11 July 1958

Report No. DSP-TN-4-58

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SATELLITE RECOVERY SYSTEM (U)

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University of Alabama Research Institute
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SATELLITE RECOVERY SYSTEM (U)

By

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SUMMARY

A satellite recovery system composed of a recovery cone and a retro-rocket system is presented. This recovery nose cone was originally designed for a Juno III type of orbital carrier.

Special design features have been included in the cone in order to render it applicable to experimentation with small animal specimens.

The primary purpose is to present an approach to the design problems involved with some attention given to basic performance.

Further investigation is necessary, especially in the categories of aeroballistics and guidance and control.

[redacted]

CONCLUSIONS

The mechanical aspects of a recovery satellite system of the type presented can be solved without difficulties.

The orbital stay time desired will determine the complexity of attitude control equipment. Spin stabilization will be sufficient for a very short stay time.

The system presented may be adapted to a more sophisticated method of attitude control without difficulty.

[redacted]

TABLE OF CONTENTS

I. THE RECOVERY SYSTEM

A. General Statement

The complete assembly is proposed in two versions shown in Figures 1 and 2. Both versions are equipped with Meteor rockets (Vanguard solid propellant motors) since it was originally proposed that this system be utilized with the Meteor cluster. The single Meteor is shown to represent the final stage of the orbiting vehicle.

The proposed system utilizes six scaled down Sergeant solid propellant motors as retro-rockets. In Figure 1 retro-rockets are rigidly mounted at an angle of 10 degrees with the roll axis in order to protect the cone from blast effects. This inclination results in less than 2% performance loss. The entire retro cluster is encased in a metal shroud, the forward portion of which may be separated prior to ignition of the retro-rockets.

The final Meteor stage will be separated after burnout. It is advisable to provide a backward kick to the empty case to prevent possible collision when the retro-rockets are fired.

The entire assembly may be spin-stabilized without introducing any serious structural difficulties.

B. Performance

From a ballistic standpoint a double kick procedure is more favorable in that the final impact point can be more accurately determined. This procedure is more desirable from a dynamic standpoint because the maximum deceleration should be limited to 10 or 12 g's.

In the double kick procedure the transition from orbital altitude and velocity to re-entry altitude will be accomplished by burning three Sergeants for the first kick and the remaining three for the final kick. After final burnout of the retro-rockets, separation will occur at the base of the re-entry cone. The cone will then enter the atmosphere along a pre-determined ballistic path.

C. Weight and Performance Data

Scale Sergeant Data (One Unit)

Loaded Weight	59.3 lb
Propellant	47.45 lb
Take-off Weight	58.83 lb
Cutoff Weight	9.32 lb
Exhaust Velocity	7015 ft/sec

Effective Exhaust Velocity 6908 ft/sec (Component Parallel to Roll Axis)

Cone and Structure Weight 513 lb

Take-off Weight of First Kick 867 lb
Cutoff Weight of First Kick 726 lb

Velocity Reduction 373 m/sec (1225 ft/sec)

Take-off Weight of Second Kick 726 lb
Cutoff Weight of Second Kick 585 lb

Velocity Reduction 455 m/sec (1492 ft/sec)

Total Velocity Reduction 828 m/sec (2717 ft/sec)

The above velocity reduction values are in the range of the theoretical values for a double kick orbital transition.

Maximum deceleration will be realized at second kick burnout.

Total weight at second kick burnout	585 lb
Combined thrust of 3 Sergeants	6,000 lb
Maximum deceleration	10.25 g's

This deceleration is within the limit for small animal specimens.

D. The Drag Device

Figure 2 shows a similar recovery system with an additional deceleration feature. In this system the retro-rockets can be rotated approximately 10° at their supports, either by hydraulic or electrical means, then locked in position and fired. The empty cases could be rotated an additional 95° and locked if found desirable in this position. The cases would then serve as aerodynamic drag devices.

Preliminary calculation indicates that the velocity reduction realized by this means might not justify the resulting reduction in reliability.

