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3,429,477

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APPARATUS FOR EJECTION OF AN INSTRUMENT COVER

Sheet 1 of 3

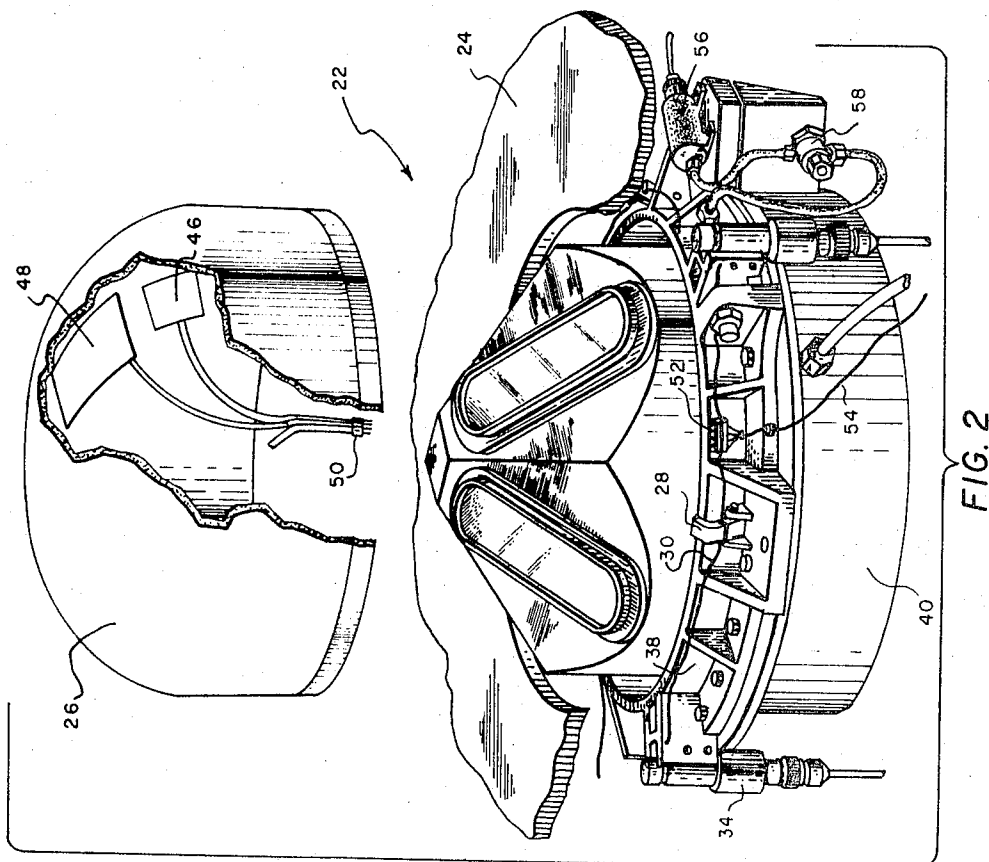


FIG. 2

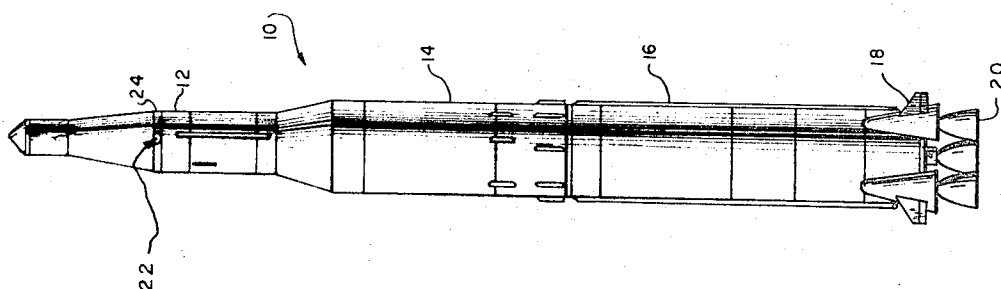


FIG. 1

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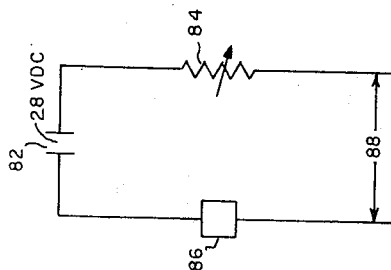


