BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Vomit Removal Apparatus for an EVA Pressure Suit: A Design Concept Case 710

DATE: July 29, 1969

FROM: M. A. Robinson

ABSTRACT

Vomit removal apparatus which can be retrofitted to an EVA pressure suit is described. Two versions of the basic design are presented: an open loop version, in which the vomit is vented into space, and a closed loop version, in which the vomit is collected in a trap. Both versions require the use of only one hand for their operation.

BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B69 07085

SUBJECT: Vomit Removal Apparatus for an EVA Pressure Suit: A Design Concept
Case 710

DATE: July 29, 1969

FROM: M. A. Robinson

MEMORANDUM FOR FILE

I. INTRODUCTION

A number of recent papers (Refs. 1-3) have pointed out the hazards of vomiting in space. In the case of an unsuited astronaut, it has already been demonstrated that he can expel the vomit into a plastic bag, or other container, by a burst of air from the lungs. In the case of the suited astronaut, vomiting is considered to be a hazard of great proportions. At the very least, the vomit will cover parts of the visor, thus interfering with vision, and the floating particles will clog the ventilation passages in the space suit. At worst, the astronaut may asphixiate by rebreathing the vomit.

With the anticipated increase in EVA activities, both orbital and lunar surface, it appears timely to consider the possibility of developing a mechanical means of removing vomit from a pressurized EVA suit. The purpose of this memorandum is to present a design concept for such apparatus, with both open loop and closed loop alternatives, and to discuss some of the areas of experimentation that can lead to the development of a working system.

II. AN OPEN LOOP SYSTEM-VENTING THE VOMIT INTO SPACE

A sketch of an open loop system for vomit removal is given in Figure 1. The essential features of the system are stated below:

A. The Mouthpiece

A mouthpiece of the size and shape to conform to the open mouth of the astronaut is fitted at one end of a hollow tube. The tube is mounted inside the helmet through a hole in the visor, with the mouthpiece held retracted away from the face. In Figure 1, the mouthpiece is shown centered in the visor. It might be desirable to position the mouthpiece off to one side, so as not to interfere with forward vision. This would require the astronaut to turn his head to the side in order to use the apparatus. Another possibility is to alter the contour of the lower part of the visor so as to place the retracted mouthpiece further away from the face.

B. The Bellows

The bellows acts as a spring to keep the mouthpiece in a retracted position, and at the same time to seal the opening in the visor through which the exhaust tube is mounted.

C. The Exhaust Tube

The exhaust tube vents the vomit into space, using the vacuum of space and the suit pressure as the driving force. A small orifice or pressure control valve may be added to the exhaust tube to prevent sudden depressurization and eliminate the possibility of lung collapse.

D. The Hand Actuated Valve

The apparatus requires the use of only one hand to simultaneously position the mouthpiece and to actuate the valve. The valve will have a sliding gate that can close even if there is material left in the exhaust tube. The flow of air and vomit can be controlled by hand pressure on the lever.

E. The Auxiliary Air Supply

In order to facilitate the retrofitting of this apparatus to existing pressure suits, the design concept includes an auxiliary air supply. By means of a pressure sensitive valve, this compressed air (or other atmospheric composition) replaces the air expelled during the vomiting episode. A pressure gauge (not shown) indicates when the auxiliary canister should be replaced.

During a vomiting episode, the astronaut positions the mouthpiece over the mouth and presses the lever to open a passage through the exhaust tube, thus allowing a mixture of air and vomit to be vented into space. In order to replace the air in the lungs, he releases the lever (thus sealing the exhaust tube), pulls the mouthpiece away from the face, and breathes in the suit atmosphere. During this inhalation period the suit pressure will tend to drop and the auxiliary air supply will automatically build up the suit pressure without delay.

III. A CLOSED LOOP SYSTEM - THE VOMIT TRAP

A diagram of a closed loop system for vomit removal is given in Figure 2. It resembles the open loop system in several respects, namely the mouthpiece, the bellows, and the exhaust tube. The latter, however, does not have a hand actuated valve, but leads to the vomit trap by means of a flexible tube.