II. THE RECOVERY CONE

Figure 3 shows the proposed cone which is based on the successfully tested missile No. 40 cone. It was found necessary to increase the length of the cone approximately 8 in. in order to incorporate the additional test mechanism into the nose. Additional ballast had to be added for stability reasons resulting in an overall weight increase of approximately 100 lb. This is a disadvantage in that the ballistic factor is somewhat lower, resulting in a higher drag-deceleration peak. This disadvantage will be offset due to the higher re-entry velocity and smaller re-entry angle, both of which greatly reduce the deceleration peak. It is believed that the drag deceleration will remain below the safe limit for the selected animal specimens.

III. THE SPECIMEN CONTAINER

Figure 4 shows the specimen container incorporated into the forward section of the cone. The specimen compartment will be sealed and pressurized. The outer wall of the compartment should be as thin as structurally possible. Fabrication problems will be the limiting factor rather than stresses due to internal pressure. Sheet steel of 0.020 in. should be adequate.

Access ports are provided at the aft end of the compartment which will be plugged or used for installation of experimental equipment such as air supply lines, photography equipment, lights, etc. Additional volume is provided aft of the container assembly and around the electric motor for additional equipment.

Figure 5 shows the compartment in an exposed position. In this position the specimen is protected from radiation only by the thin outer wall of the compartment.

The compartment is actuated by a simple mechanism composed of a reversible motor, a reduction gear and a worm shaft. The forward end of the worm shaft rotates in the internally threaded core of the container. Rotation of the worm shaft will cause a forward or backward motion of the container which is guided similarly to a piston and restrained from rotation by a pin and slot arrangement.

If the recovery system is spinning at a rate of 200 rpm, an animal specimen located at the outer wall would experience a gravitational field equivalent to approximately 2 g's. A specimen restrained near the inner wall of the compartment would experience a gravitational field of approximately 1 g.

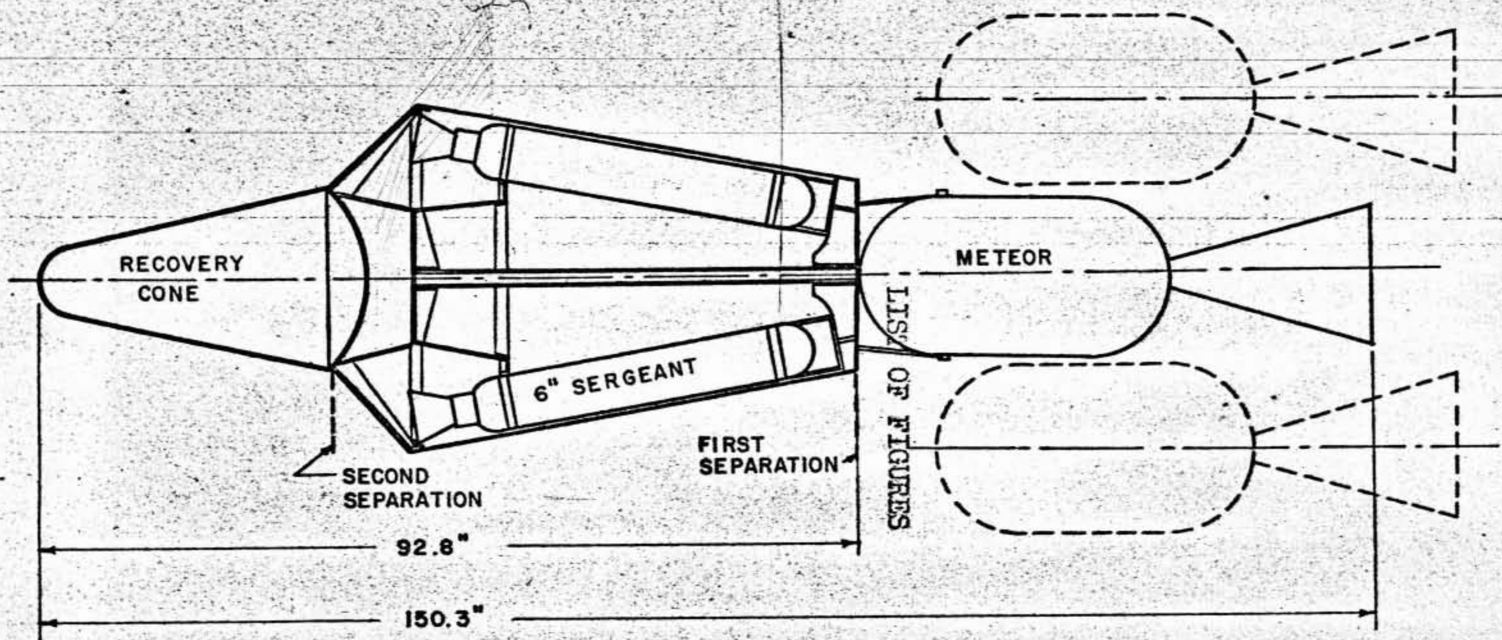
For design details of the enclosed sketches see the corresponding drawings below.

