May 20, 1958 C. B. SADTLER 2,835,348

RETARDER DEVICE

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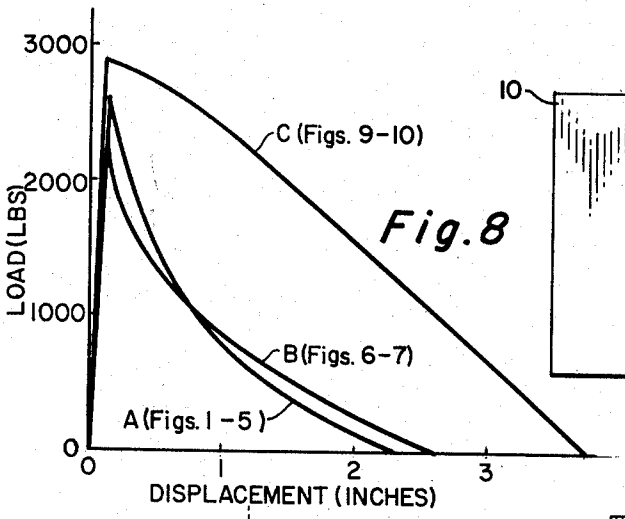


Fig. 8

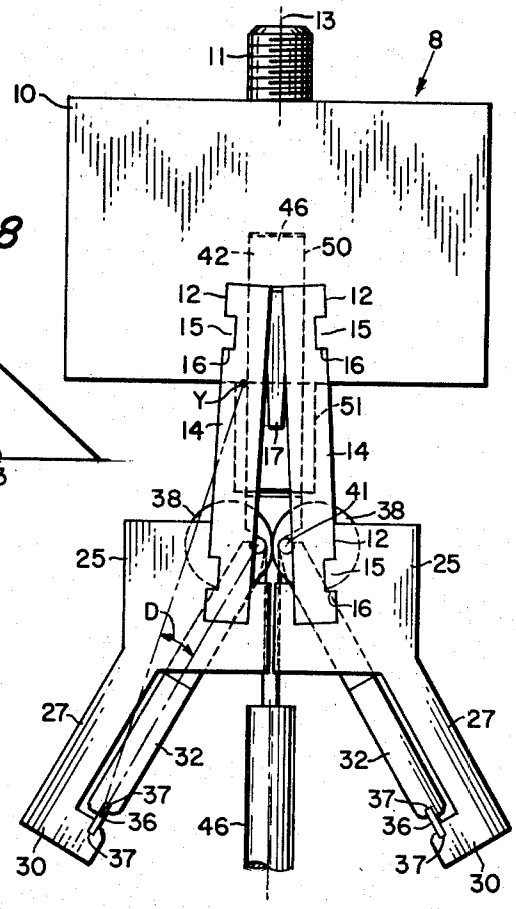


Fig. 1

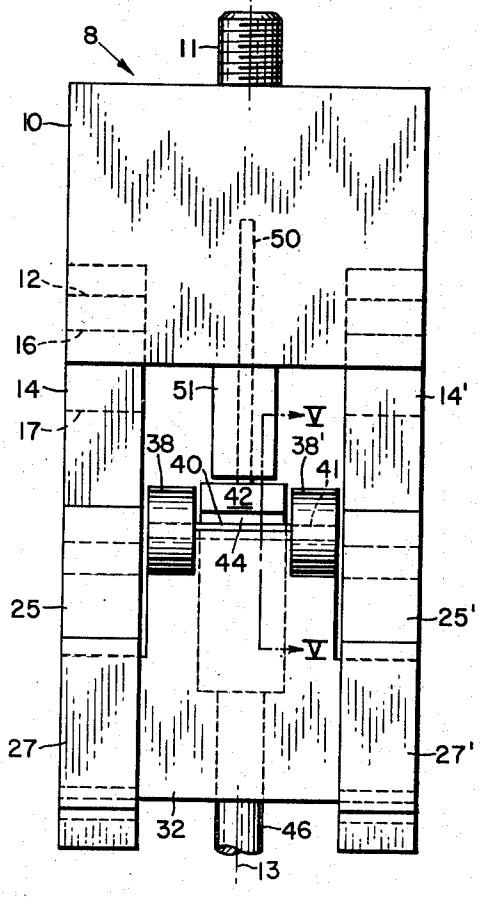


Fig. 2

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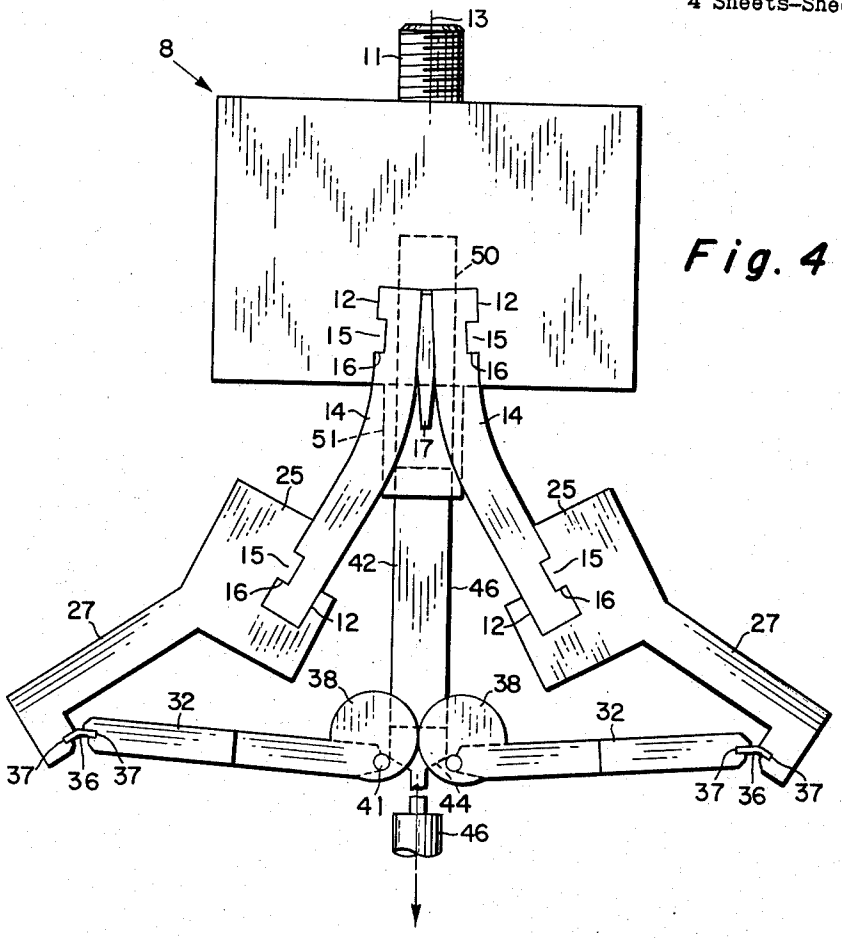


