NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,534,686

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : NA

NASA Patent Case No. : XLA-05369

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☐ No ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

Elizabeth A. Carter

Enclosure
Copy of Patent cited above

N71-15687

Patented Oct. 20, 1970 3,534,686

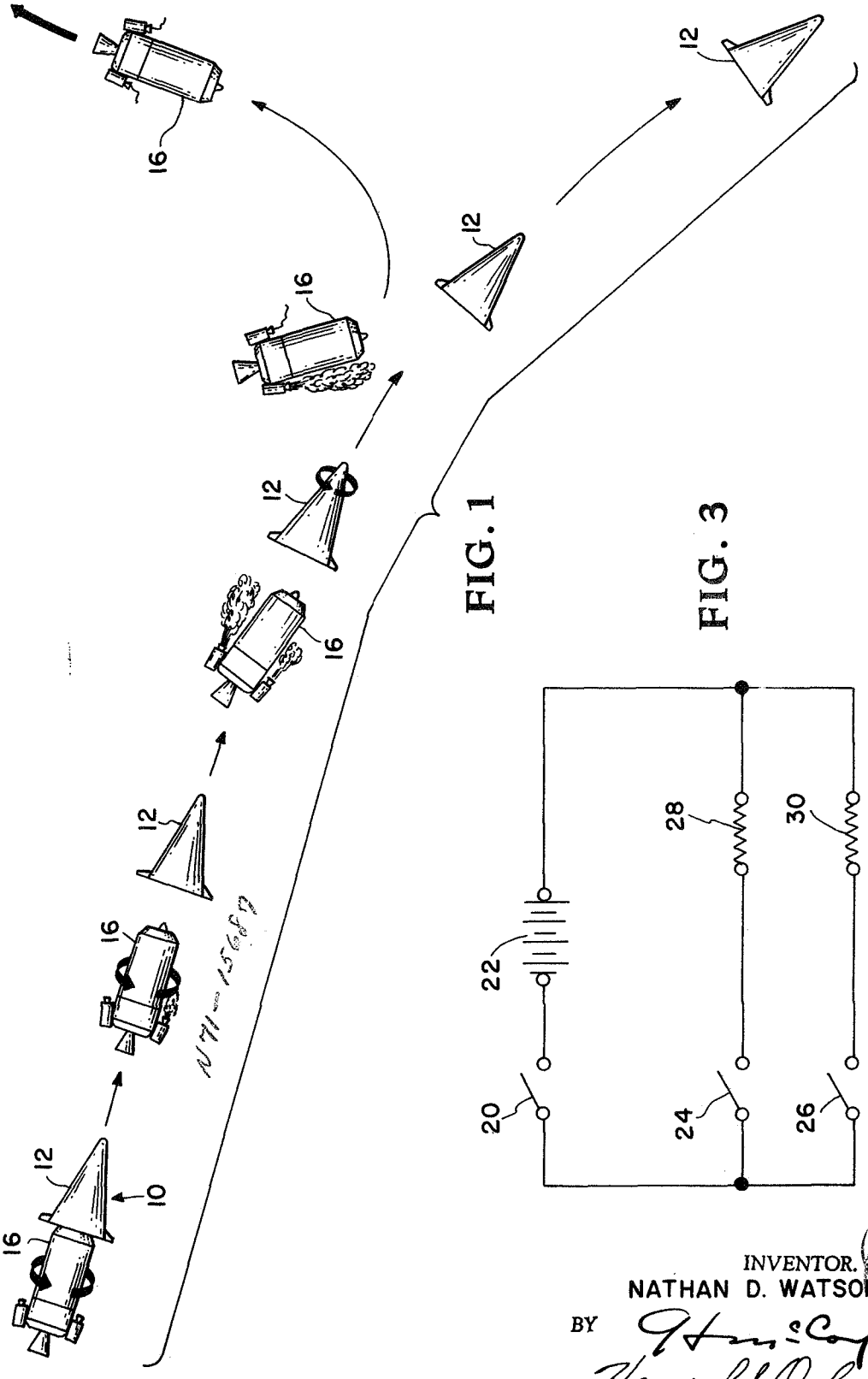

FIG. 1

FIG. 3

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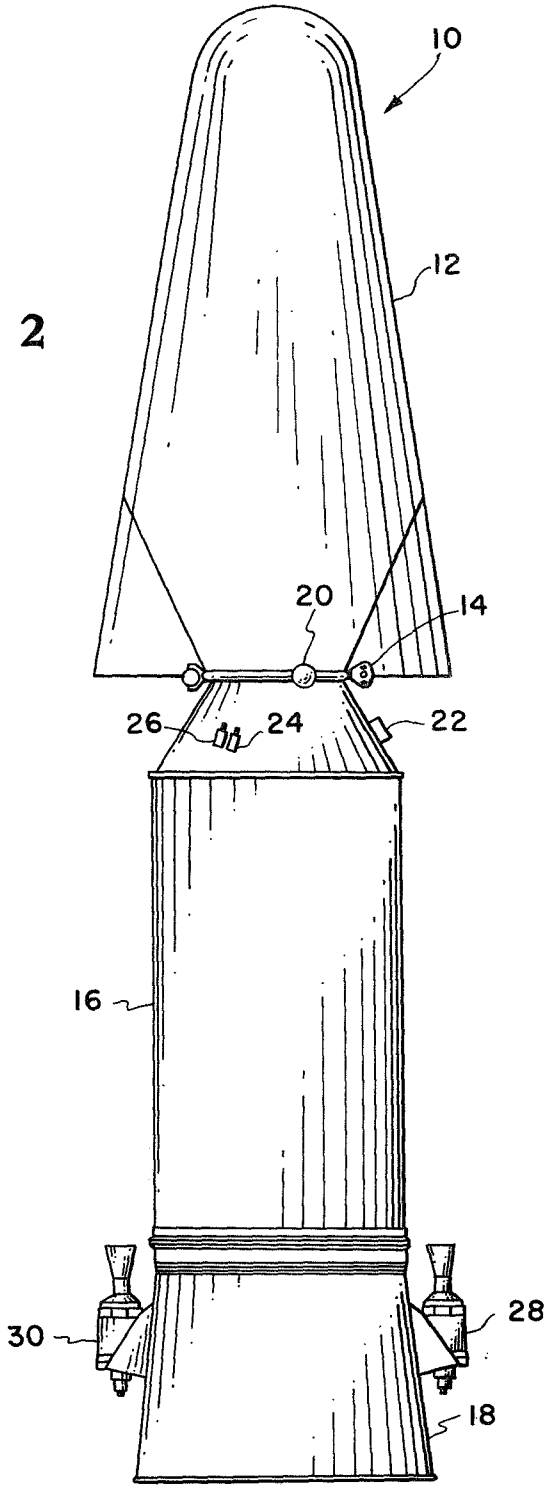
FIG. 2



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United States Patent

[11] 3,534,686

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[73] Assignee the United States of America as represented by the Administrator of the National Aeronautics and Space Administration

[54] PAYLOAD/BURNED-OUT MOTOR CASE SEPARATION SYSTEM
8 Claims, 3 Drawing Figs.

[52] U.S. Cl. 102/49.5
[51] Int. Cl. F02k 9/06
[50] Field of Search ..... 102/49.4, 49.5; 244/1(S.S.)

