United States Patent [19]

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[11] **3,903,803**

[45] **Sept. 9, 1975**

[54] MISSILE SEPARATION MEANS

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[22] Filed: **May 12, 1960**

[21] Appl. No.: **28,809**

[52] **U.S. Cl.** ..... **102/49.5**; 89/1 B

[51] **Int. Cl.** **F42b 15/12**

[58] **Field of Search** ..... 102/49; 89/1.7 B; 285/6, 285/7

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EXEMPLARY CLAIM

1. In a missile of the type having a ballistic missile component and a booster motor adapted to propel the missile component during the boost phase of its trajectory, the booster motor having a forward section and the missile component being disposed so as to co-extensively abut the forward section, the improvement comprising; an annular member secured to the forward edge of said section and extending inwardly thereof, said member having an outwardly facing recess, a plurality of studs disposed inwardly of said missile component and affixed thereto, said studs having indented portions projecting into and being at least in part contiguous with said recess, a locking band, and releasable means holding a locking portion of said band tightly within said recess and against said indented portions for securely connecting said missile component to said section.

4 Claims, 9 Drawing Figures

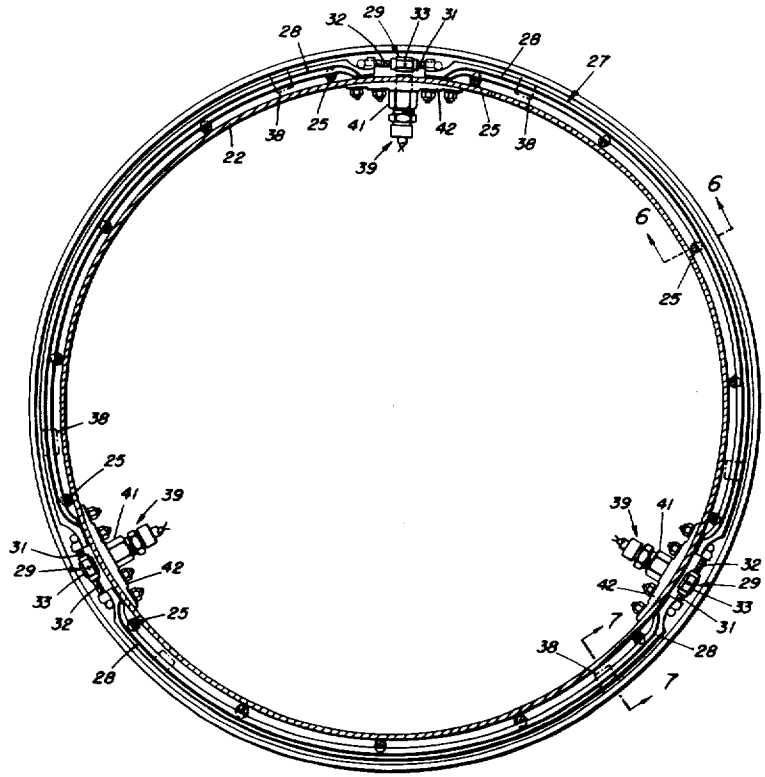


FIG. 1

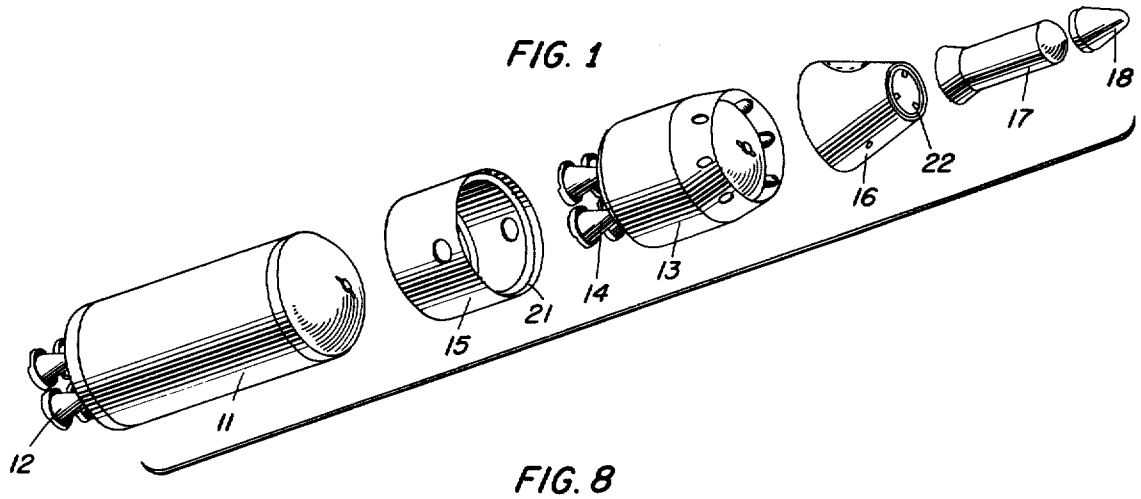


FIG. 8

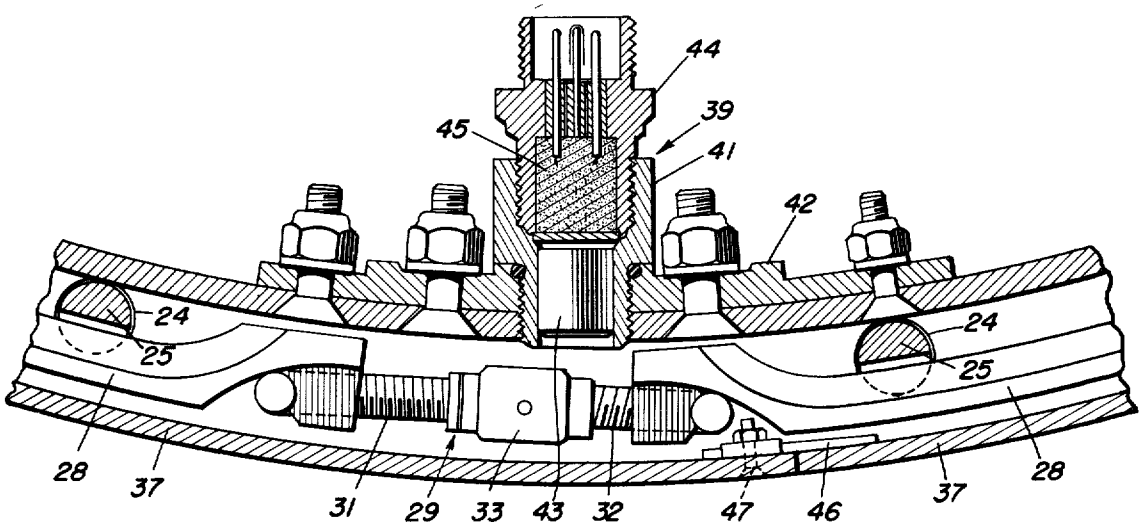
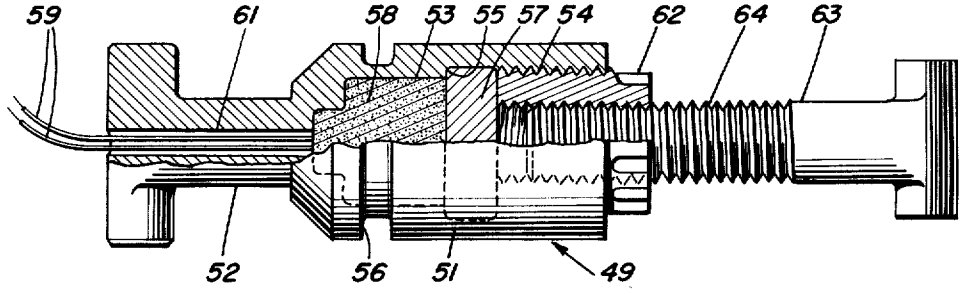


FIG. 9



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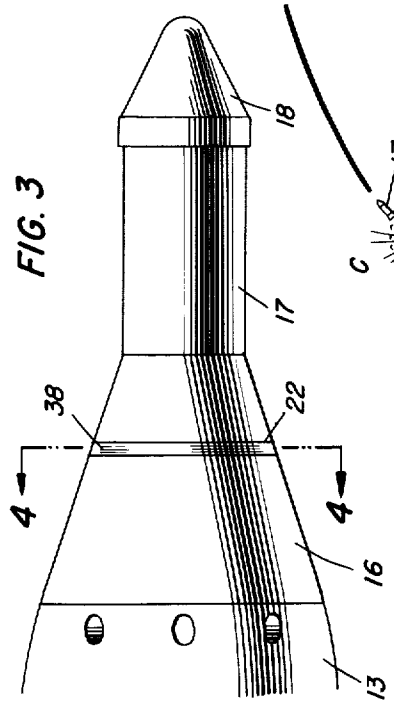


