United States Patent

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[72] Inventor **Herbert D. Curchack**
Rockville, Md.

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[73] Assignee **The United States of America as represented by the Secretary of the Army**

[54] **HYDRAULIC MITIGATOR**
6 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **188/312,** 74/89.14, 74/99, 92/31, 188/316, 188/322, 267/128
[51] **Int. Cl.** **F16f 9/32,** F16f 13/00
[50] **Field of Search** ..... 188/271, 288, 312, 316, 322; 267/34, 128; 92/31; 74/89.14, 89.15, 99 R

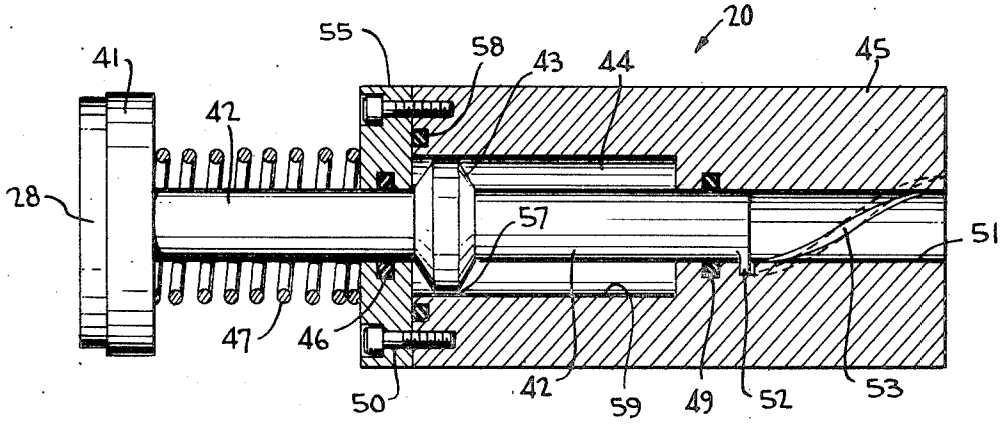
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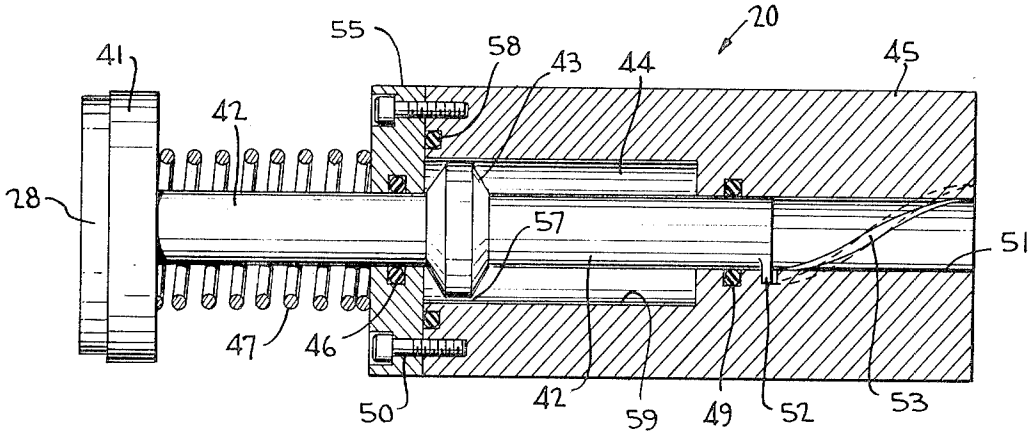
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Primary Examiner—George E. A. Halvosa
Attorneys—Harry M. Saragovitz, Edward J. Kelly, Herbert Berl and J. D. Edgerton

