

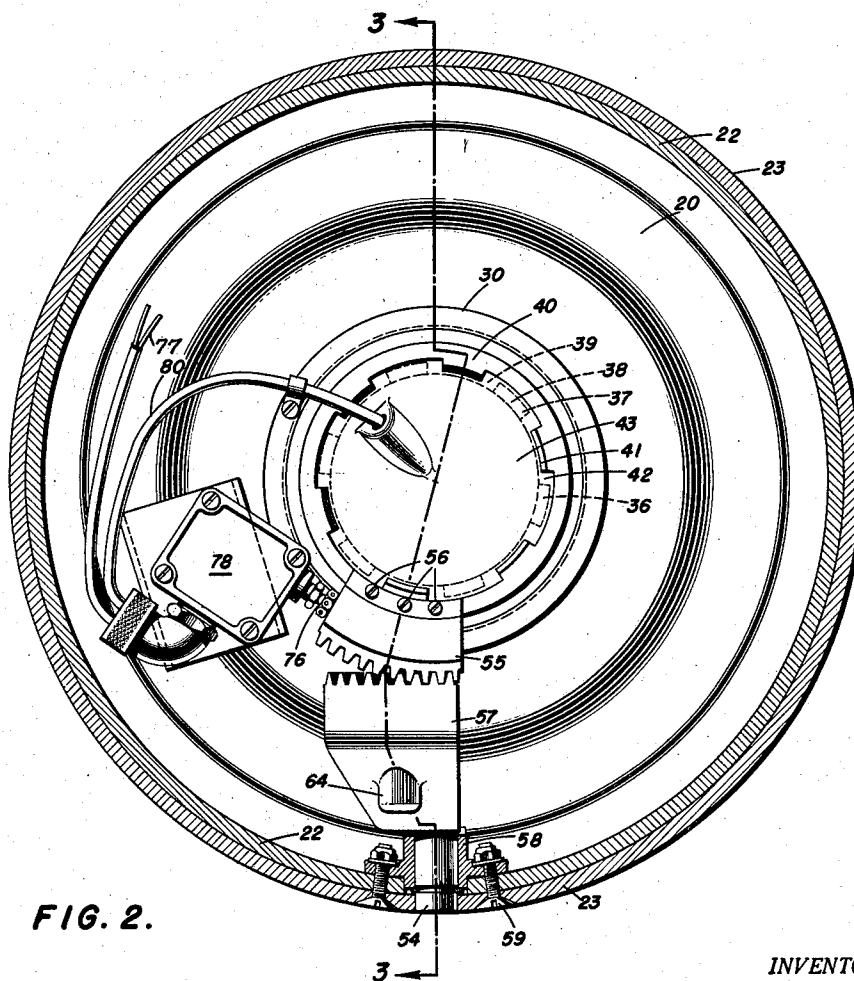
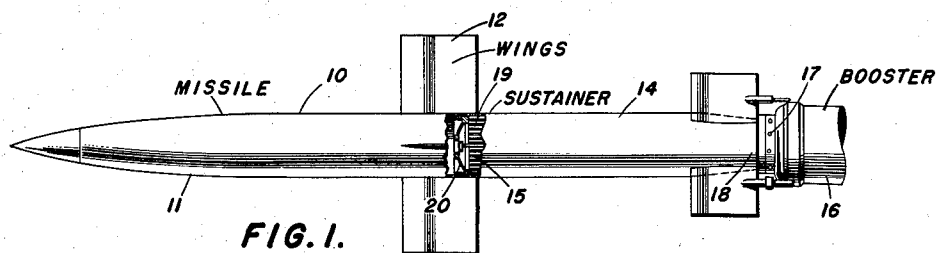
March 15, 1960

