United States Patent

Jacobson et al.

[15] **3,674,227**

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[54] FRAGMENTING COVER

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[52] **U.S. Cl.** **244/121,** 102/1

[51] **Int. Cl.** **B64d 7/00**

[58] **Field of Search** 244/121; 102/49.5, 105.1

[56] **References Cited**

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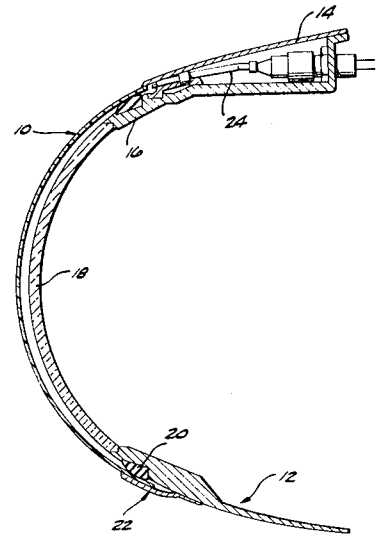
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[57] **ABSTRACT**

A protective cover for a window is made of fragmentable material, and is equipped with a fragmenting actuator so when it is desired to remove the cover, the fragmenting actuator fragments the cover. In the preferred embodiment, the cover is a dome over a window for a radiation detector, for example, in the nose of a missile.

20 Claims, 5 Drawing Figures



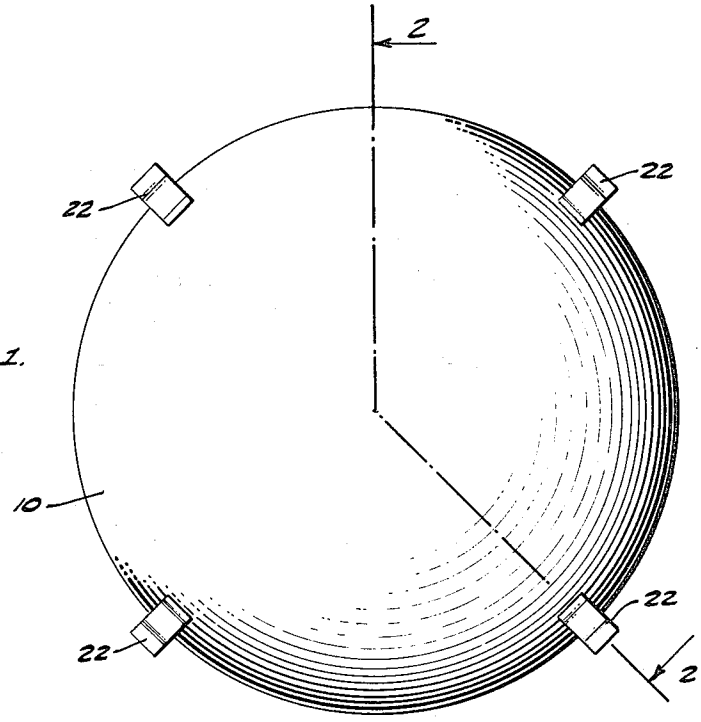


FIG. 1.

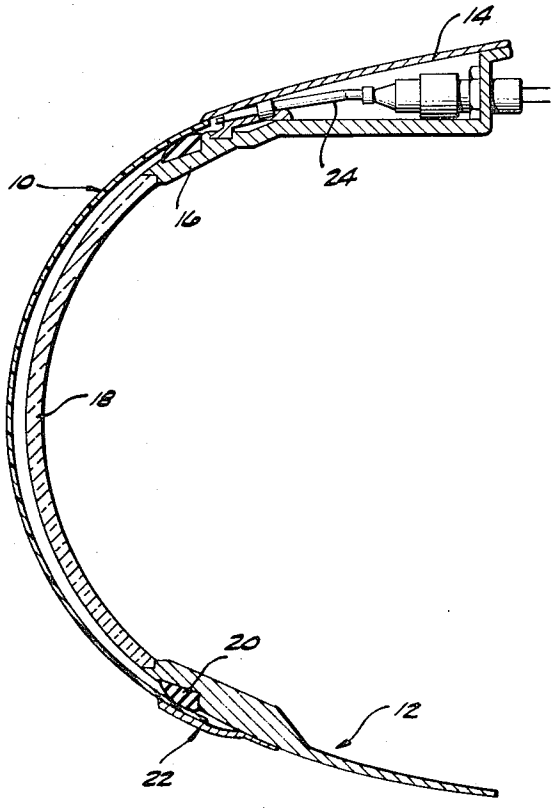


FIG. 2.

