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S. H. RUSH ETAL

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SEPARATION DEVICE

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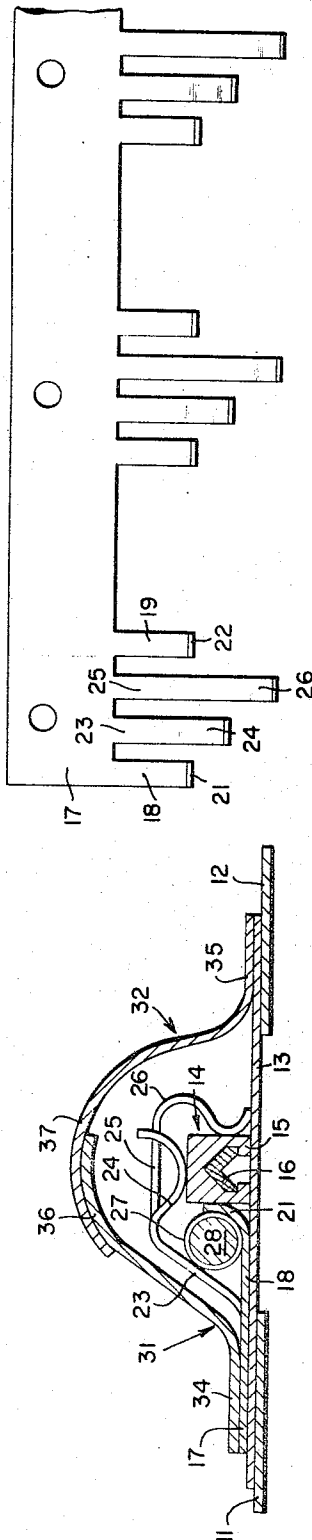


Fig. 2.

Fig. 3.

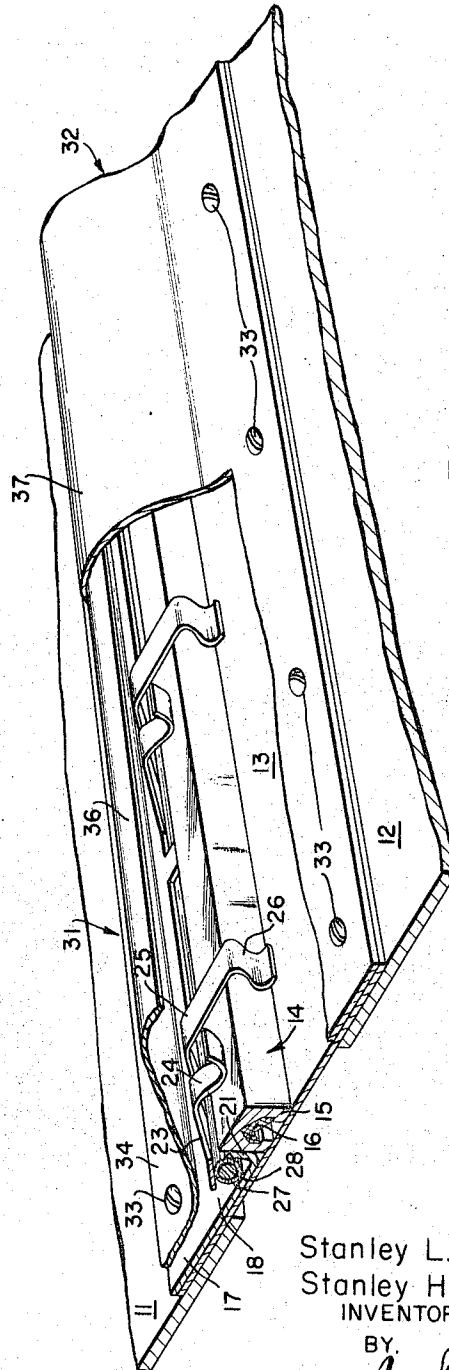


Fig. 1.

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6 Claims. (Cl. 102-24)

This invention relates to a pyrotechnic separation system employed for separating the fairing on the nose cone of a space vehicle prior to separation of a satellite from the launch vehicle and, more particularly, to a structure for confining any debris and explosive generated in the separation in a plenum chamber.

The existing pyrotechnic separation systems employ massive backup structures, attenuators, or the combination of both to protect adjacent structures from the debris and resulting forces generated by the functioning of the pyrotechnic device. The massive backup structure adds a weight penalty to a missile or launch vehicle, and furthermore the high level of shock transmitted to the basic structure by the massive backup structure can do excessive damage to the adjacent structure. The debris caused by the pyrotechnic charges and the attenuators may also damage adjacent sensitive structures, circuitry or instruments, thus degrading their functional ability.