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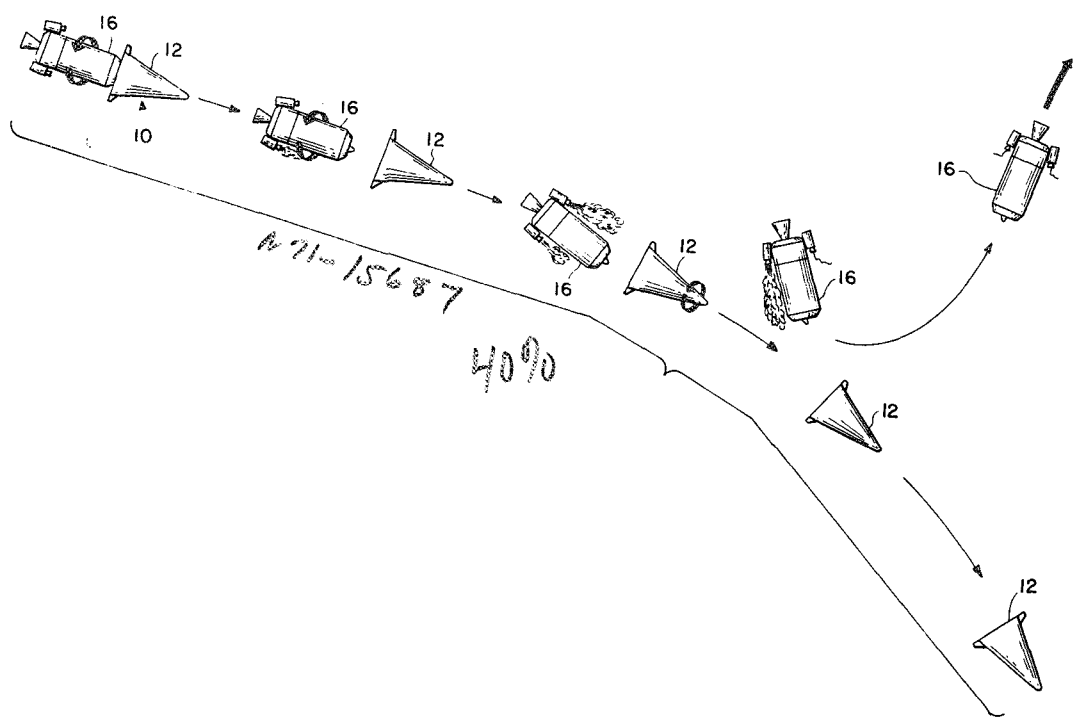
ABSTRACT: A payload separation system wherein a Marmon Band clamp separates a spent motor case from the payload. A retrorocket fixed to the motor case is fired to cant the motor case. Another opposed retrorocket is ignited while the first one is still burning and together they move the spent motor case out of the path of the payload.



PAYLOAD/BURNED-OUT MOTOR CASE SEPARATION SYSTEM

The invention described herein was made by an employee of the U.S. Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a payload separation system, and more particularly to a system for separating a payload from a spent rocket case prior to reentry of the payload into the atmosphere.

Various prior art techniques have been used in attempting to provide a clean and continued separation of a reentering payload from the last-stage motor case. One such technique is the use of retrorockets wherein the last-stage motor is separated in a direct line from the payload. Although this arrangement is successful to a degree, the mere separation of the devices is not always satisfactory because the payload breaks a trail, so to speak, resulting in a last-stage motor case encountering very little resistance and therefore at times actually catching up with and colliding with the payload.

Another technique utilized for separating the last-stage motor case from the payload is that of a despin technique which also moves the spent motor case out of the path of the payload. These devices have functioned satisfactorily to a degree; however, is not always as quick and clean as may be desired. Furthermore, the requirement for despinning the spent motor case often requires the need for a spin table between the payload and spent motor case resulting in additional structure, expense and questionable reliability.

The present invention overcomes the above difficulties by providing a technique wherein retrorockets are used to accomplish separation. The present invention, however, eliminates many of the prior art difficulties by timing the firing sequence of the retrorockets. The first retrorocket is fired causing the spent motor case to move away from the payload and also to cant or assume a position at an angle with respect to the line-of-flight of the payload. While the first retrorocket is still firing, and at an optimum calculated time, an opposed retrorocket is fired. The two retrorockets burning together, then translate the spent motor case out of the path of the payload assuring a clean and continued separation of the components.