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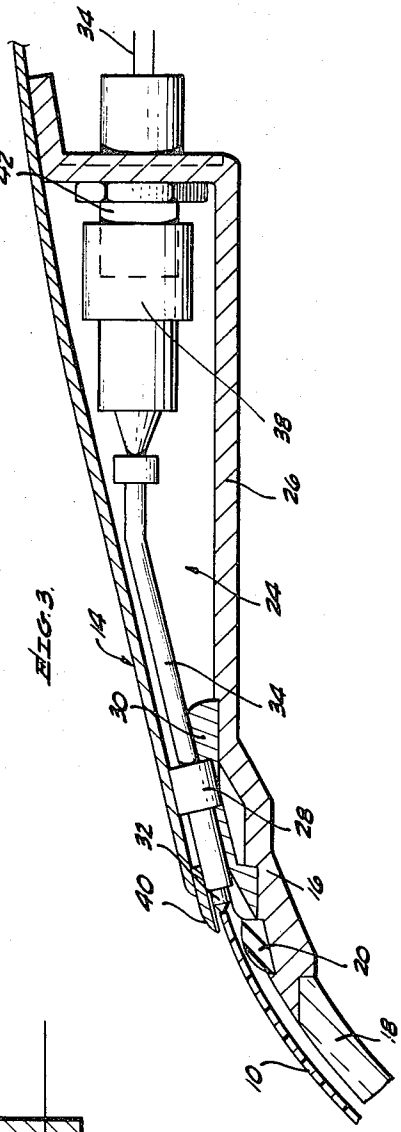


FIG. 3.

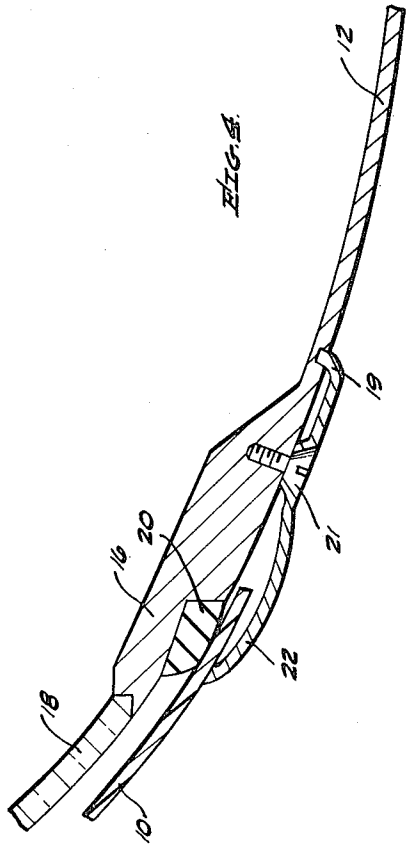


FIG. 4.

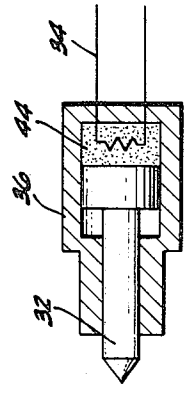


FIG. 5.

FRAGMENTING COVER

The invention herein described was made in the course of or under a contract or subcontract thereunder with the Department of Defense.

BACKGROUND OF THE INVENTION

This invention is directed to a fragmenting cover made of material which fragments into small pieces, together with the retention means therefor and an actuator for fragmenting the cover.

There are a number of windows which are subject to becoming dirty or damaged prior to their employment. It becomes necessary to protect the window against adverse environment which reduces the effectiveness of the window before the window is used. Included in the environmental problems against which protection is desirable are rain erosion, insect impingement, rocket motor exhaust, optical contamination, ice formation, general debris, humidity, heat, salt, sand, dust, and the like. Such damage to the window itself or to its radiation transparency can occur to the nose windows in missiles, which nose windows are provided for detectors for missile guidance or the like. Thus, any damage to the window prior to its employment can jeopardize the mission of a missile.