FIG. 6

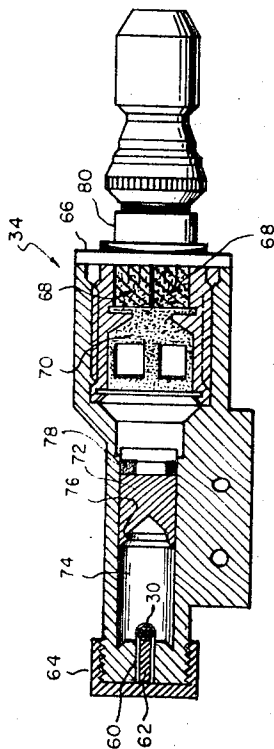


FIG. 5

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APPARATUS FOR EJECTION OF AN INSTRUMENT COVER

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9 Claims

Int. Cl. B65d 45/00; A47j 27/08, 36/10

ABSTRACT OF THE DISCLOSURE

An apparatus for ejecting a cover from an instrument case utilizing the force of differential pressure between the inside of the instrument case and the environment of the case. An air-tight seal, positioned between the cover and the case, allows the case to be pressurized, so that the cover ejects when it is released. The device has a plurality of cover latches rotatably mounted on the side of the case and latch retaining means to secure the latches against rotation. Releasing means consisting of cable cutters are provided to cut the cable and thereby release the latches.

Background of the invention

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

Field of the invention.—This invention relates to an apparatus for ejecting a cover from a case and more particularly to an apparatus for ejecting a cover of an instrument case where a pressure differential exists between the interior of the instrument case and its environment.

Description of the prior art.—In the past, instrument cover ejection devices have usually employed a separation thruster assembly. This device contains a high explosive for providing the force necessary to blow off the cover of the instrument case at a desired or prearranged time. Although this device functions well, it has several characteristics which are disadvantageous. A separation thruster assembly is armed after the cover assembly is put into place and can eject the cover at any time, thus making it unsafe for ground crews. Since a separation thruster assembly can be fired only once, it is not possible to give the device a nondestructive test, and there is no redundancy in the device. Moreover, a separation thruster assembly for a large instrument package weighs on the order of 150 pounds or more so that the size and weight of the device may become a handling problem.

Summary of the invention

Accordingly, it is an object of this invention to provide a safer and more reliable method and apparatus for ejecting a cover from a case.

It is a further object of the invention to provide an apparatus for ejecting a cover from an instrument case, which reduces size and weight of the related apparatus.

It is a still further object of this invention to provide an apparatus which utilizes the force of differential pressure for ejecting a cover from a case.

These and other objects are accomplished in the present invention in which an instrument cover is held in position on an instrument case by several pivotal latches and a cable. The cable is provided with several cable cutters which may be pyrotechnic and which function when an electric signal is applied to them. A pressure differential between the case and its environment, which occurs as a

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result of greatly decreased external pressure or by increasing the pressure within the case, is maintained by an air-tight seal under the cover. When the cable is cut, the latches pivot under the force exerted against the inside surfaces of the cover and release the cover. The cover then ejects under the continued force of the differential pressure exerted against the cover.

Brief description of the drawings

The invention will be more fully understood when taken together with the accompanying drawings in which:

FIGURE 1 is an elevation of an aerospace vehicle having an instrument assembly in position on an outside surface.

FIGURE 2 is an exploded perspective view of the instrument assembly, and its cover, shown in partial cut-away.

FIGURE 3 is a side view of the instrument assembly of FIGURE 2, in partial section, with the cover attached.

FIGURE 4 is a plan view of the instrument assembly of FIGURE 2 with the cover removed.

FIGURE 5 is a sectional view of a pyrotechnic cable cutter which may be employed as part of the invention.

FIGURE 6 is a circuit diagram of a pressure switch which may be employed as a part of the invention.

Description of the preferred embodiments

In order to better understand the construction and use of this novel cover ejection apparatus, it will be described in relation to a horizon sensor used as an external part of an aerospace vehicle. However, it is obvious that the invention may be used as part of many covered instrument cases, whenever a differential pressure exists between the interior of the instrument case and its environment. These uses on other devices will be readily apparent to those skilled in the art.