Figure No.	Drawing No.
1	GM 544229
2	GM 544232
3	GM 544230
4	"
5	"

LIST OF FIGURES

[redacted]

RECOVERY SYSTEM



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WEIGHT DATA:

CONE	423 LB
SIX 6" SERGEANTS	354 "
STRUCTURE	90 "
BURNED WEIGHT	585 "
TOTAL WEIGHT	867 "
METEOR	428 "
TOTAL ASSEMBLY	1295 LB
VELOCITY REDUCTION	828 M/SEC.
ROTATION SPEED	200 RPM.

SCALE = 1:20
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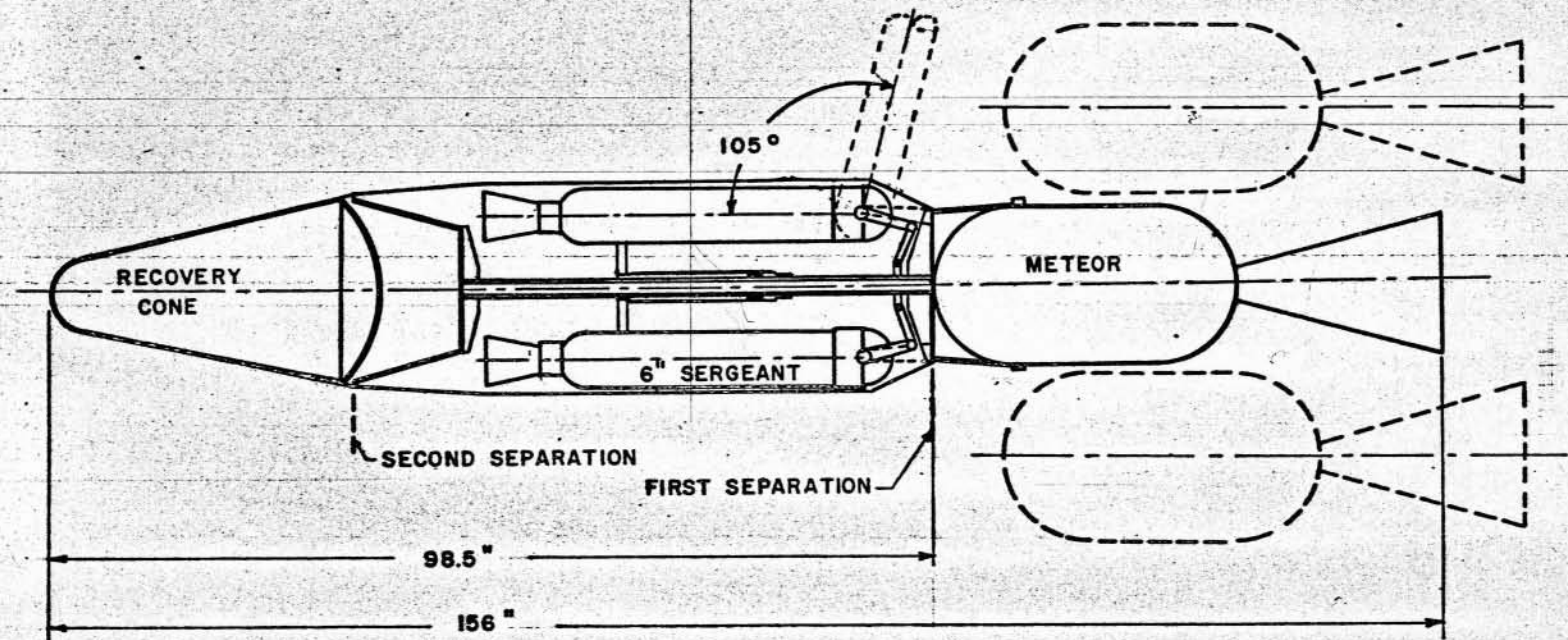
17 JUNE 1958