D. D. GRIMES
ARMING MECHANISM

2,928,346

Filed Sept. 6, 1951

4 Sheets-Sheet 1



INVENTOR.
DAVID D. GRIMES
BY *A. H. O'Brien*
attorney

March 15, 1960

D. D. GRIMES
ARMING MECHANISM

2,928,346

Filed Sept. 6, 1951

4 Sheets-Sheet 3

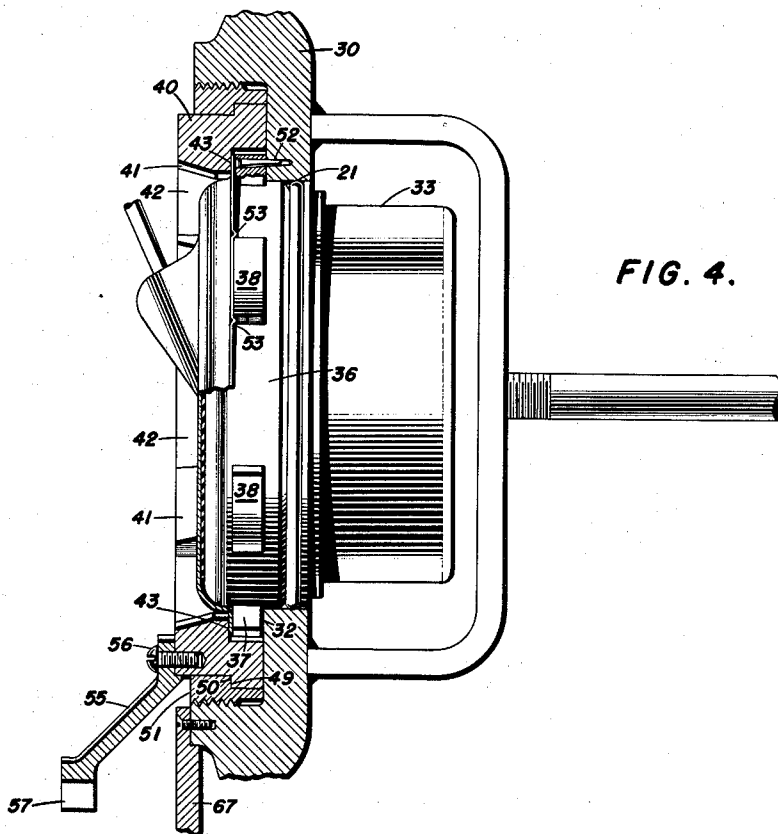


FIG. 4.

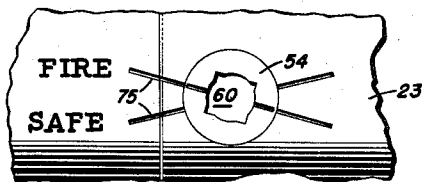


FIG. 7.

