commode or fecal canister for use during defecation.

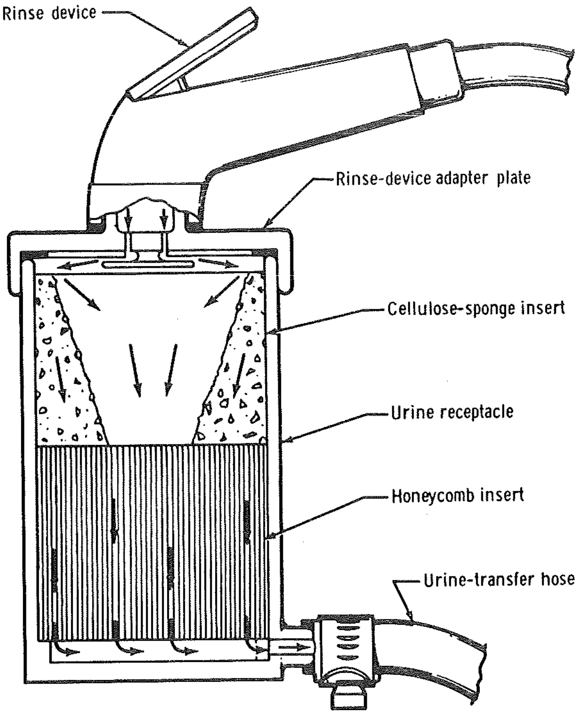

Figure 5. - Urine receptacle with rinse device.

ZERO-GRAVITY-ENVIRONMENT TEST

The purpose of the zero-gravity-environment test was to determine the operational characteristics of different receptacle configurations and insert combinations in zero gravity and to select the one receptacle design and insert combination that would yield optimum performance.

Test Equipment

A waste-management console (fig. 6), constructed for the NASA Manned Spacecraft Center (MSC), was used to simulate the Apollo CM urine-drain line and overboard-dump nozzle. This console also supplied simulated urine at various rates. The evaluation was accomplished under zero-gravity conditions in a U. S. Air Force KC-135.

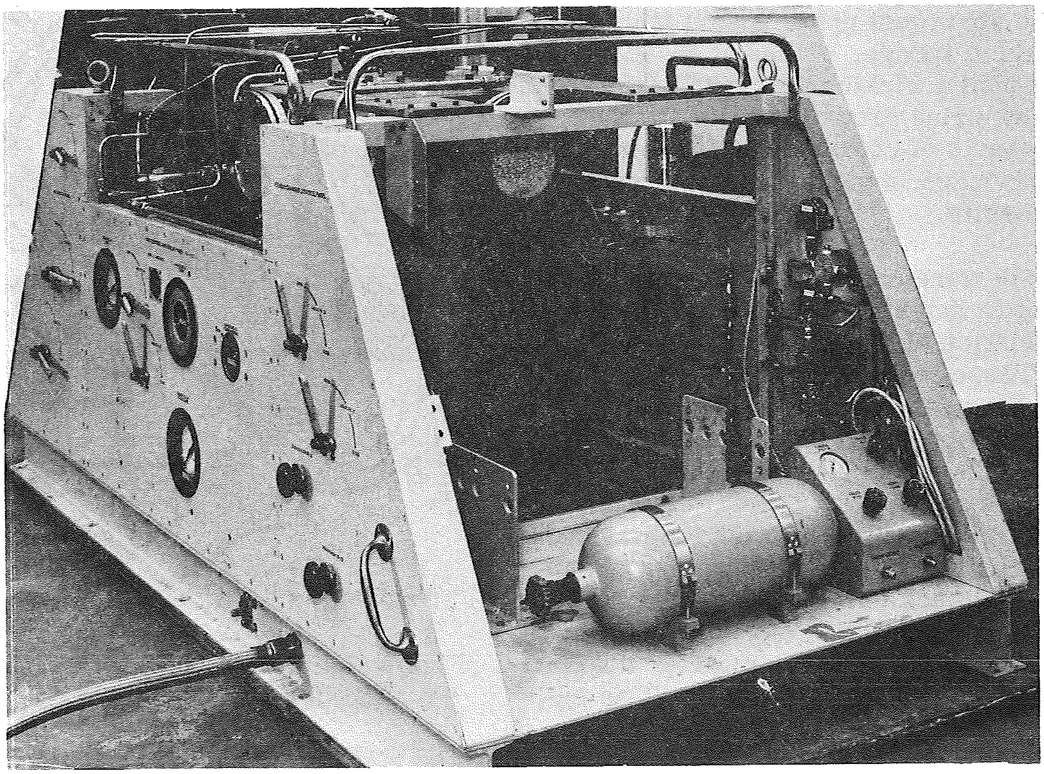

Figure 6. - Zero-gravity test assembly waste management system.