Fig. 4

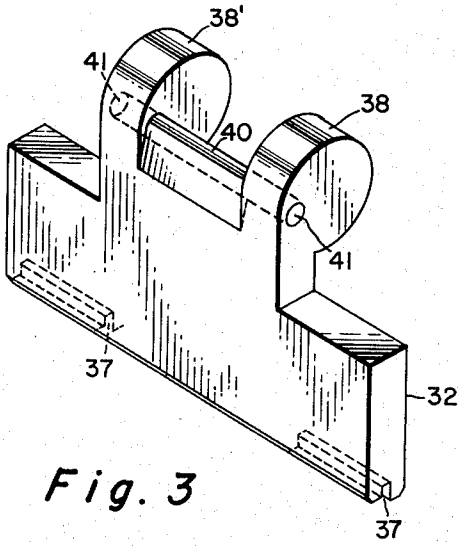


Fig. 3

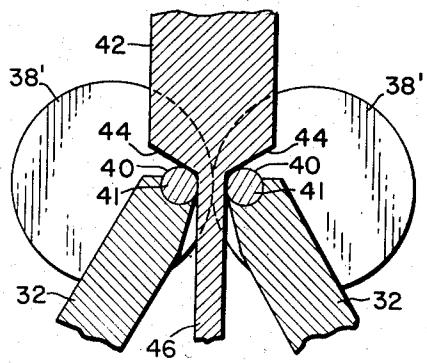


Fig. 5

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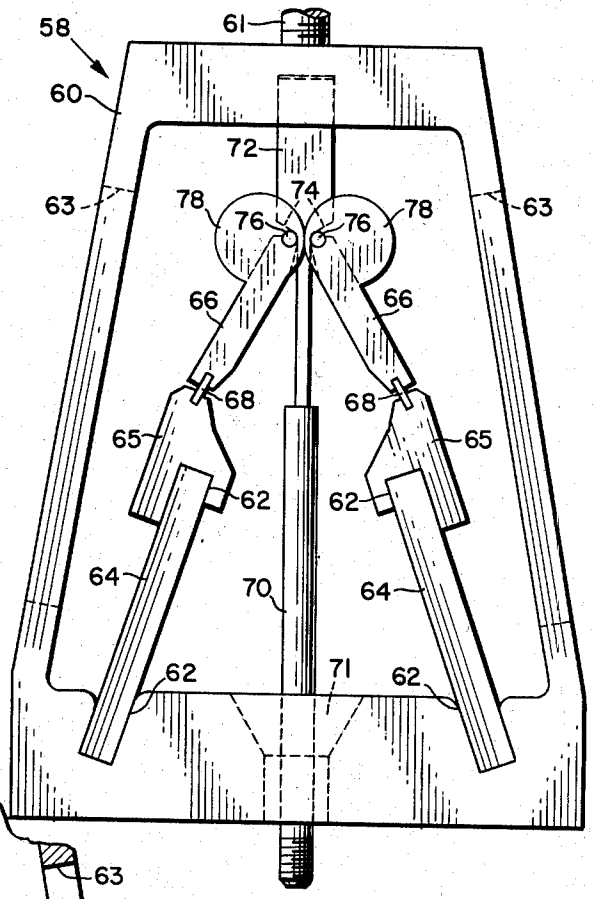
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Fig. 6