FIG. 3

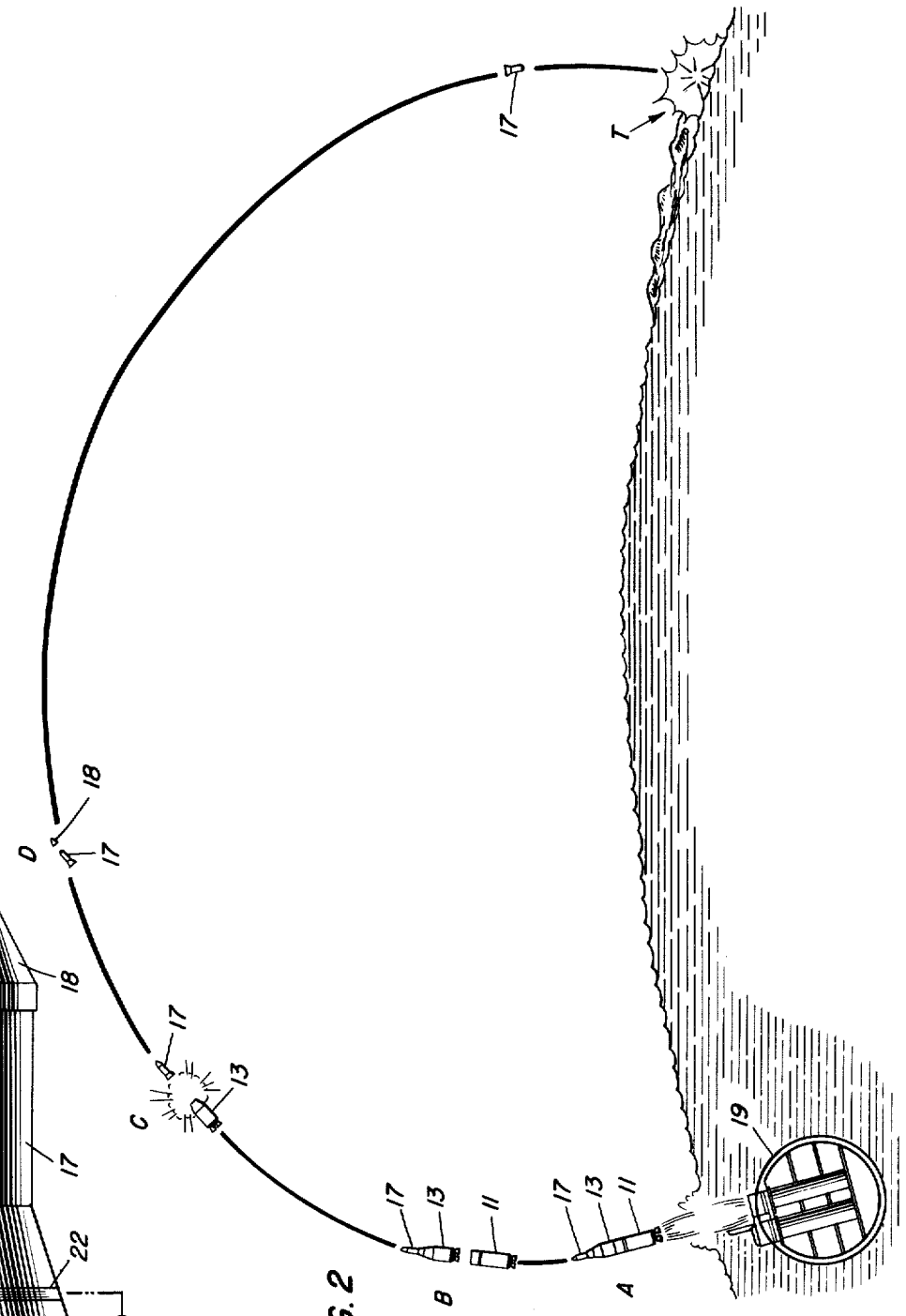