In the figure, a check valve is shown at the entrance to the vomit trap, to prevent the vomit from returning (in zero-g) to the mouthpiece. This spring loaded valve (having very slight loading, so as not to interfere with the vomit flow) might possibly be mounted in the exhaust tube itself close to the mouthpiece, thus shutting off the vomit return at an earlier point in the loop. Some of the additional features of this system are as follows:

A. The Vomit Trap

This container would be used to hold the vomit, and allow the amtosphere blown by the astronaut to return to the suit through the return port. A fine screen would keep the vomit in the trap, and a spring loaded valve, either in the trap, or in the exhaust tube as noted above, would prevent the vomit from floating back to the mouthpiece. In use, it may be necessary for the astronaut to blow air through the mouthpiece several times after the vomiting episode to clear the flexible hose, and insure that all the vomit is in the trap. Or, alternatively, if a valve is built into the exhaust tube, it may not be necessary to clear the flexible hose.

B. The Flexible Hose

The flexible hose must offer a minimum of resistance to the flow of the vomit. It must be smooth on the inside, and possibly be coated with Teflon, of or some other non-stick compound. The path of the flexible hose can be made shorter than that shown in Figure 2. In this figure, the trap is shown in a configuration suitable for training purposes in a gravitational field. The zero-g version may have the hose coming in from the top, rather than the side as shown here.

IV. SOME R&D CONSIDERATIONS

The major tradeoff between the two versions of the basic design is the question of safety versus ease and effectiveness of vomit removal. The first version (Figure 1) appears to provide the easier means of vomit removal. The astronaut exhales into the mouthpiece, and can control the outflow by means of the hand actuated valve. The vacuum of space may enhance the outflow, but this has to be verified by experiment. The major problem of this first version is the question of safety associated with the closing of the exhaust tube and the auxiliary air supply. The author feels that it is possible to design a sliding valve that is fail safe. On the other hand, if the auxiliary air supply control valve fails, or the air supply is exhausted, this could create a hazardous condition.

The second version of the design (Figure 2) tries to avoid the dangers of an open system, by providing an atmosphere return line to the suit. The problem here is to demonstrate that vomit removal can be accomplished with this configuration. The two difficulties anticipated here are the resistance to flow offered by the long path to the vomit trap, and the extent to which the screen may become clogged and restrict the air flow. The latter problem, namely a clogged screen, may be dealt with by providing a large surface area of screen by using a zig-zag screen on a wire mesh. The restriction to flow may not be a problem under zero-g, especially if all surfaces are coated with non-stick substances. Another aid to easy flow may be to use a hand actuated lever to cut off the return of the vomit, thus eliminating the spring loaded valve suggested for either the trap, or the exhaust tube.

V. FURTHER REMARKS

The evolving plans for an orbiting space station or lunar base make note of the possibility of accommodating scientists and technicians, many of whom will not be as thoroughly conditioned as the astronauts to zero-g or low-g environments. We may expect these individuals to exhibit greater incidences of nausea and vomiting than the astronauts, and for that reason, apparatus along the lines suggested in this memorandum will become even more important.

VI. ACKNOWLEDGEMENT

The author would like to acknowledge the many helpful suggestions of his colleagues, C. L. Davis, A. N. Kontaratos and J. A. Schelke.

M. A. Robinson

1011-MAR-ulg

M. A. Robinson

REFERENCES

1. Robinson, M. A., "STAC Action Item: Vomiting in a Pressurized Space Suit," Case 630, Bellcomm Addressed Memorandum, March 6, 1968.

2. Benjamin, F. B., "EVA - Medical Requirements", Appendix I to the Minutes of the OMSF Ad Hoc EVA Working Group, Meeting 68-3, Ames Research Center, April 30 and May 1, 1968.

3. Kontaratos, A. N., and Sennewald, P. F., "Some Concerns About Motion Sickness Effects in Apollo," Cases 320 and 340, Bellcomm Memorandum for File, June 9, 1969.

