Nov. 12, 1963 L. F. SLOMKA 3,110,260

MISSILE STAGE SEPARATOR

Filed Oct. 7, 1960 2 Sheets-Sheet 1

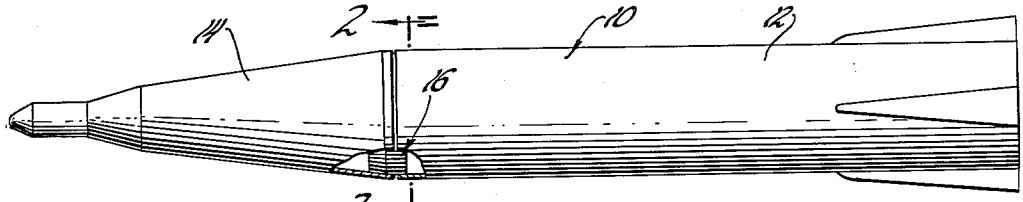


Fig. 1

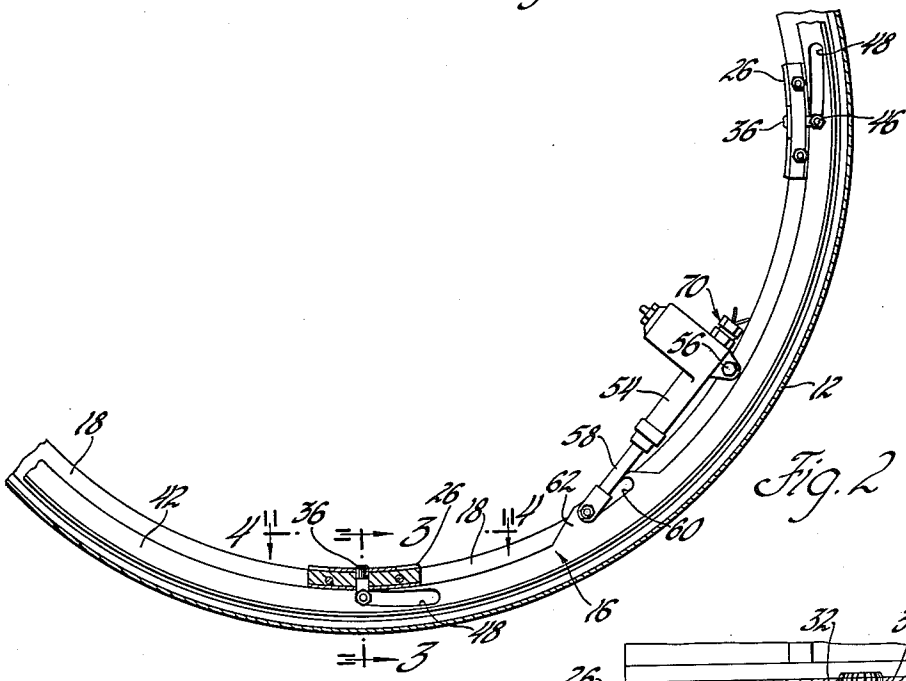


Fig. 2

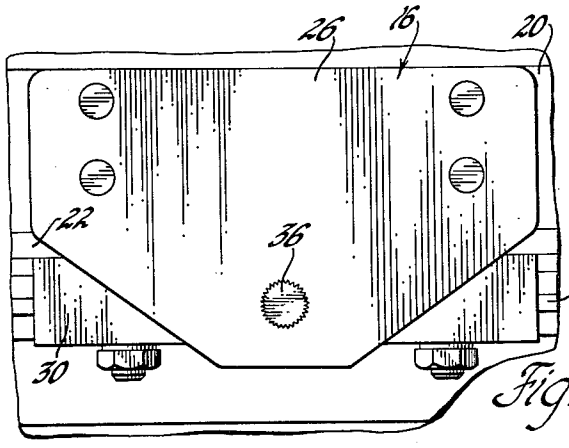


Fig. 4

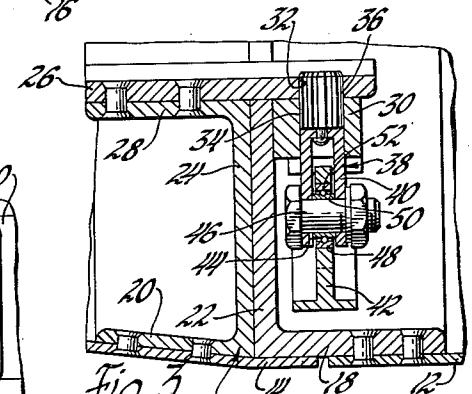


Fig. 3

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Nov. 12, 1963 L. F. SLOMKA 3,110,260

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Filed Oct. 7, 1960 2 Sheets-Sheet 2