With continued reference to the accompanying figures, wherein like numerals designate similar parts throughout the various views, and with initial attention directed to FIGURE 1, reference numeral 10 generally designates a vehicle, shown as a multistage rocket, comprising an upper stage 12, a second stage 14, and a lower stage 16, having fins 18 and reaction motors 20. A horizon sensor instrument assembly 22 is mounted on the external surface 24 of the upper stage 12 of the vehicle 10.

FIGURES 2, 3 and 4 show the details of the horizon sensor instrument assembly 22, which incorporates a cover ejection mechanism which is a typical illustrative embodiment of the invention. Looking now at FIGURES 2 and 3, the cover 26 is held in position by three equally-spaced latches 28 and a cable 30, which, for example, may be 1/8 inch diameter aircraft cable. When the cover is latched, the pointed ends of latches 28 rest in recesses 31 in the cover 26. As may be seen best in FIGURE 4, the cable 30 is tightened to a specified tension by an adjustment nut 32, located at one end of the cable 30. The opposite end of the cable 30 has a spherical end fitting 33 to keep the cable end in place under tension. Three pyrotechnic cable cutters 34, as shown in FIGURE 4, are equally spaced around the instrument, and are also equally spaced between the three latches 28. The cable cutters 34 function when an electrical control signal is applied to them.

As shown in FIGURE 3, trapped air under the cover 26 is kept from escaping by an air-tight seal 36 between the instrument cover 26 and the cover mounting collar 38. The collar 38 is bolted to the instrument mount 40. Thus a pressure differential under the cover 26 creates a force on the inside surface 42 of the cover 26. This pressure differential may be caused by reduced atmospheric pressure outside the instrument assembly or by increasing

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the inside pressure by the use of any conventional high pressure source (not shown). The force caused by the pressure differential is held in check by the three cover latches 28 positioned so that any force on the cover 26 directed away from the cover mounting collar 38 and the instrument mount 40 will cause a torque on the latches 28 about the latch pins 44. The torque on the latches 28 from the force on the inside 42 of the cover 26 rotates the latches 28 away from the cover 26 thus releasing it. The cable 30 is positioned to resist that torque and hold the latches 28 in the locked position. Thus, when a pressure differential exists and the cable 30 is cut by the cable cutters 34, the latches 28 are free to rotate and release the cover 26.

Referring again to FIGURE 2, the cover 26 is shown separated from the instrument mount 40 after the cable cutters have cut the cable 30. In this exploded view, several of the instruments associated with the invention may also be seen. Thermistor 46 is attached to the inside of the cover 26 and monitors internal temperature. Heater 48 is also attached inside the cover 26 and is used in testing the instrument 22 prior to launch. Electrical connectors consisting of a connector plug 50 attached to the cover and a connector socket 52 attached to the cover mounting collar 38 connect thermistor 46 and heater 48 to the vehicle electrical system cable 54. Pressure transducer 56 indicates the pressure under the cover 26. Hand valve 58 is used in leak testing the sealed area under the cover 26 prior to launch.

Temperature readings from thermistor 46 and pressure readings from pressure transducer 56 are transmitted to the ground from the vehicle 10. When power is applied to the cable cutters 34 and the cover 26 is ejected, electrical connectors 50 and 52 are separated and temperature readings from thermistor 46 will stop, indicating cover ejection. At this point, pressure readings from transducer 56 will have a sudden drop, also indicating cover ejection. When thermistor readings stop concurrently with a drop in pressure readings, a positive cover ejection is indicated.

FIGURE 5 shows a known type of pyrotechnic cable cutter 34 which may be used as part of the invention. To attach the cable cutter 34 to the rest of the instrument assembly 22, the cable 30 is slipped into the cable cutter 34 by way of the cable cutter slot 60. Backup piece 62 is added to fill the slot 60 and hold the cable 30 in position. The end cap 64 is then screwed on, locking the cable 30 in the cable cutter 34. The cable cutter 34 can be installed after the cover 26 has been assembled with the instrument mount 40.

The cable cutter 34 contains a cartridge assembly 66 having dual ignition squibs 68. The squibs set off a general charge 70 which drives the piston 72 down the barrel portion 74 against the cable 30. Circular cutter blade 76 on the end of piston 72 shears the cable 30 cleanly on both sides of cutter blade 76, leaving no frayed ends. Piston 72 has O-ring 78 which contains the gases generated by the explosion of general charge 70. The squibs 68 are detonated by an electrical control signal from an exterior source (not shown), which is transmitted into the cartridge assembly 66 through the connector 80. The squibs 68 may be of a well-known type, having a capability of 1 ampere, 1 watt, 5 minute no fire and 5 ampere all fire.