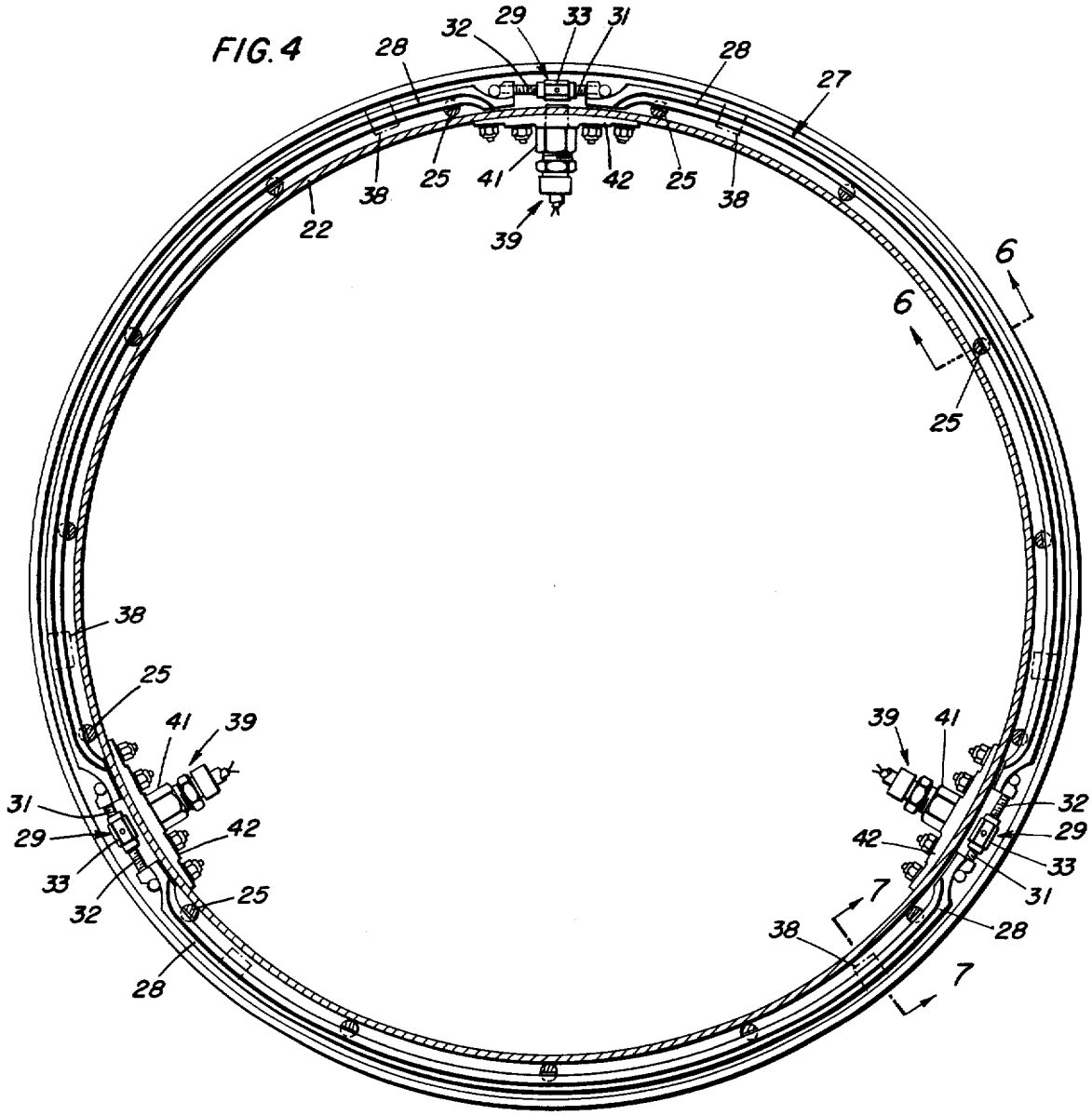


