27. MULTI-POINT RELEASE MECHANISM

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SUMMARY

The purpose of this paper is to present the design of a multi-point release mechanism used on the Communications Technology Satellite (CTS). This spacecraft is designed and being built by Spar under a contract from the Communications Research Centre in Ottawa, Canada.

The mechanism is designed to jettison one large panel (Jettisonable Body Solar Array - JBSA) and to release a second panel (Pressure plate). Both panels have independent multi-point attachments to the spacecraft and require to be released in sequence. In addition, the outermost panel, or JBSA, is easily removable without any special tools to permit quick access to the pressure plate, which retains the stowed flexible solar array. The solar array is stowed concertina fashion under 2 psi pressure to ensure that no movement occurs between the stowed folds of the array during the launch. One pair of linear pyrotechnic-actuators releases both the JBSA and the pressure plate via the release mechanism.

This release mechanism has successfully passed qualification level vibration launch and thermal environment tests and has accumulated to date close to 30 successful releases.

INTRODUCTION

With the advance of spacecraft having large flexible solar arrays and the general need to release large structural members, there is a common problem of the simultaneous or phase releasing of multi-point attachments usually spaced many feet apart. Many multiple attachment release systems have been used in the past; however, none of these systems met the basic requirements of the CTS deployable solar array system. Therefore, an unusual release mechanism was developed, where the firing of a pair of pyrotechnic-actuators releases 8 tie-down points on the pressure plate and 4 tie-down points of the JBSA. The release mechanism is designed such that both or either of the linear pyrotechnic-actuators can release all 12 points.

SOLAR ARRAY

The Communications Technology Satellite has two flexible solar arrays, each 52 inches wide and 276 inches long mounted on opposite faces of the S/C and stowed concertina fashion, for launch, between two honeycomb panels, and is shown in Figure 1.

To protect each array fold from damage during the launch, thin foam interleaves are laid between the folds from each side of the array with additional protection being provided by means of 5/8" thick foam pads attached to the inside surfaces of the honeycomb panels. These pads isolate the stowed array from local deformations created by the stowage pressure and the reactions from the spacecraft mounting face during launch and apogee motor burn. The array stowage pressure of nominally 2.0 psi is achieved by compressing the folded array and interleaves through 8 strain gaged tie-down points. Since the compressed area is approximately 400 sq. inches (giving a total of 800 pounds force) it is, therefore, very important to "free" all tie-down points simultaneously to prevent serious structural damage.

PRESSURE PANEL AND RELEASE MECHANISM

The pressure panel is required to cover the stowed array and to apply the stowage pressure. Mounted on the top surface of this panel is the tie-down and release system for both the pressure panel and the Jettisonable Body Solar Array (JBSA).

The release system, see Figure 2, is such that either one or both linear pyrotechnic-actuators can initiate the required movement of the tie-down release cable, therefore creating the required redundancy in the release system. A pair of Holex pyrotechnic-actuators mounted in a support bracket is shown in Figure 3. A compression spring opposing the pyrotechnic-actuators is mounted to remove any possibility of premature release during vibration.

The release cable is made from standard .125 in. diameter aircraft cable. In the tie-down point areas tubular metal sections are swaged onto the cable to give a rigid support for the latch beams and to provide a smooth sliding surface for the cable movement.

In addition to four latch beam supports, two "L" shaped brackets are attached to the release cable. These brackets are

positioned such that when the release cable moves, approximately .1 of an inch, the JBSA release mechanism plunger is contacted. Additional release cable movement then releases the two pairs of ball-lock retainers holding the JBSA assembly to the spacecraft. The release mechanism is designed such that JBSA release occurs before any of the pressure plate tie-down points are released.

JETTISONABLE BODY SOLAR ARRAY

A honeycomb panel completely covers the total stowed solar array subsystem. It serves a two-fold purpose; firstly, it provides thermal protection to the folded array, and its associated mechanisms; secondly, it provides additional electrical power to the S/C from solar cells mounted to its outer surface, prior to the extension of the main solar arrays.

The release mechanism consists of two pairs of cable connected ball-lock attachments as shown in the Figure 4.

The four interface feet holding the JBSA to the spacecraft have "Uniball" type seats, thus assuring that no jamming can occur during the ball-lock release. Each JBSA support leg contains an ejection spring of adequate force to give the JBSA the required 7 ft. per second separation velocity. An "exploded" view of the JBSA release mechanism is shown in Figure 5.

The JBSA is easily removable to provide access to the stored solar array. This facility is needed to permit the "last-minute" adjustment of the stowage pressure (there is a tendency for the stowage pressure to drop slightly after long periods of time) and to provide access to the pyrotechnic-actuators.

DESIGN CONSIDERATIONS

In selecting this release mechanism a number of design trade-offs were made. Many existing release mechanisms were evaluated with special emphasis on performance, weight and cost. A study for both panels was made to arrive at the optimum number of tie-down points. It is desirable that the number of pressure panel tie-down points be sufficient to assure a uniform pressure distribution within the stored array while, on the other hand, for simplicity and weight reasons, the number of attachment points should be a minimum. By using a computer assistance, an 8 point attachment mechanism for the pressure plate with 4 points for the JBSA was selected.