INVENTOR.
DAVID D. GRIMES
BY *G. D. O'Brien*
J. Horneg

March 15, 1960

D. D. GRIMES
ARMING MECHANISM

2,928,346

Filed Sept. 6, 1951

4 Sheets-Sheet 4

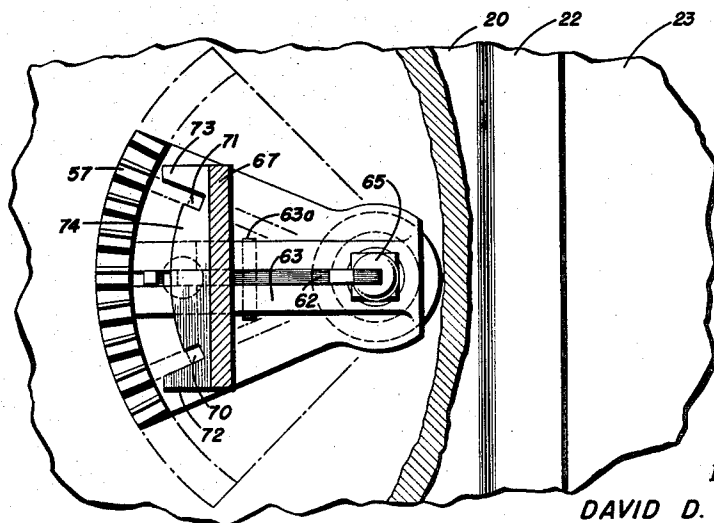
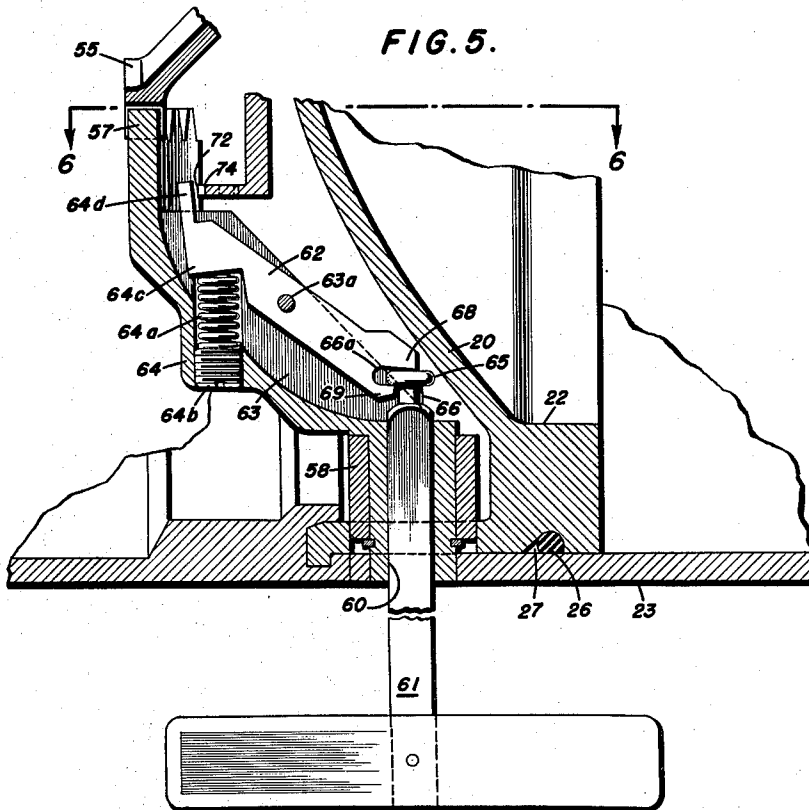


FIG. 6.

INVENTOR.
DAVID D. GRIMES
BY *G. D. O'Brien*
attorney

1

2,928,346

ARMING MECHANISM

David D. Grimes, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy

Application September 6, 1951, Serial No. 245,300

19 Claims. (Cl. 102—70.2)

This invention relates generally to rocket-propelled vehicles and more particularly to an arming mechanism for a rocket-propelled missile.

In the operation of rocket devices, the propellant is burned in a confined space or propellant chamber and the gases of combustion are allowed to flow through a thrust nozzle, the reaction to the flow of the gases acting as a thrust pressure to propel the rocket.

In the construction and utilization of rocket-propelled missiles, particularly rockets utilizing solid fuel, it is customary to store the charge of propellant in a propellant chamber and to ignite the charge and allow it to burn during the propelling interval. If, through some accident, the propellant charge should be ignited when the rockets are in shipment, in storage, or even when adjacent to a launching device, the rockets would become propelled and might do great damage in the vicinity.

It is, of course, customary to take maximum precautions to prevent such occurrences. However, a lightning stroke, an accidental direct contact with an electrical conductor, a conflagration, or possible enemy action could, under certain circumstances, ignite the propellant charges. The present invention provides an arming mechanism having a counter thrust passage so that the normal thrust produced by the burning propellant will be counteracted to prevent the rocket from being propelled under such circumstances.

The arming mechanism, according to this invention, is constructed as an exhaust passage in the end of the propellant chamber opposite the thrust nozzle. The exhaust passage is closed by a cap which may conveniently be a portion of an igniter cup containing the material for igniting the propellant charge. In the safe or unarmed condition the cap is retained in position by a shear plate which is frangible so that a material increase of pressure in the propellant chamber will destroy the shear plate and open the exhaust passage. The passage is converted from safe to armed conditions by means of an arming ring which secures the cap in pressure-resisting condition in the passage in order to retain under pressure the gases generated by the combustion of the propellant charge.