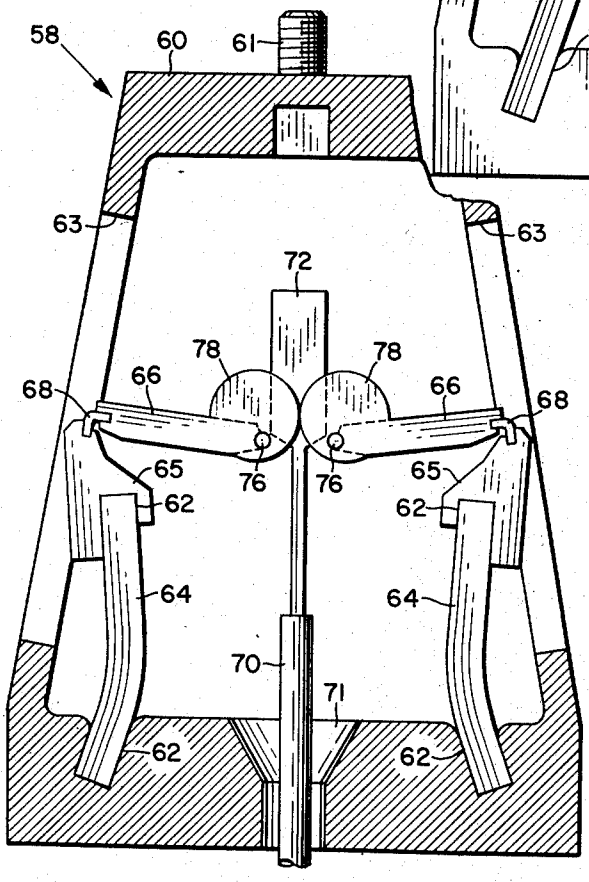


Fig. 7

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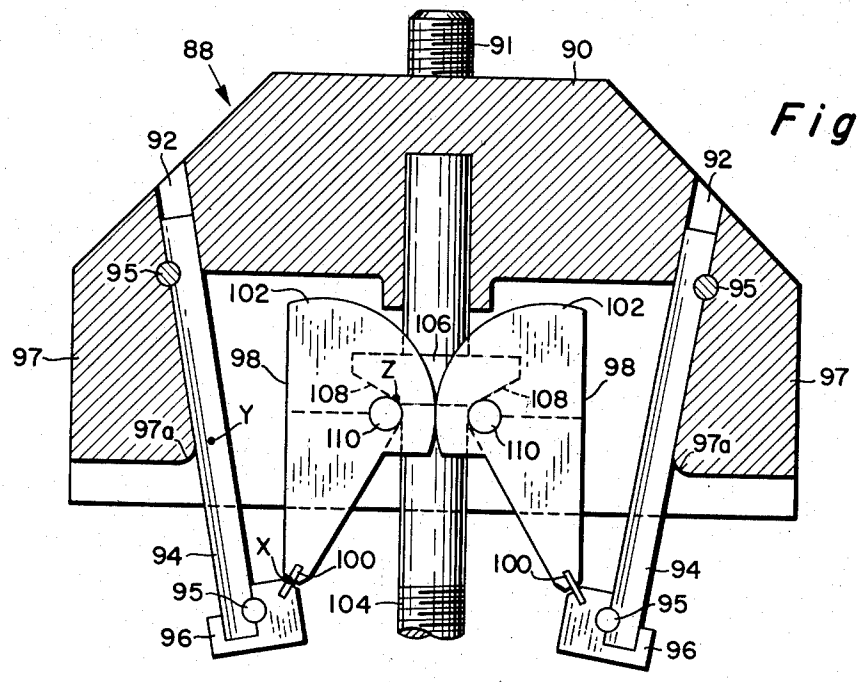