Test of Urine Receptacle

The design requirements of the open urinal dictated that it must accept a total urination of 7.0×10^{-4} m^3 (700 milliliters) at a rate of 4.0×10^{-5} m^3/sec (40 ml/sec) without splashback or overflow. Also, the absorbent insert must absorb the tail-off drops from the penis.

Two types of receptacles were tested. One type was a 5.08×10^{-2} meter (2 inch) diameter, 4.0×10^{-4} m^3 (400 milliliter) capacity receptacle (fig. 7); the other type was 6.985×10^{-2} meter (2-3/4 inch) diameter, 4.80×10^{-4} m^3 (480 milliliter) capacity receptacle. The 4.0×10^{-4} m^3 (400 milliliter) and 4.80×10^{-4} m^3 (480 milliliter) capacity urine receptacles being tested under zero-gravity conditions are depicted in figures 8 and 9, respectively. A variety of insert configurations, both 3.175×10^{-3} meter (1/8 inch) cell and 4.762×10^{-3} meter (3/16 inch) cell honeycomb, were used. Additional tests were conducted with insert combinations using both the honeycomb insert and absorbent-type insert rings. The absorbent-type inserts consisted of both the cotton fibers and the cellulose sponge. The open urinal was allowed to accept

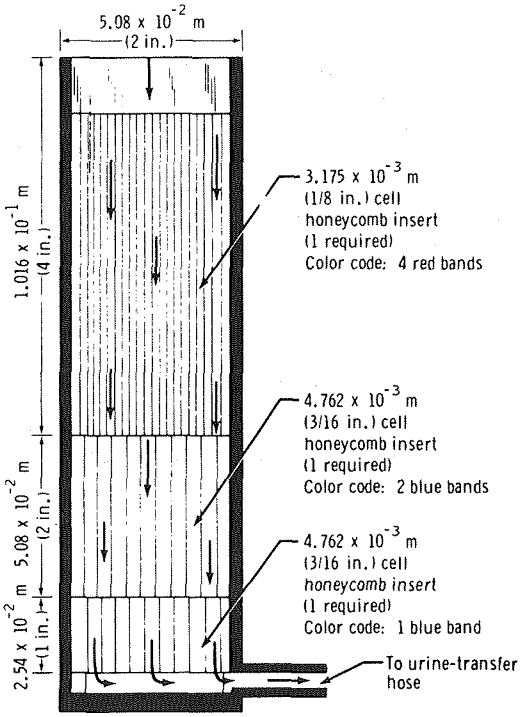

Figure 7. - Typical zero-gravity test configuration of the 4.0×10^{-4} m^3 (400 milliliter) open-type urine receptacle.

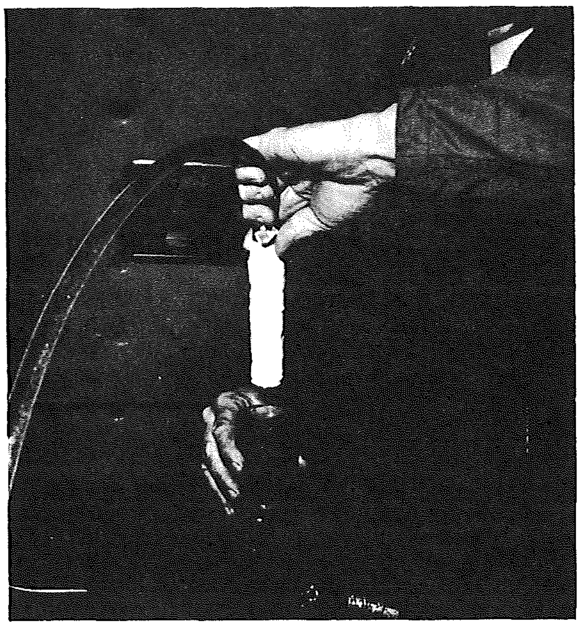

Figure 8. - The 4.0×10^{-4} m^3 (400 milliliter) capacity urine receptacle being tested under zero-gravity conditions in a U.S. Air Force KC-135.

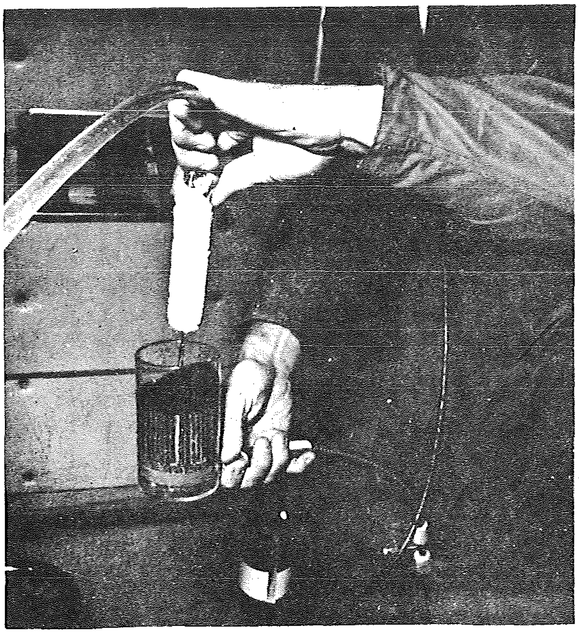

Figure 9. - The 4.80×10^{-4} m^3 (480 milliliter) capacity urine receptacle being tested under zero-gravity conditions in a U.S. Air Force KC-135.