For convenience, the exhaust passage closure cap is provided with a flange having lugs and the locking ring for the cap is provided with companion lugs, the lugs of the cap and ring readily passing through the spaces between said lugs in unarmed position and preventing passage in armed position. A linkage is provided for changing the relative position of the ring and flange. Indicating means are provided for showing the condition of the arming mechanism.

As a further safety measure, a safety switch is provided adjacent the exhaust passage and an operating mechanism is so arranged that, when the safety passage is in an unarmed condition, the safety switch will have opened an electrical igniter circuit and also shorted or grounded the leads from the switch to the igniter elements. The safety switch is of such construction that at the beginning of the arming motion the switch will be actuated

2

to the armed position so that if the electrical supply line should accidentally be alive, the igniter will itself be exploded before the arming ring moves to the armed position and the rocket will be non-propulsive.

It is accordingly an object of the present invention to provide a rocket propulsion device having an arming mechanism therein.

It is a further object of the invention to provide an arming mechanism which can be latched in either an armed or unarmed position.

Another object of the invention is to provide a linkage for actuating the arming mechanism.

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

Fig. 1 is an elevation of a rocket missile partially broken away to show the application of this invention;

Fig. 2 is an enlarged cross-section through the missile, looking at the forward end of the propellant chamber containing the arming mechanism;

Fig. 3 is a section on the line 3—3 of Fig. 2, and showing the details of the arming mechanism in its unarmed condition;

Fig. 4 is an enlarged sectional view, partly in elevation, of a portion of the arming mechanism, shown in armed position;

Fig. 5 is an enlarged section showing the construction and operation of a latch for the operating linkage of the arming mechanism;

Fig. 6 is a view on the line 6—6 of Fig. 5, showing the stop and control arrangement for the operating linkage;

Fig. 7 is an example of an indicator showing the condition of the arming mechanism, and

Fig. 8 is a diagrammatic illustration of the connections in the safety switch.

In the exemplary embodiment of the invention, as best illustrated in Fig. 1, the missile 10 has a nose section 11 to which are connected a plurality of control surfaces 12. Coupled to the nose section 11 of the missile 10 is a sustainer rocket 14 having a propellant chamber 15 provided with a charge 19 for propelling the missile 10 during the major portion of its flight, and usually coupled to the sustainer rocket 14 is an initial starting or booster rocket 16 which gives the missile 10 its initial impulse. Preferably, both the booster 16 and the sustainer rocket 14 are provided with the arming mechanism according to this invention.

The propellant chamber 15 is provided with a propelling or thrust nozzle 18 so that, when the propellant charge 19 is ignited, the escaping gases establish a thrust to propel the missile 10. To prevent propulsion of the missile 10 by premature ignition of the propellant charge 19 in the chamber 15, a bulkhead 20 in the end of the chamber 15 opposite the nozzle 18 is provided, said bulkhead having a relief passage 21 which under certain conditions may be opened by pressure in the propellant chamber 15 to allow the gases from said chamber to flow readily through said passage as well as through the nozzle 18, so that pressure sufficient to propel the missile 10 will not be generated. Since the rocket 14 is connected to other portions of the missile 10, it may be desirable to provide means, such as ports 17, to vent the exhaust gases. However, if the exhaust is into the nose 11 the wall of the missile will be ruptured by pressure, to vent the gases.