Fig. 9

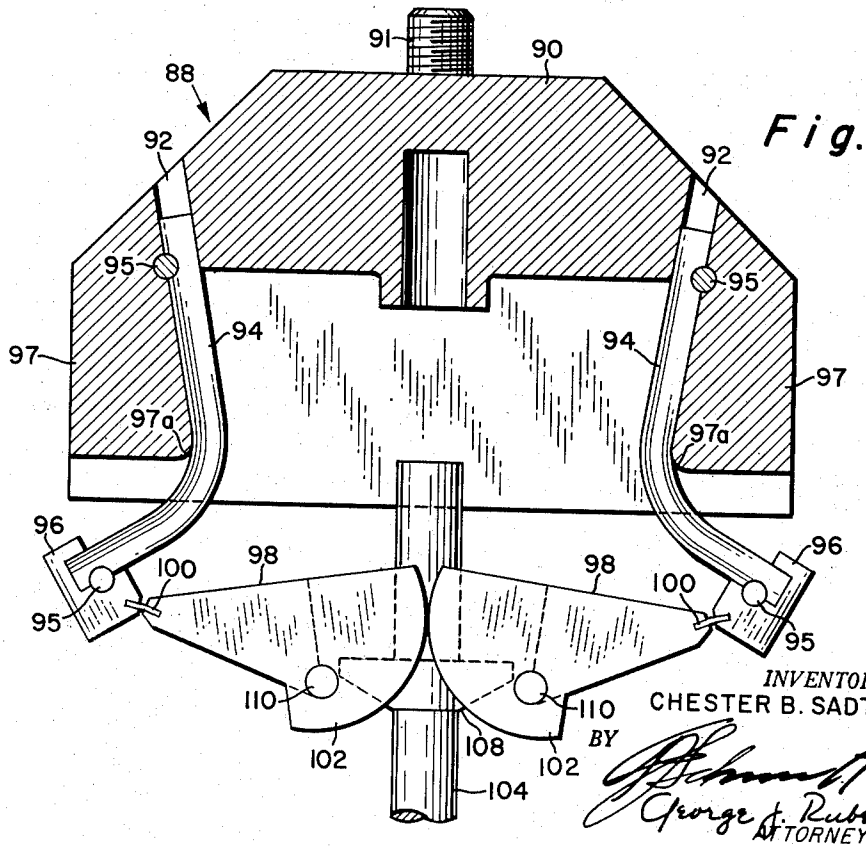


Fig. 10

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2,835,348

RETARDER DEVICE

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Application January 10, 1957, Serial No. 633,510

8 Claims. (Cl. 188—1)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to a retarder device and more particularly to a retarder device employing an arrangement whereby the bending strength of replaceable metallic members is utilized for resisting relative movement of components of the device.

This application is a continuation-in-part of a co-pending U. S. application of Chester B. Sadtler, Serial No. 357,650, filed May 26, 1953, now Patent 2,788,090.

The present invention is especially adapted for use in launching missiles wherein booster motors are employed to impart initial acceleration to the missiles. In such cases, it is desirable to provide a means for preventing the booster motor from applying large shock loads to the missile, and accordingly, a retarder device is provided whereby the accelerating force of the booster motor is gradually applied to the missile. One portion of the retarder device is secured to a member which is suitably fixed to the ground or other supporting structure, and another portion of the device is connected to the booster motor. When the booster motor is fired, it will cause that portion of the retarder device which is secured thereto to release from the other components of the device and allow the booster and missile to proceed unimpeded in flight. As the retarder device releases, a restraining force is applied to the booster motor which prevents excessive initial acceleration thereof and consequently large shock loads are not applied to the missile.

In the aforementioned co-pending application, the retarder device utilizes V-shaped flexure bars made of deformable material, each leg of the bars being bent under tension beyond its elastic limit during the retarding action by means of a gear and rack pull-out assembly. It has been found that some features of the prior construction presents disadvantages which are overcome by the present invention. For example, the V-shaped flexure bars can be replaced by a pair of straight flexure bars facilitating manufacture and assembly with a saving of cost and time. In addition, the relatively complex gear and rack pull-out assembly can be replaced by two cooperating bearing surfaces which also eliminates the need of means for maintaining the proper mating of the teeth heretofore found necessary. The retarder device can be constructed so that the flexure bars can be deformed under compression, instead of only tension as previously disclosed, eliminating means for anchoring the bars in their supports.

An object of the present invention is the provision of a new and novel retarder device which reduces the friction between components thereof to a minimum.

Another object is to provide a retarder device wherein the restraining force which it will provide may be accurately predetermined.

A further object of the invention is to provide a retarder device which will release at a desired position.

A still further object of the invention is the provision of a retarder device which is simple and inexpensive in construction, yet is sturdy and reliable in operation.