ABSTRACT: A hydraulic mitigator comprises a relatively massive hollow housing having two coaxial bores, the second bore being larger than the first. A shaft partially extending outside the housing rides in the first bore while a piston which is connected to the shaft rides exclusively within the second bore. The larger bore is filled with a fluid of a known density and a space is provided between the bore and the outer rim of the piston to enable the piston to be propelled through the fluid. The portion of the shaft which extends outside the housing is provided with an enlarged plate which is intended to be struck by the projectile. Any force directed at the plate will be only partially transmitted to the housing, the remainder being dissipated in propelling the piston through the fluid. Thus by properly selecting the density of the fluid and the size of the space between the piston and the bore, one can impose a predetermined deceleration force to the projectile. If the mitigator is spinning at the moment of impact such a spin can be partially transmitted to the projectile. This is accomplished by providing a pin and groove coupling means between the housing and the shaft in order to impart some of the angular acceleration force of the massive housing to the relatively lightweight shaft.





INVENTOR,
HERBERT D. CURCHACK
BY Harry M. Saragovitz
Edward J. Kelly
Herbert Berl
J. D. Edgerton
ATTORNEYS

HYDRAULIC MITIGATOR

RIGHTS OF THE GOVERNMENT

The invention described herein may be manufactured, used, and licensed by or for the United States Government for governmental purposes without the payment to me of any royalty thereon.

BACKGROUND OF THE INVENTION

This invention relates to hydraulic shock absorbers, and more particularly to a reusable hydraulic mitigator for use in artillery testing.

An Artillery Simulator of the type in which this invention may be used is described in U.S. Pat. No. 3,444,733, issued May 20, 1969 to Curchack, as well as in applicant's copending application entitled "Dynamic Tester for Projectile Components," Ser. No. 7,929, filed Feb. 2, 1970.

Prior art mitigators for use in artillery testing are best exemplified by the Curchack patent, U.S. Pat. No. 3,444,733. Such prior art mitigators consisted of a column of wooden blocks terminating in a heavy member also possibly of wood. When the test projectile impacts against this column of wooden blocks a linear deceleration force is applied to the test projectile, this force tending to simulate firing conditions. The obvious disadvantages of such a mitigator are that the wooden blocks deform upon impact and are therefore not reusable. In addition, it is quite difficult to calibrate such a mitigator in terms of obtaining a desired predetermined deceleration effect.

It is therefore a primary object of this invention to provide a reusable mitigator for use in an artillery testing.

Another object of this invention is to provide a hydraulic mitigator having a controllable and variable linear deceleration profile.

Still another object of this invention is to provide a mitigator in which the ratio of angular to linear force is controllable.

SUMMARY OF THE INVENTION

Briefly in accordance with this invention, the hydraulic mitigator comprises a relatively massive hollow housing having two coaxial bores, the second bore being larger than the first. A shaft partially extending outside the housing rides in the first bore while a piston which is connected to the shaft rides exclusively within the second bore. The larger bore is filled with a fluid of a known density and a space is provided between the bore and the outer rim of the piston to enable the piston to be propelled through the fluid. The portion of the shaft which extends outside the housing is provided with an enlarged plate which is intended to be struck by the projectile. Any force directed at the plate will be only partially transmitted to the housing, the remainder being dissipated in propelling the piston through the fluid. Thus by properly selecting the density of the fluid and the size of the space between the piston and the bore, one can impose a predetermined deceleration force to the projectile. If the mitigator is spinning at the moment of impact such spin can be partially transmitted to the projectile. This is accomplished by providing a pin and groove coupling means between the housing and the shaft in order to impart some of the angular acceleration force of the massive housing to the relatively lightweight shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will become apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings in which:

The FIGURE is a cross-sectional front view of an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Mitigator 20 comprises an outer hollow housing 45 having a first centrally located bore 51 and a second larger bore 59 coaxial with the first bore. Shaft 42 rides within bore 51 and is connected to piston 43 which rides within the larger bore 59. Region 44 is normally filled with fluid of a predetermined known density. The entire chamber defined by bore 59 is fluid sealed to prevent fluid flow by means of O-rings 46 and 49 and gasket 58. Bolts 50 secure a suitable cover 55 on body 45. Shaft 42 extends outside of housing 45 and is terminated by an enlarged flange or plate 41 having a rubber section 28 secured to its surface.