As shown in Fig. 3, the outer periphery or rim 22 of bulkhead 20 is attached to the outer wall 23 of the propellant chamber 15 by any suitable means, such as shear heads 24, secured to said rim 22 and extending into openings 25 in the wall 23. The joint may be made substantially gas-

tight by means of gasket ring 26 received in a groove 27. The relief passage 21 is surrounded by the hub 30 of the bulkhead 20, which is provided with a recess 32. An ignition cup 33, containing squibs 34 and an ignition charge 35, to ignite the propellant charge 19, is screwed into a cap 36. The ignition cup 33 is formed from a frangible material, preferably a plastic dielectric, and is closed by the cap 36, which has sufficient strength to withstand the propulsion pressures within the propellant chamber 15 and which has a flange 37 extending laterally therefrom and bearing against the face of the recess 32 in the hub 30.

As best shown in Fig. 2, the flange 37 is cut away so as to provide a plurality of spaced lugs 38, the spaces between the lugs being indicated at 39. An arming ring 40 surrounds the flange 37 and has inwardly extending lugs 41 and spaces 42 corresponding in number to the lugs 38 and spaces 39 of the flange 37 on the cap 36. The spaces 39 and 42 are preferably somewhat larger than the lugs 38 and 41, so that the cap flange 37 may readily pass through the arming ring 40. The lugs 41 are arranged in spaced relation to the lugs 38, so that relative rotation of the cap 36 and ring 40 may be effected for bringing the segments 41 into registry either with the lugs 38 or the spaces 39. A shear plate 43 is interposed between the flange 37 and the lugs 41 of the ring 40, and serves to maintain the cap 36 in position when the lugs 38 and spaces 42 are in registry, as shown in Fig. 3. When the arming ring 40 is moved to armed position in a manner to be described hereinafter, the lugs 38 and 41 are in overlapping position, as shown in Fig. 4, and the shear plate 43 is in compression between the lugs. The shear plate 43 consists of a thin frangible sheet of aluminum. While only an annular shear ring is necessary, it is usually desirable to extend the plate 43 completely over the cap 36 to provide a shield or cover for the cap 36.

The arming ring 40 is rotatable in the recess 32 for determining the armed or unarmed conditions of the arming mechanism. The ring 40 is retained in said recess by a shoulder 49 on said ring engaging a shoulder 50 on a securing bushing 51, screwed into hub 30. As best seen in Fig. 4, the cap 36 is prevented from rotating in the recess 32 by a fastener, such as a pin 52, and the shear plate 43 is fixed with respect to the cap 36 by crimps 53 which straddle one or more of the lugs 38.

To rotate the arming ring 40 from armed to unarmed position, an operating linkage, shown best in Fig. 2, is provided, said linkage comprising a gear segment 55 connected by screws 56 to the arming ring 40. A section gear 57 is meshed with the segment 55 and may be turned to rotate said segment and the arming ring 40 from the armed to unarmed position. The gear 57 has a trunnion 54 journaled in a bearing 58 secured to the rim 22 of the bulkhead 20 by bolts 59. As best seen in Figs. 5 and 7, the trunnion 54 has a squared opening 60 to receive an arming tool 61.

As best seen in Figs. 5 and 6, a latching means is provided for the gear 57 and segment 55, and includes a latch element 62 which is pivotally mounted in a yoke 63. The yoke 63, is formed on the inner surface of the gear 57 medially of its width, and said element 62 is pivoted by a pin 63a which extends through the yoke and element at substantially their midportions. A boss 64 is formed on the underside of the gear 57 and this boss is apertured and threaded to receive a spring 64a and a closure set screw 64b. The boss is located so that the spring 64a bears against the latch element 62, said element being cut away to define a shoulder 64c. The spring 64a biases the latch element toward latching position, in which the latch tooth, shown at 64d, engages the keeper 67, to be described in more detail hereinafter.

The arming tool 61 has a square shank, engageable in the opening 60 in the trunnion 54, and this shank is reduced at its free end to define a head 65 connected to the said shank by a neck 66. As best seen in Fig. 5, the head

65 engages in a notch 66a formed in the lower end of the element 62, said head being held in engagement with said element by jaws 68 and 69 at opposite sides of the notch. The jaw 69 is partially cut away to permit disengagement of the tool 61 when the latch element is in its lowermost position.