FIG. 2

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FIG. 4



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FIG. 6

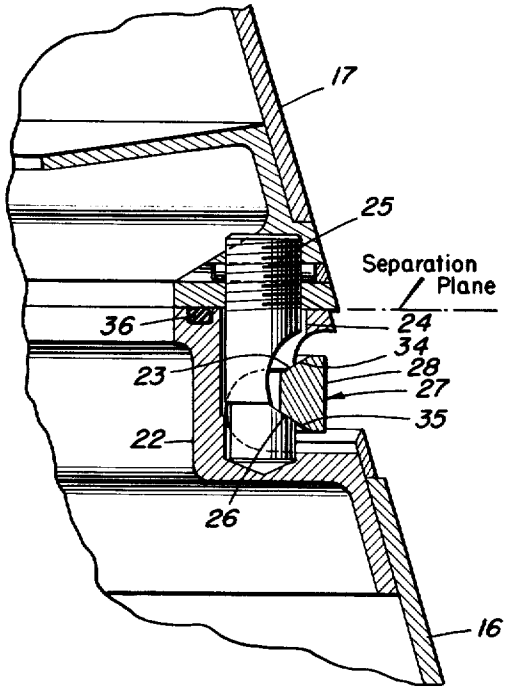
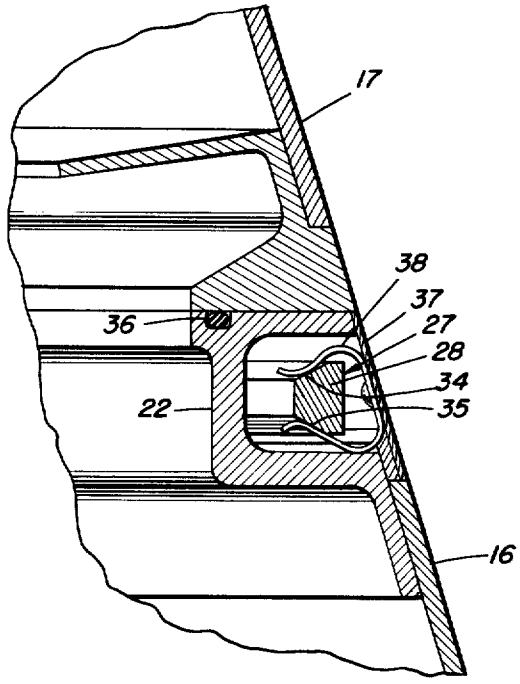


FIG. 7



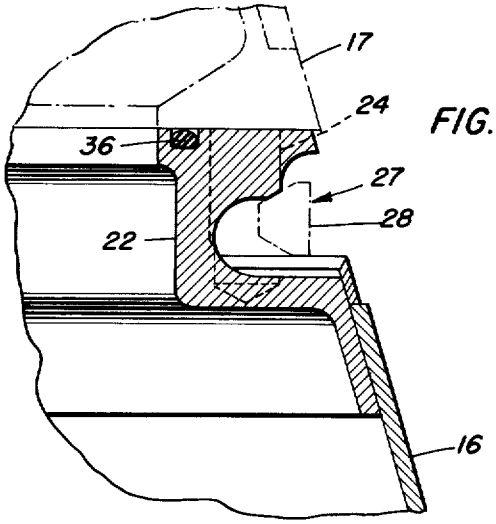


FIG. 5

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MISSILE SEPARATION MEANS

This invention relates to ballistic missiles and more particularly to means for effecting separation of the missile from the booster motor.

Means have been proposed to effect separation between a booster rocket motor and a forwardly attached component comprising an annulus of Primacord or similar type explosive placed in juxtaposition with the surface of an interconnecting skirt or the like, detonation of the explosive serving to sever the skirt circumferentially for effecting separation of the component from the booster motor. However, it has been found that the amount of explosive required to effect separation by this means is considerable and that the interconnecting skirt is not always cut evenly, the effect of which is to cause undesirable perturbations to be imparted to the component so as to cause it to depart from the desired ballistic trajectory.

In another form of separation means which has been employed heretofore, an externally disposed segmental ring of channel cross section is provided with confronting inner surfaces which are adapted to engage sloping surfaces formed on outwardly extending flanges on a rocket motor and a forwardly attached component, respectively, for holding the motor and component together. The segments of the ring are interconnected by explosive bolts which are adapted to be detonated when release of the segmental ring and separation of the component from the motor is desired; see U.S. Pat. No. 2,809,584, issued Oct. 15, 1957, to Bernard Smith. Such separation apparatus has projecting parts which do not make for a smooth outer skin of the motor and its component thereby adding to the drag of the missile in flight.

The present invention provides releasable locking means for detachably securing together a booster rocket motor and a forwardly attached component and explosively actuated means for releasing the locking means. The locking means is disposed inwardly of the outer skin of the motor-component system and is adapted to unlock upon release thereof to effect a positive and smooth separation of the component from the motor.