In operation, mitigator 20 is normally used to provide a predetermined linear deceleration force to a projectile while simultaneously imparting spin to the projectile. A projectile which has been fired from a linear accelerator normally strikes rubber surface 28 which in turn exerts a force on fluid 44 through shaft 42 and piston 43. As this force is applied, fluid from region 44 is forced toward the left through spaces 57, thereby allowing piston 43 to travel toward the right as shown in the FIGURE. Depending upon the size of space 57 and the density of the fluid, more or less of the force will be transmitted directly to housing 45. It will thus be appreciated that by varying the diameter of the bore 59, the size of space 57, or the density of the fluid, it is possible to provide a controllable linear deceleration profile.

As was mentioned previously, the hydraulic mitigator of this invention is also used to impart a predetermined spin to a nonspinning projectile. This is accomplished by first maintaining hydraulic mitigator 20 in a spinning orientation by means of a suitable spin tube such as that disclosed in applicant's copending application, Ser. No. 7,292, filed Feb. 2, 1970. At the moment of impact, the spinning force of mitigator 20 will be partially transmitted to the nonspinning projectile through rubber surface 28. Since the projectile has a greater mass than shaft 42 together with plate 41, spin would not be imparted to the projectile unless the spin of more massive housing 45 is coupled to plate 41. This is accomplished by providing a pin 52 extending from shaft 42 into a helical groove 53 within housing 45. Because shaft 42 must rotate along the path defined by groove 53, some of the angular acceleration force of housing 45 is coupled through shaft 42 to the projectile, thereby increasing the effective mass of shaft 42. The reason for a helical groove rather than a slot is to provide a gradual transmission of force from housing 45 to shaft 42. If pin 52 were merely located within a slot rather than a helical groove it is very likely that the shear force would break the pin. In addition, by selecting the appropriate pitch of the helix one can select the precise magnitude and rate at which the force is transmitted.

Coil 47 is designed to reset shaft 42 to its initial extended position prior to impact. It does not have sufficient resistance to materially affect the magnitude of the deceleration force applied to the projectile upon impact.

It will be appreciated from the foregoing description that this invention provides a novel hydraulic mitigator capable of providing a predetermined linear deceleration force as well as imparting a predetermined angular acceleration to the impacting object.

It should be understood that I do not desire to be limited to the exact details shown and described, for obvious modifications can be made by one skilled in the art.

I claim as my invention:

1. A hydraulic mitigator for providing linear deceleration and angular spin to an impacting projectile comprising:

a. a hollow housing having a first bore and a second bore;

b. a shaft partially extending outside said housing and riding within said first and second bore;

c. a piston connected to said shaft and riding within said second bore;

d. a fluid confined within said second bore;

e. means for sealing said second bore to prevent the escape of said fluid;

f. a space between the outer rim of said piston and the wall of said second bore to enable said fluid to transfer to both sides of said piston completely fill said second bore; and

g. an enlarged plate firmly secured to that end of the shaft which normally extends outside said housing, whereby a projectile impacting said plate will be decelerated at a predetermined rate; and

h. a groove located within said first bore and a pin secured to said shaft and extending into said groove such that a predetermined portion of angular acceleration of said housing will be coupled to said shaft.

2. The hydraulic mitigator of claim 1 wherein said groove is helical and extends along the length of said first bore, whereby a predetermined portion of angular acceleration of said housing will be transmitted to said shaft.

3. The hydraulic mitigator of claim 1 further comprising spring means to reset said shaft to an extended position after impact.

4. The hydraulic mitigator of claim 1 wherein said housing has a greater mass than the combined mass of said shaft and plate, thereby increasing the effective mass of said shaft.

5. The hydraulic mitigator of claim 1 wherein said first bore and said second bore are coaxial.

6. The hydraulic mitigator of claim 5 wherein said second bore is larger than said first bore.

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