FIG. 1

RECOVERY SYSTEM

WITH DRAG DEVICE



WEIGHT DATA:

CONE	423 LB
SIX SERGEANTS	354 "
STRUCTURE	60 "
MOVING PARTS	50 "
BURNED WEIGHT	605 "
TOTAL WEIGHT	887 "
METEOR	428 "
TOTAL ASSEMBLY	1315 LB

SCALE = 1:20
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FIG. 2

RECOVERY CONE

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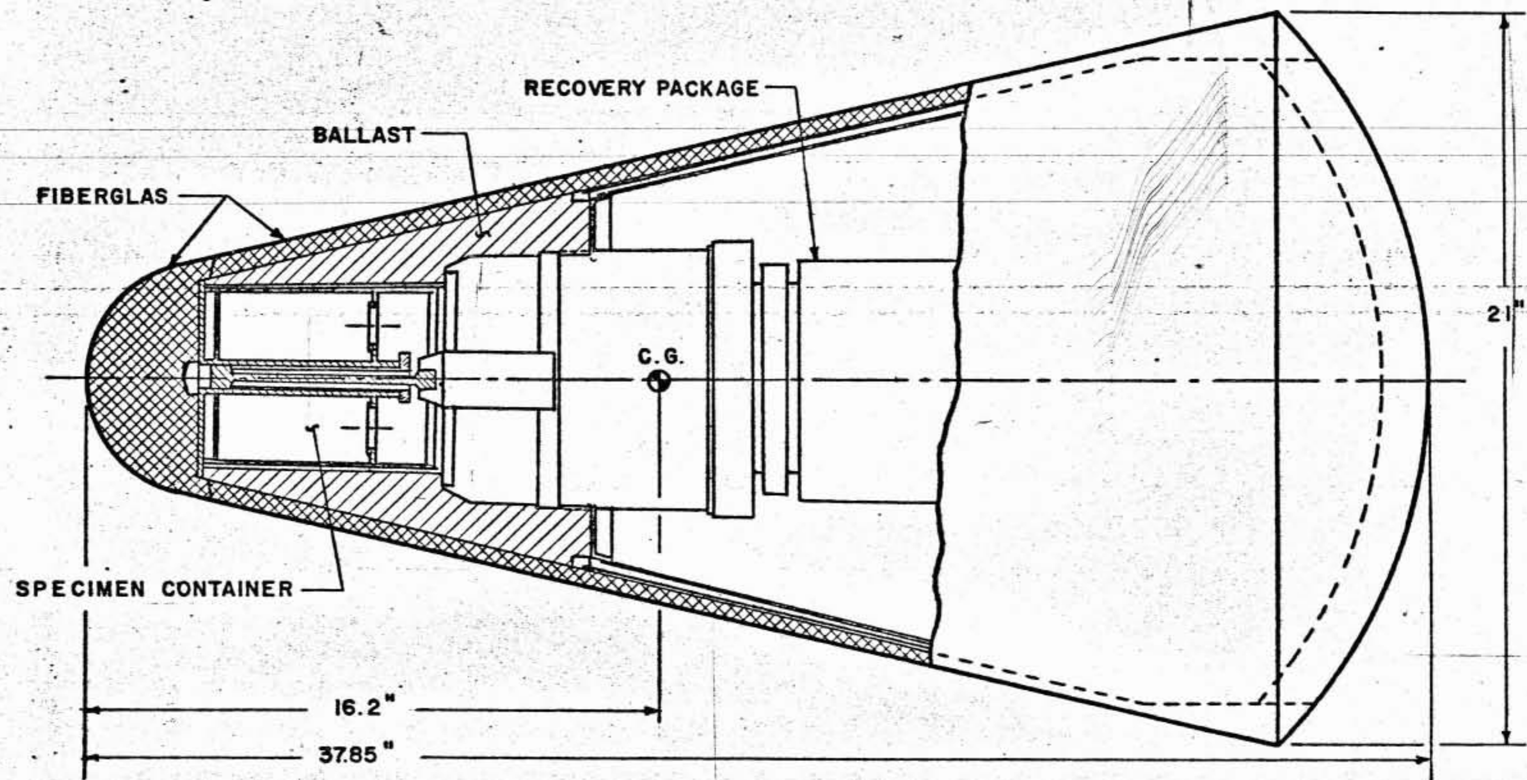