Briefly stated one preferred embodiment of the present invention consists essentially of a pyrotechnic separation device which extends along a separation plane on the structure to be cut, such as the fairing on the nose cone of a missile or launch vehicle, which must be severed before a satellite or re-entry vehicle can leave the launch vehicle. The pyrotechnic device is preferably a linear shaped charge secured to the inside of the fairing along a substantially straight line, and may be held in position by an elongated hold-down clip. If desired, a mild detonating fuse may be positioned alongside of the linear shaped charge for redundancy to assure there is no malfunction in case of a break in the linear shaped charge. A pair of overlapping channels are secured to the structure on both sides of the separation plane and are preferably arcuate in cross section and overlapping for a substantial portion of their width for enclosing the pyrotechnic separation device. The overlapping portions provide confinement for any debris generated by the pyrotechnic device and also as an expansion or plenum chamber for the gaseous by-products resulting from the functioning of the pyrotechnic system. As the gas pressure builds up in the plenum chamber formed by the interlocking or overlapping channels, the two parts or sections of the fairing, or other structure to be cut, are forcibly separated by the gas piston action in the plenum chamber, thus providing a separation velocity between the sections, after the linear shape charge has cut through the material. In this manner the expanding chamber increases in volume as the gas expands.

The outer edge of the inner channel deflects against the overlapping portion of the outer channel, thus sealing the plenum chamber and confining the detonation by-products while permitting expansion of the detonation gases which results in a reduction of pressure, thereby reducing chuck loading of the adjacent structure to which the pyrotechnic separation system is attached. This seal is maintained until the structure has been moved apart sufficiently by the gas piston action to vent the gases outwardly through the slot formed by the linear shaped charge. Thus, no gases or solid by-products are deposited on nearby instruments, circuits, or other structure which may be delicate and sensitive or easily damaged. The gas piston action, before the pressure is reduced by venting of the gases through the opening, forcibly separates

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the two sections and imparts an initial velocity which facilitates and speeds up the separation of the fairing from the launch vehicle.

One object of the present invention is to provide a lightweight and efficient backup structure for a linear shaped charge or other pyrotechnic separation device for cutting through the fairing on the nose cone of a missile or launch vehicle, or similar applications, without damaging adjacent structures or components.

Another object of the present invention is to provide a pyrotechnic separation system which facilitates the separation of the two sections of fairing or other structure, after the material has been cut through, by utilizing a gas piston action energized by the gases generated to impart an initial velocity for separation of the sections.

Other objects and advantages of this invention will become more apparent by referring now to the accompanying drawings wherein:

FIGURE 1 is a perspective view illustrating a preferred embodiment of the present invention;

FIGURE 2 is a sectional view taken transversely through the structure illustrated in FIG. 1; and

FIGURE 3 is a plan view of the hold-down clip shown in FIGURES 1 and 2.

Referring now to the drawings and more particularly to the perspective view of FIGURE 1 and the sectional view of FIGURE 2, there is shown a preferred embodiment of the present invention wherein two portions of a fairing or other structures 11 and 12 are slightly separated along their adjacent edges and adjoined together by an elongated strip of sheet metal or other material 13. The two portions 11 and 12 of the fairing may be constructed of fiberglass and resin or heavy sheet metal, depending upon the particular application.

A linear shaped charge 14 extends along the center of the strip 13 and consists of a plastic sheath 15 enclosing a shaped explosive charge 16 that is positioned within a channel formed by the end portions of the plastic sheath 15.

The linear shaped charge 14 is held in position by an elongated hold-down clip 17, also illustrated in FIGURE 3, which may be formed of sheet metal and provided with a plurality of fingers at spaced intervals along its length for engaging each side and the top of the linear shaped charge 14. Fingers 18 and 19 are of similar size and shape, in the form of an L which include angle portions 21 and 22 for engaging one side of the plastic sheath 15.

Another finger 23 has an S-shaped resilient portion 24 for engaging the inner side of the plastic sheath 15 which holds the linear shaped charge 14 against the connecting strip 13 along the separation plane. Another finger 25 extends around the linear shaped charge 14 and has an S-shaped resilient portion 26 which engages the other side of the plastic sheath 15, urging it against the angle portions 21 and 22 of the fingers 18 and 19 for proper alignment.

A mild detonating fuse, consisting of a thin metallic sheath 27 and an explosive or pyrotechnic core 28, may be positioned alongside of the linear shaped charge 14 and in the area between the fingers 18 and 19 and the fingers 23 and 25. The mild detonator fuse is provided for redundancy only to assure firing of the entire length of the linear shaped charge 14 should there be any cracks or breaks throughout the length of the charge. The mild detonator fuse would be ignited simultaneously with the linear shaped charge 14 and would burn at approximately the same speed to assure firing of the linear shaped charge throughout its entire length.