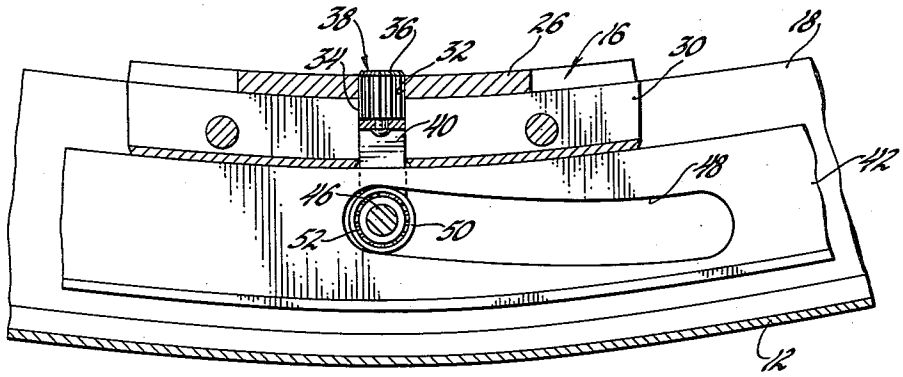


Fig. 5

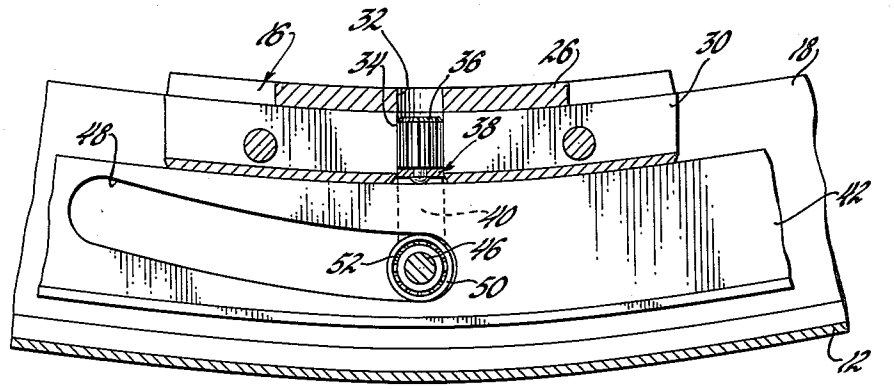


Fig. 6

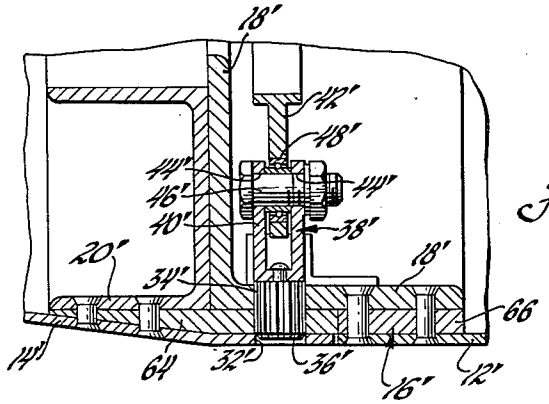


Fig. 7

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MISSILE STAGE SEPARATOR

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This invention relates to a multi-stage missile or the like. More particularly, this invention relates to a device for automatically separating stages of a multi-stage missile in flight.

In multi-stage missile designs, some means must be provided for maintaining the stages connected together during take-off or first stage operation while yet permitting the severance of the stages after a predetermined time has elapsed, or after the first stage is spent, to permit the other stage to operate.

This invention relates to a mechanism or device for connecting the stages of a rocket together in a manner such that at the proper time, the spent stage can be severed from the unused stage.

Therefore, it is an object of this invention to provide a separation device for a multi-stage missile or the like for automatically decoupling the missile stages.

It is a further object of this invention to provide an interstage separation device including a latching mechanism for connecting the stages, and camtrack and cam-follower means automatically operably connected to release the latching mechanism at a predetermined time to separate the stages.

Other features, objects and advantages will become apparent upon reference to the succeeding description and to the drawings illustrating the preferred embodiments of the invention, wherein:

FIGURE 1 is a schematic illustration of a missile or the like embodying the invention;

FIGURE 2 is an enlarged cross-sectional view of a portion of the FIG. 1 construction with parts broken away and in section, taken on a plane indicated by and viewed in the direction of the arrows 2—2 of FIG. 1;

FIGURE 3 is an enlarged cross-sectional view taken on a plane indicated by and viewed in the direction of the arrows 3—3 of FIG. 2;

FIGURE 4 is an enlarged plan or top view of a detail of FIG. 2 further illustrating the construction of FIGS. 2 and 3; and,

FIGURES 5 and 6 are enlarged views of a detail of FIG. 2 in different operative positions;

FIGURE 7 is a modification of the FIG. 3 construction.