While the fragmenting cover of this invention is disclosed in association with a missile nose, it is clear that it is useful for other purposes, for example, rocket motor outlet environmental seal and special antenna cover. Former missile nose covers include the use of a truncated cone attached to the missile nose. This device utilized an explosively released latch with a special disengaging hinge located opposite the latch. The cover was deployed when the latch was disengaged. Assymmetrical aerodynamic forces caused the cover to pivot about the hinge and swing away. The cover was then released from the hinge and carried away in the slip stream. The problem with this cover is that since it was deployed in one piece, it posed a potential debris hazard to the aircraft carrying the missile. In another similar cover, deployment was accomplished by inflating a bladder located between the cover and the missile nose. This caused the cover to swing out into the slipstream to be carried away in one piece.

In another attempt, a foam polyurethane cover having a detonating fuse imbedded therethrough was employed. When the detonating fuse was ignited, the cover broke into pieces. The pieces were intended to be carried away in the slipstream. Wind tunnel tests showed that not all of the pieces were properly carried away, so that the window was not always completely uncovered. Furthermore, the debris created when the cover was deployed could damage the aircraft, and there is a high probability of damage to the optical window during deployment.

SUMMARY OF THE INVENTION

In order to aid in the understanding of this invention, it can be stated in essentially summary form that it is directed to a fragmenting cover, particularly a cover for protecting a window before use, the cover being made of fragmentable material and having a fragmenting device associated therewith. The fragmenting device engages the cover upon actuation to cause it to fragment and fall away, to thus expose the window.

Accordingly, it is an object of this invention to provide a fragmenting cover which is positionable over a window to be protected, and is fragmentable to expose the window, when window usage is desired. It is a further object to provide a fragmenting cover made of glass-like material which breaks into small pieces which fall away from the window, when fragmentation is accomplished. It is a further object to provide a fragmenting device which is associated with a fragmenting cover so that upon actuation of the device, fragmentation is caused. It is still another object to provide a fragmenting cover which can protect a missile sensor window from damage. It is yet another object of this invention to employ a pyrotechnically actuated fragmentor positioned adjacent the rim of the domelike cover so that upon actuation, the fragmentor engages the rim with a sharply pointed plunger to cause fragmentation. It is still another object of this invention to provide seal means around the fragmenting cover to seal the cover with respect to the window it protects before fragmentation.

Other objects and advantages of this invention will become apparent from a study of the following portion of this specification and the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevational view of the fragmenting cover of this invention shown installed on a missile nose;

FIG. **2** is a section taken generally along line **2—2** of FIG. **1**;

FIG. **3** is an enlarged sectional view, taken partly in side elevation, showing the details of the fragmentor;

FIG. **4** is an enlarged section showing the details of the fragmenting cover retaining clip and the sealing means sealing the cover with respect to the nose;

FIG. **5** is a further enlarged partial section of the fragmentor of FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The fragmenting cover **10** of this invention is shown as being mounted upon the nose of a missile **12**. The nose of the missile includes a cover skin **14** which terminates at nose ring **16**. Detector window **18** is fitted into nose ring **16**. The detector window is of such transparency as to permit the desired radiation to pass therethrough into the interior of the missile to a radiation-sensitive detector. The detector may be a seeker which is connected to aid in the command of missile direction, or may be for other functional purposes, such as surveillance, independent of missile direction. In any event, the detector window **18** must be in clean, undamaged condition when its employment is desired. If the detector window is not suitably protected, it is subject to rain erosion, insect impingement, rocket or turbojet motor exhaust, optical contamination, ice formation, or other radiation disturbing damage. Such damage to the window itself can jeopardize the state of the radiation to the detector to thus reduce the sensitivity or discrimination of the detector.

In order to prevent this, the fragmenting cover **10** is placed over the detector window, until employment of the detector window is required. Fragmenting cover is semi-spherically shaped in order to conform with the exterior shape of detector window **18**. It is configured to allow a minimum clearance between the cover and the window, preferably less than one-quarter inch with the intervening air space serving as a thermal barrier. Of course, with other detector window shapes, the fragmenting cover **10** would be appropriately configured.

Elastomeric seal ring **20** is positioned in a groove in nose ring **16**. Seal ring **20** is continuous around the nose ring so that when fragmenting cover **10** is sealed thereagainst, as shown in FIGS. **2**, **3** and **4**, the outside surface of detector window **18** is completely protected from exterior contamination. The elastomeric seal ring serves to locate the cover radially, while allowing for differential thermal expansion between the nose ring **16** and the fragmenting cover **10**.