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WEIGHT DATA:

RECOVERY PACKAGE	95 LB
BALLAST	210 "
SPECIMEN PACKAGE	10 "
STRUCTURE	40 "
HEAT PROTECTION	68 "
TOTAL WEIGHT	423 LB.

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FIG. 3

[redacted]

SPECIMEN CONTAINER

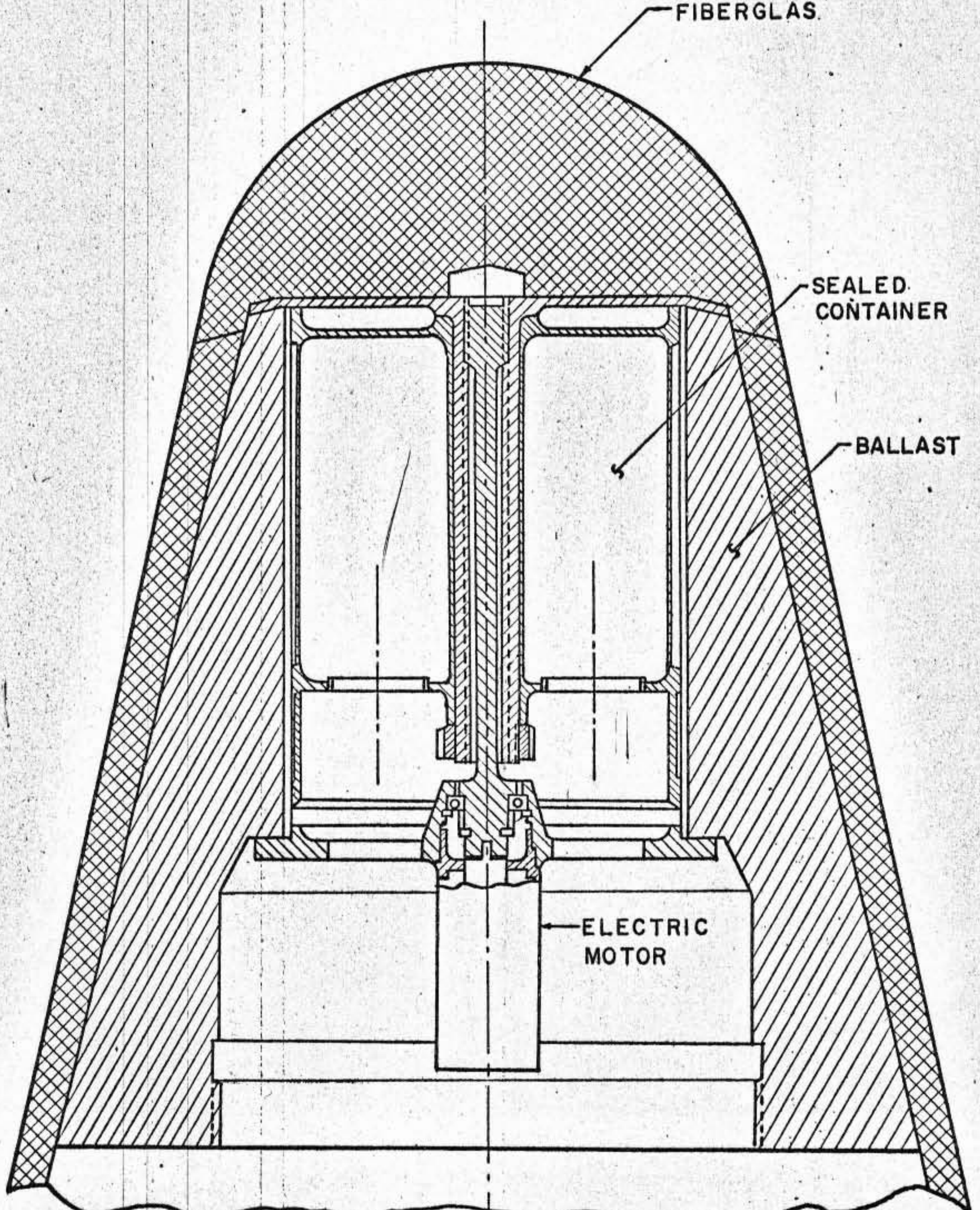

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FIG. 4

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SPECIMEN CONTAINER

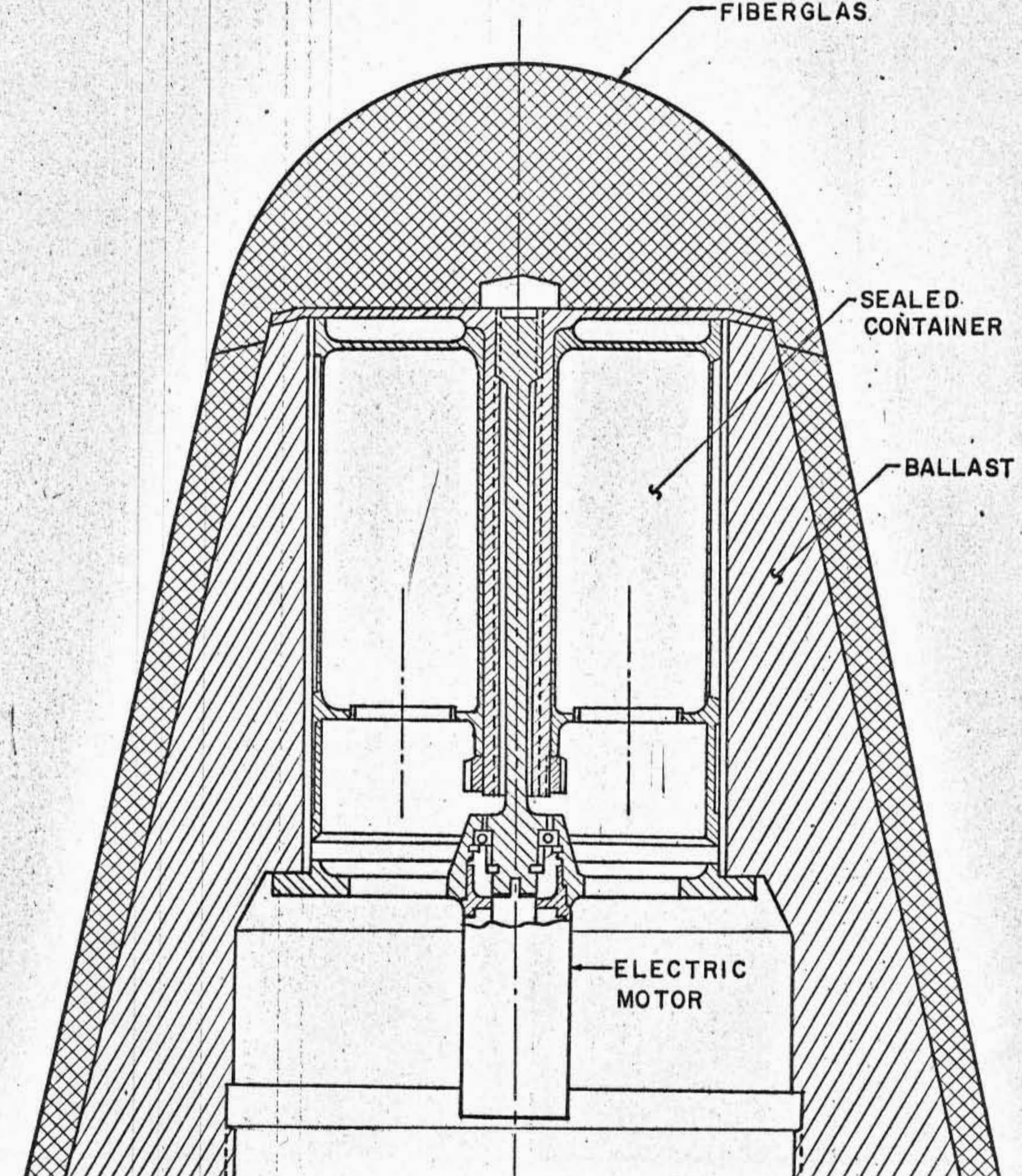

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FIG. 4

[redacted]