The drawings, particularly FIG. 1, show the invention illustrated schematically in connection with a two-stage missile 10. It has first and second hollow annular stages 12 and 14 axially aligned with each other and adapted to be connected by the device 16 constituting the subject of this invention. While the invention is illustrated in connection with a missile of the type shown, it will be clear that the invention is capable of use in many types of installations other than that illustrated where the automatic separation of adjacent members in the manner to be described is desired.

The invention consists generally of a device for joining the stages by means of flanges secured to each, with holes in the flanges and releasable pin means insertable simultaneously through the holes to lock the stages together. The pin means is withdrawn from one or both holes automatically at a predetermined time by a cam-cam slot combination operated by a rotatable drive ring.

More specifically, the two missile stages 12 and 14 substantially abut each other at their adjacent casing edges, and as best seen in FIG. 3, are each reinforced at the edge

by an annular internal flange 18 and 20 riveted thereto. Flange 18 is L-shaped in cross-section, with the web portion 22 abutting the web 24 of flange 20, which is channel-shaped in cross-section. The abutment of the two flanges is staggered axially with respect to the meeting of the edges of the casings of the two stages for a better seal between stages, and to permit the critical measuring to be done at the abutting flange surfaces rather than at the casing joint.

Flange 20 has a somewhat arcuate sheet metal plate 26 secured to its internal axial leg 28 at four equally spaced locations on the circumference of the flange. Each of the plates is substantially triangular in shape and extends axially from the flange leg 28 past the web 22 of flange 18 to a position as shown. At each of these same four circumferential locations, the web 22 of flange 18 has an arcuate boss 30 bolted or otherwise secured to the face of the flange web at its inner end to abut the face of plate 26. Each of the plates 26 and bosses 30 is apertured and bored at 32 and 34, respectively, the holes being aligned with each other to slideably receive the pin end 36 of a latch 38 through both holes. This locks the plates and bosses and thus stages against axial separation. Since each of the four latches and associated operating mechanisms are identical, it is believed the description of one will suffice.

The pin end 36 of each latch 38 is formed integrally with or may be secured as shown to a yoke or tanged member 40. The tangs of yoke 40 straddle an annular rotatable camtrack drive ring 42 and are provided with a number of holes 44 in which the ends of a shaft 46 are non-rotatably fixed. The shaft extends through a substantially crescent-shaped cam-slot or track 48 in the drive ring and has a roller 50 rotatably mounted thereon by means of bearings 52. The roller 50 constitutes a cam follower and is confined for rolling within the slot 48. As best seen in FIG. 5, cam-slot 48 is canted such with respect to the circumferential direction of rotation of the drive ring 42 that movement of the drive ring and cam slot causes the roller, yoke 40 and pin or latch 36 to move radially. This radial movement either axially connects the two stages, as shown in FIG. 5, or withdraws the pin from hole 32 in plate 26 as seen in FIG. 6 to thereby permit separation of the two stages. Of course, in initial assembly and operation, the parts will be connected with the pin 36 through both holes, and the pin withdrawn later only when the first stage is spent.

The drive ring 42 is both supported upon and mounted for rotation on the annular flange 18 by means of four fluid actuators 54 (only one shown) located around the circumference of the flange. As best seen in FIG. 2, each of the actuator casings is pivotally secured at 56 to the structural ring flange 18, and has a fluid operated plunger rod 58 pivotally secured at one end in a circumferentially extending slot 60 cut in a locally enlarged area 62 of the drive ring 42. The actuators may be of any known type having a source of compressed fluid or the like to operate a plunger connected to rod 58, and are rendered operable by an explosive valve of known type indicated schematically at 70. Valve 70 may be set to explode automatically after a predetermined elapsed time to release the compressed fluid thereby actuating the piston rod to rotate the drive ring 42 to cam the connecting pin radially outwardly to disconnect the two stages. Further details of the actuator are not given since they are believed to be unnecessary to an understanding of the invention.

The elongated slot 60 provides a lost motion connection between the actuators and the drive ring. In the event one or more of the actuators fails to operate because its particular explosive valve fails to fire, the drive ring will still be actuated by any one of the other actuators since

the stationary end of the piston rod of the inoperable actuator merely slides in the slot 60 upon rotation of the drive ring.

Therefore, it will be seen that explosion of the valve causes the circumferential rotation of the drive ring to withdraw the pins and permit separation of the two stages.