the simulated urine stream at three flow rates: 1.95×10^{-5} m^3/sec (19.5 ml/sec), 3.30×10^{-5} m^3/sec (33 ml/sec), and 4.05×10^{-5} m^3/sec (40.5 ml/sec). The flow was discontinued at zero-gravity terminations or if the receptacles were about to overflow.

Test Results

The desired performance of the receptacle was to accept a maximum flow rate of 4.00×10^{-5} m^3/sec (40 ml/sec) for 17.5 seconds (requiring a total capacity of 7.0×10^{-4} m^3 (700 milliliters)). Tests 1 to 12A (table I) were used to determine the performance of the honeycomb inserts, and tests 13 to 16 were used to determine performance of the complete receptacle.

The results of these tests indicated that the open-type urine-receptacle concept performed satisfactorily and that the 4.80×10^{-4} m^3 (480 milliliter) receptacle with the 3.175×10^{-3} meter (1/8 inch) cell honeycomb and cellulose-sponge insert combination exceeded the design requirements. The capillary force in the cells of the honeycomb insert held the fluid in place in the zero-gravity field environment until the fluid had time to be sucked into the urine-dump line. Small droplets of splashback occurred at urine-stream-to-honeycomb-cell angles of approximately 25° and greater.

A man (test subject) accomplished a urination in zero gravity. At the end of the urination cycle, a drop of urine approximately 9.525×10^{-3} meter (3/8 inch) diameter, that remained on the end of the penis, was removed satisfactorily by touching the drop with a cellulose sponge.

TABLE I. - URINE-RECEPTACLE ASSEMBLY ZERO-GRAVITY-TEST RESULTS

Test number	Honeycomb-insert		Flow rate		Total time, sec	Capacity		Reason stopped
	m	in.	m^3/sec	ml/sec		m^3	ml	
4.0×10^{-4} m^3 (400 milliliter) receptacle								
1	3.175×10^{-3}	1/8	19.5×10^{-5}	19.5	20.2	3.94×10^{-4}	394	Zero g[a]
2	3.175	1/8	33.0	33.0	19.2	6.34	634	Zero g[a]
3	3.175	1/8	40.5	40.5	14.0	5.67	567	Filled
3A	3.175	1/8	40.5	40.5	14.6	5.91	591	Filled
4	4.762	3/16	19.5	19.5	20.5	4.00	400	Zero g[a]
5	4.762	3/16	33.0	33.0	20.3	6.70	670	Zero g[a]
6	4.762	3/16	40.5	40.5	16.5	6.68	668	Filled
6A	4.762	3/16	40.5	40.5	17.5	7.09	709	Filled
4.80×10^{-4} m^3 (480 milliliter) receptacle								
7	3.175×10^{-3}	1/8	19.5×10^{-5}	19.5	20.5	4.00×10^{-4}	400	Zero g[a]
8	3.175	1/8	33.0	33.0	20.5	6.77	677	Zero g[a]
9	3.175	1/8	40.5	40.5	17.0	6.89	689	Filled
9A	3.175	1/8	40.5	40.5	18.7	7.57	757	Filled
10	4.762	3/16	19.5	19.5	17.8	3.47	347	Zero g[a]
11	4.762	3/16	33.0	33.0	20.5	6.77	677	Zero g[a]
12	4.762	3/16	40.5	40.5	16.9	6.84	684	Filled
12A	4.762	3/16	40.5	40.5	16.0	6.48	648	Filled
Cotton foam top insert								
13	3.175×10^{-3}	1/8	40.5×10^{-5}	40.5	19.1	7.74×10^{-4}	774	Filled
14	3.175	1/8	40.5	40.5	17.4	7.05	705	Filled
Cellulose foam top insert								
15	3.175×10^{-3}	1/8	40.5×10^{-5}	40.5	18.2	7.37×10^{-4}	737	Filled
16	3.175	1/8	40.5	40.5	17.9	7.25	725	Filled

[a]Zero gravity is terminated.

Recommendations

The test results were the basis for recommendations that space-flight hardware be fabricated and tested in zero gravity, that the receptacle be 1.270×10^{-1} meter to 1.524×10^{-1} meter (5 to 6 inches) long and have an inside diameter of 6.985×10^{-2} meter to 7.62×10^{-2} meter (2.75 to 3 inches), and that a combination insert of 3.175×10^{-3} meter (1/8 inch) cell aluminum honeycomb and cellulose sponge be used, and that the prototype flight-test item be used on the Apollo 12 mission.