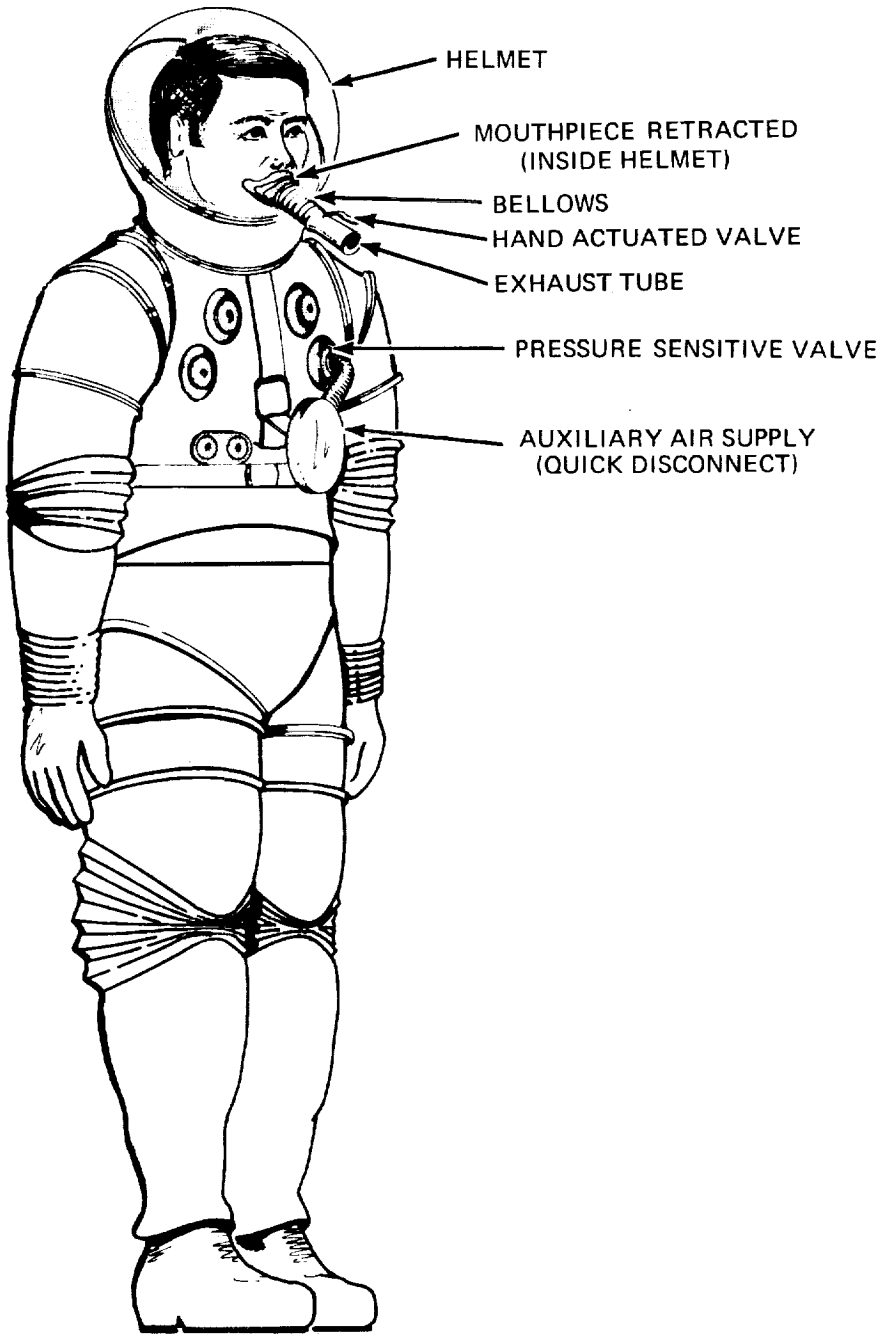

FIGURE 1 - VOMIT REMOVAL APPARATUS FOR EVA PRESSURE SUIT.

BELLCOMM, INC.

Subject: Vomit Removal Apparatus for an EVA Pressure Suit: A Design Concept
Case 710

FROM: M. A. Robinson

DISTRIBUTION LIST

NASA Headquarters

W. O. Armstrong/MTX
F. B. Benjamin/MMR
H. S. Brownstein/MMC
C. J. Donlan/MD-T
S. Deutsch/RBM
D. L. Forsythe/MLA
E. W. Hall/MTG
J. W. Humphreys/MM
T. A. Keegan/MA
R. L. Lohman/MTY
D. R. Lord/MTD
E. J. McLaughlin/MMS
W. C. Schneider/ML
A. D. Schnyer/MTV
S. P. Vinograd/MMR
M. G. Waugh/MTP
J. W. Wild/MTE

ARC

C. C. Kubokawa/LTI
L. Roberts/MAD

LARC

R. W. Stone/152

GSFC

J. E. Kupperian/613

MSC

L. E. Bell/EC6
C. A. Berry/DA
L. F. Dietlein/DA
W. E. Hull/DA3
R. S. Johnston/AC
M. I. Radnofsky/EC7

MSFC

S. A. Johns/R-P&VE-VA

Bellcomm, Inc.

G. M. Anderson
C. Bidgood
A. P. Boysen
T. A. Bottomley
D. R. Hagner
B. T. Howard
D. B. James
J. Z. Menard
I. M. Ross
P. F. Sennwald
J. W. Timko
R. L. Wagner
All Members Division 101
Central File
Department 1024 File
Library