It is therefore an object of the present invention to provide an improved and reliable connection between a booster motor and another missile component.

Another object is to provide an improved detachable connection between a booster motor and a forwardly attached ballistic component which permits separation of the component from the motor without applying to the component, during separation, deflecting forces which would cause the component to depart from the desired ballistic trajectory intended therefor.

A further object of the invention is to provide a segmental locking band for detachably connecting a ballistic missile to a booster motor, the segments of the band being adapted to be forced apart for affecting smooth separation of the missile from the motor.

Still another object is to provide locking means comprising segments of spring metal and connecting means between the segments, the connecting means being adapted to be ruptured by explosive means for releasing the segments and permitting them to spring outwardly for affecting smooth separation of the missile component from the motor.

Yet another object of the invention resides in the provision of a volume of pressurized gas between the missile component and the booster motor whereby upon release of means connecting the component to the motor, expansion of the gas uniformly forces the component away from the motor for a smooth separation thereof without the existence of an unbalanced condition of the forces acting on the booster and component.

Other objects and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. **1** is an exploded perspective view of a ballistic missile system with which the separation means of the present invention is associated;

FIG. **2** is a diagrammatic view illustrating the function of the separation means of this invention during the flight of the missile system;

FIG. **3** is a fragmentary side view of the missile system showing the joint between the missile component and the booster motor;

FIG. **4** is a cross-sectional plan view taken substantially along the line **4—4** of FIG. **3**, as viewed in the general plane of the separation means of the present invention;

FIG. **5** is a detailed view on a larger scale showing the cross section of the annulus located at the forward end of the equipment section of the missile system;

FIG. **6** is a detailed view of a larger scale taken substantially along the line **6—6** of FIG. **4** and illustrates the manner in which the segmental locking band secures the missile component to the equipment section;

FIG. **7** is a detailed view on a larger scale taken substantially along the line 7—7 of FIG. **4** and depicts the manner in which the fairing strip is secured to the locking band.

FIG. **8** is a fragmentary detailed view, partly in section, showing the T-bolt connector between the ends of the pair of segments of the locking band and the explosive means employed for rupturing the connector to release the locking band; and

FIG. **9** is a view of another form of explosive means which may be employed for releasing the segments of the locking band.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is disclosed in FIG. **1** a ballistic missile system with which the separation means of the present invention may be associated. The components of the missile system are shown separated for a better understanding thereof. The missile system comprises a first stage solid propellant rocket booster motor **11** having propulsion control means **12**, a second stage solid propellant rocket booster motor **13** with its propulsion control means **14**, and an interconnecting skirt section **15** which joins the rocket motors and is adapted to contain explosive means for separating the first stage motor **11** and the skirt section **15** from the remainder of the missile system. Forwardly of the second stage motor **13** is an equipment section **16** to which a ballistic missile or re-entry body **17** is detachably connected by the separation means, the nose of the re-entry body being provided with a nose fairing **18**. It will be understood, of course, that the several components of the missile system are adapted to be connected to-

gether and that the equipment section **16** houses suitable guidance and control mechanisms operatively connected to the propulsion controls and separation means for guiding the system along the proper booster trajectory or flight path and for separating the portions of the system as is necessary for delivery of the missile component or re-entry body **17** on the intended target.

Turning now to FIG. **2** for a better understanding of the flight of the missile system and the function of the separation means of this invention in such flight, the missile system is shown as being ejected from a submerged submarine **19**; although, of course, it could be launched from a surfaced submarine, surface vessel, or from dry land, if desired. Timed with the launching of the missile system is the ignition of the first stage motor **11** as at A in FIG. **2.**

Upon burn-out of the first stage motor **11**, first separation is effected as at B, FIG. **2.** Such separation can be effected by a loop of Primacord **21** disposed within the skirt section **15**, FIG. **1**, the Primacord being detonated at the proper time by control mechanisms in the equipment section **16** which are responsive to the burning out or tailoff of the motor **11.**

After this first separation, the first stage motor **11** falls and the second stage motor **13** continues on its guided trajectory to a point where the velocity and the direction of the re-entry body are such that, if free from the second stage motor, the ballistic missile or re-entry body **17** would follow a ballistic trajectory intersecting the target. At this point, C in FIG. **2**, second separation and thrust termination occur in response to appropriate signals from the control mechanisms in the equipment **16.** After separation at point C, the second stage motor **13** and attached equipment section fall away from the re-entry body **17** which continues on its unguided or ballistic trajectory to target T.