DESIGN OF FLIGHT HARDWARE

In order for the urinal to qualify as flight hardware (figs. 10 to 14), it was necessary that all of the materials used for its fabrication be qualified for use on the CM. Additional restrictions on the selection of materials were imposed by the corrosive action of the urine and its tendency to nurture bacteria.

A number of modifications in the urinal design were made to comply with requirements for lightweight, noncorrosive, nonflammable materials and materials that are nonnutritional to bacteria. The urinal housing and cover components were made from 6061 T6 aluminum material and were coated with a hard anodized surface.

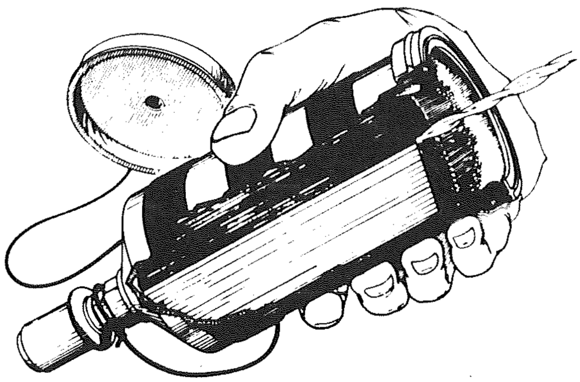

Figure 10. - Urine-receptacle assembly, cutaway view.

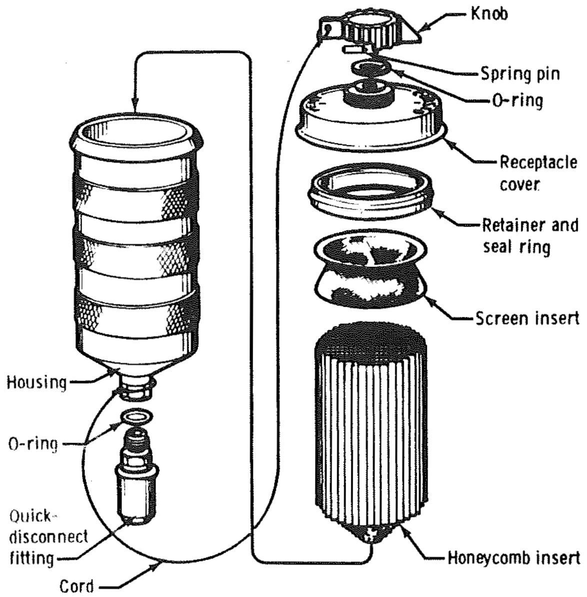

Figure 11. - Urine-receptacle assembly, exploded view.