The keeper 67 is provided with two latching notches 70 and 71, one to receive the element 62 in armed position of the ring 40 and the other to retain said element in unarmed position. Stops 72-73 are provided on the keeper to prevent shifting of the ring 40 beyond either of the extreme positions 70-71, and a guide surface 74 between the extreme positions 70-71 is provided and so designed that when the latch 62 is between the extreme positions 70-71, the jaw 69 of the element 62 retains the arming tool 61 in the support 54, so that the mere presence of said tool 61 extending from the side of the missile 10 will indicate that the arming mechanism should be inspected at once.

It is desirable to provide an indicator for the actuating mechanism so that it will be possible to tell at a glance whether it is in the safe or armed position. For this purpose indicia 75, shown in Fig. 7, have been applied to the wall of the propellant chamber 15 as well as to the outer end portion of the trunnion 54. For night operation the indicia 75 may be luminous, or, if this is undesirable, the indicia may be knurled, or may even comprise raised or indented markings.

The squibs 34 are usually ignited, as shown in Fig. 8, by an electrical impulse supplied over an igniter circuit 77 and, in order to prevent accidental ignition by stray impulses, it is customary to provide a short-circuiting or deactivating switch 78 for the circuit 77. The switch 78 is mechanically coupled with the arming mechanism so that, when the arming ring 40 is moved to the unarmed position, said switch 78 will be in such position that the igniter circuit 77 is open and the squib leads grounded. The switch 78 is of the single pole double throw type and includes an actuating plunger 76. Said switch is of the well-known "micro-switch" variety, so that the plunger need only travel an extremely short distance, i.e., of the order of one sixteenth of an inch, to shift the switch arm, 78a in Fig. 8, from one closed position to the other. As best seen in Fig. 2, the switch 78 is mounted on the bulkhead 20 with the plunger 76 positioned to confront, and engage in unarmed condition, one end of the segment 55. Slight movement of the segment 55 toward armed condition will shift the arm 78a from the position shown in Fig. 8 to the armed position, wherein the squib is connected in the firing circuit. This arrangement has been provided so that, if the firing circuit should be alive, the squibs 34 will fire while the lugs 38 on the flange 37 are still free to move between the lugs 41 on the arming ring 40. Thus, while ignition of the propellant charge 19 by detonation of the squibs 34 will cause blowing out of cap 36, the rocket will remain non-propulsive.

As best seen in Fig. 3, energy is delivered to the squibs 34 by means of an insulated terminal 79 extending through the cap 36 and carrying the live conductor 80 of the ignition circuit 77. The grounded conductor 81 of the circuit 77 is connected to the exterior of the cap 36 while the squibs 34 themselves are connected between the terminal 79 and a ground connection 82 on the cap 36. A disk 84 of insulating material is provided within the shear plate 43, so that if the shear plate 43 should accidentally be bent or pushed in against the live terminal 79 it would not short-circuit or ground said terminal.

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

What is claimed is:

1. An arming mechanism including, in combination with a missile having a sustainer rocket provided with a

5

propellent chamber, and a propellent charge in the chamber, a bulkhead closing the propellent chamber, charge ignition means mounted on said bulkhead, and means for mounting said charge ignition means on the bulkhead and shiftable from an unarmed position whereby the rocket will be non-propulsive in the event of premature firing of the charge ignition means to an armed position whereby said rocket may become propulsive.

2. An arming mechanism including, in combination with a missile having a sustainer rocket provided with a propellent chamber, and a propellent charge in the chamber, a bulkhead closing the propellent chamber and having a relief passage, propellent charge ignition means displaceably mounted in the passage, and means shiftable from an armed position locking the charge ignition means in the relief passage for rendering the rocket propulsive upon charge ignition to an unarmed position displaceable from the passage upon such charge ignition for rendering the rocket non-propulsive.

3. An arming mechanism as recited in claim 2, wherein said last mentioned means includes a flanged cap closing the relief passage and having lugs, and an arming ring on the bulkhead and movable with respect to the cap and having lugs shiftable into and out of positions confronting said first mentioned lugs.