Four attachment clips **22** are employed to secure the fragmenting cover **10** in place. As is best seen in FIGS. **2** and **4**, the attachment clips **22** are secured to the nose ring, and extend over the outer edge of the fragmenting cover. The attachment clips are aerodynamically faired. Each attachment clip has a rear foot **19** which extends into a recess in the nose ring **16**, thereby causing aligning and preventing rotation of clip **22** and a securing screw **21** so the screw holds the finger-like front end of the clip down against cover **10**. The attachment clips are made of resilient metallic material to resiliently restrain the fragmenting cover **10** in place. They provide adequate holding force to overcome handling and maneuver loads of cover **10** with respect to the missile, and to prevent separation of the fragmenting cover **10** resulting from pressure differentials on opposite sides of the cover, resulting from changes in altitude.

Fragmenting cover **10** is made of a material which has adequate resistance to particle impingement at high velocities, including such particles as rain drops, rocket exhaust particles and flying insects. It must be capable of being fragmented in a controlled manner. Materials which meet these requirements are highly stressed glass and some other highly stressed brittle materials including some ceramics and synthetic polymer composition materials. The glass-like materials are preferred. Thus, glass-like materials are chosen for fragmenting character, rather than transparency.

Particular materials suitable for employment as the fragmenting cover **10** include Chemcor 0313, Chemcor 0315, Prestressed Pyro-ceram 9606, and Prestressed Pyroceram 9605, all manufactured by the Corning Glass Works, Corning, New York. Also suitable is Herculite II, manufactured by PPG Industries, Inc., Pittsburgh, Pa. and chemically strengthened CerVit, manufactured by Owens-Illinois of Toledo, Ohio. Another suitable glass, not presently having a trade name assigned, is a chemically strengthened glass manufactured by Anchor-Hocking of Lancaster, Ohio. Each of these materials is formed, prior to stressing, into the shape of cover **10** and is then treated to cause it to be fragmenting in character.

The recited materials are treated by placing them in a bath which includes ions which exchange with ions in the material. The temperature of the bath and the character of the ion exchange process, as well as the time, control the amount and depth of ion exchange. In the treated structure, the new ion is larger than the old one so that the surface of the fragmenting cover becomes stressed in compression, with consequent balancing tensile forces in the cover away from the surfaces. As soon as these forces are unbalanced, rapid and progressive fragmenting occurs. The nature of the fragmentation, such as the size of the fragmented particle, is controlled by these manufacturing steps.

A similar fragmenting material is produced by heat treatment of glass subsequent to its fabrication, to result in similar balanced stresses. At present, the chemically strengthened material is preferred, although upon further development it is possible that heat treated material would be satisfactory.

Fragmentation is caused by fragmentor **24**, illustrated in FIGS. **2** and **3**. Fragmentor **24** is mounted upon bracket **26** which extends between the missile skin and nose ring **16**. Pyrotechnic actuator **28** illustrated in FIG. **5** is mounted upon base **30** which rests on bracket **26**. The actuator **28** is such that a gas generating material **44** is positioned in actuator housing **36**. When gases are generated by pyrotechnic actuation of the material, the sharply pointed piston **32** is forced away from **44** by the generated pressure forces. Actuation is accomplished by suitable electric energization of leads **34** through electrical connectors **38** and **42**. Alternatively to pyrotechnic operation, it is clear that the cylinder can equivalently be thrust to the left by electrical means, by fluid means or mechanical means.

Pyrotechnic actuator housing **36** carries the pointed piston **32**. The pointed piston is slidably mounted in actuator housing **36**.

The forward end of the base **30** includes finger **40** which locates the edge of fragmenting cover **10** opposite pointed piston **32**. In quiescent state, there is a small clearance between the pointed piston and the edge of the fragmenting cover **10**.

When pyrotechnic actuator **28** is actuated, pointed piston **32** moves to the left under gas pressure, with the consequent sharp engagement of the pointed piston **32** upon the edge of fragmenting cover **10** to notch the edge of the cover.