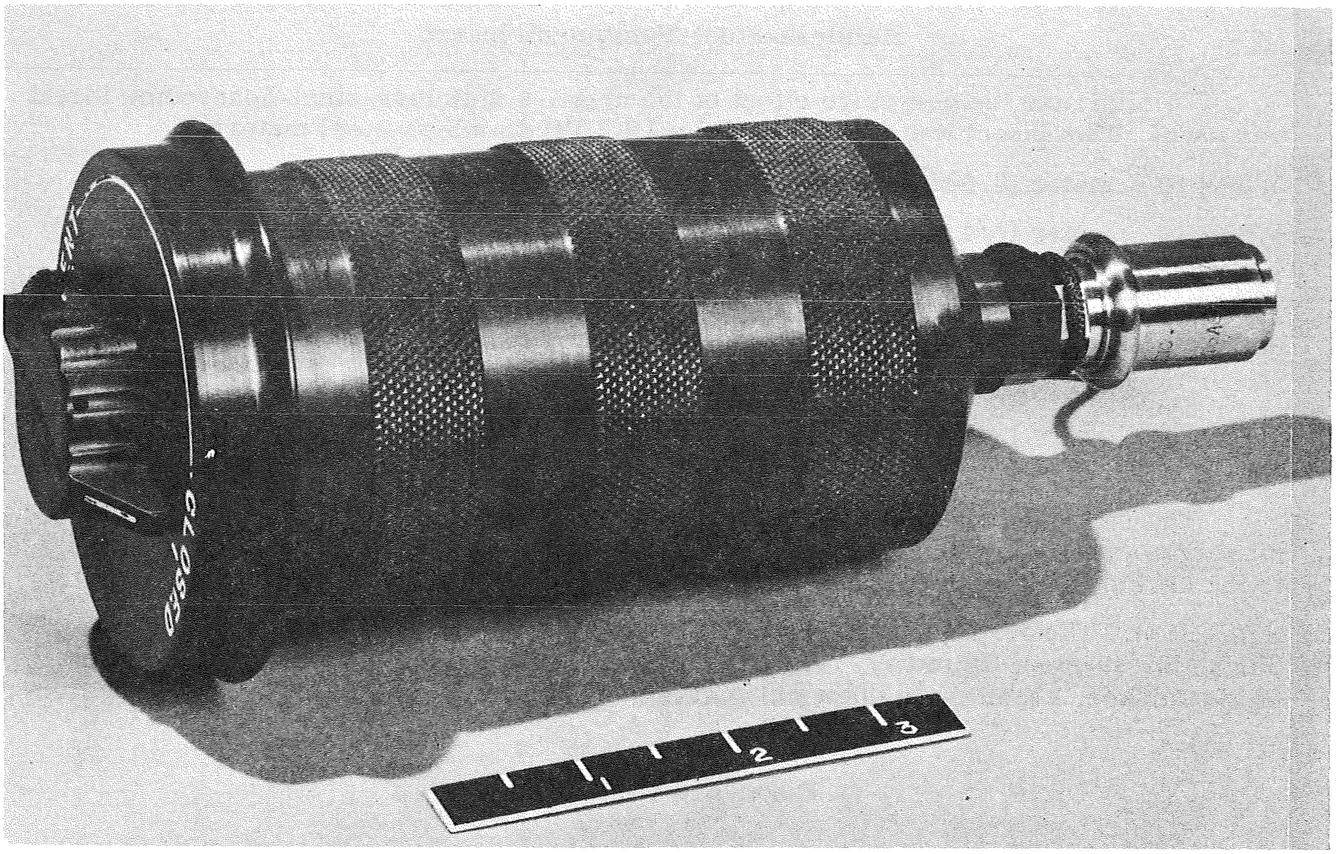

Figure 12. - Urine-receptacle assembly (complete unit).

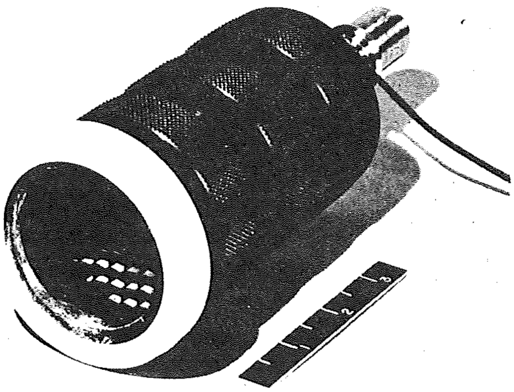

Figure 13. - Urine-receptacle assembly with cover omitted.

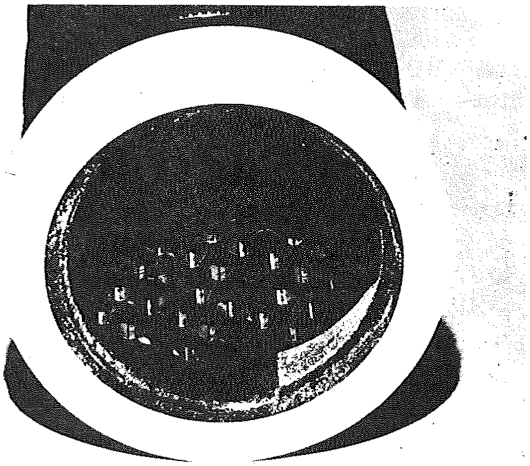

Figure 14. - Closeup of honeycomb insert in urine receptacle.

Stainless-Steel-Honeycomb Insert

To minimize the corrosive effect of the urine, a stainless-steel-honeycomb insert was used. This insert was fabricated from 15-7 PH stainless-steel material, 5.08×10^{-5} meter (0.002 inch) foil thickness, perforated, and made into 6.35×10^{-3} meter (1/4 inch) square-cell honeycomb. The 6.35×10^{-3} meter (1/4 inch) cell size had minimum splashback during qualification tests. However, both the 3.175×10^{-3} meter (1/8 inch) cell aluminum and 6.35×10^{-3} meter (1/4 inch) cell stainless-steel honeycomb were tested.

Stainless-Steel-Screen Insert

The medical requirements regarding bacterial growth necessitated the development of a wicking-type insert made from an inorganic material. Eventually, this led to the development of an oxidized stainless-steel-screen insert which would provide this action. The screen insert was made from Type R, 4.0×10^{-5} meter (40 micron), 304 stainless-steel Rigimesh. The oxide coating enhanced the hydrophilic properties of the surface, resulting in the wicking action.

Cover and Vent Valve

The cover caps the receptacle when it is not in use and prevents the loss of cabin air. The cover permits maximum odor control and allows the inside of the urinal to dry by exposing it to space vacuum. To facilitate cap removal after the urinal has been in a storage mode, it is necessary to equalize the pressure in the urinal with that of the spacecraft. Pressure equalization is accomplished by use of the vent valve by bleeding the 3.447×10^{4} N/m^{2} (5.0 psia) cabin pressure into the receptacle. A force of 1.468×10^{2} newtons (33 pounds) would be required to uncover the urinal if it were not vented. The spring pin, which limits the knob rotation, is made of stainless steel.