It is therefore an object of the invention to provide a technique for separating a payload from a spent rocket case with the use of sequentially timed retrorockets.

Yet another object of the invention is to provide a technique for separating a spent rocket motor case and a payload wherein it is not necessary to despin the motor case prior to separation.

A further object of the invention is to provide separation of a spent rocket motor case and a payload wherein the components utilized for separation are simple to manufacture, operate and maintain.

An additional object of the invention is to provide a separation technique which is highly reliable and will result in the spent rocket motor case being translated out of the flightpath of the payload as well as separated from the payload.

Still another object of the invention is to provide an arrangement for separating a payload from a spent motor case wherein the initial separation of the components initiates the separation system.

These and other objects and advantages of the invention will become more apparent upon reading the specification taken in conjunction with the accompanying drawings.

In the drawings:

FIG. 1 is an elevational view showing the sequence of payload and spent motor case separation;

FIG. 2 is an elevational view showing the connected payload and motor case and the location of the separation system components; and

FIG. 3 is a schematic diagram of a circuit utilized to energize the separation system.

Referring now more specifically to the details of the invention, FIG. 2 shows the joined payload and spent motor case as it might appear just prior to entering the atmosphere, these components being designated generally by the reference numeral ten.

The payload 12 may take various shapes and forms, the particular payload shown being that of one utilized to test the properties of an ablation material which has possible use on a reentry capsule.

The payload 12 is joined to a motor case 16 by a clamping mechanism 14. The clamping mechanism 14 is of the explosive bolt type, known in the prior art as a Marmon Band clamp. This type clamp utilizes an explosive bolt to release the clamping arrangement, and usually has some type of compressed spring associated therewith, the energy of which causes initial separation between the payload and the body being separated therefrom. The motor case 16 is a conventional solid propellant type, having an adapter 18 attached to the lower portion thereof in the usual manner.

Affixed to the adapter 18 are retrorockets 28 and 30. The retrorockets are of the squib-actuated solid propellant type and are located directly opposite each other on the adapter. It has been found by experimentation that the general location of the retrorockets as shown in FIG. 2 is advantageous to the separation procedure. However, it should be understood that the retrorockets may assume other positions and accomplish the purpose of the invention.

FIG. 3 shows a circuit which is utilized to energize the retrorockets to accomplish separation of the payload 12 and the motor case 16. The separation switch 20 is positioned in series with a battery 22, the separation switch 20 being designed so that it is closed upon separation of the payload from the motor case. Closing of the separation switch 20 also results in the simultaneous closing of switches 24 and 26 which are in parallel with the battery and in series with the retrorockets 28 and 30, respectively. The particular switches utilized are of the pyrotechnic type which are selected to burn at different time intervals upon being closed. Thus, the switch 24 can be set to burn immediately and ignite the first retrorocket 28, and the other switch 26 is selected to burn a fraction of a second prior to igniting the second retrorocket. Obviously, the switches 24 and 26 could be of some time-delay type to allow sequential burning of the retrorockets thereby accomplishing the purpose of the invention.

OPERATION

From the above description of the separation system, it is believed that the operation thereof is readily apparent. However, the details will be explained to assure ample understanding.

The particular payload utilized with this separation technique is normally of the type which is launched into space and then directed back toward the atmosphere and accelerated as it returns toward the atmosphere. This is the reason why the motor case is still usually attached to the payload just prior to its reentry into the atmosphere. The purpose of obtaining as high a velocity as possible for the payload is also the reason for separating the motor case from the payload.