The two overlapping channels 31 and 32 forming the backup structure are secured to the two sections 11 and

12 by means of screws 33 or other conventional fastening means which also extend through the strip 13 and the hold-down clip 17, thereby holding the complete pyrotechnic separation system in its assembled relationship. The screws 33 extend through the flat portions 34 and 35 of the channels 31 and 32 and the curved overlapping portions 36 and 37 form a plenum chamber completely enclosing the pyrotechnic separation device. The chamber provides confinement for any debris generated and also provides an expansion chamber for the gaseous by-products resulting from the functioning of the mild detonator fuse and the linear shaped charge 14. As the gas pressure builds up in the plenum chamber formed by the overlapping channels 31 and 32, the two parts or sections of the fairing or other structure to be cut, are forcibly separated by a gas piston action in the plenum chamber, thus providing an initial separation velocity between the sections when strip 13 is separated. Obviously, the pyrotechnic or explosive material 28 in the mild detonating fuse will also contribute to the buildup of gas pressure in the plenum chamber formed by the two overlapping channels 31 and 32. This will increase the force exerted by the gas pressure in the plenum chamber to forcibly separate the two sections of fairing or other similar structure.

It will be apparent that the debris caused by the detonation of the linear shaped charge 14 and the explosive material 28 will be vented or dissipated through the slot cut in the strip 13 by the shaped explosive charge 16, particularly as the two sections are separated, but all or most of this solid and gaseous debris will be vented overboard and expelled externally before the two arcuate portions 36 and 37 separate. The gas pressure in the plenum chamber will also tend to keep the overlapping arcuate portions 36 and 37 in tight sealing contact until the separation and the expulsion of the debris is completed.

While the backup structure of the present invention has been shown as two curved overlapping channels secured to adjacent edges of the relatively thin sections of fairing or other structure, the basic concept may also be incorporated in the abutting portions of a relatively thick, honeycomb structure.

Obviously, many other applications and variations of the present invention may be made within the scope of the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A separation system having pyrotechnic means for cutting through a structure along a separation line, the improvement comprising:

a plenum chamber means including two members secured to said structure on opposite sides of said separation line and having overlapping portions in firm contact to provide a plenum chamber for containing debris and expanding gases that force apart the overlapping portions, thereby providing an expandable chamber increasing in volume as the gas expands.

2. A separation system having pyrotechnic means for cutting through a structure along a separation line, the improvement comprising:

a plenum chamber means including two channel members secured to said structure on opposite sides of said separation line and having overlapping portions

fractionally contacting each other to thereby provide a plenum chamber for containing debris and expanding gases that force apart the overlapping portions, thereby providing an expandable chamber increasing in volume as the gas expands.

3. A pyrotechnic separation system comprising pyrotechnic means contacting a structure for cutting through said structure along a separation line;

a plenum chamber means including two members secured to said structure on opposite sides of said separation line and having overlapping portions in firm contact to provide a plenum chamber for containing debris and expanding gases that force apart the overlapping portions, thereby providing an expandable chamber increasing in volume as the gas expands.

4. A pyrotechnic separation system comprising:

a linear shaped charge positioned on a structure adapted to be separated along a predetermined line; means for securing said linear shaped charge in position on said line;

a plenum chamber means having two parts, each secured to said structure on opposite sides of said linear shaped charge and overlapping in contiguous contacting relationship to provide a plenum chamber for containing debris and expanding gases that force apart the overlapping portions, thereby providing an expandable chamber increasing in volume as the gas expands.

5. A pyrotechnic separation system comprising:

a linear shaped charge adapted to be positioned on a structure along a separation line;

means including a hold-down clip having a plurality of fingers for securing such linear shaped charge in position on said structure;

a plenum chamber means having two parts, each secured to said structure on opposite sides of said linear shaped charge and overlapping in contiguous contacting relationship to provide a gas plenum chamber for containing debris and expanding gases that force apart the overlapping portions, thereby providing an expandable chamber increasing in volume as the gas expands.

6. A pyrotechnic separation system comprising:

a linear shaped charge adapted to be positioned on a structure along a separation line;

means including a hold-down clip for securing said linear shaped charge in position on said structure;

a plenum chamber means including a pair of backup channels secured to said structure on opposite sides of said linear shaped charge and overlapping in contiguous contacting relationship to provide a gas plenum chamber for containing debris and expanding gases that force apart the overlapping portions, thereby providing an expandable chamber increasing in volume as the gas expands.

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