Retainer and Seals

The retainer ring provides a slight interference fit between the cover and housing so that the cover will remain on the housing when snapped together. This retainer ring, made from TFE Teflon (a fluorocarbon resin), also acts as a pressure seal between the cover and housing when the unit is vented to space vacuum. The O-ring seals are made from Viton A, a fluoroelastomer. The tie cord, which keeps the cover assembly tied to the receptacle, is a 4.762×10^{-3} meter (3/16 inch) (S-121) braided cord made from Polybenzimidazole 200-50-0.

QUALIFICATION TESTS

Qualification tests were conducted in both zero-gravity and laboratory environments. The purpose of qualification tests was to certify that the urine-receptacle assembly (URA) would function in zero gravity while connected to a simulated CM WMS, and that the URA would withstand the environments expected during its operational life (consisting of prelaunch preparations and inflight usage during an Apollo mission).

Zero-Gravity Test

The zero-gravity portion of these tests was conducted with the same WMS console and flight-support equipment used in previous tests. The qualification test URA was subjected to the following combination of urination rates and volumes.

Low Flow Rates

The unit was subjected to a minimum of two zero-gravity sequences at a flow rate of $2.0 \times 10^{-5} \pm 4.0 \times 10^{-6}$ m^3/sec (20 ± 4 ml/sec) for a period of 20 to 30 seconds. Flow number 20, at a rate of 1.94×10^{-5} m^3/sec (19.4 ml/sec), totaled 4.07×10^{-4} m^3 (407 milliliters) in 21.0 seconds. Flow number 21, at a rate of 1.94×10^{-5} m^3/sec (19.4 ml/sec) for a period of 22.6 seconds, totaled 4.38×10^{-4} m^3 (438 milliliters).

Medium Flow Rate

The unit was subjected to a minimum of two zero-gravity sequences at a flow rate of $3.0 \times 10^{-5} \pm 4.0 \times 10^{-6}$ m^3/sec (30 ± 4 ml/sec). The capacity goal was $6.50 \times 10^{-4} \pm 5.0 \times 10^{-5}$ m^3 (650 ± 50 milliliters). Flow number 11, at a rate of 3.05×10^{-5} m^3/sec (30.5 ml/sec), totaled 6.59×10^{-4} m^3 (659 milliliters) in 21.6 seconds. Flow number 12, at a rate of 3.05×10^{-5} m^3/sec (30.5 ml/sec), totaled 6.86×10^{-4} m^3 (686 milliliters) in 22.5 seconds.

High Flow Rate

The unit was subjected to a minimum of two zero-gravity sequences at a flow rate of $4.0 \times 10^{-5} \pm 4.0 \times 10^{-6}$ m^3/sec (40 ± 4 ml/sec) and a flow time of 15 of 20 seconds. The capacity goal was $6.50 \times 10^{-4} \pm 5.0 \times 10^{-5}$ m^3 (650 ± 50 milliliters). Flow number 4, at a rate of 4.05×10^{-5} m^3/sec (40.5 ml/sec), totaled 7.05×10^{-4} m^3 (705 milliliters) in 17.4 seconds. Flow number 7, at a rate of 4.05×10^{-5} m^3/sec (40.5 ml/sec), totaled 6.89×10^{-4} m^3 (689 milliliters) in 17.0 seconds.

The results of these tests verified that the performance of the URA in zero gravity was acceptable because it collected, with minimal splashback, urine volumes greater than the maximum requirement of 7.0×10^{-4} m^3 (700 milliliters).

Although not part of the qualification test, a man accomplished a satisfactory urination into the urine receptacle in a zero-gravity environment for the second time.

Laboratory-Environment Test

The laboratory-environment tests consisted of four phases. First, a proof test was performed during which the URA was evacuated to a pressure of $6.67 \pm 6.67 \times 10^2$ N/m^2 (5 ± 5 millimeters of mercury absolute) and was maintained at this pressure for a minimum of 15 minutes. Second, a leakage test was performed, during which the pressure in the URA was raised to $6.69 \times 10^4 \pm 2.0 \times 10^3$ N/m^2 (502 ± 15 millimeters of mercury absolute), allowed to stabilize, and then required to not have a pressure change greater than 1.0×10^3 N/m^2 (7.5 millimeters of mercury) over a 15-minute period. Third, a vent-valve performance test was performed, during which the URA pressure was stabilized at $6.67 \pm 6.67 \times 10^2$ N/m^2 (5 ± 5 millimeters of mercury); the vent valve was opened, and the cover had to be easily removed in less than 5 seconds. Fourth, a urine-exposure test was performed, during which simulated flight usage of the URA was accomplished by allowing the flight-environment sequence of wetting with urine, rinsing (by use of the water dispenser), vacuum drying, and repressurizing with oxygen to 3.447×10^4 N/m^2 (5.0 psia). The pressure-decay rate during vacuum drying was controlled to duplicate CM WMS performance by the 1.397×10^{-3} meter (0.055 inch) diameter orifice in the vacuum-source line. To simulate inflight usage, the URA was subjected to 10 days of urine exposure, which consisted of 18 simulated urinations of $4.50 \times 10^{-4} \pm 5.0 \times 10^{-5}$ m^3 (450 ± 50 milliliters) daily, spaced at a minimum of 20-minute intervals. A total of 1.845×10^{-2} m^3 (18 450 milliliters) of urine was collected and discharged through the URA during this test.