Other objects and many of the attendant advantages of this 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 shows a front elevation view of a preferred embodiment of a retarder device at an initial position prior to the start of the retarding action;

Fig. 2 is a side view of Fig. 1;

Fig. 3 is a perspective view of one of the hinge plate components of the device;

Fig. 4 is a similar view of the retarder device of Fig. 1 at the end of the retarding action;

Fig. 5 is a partial enlarged sectional view of the bearing surfaces taken along line V—V of Fig. 2;

Fig. 6 is a front elevation view of a modified retarder device at the start of the retarding action;

Fig. 7 is a longitudinal section of Fig. 6 at the end of the retarding action;

Fig. 8 is a graph showing load vs. displacement curves for each of the various illustrated modifications of the retarder device;

Fig. 9 is a front elevation of another modified retarder device at the start of the retarding action; and

Fig. 10 is a similar view of the retarder device in Fig. 9 at the end of the retarding action.

Referring now to the drawing wherein like reference numerals designate like or corresponding parts throughout the several views, there is shown in Figs. 1–5 a retarder device **8** comprising a support member **10** adapted to be fixed by threads **11** to a ground support, not shown. Member **10** supports at least one pair of flexure bars **14** and, as in the co-pending application, these flexure bars may be formed of an annealed, low carbon steel, brass or other similar moderately ductile material capable of bending to provide the desired retarding action.

As viewed in Figs. 1 and 2, retarder device **8** has lateral symmetry about a vertical axis **13**, and two pairs of flexure bars **14** and **14'** are preferably employed, one pair of bars being on each side of axis **13** as shown in Fig. 2.

Hereinafter in the specification the description will be limited to one pair of flexure bars **14** and their associated components as shown in Fig. 1, and this description will apply equally to the lateral and identical pair of flexure bars **14'** and their components being identified by the same number with the addition of a prime.

It will be noted that each pair of flexure bars consists of two individual straight bars as compared to the V-shaped configuration in the aforementioned patent application. The ends of flexure bars **14** are detachably anchored in fixed support **10** by a keyway joint consisting of a slot **12** in which is formed oppositely disposed flanges **15** each capable of engaging a complementary slot **16** on the corresponding sides of the flexure bars. The sides of slot **12** are slightly canted with respect to axis **13** so that the opposite ends of the flexure bars are supported in a diverging and spaced relation being maintained therein by a removable wedge **17**. Instead of utilizing a separate removable wedge **17**, the wedge can be incorporated as an integral portion of one or both of the flexure bars.

The opposite ends of flexure bars **14** are detachably supported in a pair of movable support members **25** by a keyway joint similarly provided in the opposite ends, one support member for each flexure bar. Support members **25** are swung apart to bend the flexure bars and provide the retarding action by a pull-out bolt **46** forming a part of the missile or the like being retarded until released by a mechanism presently to be described.

Each movable support 25 is provided with an integral diverging extension 27 terminating in an inwardly directed flange 30, the extension of each pair of movable supports forming an inverted V. The degree of divergence of extensions 27 will depend on factors later to be described. A hinge plate 32, shown in detail in Fig. 3, has an enlarged base portion supported on and extending between the flanges of corresponding movable supports 25, 25' of each pair, and, accordingly, one pair of hinge plates 32 are utilized for the two pair of flexure bars. The hinge plates are hinged to flanges 30 by straps 36 supported in opposing slots 37 machined in the respective members. Straps 36 are preferably made of a similar ductile material as flexure bars 14 and provide a flexible and frictionless hinge, and, as the flexure bars, are replaceable after each retarding action. The two hinge plates 32 also form an inverted V substantially parallel to movable support extensions 27. An end of each plate 32 opposite the hinged end is formed with a pair of spaced roller portions 38 and 38', having a combined width reduced sufficiently to be interposed in the space between the two pairs of flexure bars 14 and 14', as shown in Fig. 2. The roller portions on one hinge plate are adapted to engage the corresponding roller portions on the other hinge plate throughout the retarding action. Between each pair of roller portions the hinge plate is recessed and provided with a round bearing surface 40 which, as a manufacturing expedient, may comprise portion of a pin 41 inserted through drilled apertures in the roller portions and the recessed end of the hinge plate. The longitudinal axis of pins 40 are offset with respect to the longitudinal axes if their respective roller portions to provide an eccentric relation therebetween. Each pin is made of a suitably hardened material to prevent excessive wear.