SPECIMEN CONTAINER
EXPOSURE POSITION

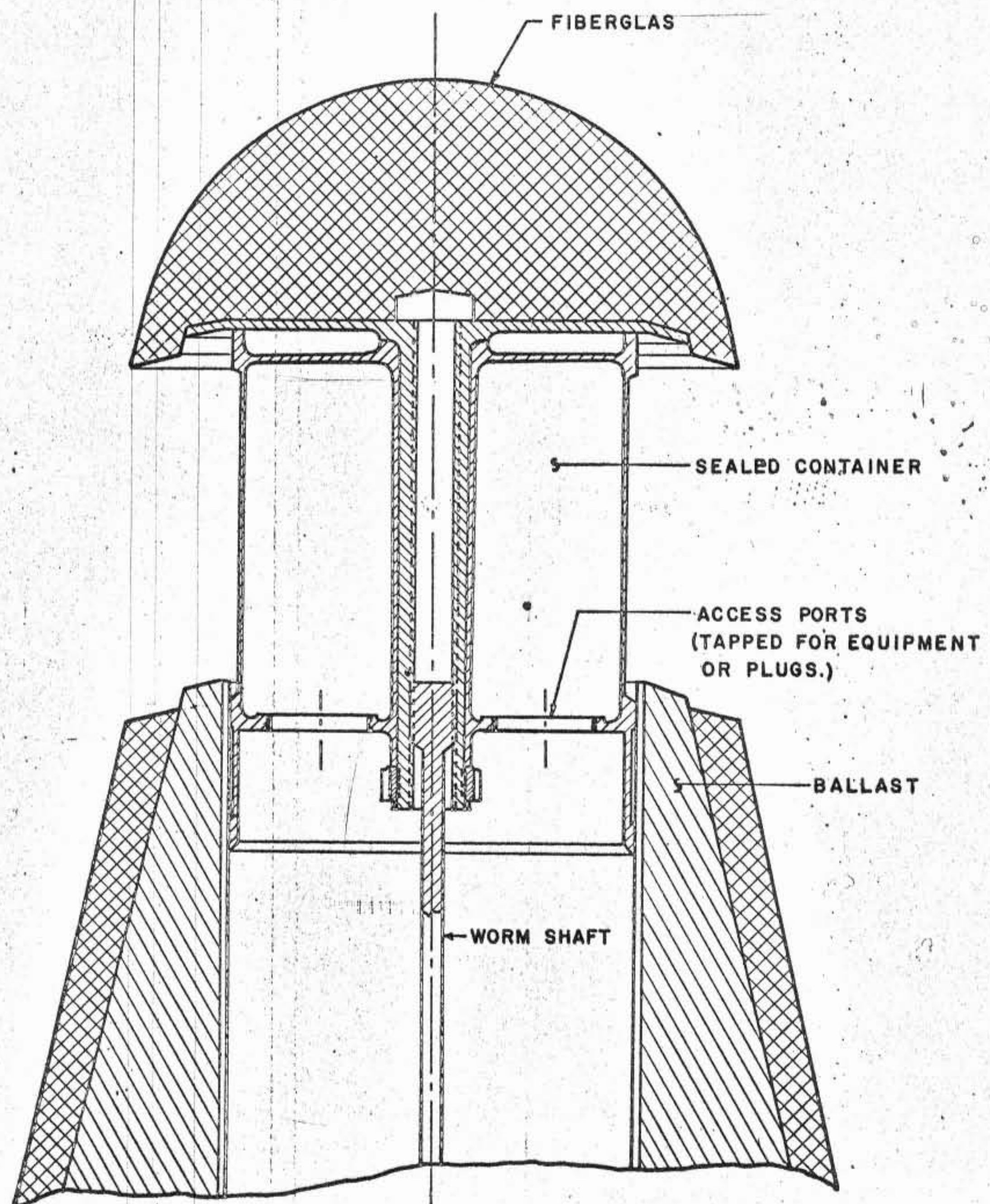

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FIG. 5

APPROVAL for:

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