The upward flight of the ballistic missile or re-entry body **17** carries it though the outer reaches of the earth's atmosphere and beyond the mesosphere. The nose fairing **18** is provided to protect the nose of the re-entry body **17** during passage through the lower, thicker regions of the earth's atmosphere. Prior to re-entry of the ballistic missile **17**, nose fairing **18** is forced off or jettisoned in response to ambient conditions in the upper rarefied atmosphere, as at D in FIG. **2**, the nose fairing being needed only for the upward flight and unnecessary during re-entry because of the design of the re-entry body.

It will be appreciated that after second separation the ballistic missile **17** is no longer powered or guided and that if deflecting forces were exerted upon the re-entry body it could be caused to depart from the intended ballistic trajectory. It is therefore important at second separation that such deflecting forces be absent or be minimized so that the ballistic missile will proceed to the target. Thus, the second separation must be as smooth as possible. The separation means of the present invention is designed to effect smooth separation of the ballistic missile from its propulsion means.

For a detailed description of the separation means of the present invention, reference is made to FIG. **4** showing a cross sectional view generally in the plane of the joint between the equipment section **16** and the re-entry body **17**, that is, generally along the line **4—4** of FIG. **3.** Equipment section **16**, in the form of a frustum of a cone, is forwardly terminated by an annulus or annular member **22** having the cross section shown in FIG. **5** and providing an outwardly faced opening. At spaced intervals around the circumference of the annulus **22** there are formed openings **24** through which studs **25** secured to the re-entry body protrude, see FIGS. **5** and **6.** Each of the studs **25** has a notch on the side thereof facing outwardly and has a sloping surface **26** oppositely disposed with respect to a surface **23** of annular member **22**, see FIG. **6.**

Associated with the annulus **22** and studs **25** is a segmental locking band **27** comprising three segments **28** and the associated interconnecting means **29.** Each of the interconnecting means **29** may take the form of a pair of T-bolts **31** and **32** connected to the adjacent ends of segments **28** and a turnbuckle **33.** The ends of the segments **28** are suitably formed to be engaged by the T-bolts as is well known in the art and need not be further described.

The intermediate portion of each segment **28** is formed with a pair of sloping surfaces **34** and **35** complementary to and adapted to engage with surfaces **23** and **26**, respectively. Thus, it will be seen that as the turnbuckles **33** are turned to draw the associated T-bolts together, segments **28** will be drawn into a tighter relation with respect to annulus **22** and studs **25** with the result that surfaces **34** and **35** will slide along surfaces **23** and **26** causing them to spread and bring the re-entry body **17** into a secure relationship with the equipment section **16.** For the purpose of providing an airtight seal between the re-entry body **17** and the equipment section **16** there is provided an O-ring **36** disposed in a groove in the annulus **22.**

It will be noted that the flare of the equipment section **16** is a continuation of the flared portion of the re-entry body **17** and, in order to provide a smooth surface, the outwardly facing opening of the annulus **22** is covered by a fairing strip **37** formed in segments and provided with a plurality of spring clips **38** having fingers gripping the surfaces **34** and **35** of the associated locking band segments **28**, see FIG. **7.**

Portions of the annular member **22** are cut away as necessary to admit the spring clips **38** and the ends of the segments **28** and associated interconnecting means **29.**

Each of the segments **28** is made of spring steel and tends to assume a straight line position. Hence, when the segments **28** are tightened into the bent positions shown in FIG. **4**, they are placed under stress whereby upon release of the interconnecting means **29**, the segments will tend to fly out from engagement with the studs **25** and annular member **22** thereby effecting separation of the re-entry body **17** from the equipment section **16.** The space inwardly of the joint between the re-entry body and the equipment section is filled with air or any suitable gas under a pressure of about 12 psi with the result that when the interconnecting means **29** are ruptured for release of the segments **28**, which occurs at a high altitude where the atmospheric pressure is quite low, the pressurized air or gas forces the re-entry body **17** away from the equipment section **16.**