A free end of pull-out bolt 46 extends between the roller portions of both hinge plates and is provided with an enlarged head portion 42 having tapered cam surfaces 44 adapted to engage pins 41 and be restrained thereby. It has been found that a tapered cam surface of 30 degrees with a plane normal to axis 13 will provide a satisfactory camming action with pin 41. Since a plane passing through hinge 36 and the initial point of contact of the bearing surfaces is perpendicular to cam surface 44, this plane also forms a 30 degree angle with axis 13. The extent of lateral movement of pins 41 by tapered cam surfaces are shown in Figs. 5 and 4; the initial and innermost position of the pins at the start of the retarding action being shown in Figs. 1 and 5, and the outermost position of the pins at the end of the retarding action, the release point of pull-out bolt 46, being shown in Fig. 4. Roller portions 38 enable bearing pins 41 to be spread apart by rolling on the tapered cam surfaces 44 minimizing friction therebetween. Hinge plates 32 are in a position substantially normal to axis 13 at the point of separation shown in Fig. 4, at which time pins 41 have been spread apart the width of pull-out bolt 46 releasing the latter from the retarding device.

For any given size flexure bar, the amount of initial resistance offered by the retarder device will depend on angle D, being the angle of intersection of a plane passing through flexible hinge strap 36 and the center of flexure Y of each bar and a plane passing through strap 36 and the initial point of contact between pin 41 and cam surface 44. For example, decreasing angle D will increase the initial resistance of the retarder device to the missile or other object being retarded.

The free end of pull-out bolt 46 may be of a length sufficient to extend freely into a corresponding recess 50 in yoke 10 and yoke sleeve 51 so as to guide the movement of the pull-out bolt along axis 13 during the retarding action, and, their abutment may be utilized to initially position bearing surfaces 40 and 44. The free end of the pull-out bolt 46 may be rectangular in cross section to prevent rotation during longitudinal displacement.

Operation of retarder device 8 is apparent from Figs. 1 and 4. When the missile is fired tension is applied to bolt 46 which advances along axis 13 in the direction of the arrow (Fig. 4) applying a force on pins 41 and to their respective hinge plates 32. The initial perpendicular relationship between the hinge plates and the respective cam surfaces enables the device to absorb the maximum load at the start of the retarding action. A horizontal component of the force is transmitted to the flexure bars through hinge plates 32, bending the bars under tension which supplies the retarding action. As the pull-out bolt 46 is withdrawn, bearing surfaces 40 of pins 41 are advanced outwardly along cam surface 44 by the swinging action of hinge plates 32 about their roller portions 38. The reaction of the flexure bars to the bending force maintains roller portions 38 in contact.

When the pull-out bolt 46 has advanced to a portion where the point of contact of rollers 38 are substantially in a plane passing through hinge straps 36, pins 41 have advanced on cam surfaces 44 to a position where the distance therebetween is approximately the same as the width of head portion 42, at which point pull-out bolt 46 is released ending the retarding action.

The retarder device can be readily restored to an operative condition by replacing flexure bars 14 and hinge straps 36. As pull-out bolt 46 remains with the object being retarded, this invention enables bolt 46 to be simple and light weight, which are important considerations in missile applications.

In the modification of Figs. 1–5, flexure bars 14 are bent under superimposed tension during the retarding action necessitating a keyway means or the like for anchoring the ends of the flexure bars in their respective supports. In Figs. 6 and 7 the components of the retarder device 58 for the most part are the same as in the prior modification but are rearranged so that flexure bars 64 are bent under superimposed compression during the retarding action eliminating the need for anchoring means. As before, two pairs of identical flexure bars can be used in spaced lateral arrangement, the discussion being confined to only one pair as shown in Figs. 6 and 7. A fixed support 60 having an attaching bolt 61 at one end is constructed as a rigid frame in which are housed the various components presently to be described, sides of the frame being open at 63 to permit lateral movement of the parts. One end of each flexure bar 64 is seated in a corresponding recess 62 formed in the opposite end of the frame, the other end of each bar being received in similar recess 62 formed in movable supports 65. A hinge plate 66, which can be identical in configuration as hinge plate 32 (Fig. 3), is hinged to each rotatable support 65 through flexible hinge straps 68.

A pull-out bolt 70 extends freely through opening 71 in fixed support 60 and terminates in a head portion 72 having tapered cam surfaces 74 on each side thereof for engaging respective bearing pins 76 mounted in hinge plates 66 and roller portions 78. As before, the longitudinal axes of hinge plates 66 are perpendicular to their respective cam surfaces 74 at the initial position. If desired, head portion 72 can be extended and support 60 provided with a suitable sleeve to guide the free end of the pull-out bolt throughout the retarding action, as in the prior modification. It will be noted that because of the arrangements of the components, pull-out bolt 70 is of necessity longer than bolt 46 in the prior modification. The operation of the embodiment of Figs. 6 and 7 is substantially the same as previously described in the device of Figs. 1–5 with the exception that flexure bars 64 are arranged to be bent under compression, rather than tension, throughout the retarding action; the flexure bars being maintained in their respective supports by the compressive forces acting on their ends.