4. An arming mechanism as recited in claim 2, wherein said last mentioned means includes a cap closing the relief passage, an arming ring on the bulkhead and movable with respect to the cap, a gear segment connected to the arming ring, and a sector gear movable on the bulkhead and meshing with the segment.

5. An arming mechanism for a missile having a sustainer rocket provided with a propellent chamber; including a bulkhead closing the chamber and having a hub formed with a relief passage, means for detonating a charge in the propellent chamber, a displaceable cap mounting said means in the relief passage, an arming ring on the hub and surrounding the cap, means positioning said ring for limited rotation on the hub, means in one position locating the cap and ring so that said cap will not be displaced from the hub by detonation of the charge and the rocket will be propulsive, and in another position permitting displacement of the cap from the hub upon such charge detonation rendering the rocket non-propulsive, and means for effecting movement of said last mentioned means.

6. An arming mechanism as recited in claim 5, wherein said penultimate means consists of cooperating lugs on the cap and ring, and said last mentioned means includes a gear segment on the ring, and a sector gear movably mounted on the bulkhead and meshing with the gear segment.

7. In a rocket propulsion chamber containing a propellent charge and having a thrust nozzle, an arming mechanism comprising means defining a relief passage opposed to said nozzle, a cap for said passage, a flange on said cap, alternate portions of said flange being removed to provide a plurality of spaced-apart, radially extending lugs, a shear plate adjacent said cap and extending over said flange, means securing said shear plate against rotation with respect to said cap, an arming ring mounted for limited rotation about the cap and having inwardly extending lugs extending over said flange, said arming ring being normally so positioned with respect to said flange that the lugs of said ring fall between the lugs of said flange whereby said cap is retained by said shear plate in an unarmed position, and means for rotating said arming ring until the lugs of said ring confront the lugs of said flange for retaining the cap in an armed position.

8. In an arming mechanism for a rocket having a propellent chamber, an annular rim secured in substantially gas-tight relation to said chamber, a hub attached to said rim, said hub having a relief passage, a locking ring on said hub and having lugs, a cap positioned in said

6

passage, a flange on said cap and having lugs, the spaces between the lugs of said locking ring providing clearance for the lugs of said flange, a shear plate interposed between said flange and said locking ring, and means for selectively positioning the lugs of said locking ring with respect to the lugs of said flange.

9. In combination with a missile having a sustainer rocket having a propellent chamber containing a propellent charge, an arming mechanism comprising a bulkhead including an annular rim secured in substantially gas-tight relation to the wall of said chamber, a hub on said bulkhead, said hub having a relief passage, an arming ring on the hub and having lugs, a cap in said passage and having a flange cut away to form spaced lugs, a frangible shear plate interposed between said flange and said ring, a gear segment attached to said ring, a sector gear meshing with said gear segment, and means for operating said sector gear to determine the relative position of said ring with respect to said flange.

10. In an arming mechanism for a rocket having a propellent chamber, a bulkhead closing the chamber at one end and having a hub, said hub being formed with a relief passage, an arming ring on the hub about the passage and having spaced lugs, a cap in the passage and having a flange shaped to define spaced lugs, said ring being movable to an armed position, wherein the lugs on the ring and those on the cap confront each other for preventing displacement of the cap from the relief passage, means for moving the ring to an unarmed position wherein the lugs on the cap may pass between those on the ring, and a shear plate between the ring and the cap.

11. In an arming mechanism for a rocket having a propellent chamber, and a propellent charge in the chamber, a bulkhead closing the chamber at one end, a relief passage in the bulkhead, charge ignition means, a cap mounting the charge ignition means in the passage, an arming ring surrounding the cap and movable to an armed position locking the cap against displacement from the passage and to an unarmed position wherein said cap will be blown from said passage in the event of premature ignition of the charge ignition means, means for effecting movement of the arming ring and including a gear segment, an electric circuit including said charge ignition means and a power source, and a switch having a plunger depressed by contact with said gear segment for grounding the charge ignition means, said plunger being movable for connecting said charge ignition means to a power source upon small movement of the segment toward armed position, whereby said charge ignition means will be fired with the arming ring unarmed in the event the circuit should be alive.