The first three tests (mechanical cycling) were repeated for 450 cycles each, which was equivalent to 2-1/2 missions. The laboratory qualification tests were performed on the mechanical-cycling test equipment (fig. 15) and the urine-exposure-cycle test equipment (fig. 16). The results of these tests verified that the URA would perform the mechanical cycles expected during flight usage and that the internal components of the urinal would function without degradation during a 10-day mission.

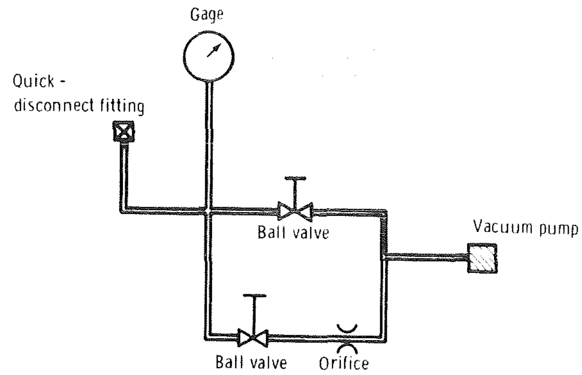

Figure 15. - Laboratory test equipment setup for urine-receptacle mechanical-cycling test.

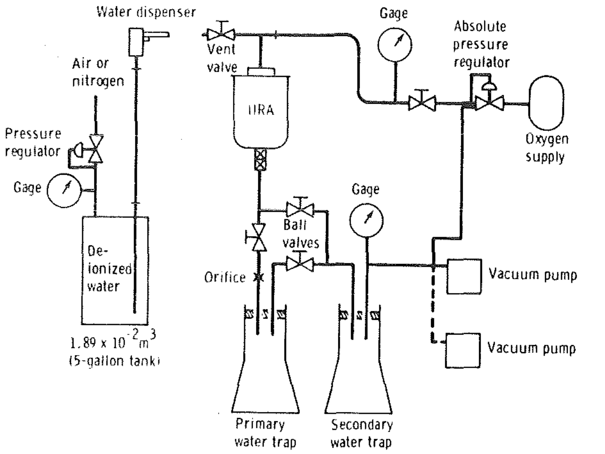

Figure 16. - Laboratory test equipment setup for urine-receptacle exposure-cycle test.

PERFORMANCE OF URINE-RECEPTACLE ASSEMBLY ON THE COMMAND MODULE

The URA performed satisfactorily on the Apollo 12 mission, on which it was flown as a test item, and on subsequent Apollo flights, on which it has been used as base-line equipment. Although the URA was carried on board the Apollo 12 mission as a test item (with the Gemini cuff-type urine collector to serve as a backup system), the URA was used almost exclusively as base-line equipment.

Excessive cabin-oxygen-makeup flow rates on several occasions during the Apollo 12 flight were traced to the URA vent valve, which had been inadvertently left open when the URA was stowed. This was considered an operational-procedure problem and has been corrected. To circumvent procedural errors, a spring-loaded vent valve (fig. 17), which automatically closes when released, has been proposed to replace the existing totally manually operated valve.

Although the screen insert will wick the tail-off drops after urination, disposable tissue wipes were supplied as an alternate method for posturination cleanup. After each urination, the open receptacle was rinsed by spraying water into it with the CM potable water dispenser.