In FIG. **8** there is shown one form of explosive actuated means **39** for rupturing or fracturing the interconnecting means **29.** The explosive actuated means **39** comprises a tubular housing **41** connected to a plate **42** which is secured to the equipment section **16** in any suitable manner, as, for example, by bolts. The housing **41** contains a slug **43** which is aligned with the turnbuckle **33.** The housing **41** is adapted to receive an

electrically fired squib **44** containing explosive **45**, the detonation of which serves to drive the slug **43** against the turnbuckle **33** for fracturing the same. The fracturing of the turnbuckles **33** releases the interconnecting means **29** and the segments **28** of the locking band. Incident to the release of the interconnecting means **29**, adjacent portions of the segments of the fairing strip **37** will also be ruptured and the segments of the fairing strip will fly out with the associated segments **28** of the locking band. The adjacent ends of the segments of the fairing strip may be interconnected by providing a backing strip **46**, as shown in FIG. **8**, secured to one end of a fairing strip segment and disposed in underlapping relation to the adjacent end of another fairing strip segment and fastened thereto by a bolt **47**, or the like.

In the embodiment of FIG. **9**, the explosive means is incorporated in the interconnecting means. In this form of the interconnecting means, which is designated generally by reference numeral **49**, there is provided a hollow housing **51** having integrally formed therewith a T-portion **52** at one end thereof. Housing **51** is formed with coaxial bores **53** and **54** of different diameters and a shoulder **55** therebetween, bore **53** being located adjacent T-portion **52** and bore **54** being threaded. Externally, housing **51** is provided with a circumferential groove **56** encompassing bore **53**.

A spacer block **57** is seated against shoulder **55** for closing off bore **53**, thereby forming a chamber for an explosive mixture **58**. The explosive mixture **58** may be detonated by any suitable means such as, for example, electrical wires **59** extending through a bore or channel **61** in T-portion **52**. Also received in bore **54** is a tubular lock nut **62** having outer threads engaging the threads of bore **54** and inner threads engaging a T-bolt **63**.

Although the device of FIG. **9** is not shown connected to segments **28** of the locking band **27**, it is obvious that such device may replace elements **31**, **32** and **33** of FIG. **8**. The device of Fig. **9** is so proportioned and related to the segments **28** that when lock nut **62** has been tightened to hold the spacer block **57** against shoulder **55**, T-bolt **63** may be drawn toward T-portion **52** sufficiently to provide the desired tightness of the segments **28** of the locking band **27**. When the device in Fig. **9** is used in lieu of parts **31**, **32** and **33** of FIG. **8**, the need for the explosively actuated means **39** is eliminated and means **39** therefore may be omitted.

The operation of the device of FIG. **9** is similar to that of the device of FIG. **8** in that upon receipt of the proper electrical impulse, explosive mixture **58** is detonated, thereby causing rupture of the housing **51** in the area of the groove **56** for forcing apart each T-portion **52** and T-bolt **65**. This releases the segments **28** of the locking band **27** for separation of the re-entry body **17** from the equipment section **16**.

Briefly summarizing, rupture or fracture of the means interconnecting the segments **28**, whether such means comprise turnbuckles **33** (FIG. **8**) or housings **51** (FIG. **9**), serves to release the segments **28** which tend to assume straight-line unstressed conditions and fly outwardly from surfaces **23** and **26** on annular member **22** and studs **25**, respectively, thereby permitting re-entry body **17** to separate from the equipment section **16** smoothly and with very little or no vibration. A volume of pressurized air or gas between the equipment section and the re-entry body assists and assures such separation.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practices otherwise than as specifically described.

What is claimed is:

1. In a missile of the type having a ballistic missile component and a booster motor adapted to propel the missile component during the boost phase of its trajectory, the booster motor having a forward section and the missile component being disposed so as to coextensively abut the forward section, the improvement comprising; an annular member secured to the forward edge of said section and extending inwardly thereof, said member having an outwardly facing recess, a plurality of studs disposed inwardly of said missile component and affixed thereto, said studs having indented portions projecting into and being at least in part contiguous with said recess, a locking band, and releasable means holding a locking portion of said band tightly within said recess and against said indented portions for securely connecting said missile component to said section.

2. A missile as set forth in claim **1** wherein the locking band comprises a plurality of segments interconnected by releasable members.

3. A missile as set forth in claim **2** wherein said releasable member includes an explosive element for effecting the release thereof.

4. A missile as set forth in claim **3** wherein said segments of the locking band are of spring metal, said releasable members holding said locking band segments in a curved manner so that upon explosion of said explosive element rupturing said releasable members the bands will straighten.

* * * * *