Fig. 8 is a graph showing the relationship between load in pounds on the several retarder devices of this invention plotted as the ordinate, and displacement of each respec-

tive pull-out bolt in inches as the abscissa. Curve A represents the load-displacement relationship for the retarder devices of Figs. 1–5, while curve B is the same relationship for the modification shown in Figs. 6 and 7. Both curves A and B have a similar and pronounced curvature indicating that the respective retarder devices produce a non-uniform retarding action. However, in some installations, such as in guided missiles, a non-uniform retarding action may be undesirable in producing a shock on delicate components and changing sensitive adjustments. A retarder device 88 of Figs. 9 and 10 will satisfy such requirements by producing a uniform load-displacement curve as shown by curve C in Fig. 8.

As in the prior two retarder modifications, the various components are substantially the same differing principally in arrangement of components. The arrangement of the device of Figs. 9 and 10 is similar to the retarder of Figs. 1–5, and in both of these modifications the flexure bars are bent under tension. However, the device in Figs. 9 and 10 produces a uniform displacement of the pull-out bolt throughout the retarding action shown by curve C in Fig. 8, whereas, the retarder of Figs. 1–5 produces a non-uniform displacement as shown by curve A.

Retarder device 88 comprises a fixed support 90 having a central attaching bolt 91 and a pair of longitudinal slots 92 one on each side thereof capable of supporting a pair of spaced flexure bars 94. As in the prior modifications, shown in Fig. 2, a second pair of laterally arranged slots and flexure bars can be provided in this device and need not be illustrated. Flexure bars 94 are detachably anchored in their respective slots by means of a slidable locking pin 95 engageable with corresponding semi-circular grooves in the fixed support and bars, being similar to the keyway construction of the device of Figs. 1–5. The other end of each flexure bar is similarly secured by a locking pin 95 to a movable support 96.

Each flexure bar 94 is supported along a substantial portion against a shoulder 97 of the fixed support, one corner 97a of the shoulder being curved to form a bearing surface for the bars during the bending action. Each pair of flexure bars are sufficiently spaced apart to house therebetween a pair of hinge plates 98 similar in design to the hinge plates 32 and 66 of the previous modifications. One end of the hinge plates 98 are connected to their respective movable supports 96 through flexure straps 100, and the other ends of the plates are provided with roller portions 102 in mutual engagement. Pull-out bolt 104 extends between roller portions 102 and is provided with a head portion 106 having opposite cam surfaces 108 adapted to engage bearing pins 110 extending between the roller portions of their respective hinge plates. It is believed that the uniform displacement of pull-out bolt 104 obtainable with the retarder device of Figs. 9 and 10 is achieved by a relationship between the components providing somewhat equal distances between points X, Y, and Z forming substantially an equilateral triangle. Point X is the flexure point of hinge straps 100; point Y is the point of maximum bending of flexure bars 94; and point Z is the point of contact between bearing pins 110 and cam surfaces 102. As in the prior modifications, a plane passing through hinge point X and the bearing point Z should initially be perpendicular to cam surface 108 and if the cam surface is a 30 degree slope, this plane will be 30 degrees from the longitudinal axis of pull-out bolt 104. It has been noted that although the retarder device of Figs. 9 and 10 provides a uniform displacement, as compared to the non-uniform displacement of the other two modifications, the flexure bars 94 must be made somewhat larger than flexure bars 14 and 64 of the first two modifications to provide the same retarding force.

The retarder devices of this invention enable a preselected and predetermined restraining force to be applied to an object to be retarded. The invention devices are rugged, simple, and inexpensive in construction and operation. The devices are particularly suitable for missile applications, because that portion of the retarder device remaining on the missile is of minimum size and weight. The retarder components can be arranged to bend the flexure bars under tension or compression forces depending on the particular configuration and requirements of any particular application.

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.

I claim:

1. A retarder device which comprises a support member, means for fixedly securing said support member, an elongated deformable force-resisting member having one end mounted to said support member, a movable support member attached to the other end of said deformable member, a force-transmitting member hinged at one end to said movable support, a load member adapted to be secured to the object to be retarded, said force-transmitting member and the load member having disengageable cooperating bearing surfaces for swinging said force-transmitting member laterally against the movable support, means for guiding the movement of the load member, said deformable member and force-transmitting member being so disposed as to form an angle greater than zero degrees and less than 180 degrees between the intersection of a plane passing through said hinge and the point of maximum bending of the deformable member and a second plane passing through the hinge and the point of contact of said bearing surfaces, the force-transmitting member and the load member at the start of the retarding action being so disposed as to form an acute angle between the intersection of a plane containing the direction of force through the load member and said second plane, said load member being withdrawn from the device during the retarding action to increase said acute angle by flexing said deformable member until the bearing surfaces disengage to release the load member.

