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Sounding Rocket Design for Improved Stability and Augmented Payload Carrying Capacity

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Abstract

Sounding rockets are compact and small and can carry limited payload. Conventional design of ejection system restricts the payload dimensions and can harm delicate payload instruments. A new recovery system is developed which improves the aerodynamic stability of the rocket and allows increased weight and dimensions of the payload.

Conventional design of sounding rockets houses the ejection system and charge above the rocket motor and payload is housed above the ejection system. Ejection charge in this system directly pushes the payload and parachute and usually have one main parachute for both payload and rocket body. However the payload deployed is intended to descend slowly and separately.

The new design evolved when the conventional design posed problems in fabrication of the sounding rocket and an unstable descent was observed in the conventional design, which could be harm delicate payloads. This new approach uses two separate parachutes systems for payload and main rocket body. Break chute system is attached on the outside of the lower part of rocket body and the secondary system is housed with the payload in the payload bay. Break system is deployed earlier when the rocket is in coasting phase and it creates a force opposite to the direction of the motion of the rocket, this force tries to stop the rocket. Due to the inertial force the payload and the payload chute system pushes itself out of the payload bay and thus deploying the payload. This new design has been tested in an experimental sounding rocket and resulted in successful deployment of payload and utilized 30% less ejection charge then the conventional design.

1. Introduction

The recovery system of a rocket is deployed by igniting a charge housed in a chamber and the charge pushes a piston which in turn pushes the payload and parachute placed on above it. Ignition of the charge is controlled by the avionics which senses the desired height at which the payload should be deployed, this height is achieved when rocket has burned its fuel and is ascending in coasting phase.

Avionics plays the same role in new system, but the location of ejection charge and the parachutes is altered and this was done to overcome fabrication and stability problems posed by the conventional design; but it also resulted in an increased payload volume and reduced the amount of ejection charge required to deploy the whole system.

This new configuration improves aerodynamic stability of the rocket by shifting Centre of Pressure backwards and uses less fuel to deploy two small rear brake parachutes. The payload parachute does not require a charge and is deployed by the force of inertia making the deployment smooth for the payload.

2. Design

The recovery system is divided in three parts: two rear break chute chambers and one payload chamber. The avionics is housed in the middle chamber of the rocket body. The new design and its differences from the conventional design are described below.

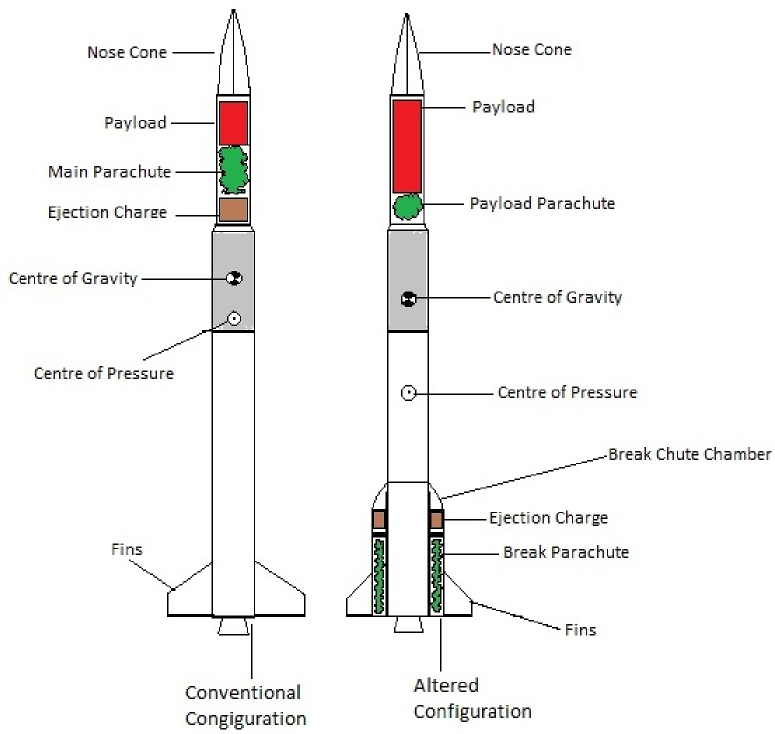

Fig. 1: Side view of the two rocket designs.

The alterations shown in the above Fig. were implemented in the design. Two chambers for the housing of break parachute were joined to the rear part of the rocket, this altered the aerodynamics of the rocket body and Centre of Pressure was shifted rearwards and resulted in a reduced fin area for two fins. The new design was analysed and the stability parameters were calculated.

The volume of payload bay and avionics bay were kept same in the design and the following observations were made:

- Payload dedicated volume increased by 100%.
- Distance between the Centre of Gravity and Centre of Pressure increased by a factor of 2.
- 30% reduction in ejection charge was observed.

3. Operating Principle

The new design and system uses inertial force for the deployment of payload parachute and relies on break parachutes for the recovery of the rocket body. The system works in the following sequence:

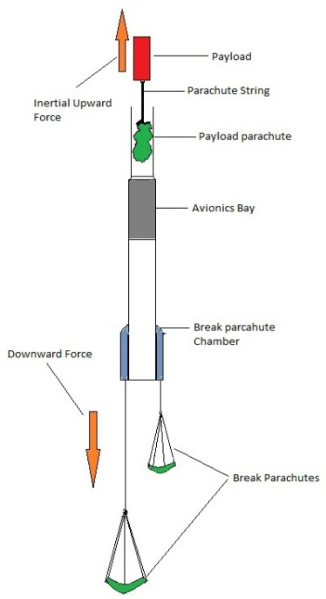

Fig. 2: (Right)Description of the recovery system deployment, (Left) Rocket with the new recovery system at the launch rail.

- The rocket is in coasting phase when the system executes.
- Avionics observes and confirms target altitude and sends signal for deployment of break parachutes.
- The connection between the ignition wire and batteries is established.
- Ejection charge ignites creating a force on piston and both break parachutes are deployed at the same time.

- Break parachutes creates a drag force and tries to pull the rocket body backwards.
- The payload tries to move in the same direction due to the force of inertia and pushes the nose.
- The nose cone is detached from the rocket body and the payload exits the bay carrying the parachute with it.
- The parachute inflates and the payload starts descending, the rocket body starts descending separately.

4. Conclusion

A new recovery system and rocket design is developed which was tested on a rocket launched at 8th Intercollegiate Rocket Engineering Competition which was organized by ESRA at Green River, U.S.A. The rocket underwent a stable flight and recovery system worked as expected, the payload and rocket body were recovered successfully.

References

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