In view of the force balance within fragmenting cover **10**, the upset of this force balance by notching the edge of the fragmenting cover causes shattering of the entire cover. The local fracture causes imbalance in the stored stresses in the cover to result in immediate and complete fragmentation of the cover. The fragments are propelled away from detector window **18** as a result of the stored energy in the cover material. Complete removal of the cover fragments is accomplished by aerodynamic forces acting on the individual particles, within one second after the application of the signal to actuator **28**.

Fragmenting cover **10** is produced to be of such configuration as to closely conform to the shape of the detector window and leave a substantially uniform air gap therebetween to protect the detector window against thermal shock or icing. The fragmenting cover **10** is preferably coated on the outside with an electrically conductive material of such nature as to prevent the buildup of static electricity thereon. The attachment clips **22** engage the exterior conductive surface of the cover to carry away any charge that may otherwise form. This conductive coating thus prevents arcing, by prevention of the static electric charge buildup.

This invention having been described in its preferred embodiment, it is clear that it is susceptible to numerous modifications and embodiments within the ability of those skilled in the art and without the exercise of the inventive faculty.

What is claimed is:

1. The combination of a missile having a nose and a radiation transparent detector window in the missile nose, with a fragmentable protective cover over the detector window;

said protective cover being made of fragmentable material;

attachment means for attaching and retaining the protective cover on the missile nose over the detector window in the missile nose;

fragmenting means responsive to a fragmenting signal and positioned with respect to the fragmentable cover so that upon receipt of a fragmenting signal, said fragmenting means fragments said protective cover to expose the detector window in the missile nose.

2. The combination of claim **1** wherein said fragmentable cover has internal balanced stresses, which stresses are unbalanced by said fragmenting means to cause fragmentation of said cover.

3. The combination of claim **2** wherein said fragmentable cover is made of glass-like material.

4. The combination of claim **3** wherein said fragmentable cover has compressive stresses near its external surfaces and tensile stresses interiorly of its surfaces so that notching of the fragmentable cover by said fragmenting means causes restabilization of stresses which causes fragmentation of the cover.

5. The combination of claim **4** wherein said fragmentable cover is made of chemically strengthened glass.

6. The combination of claim **1** wherein said attachment means comprises at least three attachment clips secured to the missile nose and engaging over said protective cover to retain the protective cover with respect to said missile nose.

7. The combination of claim **6** wherein said missile nose has a seal ring therearound posteriorly to the detector window and said protective cover engages over said detector window and engages on said seal ring.

8. The combination of claim **7** wherein said protective cover is spaced from said detector window.

9. The combination of claim **8** wherein said fragmentable cover has internal balanced stresses, which stresses are unbalanced by said fragmenting means to cause fragmentation of said cover.

10. The combination of claim **9** wherein said fragmentable cover is made of glass-like material.

11. The combination of claim **10** wherein said fragmentable cover has compressive stresses near its external surfaces and tensile stresses interiorly of its surfaces so that notching of the fragmentable cover by said fragmenting means causes re tabilization of stresses which causes fragmentation of the cover.

12. The combination of claim **11** wherein said fragmentable cover is made of chemically strengthened glass.

13. The combination of claim **1** wherein said fragmenting means comprises a sharp device movably mounted with respect to said missile nose and movable into engagement with the edge of said protective cover so that said sharp device notches said protective cover to cause its fragmentation.

14. The combination of claim **13** wherein said sharp device is a point on a piston, said piston being substantially axially movable toward the edge of said protective cover.

15. The combination of claim 14 wherein said fragmenting means has a pyrotechnic actuator attached to the missile nose and positioned to drive said pointed piston toward said protective cover so that upon actuation of said pyrotechnic actuator, said fragmenting cover is fragmented.

16. The combination of claim 15 wherein said detector window is substantially spherical and said protective cover is substantially semispherical and substantially uniformly spaced from said detector window.

17. The combination of claim 16 wherein said fragmentable cover has internal balanced stresses, which stresses are unbalanced by said fragmenting means to cause fragmentation of said cover.

18. The combination of claim 17 wherein said fragmentable cover is made of glass-like material.

19. The combination of claim 18 wherein said fragmentable cover has compressive stresses near its external surfaces and tensile stresses interiorly of its surfaces so that notching of the fragmentable cover by such fragmenting means causes restabilization of stresses which causes fragmentation of the cover.

20. The combination of claim 19 wherein said fragmentable cover is made of chemically strengthened glass.

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