12. In a rocket having a propellent chamber containing a charge of propellent, an arming mechanism comprising means defining a relief passage in said chamber, an igniter cup extending through said passage, a cap on said cup and closing said passage, a flange on said cap and having lugs, an arming ring over-riding said flange, said arming ring being provided with lugs, means for positioning said ring to determine the registry or non-registry of the lugs of said ring and said flange, a shear plate interposed between said flange and said ring, said shear plate maintaining said cap in position during non-registry of said lugs, electrically-operated charge ignition means in said cup, an electrical circuit for energizing said charge ignition means, at least one energizing conductor extending in insulated relation through said cap, a safety switch in said circuit, and actuating means for said switch, said actuating means being mounted on the ring and engageable with the switch whereby motion of said ring to bring the lugs from non-registry to registry will cause actuation of said switch before said lugs come into registry.

13. In a rocket having a propellent chamber containing a charge of propellent, an arming mechanism including

means defining a relief passage in a wall of said chamber, a cap in said passage, laterally-extending, spaced-apart lugs on said cap, an arming ring surrounding said passage, inwardly-extending spaced lugs on said ring corresponding to the lugs on said cap, the lugs of said ring normally being so positioned that the lugs on said cap may pass through the spaces between the lugs of said ring, a shear plate interposed between said cap and said ring, means for moving the lugs of the ring into register with the lugs of said cap, said means including a gear segment secured to said ring, a sector gear movably mounted on said chamber and meshing with said gear segment, a spring biased latch between said sector gear and the chamber wall, an arming tool having means engaging said latch for shifting said latch, and means on said latch locking said tool in position when said latch is between armed and unarmed positions.

14. In a rocket having a propellant chamber containing a charge of propellant, an arming mechanism comprising a relief passage in said chamber, a cup extending through said passage, a cap on said cup closing said passage, said cap having a flange shaped to define spaced lugs, an arming ring overlaying said flange and having lugs, means for positioning said ring for registry or non-registry of the lugs of said ring and said flange, a shear plate interposed between said flange and said ring, said shear plate maintaining said cap in position during non-registry of said lugs, electrically-operated charge ignition means in said cup, an electrical circuit for energizing said charge ignition means, a safety switch in said circuit, and actuating means for said switch, said actuating means initially retaining the switch unarmed and being operable by motion of said arming ring whereby any motion of said ring eventually to bring the lugs from non-registry to registry will cause arming of said switch.

15. In an arming mechanism for a missile propelling rocket having a propellant chamber, and a propellant charge in the chamber; propellant charge ignition means in the propellant chamber, means for mounting said charge ignition means in said chamber, said means for mounting being movable from an unarmed position displaceable from the chamber to an armed position not displaceable from said chamber, a firing circuit for said charge ignition means and including a power source, and a switch connected in said circuit and operable by movement of said mounting means for connecting said charge ignition means to said power source.

16. In an arming mechanism, a bulkhead having a relief passage, a cap closing the passage, an arming ring surrounding the cap and in one position retaining the cap against displacement from the passage, said ring being movable to a second position permitting displacement of the cap, means for shifting the ring to either of said positions, and a latch for retaining said last mentioned means in either of said positions.

17. An arming mechanism as recited in claim 16, wherein said means comprises a gear segment on the arming ring, and a sector gear movable on the bulkhead and meshing with the gear segment.

18. An arming mechanism as recited in claim 16, wherein said latch includes a latch element, and a keeper engageable by the latch element.

19. An arming mechanism as recited in claim 16, wherein said means includes a gear segment on the arming ring, a sector gear having a trunnion formed with a square opening, and a bearing journaling said trunnion.

References Cited in the file of this patent

UNITED STATES PATENTS

2,400,242 Malina May 14, 1946