The initial release mechanism design used a light weight release rod. However, the bread board mechanism tests showed that the use of a rod created very difficult alignment problems of the support brackets. In addition, when pressurized, the pressure plate deflected, causing a complete jam-up which was solved by changing the rod to a cable with swaged fittings in the support bracket area.

ACKNOWLEDGMENT

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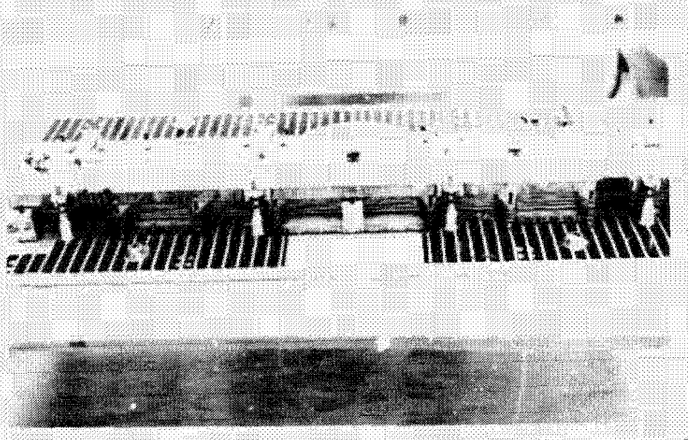

Figure 1.- Stowed solar array with JBSA removed.

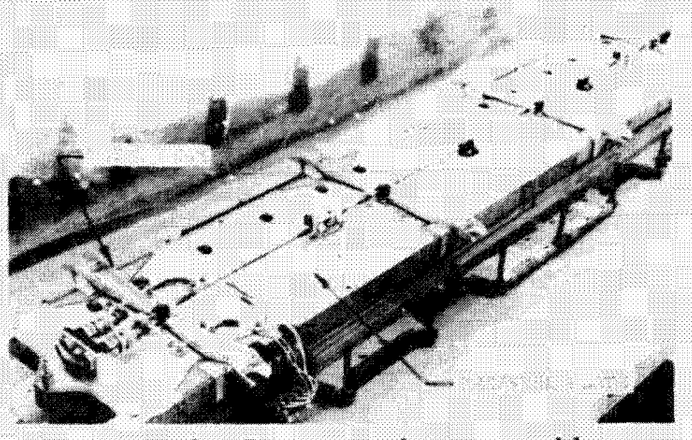

Figure 2.- Pressure plate assembly.

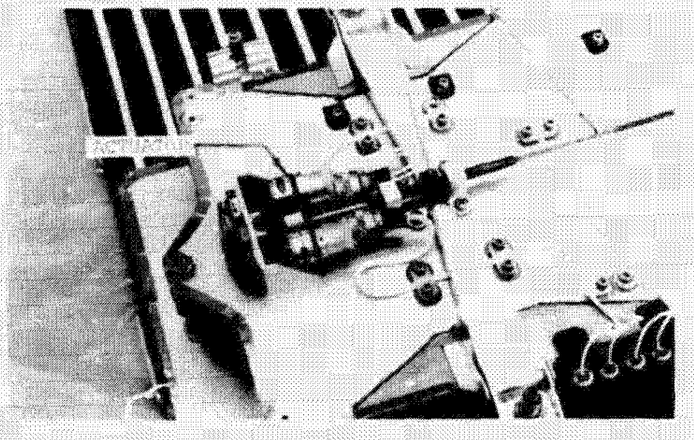

Figure 3.- Redundant pyrotechnic-actuator assembly.

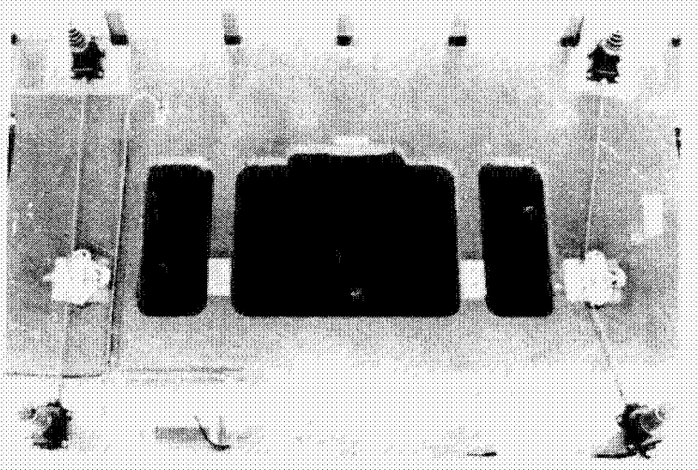

Figure 4.- JBSA assembly.

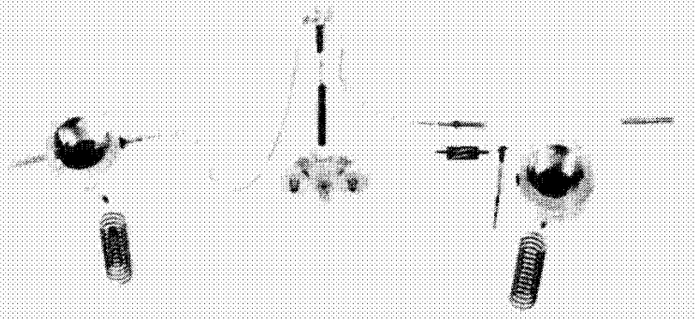

Figure 5.- JBSA release mechanism details.