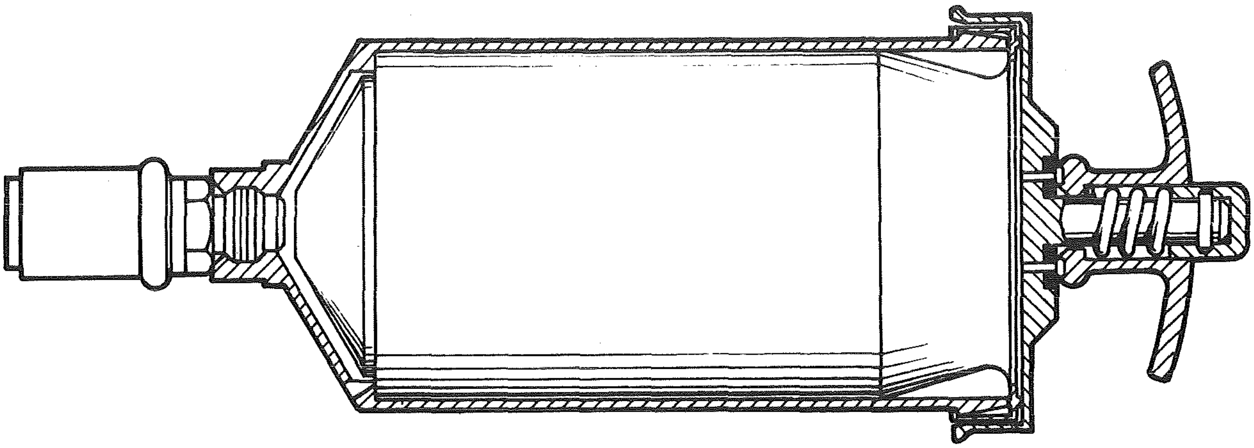

Figure 17. - Proposed urine-receptacle assembly with modified cover to facilitate venting with spring-loaded vent valve.

URINE-RECEPTACLE ASSEMBLY WITH INTEGRAL RINSE DEVICE

The technical management personnel at the NASA Langley Research Center asked the cognizant MSC personnel if a URA with a built-in flush-water injector could be provided for a 90-day manned test. In answer to this request, a modification was incorporated into the URA to provide a rinse device integral to the unit; this modification allowed the unit to be capped-off, completely rinsed after each urination, and then vacuum dried. The unit with the integral rinse device (figs. 18 and 19) was designed, fabricated, and supplied to the Langley Research Center for testing. The unit performed satisfactorily during the 90-day manned test. The addition of a germicide to the rinse water will ensure sanitary conditions.

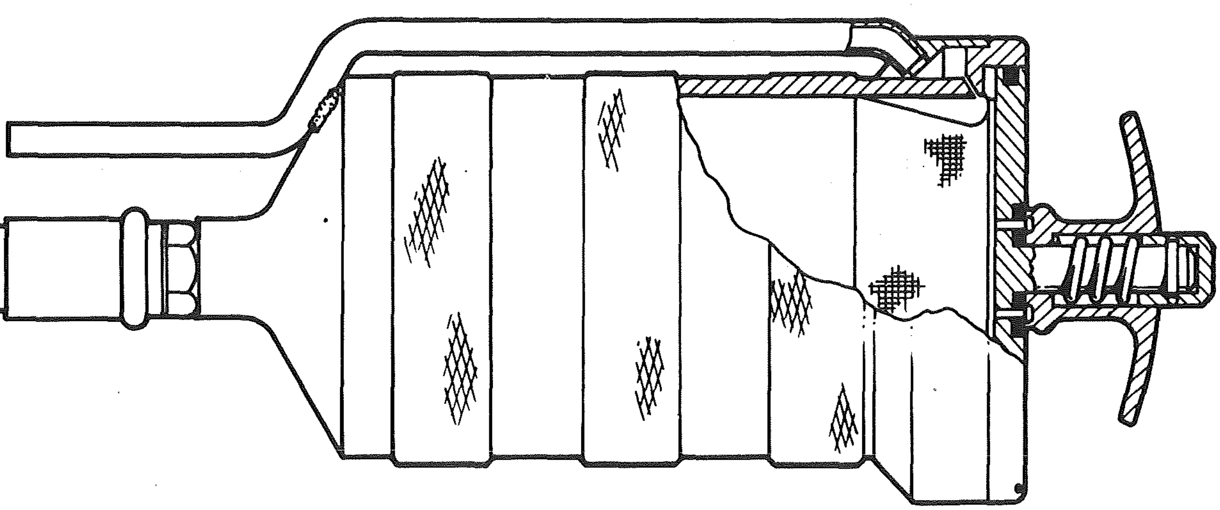

Figure 18. - Prototype urine-receptacle assembly with integral rinse.

Figure 19. - Prototype urine receptacle with integral rinse provisions (vented cover omitted).

CONCLUDING REMARKS

The qualification-test results of the urine-receptacle assembly, the receptacle performance, and the acceptance of the device by the Apollo crewmen are indicative that the open-type urine-receptacle concept is practical for spacecraft and space-station applications. The honeycomb insert eliminated splashback and provided a storage medium for the urine, allowing the urine-receptacle assembly to function in a manner similar to a standup urinal on earth. The open-type urinal eliminates the need for circumferential contact between the penis and the urinal, eliminating user discomfort. The use of a urine-receptacle cover permitted odor control and permitted the unit to dry out when in the storage mode.

Manned Spacecraft Center
National Aeronautics and Space Administration
Houston, Texas, February 11, 1972
914-50-CA-96-72

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-264/1162