2. A retarder device which comprises a support member, means for fixedly securing said support member, a pair of spaced elongated deformable force-resisting members each having one end mounted in said support members, a pair of movable support members attached to the other end of said deformable members, a pair of force-transmitting members hinged to said movable supports, said force-transmitting members having roller portions formed at the opposite ends adapted to roll with respect to each other, a load member adapted to be secured to the object to be retarded, said load member and force-transmitting members having disengageable cooperating bearing surfaces for swinging said force-transmitting members about their responsive roller portions, each deformable member and corresponding force-transmitting member being so disposed as to form an angle greater than zero degrees and less than 180 degrees between the intersection of a plane passing through said hinge and the point of maximum bending of the respective deformable member and a second plane passing through the hinge and the point of contact of said corresponding bearing surfaces, each force-transmitting member and the load member at the start of the retarding action being so disposed as to form an acute angle between the intersection of a plane containing the direction of force through the load member and said second plane, said load member being withdrawn from the device during the retarding action to increase each acute angle by flexing the deformable members until the respective bearing surfaces disengage to release the load member.

3. The retarder device of claim 2 wherein the angle greater than zero degrees is an acute angle, whereby said deformable members are under tension at the start of the retarding action.

4. The retarder device of claim 2 wherein the angle

greater than zero degrees is an obtuse angle, whereby said deformable members are under compression at the start of the retarding action.

5. The retarder device of claim 2 wherein said roller portions are in engagement and at the initiation of the retarding action the distances between the force-transmitting member hinge, the point of contact of the roller portions, and the point of maximum bending of the deformable member are substantially equal.

6. The retarder device of claim 2 wherein each force-transmitting member has a pair of spaced apart roller portions, the respective roller portions of each force-transmitting member adapted to be in rolling engagement throughout the retarding action, said load member freely passing through the space formed between the engaged roller portions.

7. A retarder device which comprises a support member, means for fixedly securing said support member, a pair of spaced elongated deformable force-resisting members each having one end mounted to said support member, a pair of movable support members attached to the other end of said deformable members, a pair of force-transmitting plates hinged to said movable supports, said hinges being made of deformable material, said force-transmitting plates having roller portions formed at the opposite ends and adapted to be in rolling engagement throughout the retarding action, a load member adapted to be secured at one end to the object to be retarded and having an opposite end positioned between said roller portions, said force-transmitting members and the load member having cooperative bearing surfaces for swinging said force-transmitting members about their roller portions, said bearing surfaces comprising a curved surface and a flat tapered surface, the longitudinal axes of said force-transmitting plates being normal to the tapered bearing surfaces at the initial point of contact between said bearing surfaces, each deformable member and corresponding force-transmitting member being so disposed as to form an angle greater than zero degrees and less than 180 degrees between the intersection of a plane passing through said hinge and the point of maximum bending of the respective deformable member and a second plane passing through the hinge and the point of contact of said corresponding bearing surfaces, each force-transmitting member and the load member at the start of the retarding action being so disposed as to form an acute angle between the intersection of a plane containing the direction of force through the load member and said second plane, said load member being withdrawn from the device during the retarding action to increase each acute angle by flexing the deformable members until the respective bearing surfaces disengage to release the load member.

8. A retarder device which comprises a support member, means for fixedly securing said support member, a pair of spaced elongated deformable force-resisting members having one end mounted to said support member, a pair of movable support members mounted to the other end of said deformable members, a pair of swingable force-transmitting members hinged to said movable supports, said hinges being made of a deformable material, said force-transmitting members having roller portions formed at the opposite ends in rolling engagement throughout the movement of the force-transmitting members, said force-transmitting members having curved bearing surfaces arranged in spaced relation, a load member adapted to be secured at one end to the object to be retarded and having at the other end tapered bearing surfaces positioned between and cooperating with said curved surfaces, each deformable member and corresponding force-transmitting member being so disposed as to form an angle greater than zero degrees and less than 180 degrees between the intersection of a plane passing through said hinge and the point of maximum bending of the respective deformable member and a second plane passing through the hinge and the point of contact of said corresponding bearing surfaces, each force-transmitting member and the load member at the start of the retarding action being so disposed as to form an acute angle between the intersection of a plane containing the direction of force through the load member and said second plane, said load member being withdrawn from the device during the retarding action to increase each acute angle by flexing the deformable members until the respective bearing surfaces disengage to release the load member, said force-transmitting members being swingable about the roller portions as the load member is withdrawn from the device until the curved bearing surfaces have been spread apart a distance equal to the width of the tapered bearing surfaces at which time the load member is released.

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