As the payload enters the atmosphere, the explosive bolt mechanism of the Marmon Band is actuated which allows the clamping mechanism to separate. Separation of the components of the clamp is assured by the spring mechanism under compression which exerts a pressure against the payload and motor case causing initial separation. This closes the separation switch 20 which places switches 24 and 26 across the battery thereby closing the switches. Switch 24 associated with the first retrorocket 28 is set so that it immediately ignites the first retrorocket. Since the retrorocket 28 is placed on one side of the adapter nozzle 18, it will apply an unbalanced force to the motor case causing it to cant or assume an angle with respect to the normal flightpath of the payload as shown in FIG. 1. The second switch 26 after being

closed a time interval, for example, 0.8 seconds, then allows ignition of the second retromotor **30**. Sufficient fuel is provided in the first rocket motor **28** such that both retromotors **28** and **30** burn simultaneously. A balanced force is now applied to the motor case **16**, and the case is thereby translated out of the path of the payload.

It should be apparent that different size retromotors, as well as different time sequences of firing will be necessary depending on the size of the payload and motor case, the velocity of the components and other factors. By experimentation it has been shown that the transverse and longitudinal separation distances versus time can be readily calculated on commercially available computing equipment enabling proper setting for retrorocket firing.

From the above description, it is apparent that the invention provides an arrangement for rapid and clean separation of a payload from a burned-out rocket motor case. By using retrorockets which are fired at different intervals than simultaneously, the spent motor case is not only separated but moved out of the path of the payload, thus preventing any possibility of the motor case overrunning and colliding with the payload. The separation system has few component parts resulting in a device economical to manufacture and maintain. Also, the minimum number of components greatly enhances the reliability of the separation technique since there are few pieces of mechanism subject to failure. The system is also readily adaptable to various size payloads and motor cases making a particularly versatile arrangement. Since separation is effectively accomplished without the necessity of despinning the burned-out rocket motor case, the structure normally required for despinning is eliminated.

While a preferred embodiment of this invention has been described, it is understood that modifications and improvements can be made thereto. Such of these modifications and improvements as incorporate the principles of this invention are to be considered in the hereinafter appended claims unless these claims by their very language expressly state otherwise.

I claim:

1. A payload rocket motor separation system for a spin-stabilized vehicle comprising:

payload means;

rocket motor means;

clamping means for connecting said payload means and rocket motor means;

means for releasing said clamping means at a selected time;

a first retro propulsion means attached to said rocket motor means activated upon release of said clamping means; and

a second retro propulsion means attached to said rocket motor means actuated subsequent to said first retro propulsion means whereby said rocket motor means is separated and laterally displaced from said payload means.

2. A payload rocket motor separation system for a spin-stabilized vehicle as in claim 1 wherein said first and second retro propulsion means are solid propellant retrorockets.

3. A payload rocket motor separation system for a spin-stabilized vehicle as in claim 2 wherein said first and second retrorockets are secured to the adapter of the rocket motor means; said first and second retrorockets being positioned on opposite sides of said rocket motor adapter.

4. A payload rocket motor separation system for a spin-stabilized vehicle as in claim 1 wherein a separation switch is located between said rocket motor means and payload means; first and second delay switches closed by the operation of said separation switch, said separation switch being closed by release of said clamping means.

5. A payload rocket motor separation system for a spin-stabilized vehicle as in claim 4 wherein said first delay switch initiates said first retro propulsion means and said second delay switch initiates said second retro propulsion means.

6. A payload rocket motor separation system for s spin-stabilized vehicle as in claim 1 wherein said first retro propulsion means burns while said second retro propulsion means is initiated and operative.

7. A payload rocket motor separation system for a spin-stabilized vehicle as in claim 1 wherein said first and second retro propulsion means are activated while said payload and rocket means are spinning.

8. A payload rocket motor separation system for a spin-stabilized vehicle as in claim 1 wherein said first retro propulsion means upon initiation tips said rocket motor means case to a new attitude; and said first and second retro propulsion means move the rocket motor means back and to the side of said payload means.