FIG. 7 illustrates a modification of the FIG. 3 construction but differs only as to the arrangement of parts to permit connecting or latching of the outer portions of the abutting flanges instead of as shown in FIG. 3. In FIG. 7, a series of plates 64 is secured to the channel-shaped flange 20' and casing 14' and overlaps L-shaped flange 18'. A similar number of plates or bosses 66 is secured between casing 12' and flange 18'. Holes 32' and 34' are provided in the plates and flanges, and the pins 36' engage in the holes to lock the stages together in the same manner as described in connection with FIG. 3. The pin, yoke, drive ring, connecting shaft, and the remaining parts are the same as in FIG. 3. Only the assembly as a whole is turned "upside-down" or reversed 180° to provide the described connection. Otherwise, the operation of the device remains the same as that of FIG. 3.

From the foregoing, therefore, it will be seen that this invention provides a separation device for decoupling the two stages of a rocket, for example.

While the invention has been illustrated in its preferred embodiments in the figures, it will be obvious to those skilled in the arts to which this invention pertains that many modifications may be made thereto without departing from the scope of the invention.

I claim:

1. A stage separation device for use in connection with a missile or the like having a plurality of axially aligned and adjacent hollow separable stages, portions of adjacent stages having aligned holes therein, said stage separating device comprising removable means insertable through said holes to lock said adjacent stages together, and actuating means rotatably mounted on one of said stages and engaging said removable means, rotation of said actuating means in one direction removing said actuatable means from said holes permitting separation of said stages, and a plurality of explosively operable means each connected to said actuating means by an engaged cam and cam-slot connection between to effect rotation of said actuating means upon the explosion thereof, the cam and cam-slot connection permitting the rotation of said actuating means in response to the explosion of any one of said plurality of explosively operable means irrespective of the failure of explosion of the remaining.

2. A stage separation device for use in connection with a missile having a plurality of axially aligned hollow separable stages, the adjacent portions of said stages each having a plurality of circumferentially spaced holes therein, the holes of one stage being adapted to be aligned with the holes in the adjacent stage, said stage separating device comprising pin means removably extending through both of said holes upon alignment thereof locking said stages together against axial separation, and means to move said pin means out of said holes to axially uncouple said stages, said means to move said pin means including a plurality of cam slots and cooperating cam follower means, each of said cam follower means being secured to one of said pin means for actuation thereof, said means to move said pin means including rotatable actuating means containing said cam slots engaged by said cam followers for actuating said follower and said pin means, said actuating means being rotatably secured to one of said stages, rotation of said actuating means in one direction withdrawing said pin means from said holes.

3. A stage separation device for use in connection with a missile having a plurality of axially aligned hollow separable stages, the adjacent portions of said stages each having a plurality of circumferentially spaced holes therein, the holes of one stage being adapted to be aligned with the holes in the adjacent stage, said stage separating device comprising pin means extending through both of said holes upon alignment thereof to lock said stages together against axial separation, and means to move said pin means out of said holes to unlock and uncouple said stages, said means to move said pin means including a plurality of cam slots and cooperating cam follower means, each of said cam follower means being secured to one of said pin means for actuation thereof, said means to move said pin means including rotatable actuating means containing said cam slots engaged by said cam followers for actuating said follower and said pin means, said actuating means being rotatably secured to one of said stages, rotation of said actuating means in one direction withdrawing said pin means from said holes, and explosively actuated means connected between said one stage and said actuating means to rotate said actuating means in said one direction upon explosion thereof.

4. A stage separation device for use in connection with a missile having a plurality of axially aligned hollow separable stages, comprising an axially extending flange means secured to one of said stages and overlapping an adjacent stage, said overlapping flange means having a plurality of circumferentially spaced radially extending first holes therein, arcuate means on said adjacent stage also having a plurality of circumferentially spaced radial second holes aligned with said first holes, pin means radially movably extending through both pluralities of said holes locking said stages together against movement, and means to move said pin means out of said holes to unlock and uncouple said stages, said means to move said pin means including a plurality of cam follower means each secured to one of said pin means for actuation thereof out of said holes, said means to move said pin means also including a rotatable cam slot drive ring having a plurality of circumferentially spaced cam slots therein each drivingly engaging one of said cam followers for radially actuating said followers and said pin means, and a plurality of circumferentially spaced and movable actuators secured between said arcuate means and said drive ring for actuating said drive ring, and unidirectional drive means between said actuators and said drive ring to assure actuation of said ring upon the operation of only one of said actuators.

5. A stage separation device for use in connection with a missile or the like having a plurality of axially aligned and adjacent hollow separable stages, portions of adjacent stages having aligned holes therein, comprising removable means insertable through said holes to lock said adjacent stages together, and actuating means rotatably mounted on one of said stages and engaging said removable means, rotation of said actuating means in one direction removing said removable means from said holes uncoupling the said stages, a plurality of power operating means, and a unidirectional drive connection coupling each power operating means to said actuating means to effect rotation of said actuating means upon the operation thereof, the unidirectional drive connection causing the rotation of said actuating means in response to the operation of any one of said plurality of operating means irrespective of the failure of the remaining operating means.

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