With sufficient differential pressure acting on the instrument cover, one cycle of operation of the instrument cover ejection mechanism follows: a programmer or exterior signal source (not shown) sends an electric control signal to the two dual ignition squibs 68 of each of the three pyrotechnic cable cutters 34. In each cable cutter, the squibs 68 set off a general charge 70 which drives the cutter blade 76 against the cable 30. Thus, each cutting blade 76 of each cable cutter 34 cuts the cable 30 at two points. The force on the inside surface 42 of the cover 26, caused by the differential pressure, in turn causes a torque on the latches 28, about the latch pins 44, which is held in check by the cable 30. When the cable 30 is cut,

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this torque rotates the latches 28 away from the cover 26, thus releasing the cover 26 and allowing it to eject.

An alternative embodiment of the invention has a built-in source for the electrical signal which fires the pyrotechnic cable cutter 34. The electrical circuit shown in FIGURE 6 can be used for the built-in electrical source. The circuit consists of a 28 volt DC power source 82, a variable resistor 84 and a pressure switch 86. The pressure switch 86 which is located outside the instrument cover 26, actuates the electrical circuit, producing an electrical signal output 88 to fire the pyrotechnic cable cutter 34. Since there is a definite relationship between altitude and pressure, the pressure switch 86 can be set to actuate the electrical circuit at the desired altitude, thereby causing cover ejection.

From the foregoing it may be seen that applicants have invented a novel mechanism for ejecting an instrument cover. The mechanism disclosed is a novel arrangement of latches, cables, and cable cutters which functions as a release mechanism for an instrument cover by allowing the cover to eject under differential pressure. This apparatus permits the use of differential pressure developed by either an increase in altitude or by raising the internal pressure of a sealed instrument case with a high pressure source. The device is redundant, and therefore exceptionally reliable, since the functioning of only one of the three cable cutters is enough to release the cover. Lastly, the device is more compact and considerably lighter than the prior art devices.

We claim:

1. An instrument enclosure having a cover ejection device comprising:

- (a) an instrument case;
- (b) an instrument cover releasably fastened to said case, said cover having recess means in its outside circumference;
- (c) a sealing means positioned between said case and said cover, for permitting a pressure differential between said case and its environment;
- (d) a plurality of cover latches rotatably mounted on the side of said case, said latches being adapted to grip said recess means;
- (e) latch retaining means connected to said plurality of latches, said latch retaining means comprising a cable positioned so as to prevent said latches from rotating;
- (f) releasing means connected to said latch retaining means for releasing said cover so as to allow it to eject under a pressure differential between said case and its environment.

2. The instrument enclosure of claim 1 wherein the said cable is connected to tension adjustment means.

3. The instrument enclosure of claim 2 wherein the said releasing means for said latch retaining means comprises pyrotechnic cable cutting means.

4. The instrument enclosure of claim 3 including a pressure sensing means attached to said case for indicating the pressure under the cover, whereby a loss of pressure will indicate cover ejection.

5. The instrument enclosure of claim 4 including temperature sensing means attached to said cover and releasably connected to said case, whereby disconnection of said sensing means will indicate cover ejection.

6. In a device for ejecting a cover from an instrument case having a plurality of cover latches rotatably mounted on the side of the case, the improvement comprising:

- (a) recess means around the outer circumference of said cover, positioned and adapted to be gripped by said latches;
- (b) a cable positioned to prevent said latches from rotating;
- (c) a sealing means positioned between the case and the cover, for permitting a pressure differential between the case and its environment;

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- (d) means for cutting said cable at at least one point along its length, thereby releasing said latches and allowing said cover to eject under said pressure differential.
7. In the cover ejection device of claim 6, the further improvement wherein the cable cutting means comprises at least one pyrotechnic cable cutter.
8. In the cover ejection device of claim 7, the further improvement comprising pressure sensing means attached to the case for indicating the pressure under the cover, whereby a loss of pressure will indicate cover ejection.
9. In the cover ejection device of claim 8, the further

improvement comprising temperature sensing means attached to said cover and releasably connected to said case, whereby disconnection of said sensing means will indicate cover ejection.

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