United States Patent

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

[54] DYNAMIC TESTER FOR PROJECTILE COMPONENTS

6 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **73/167,** 73/12
[51] **Int. Cl.** **G01m 19/00**
[50] **Field of Search** 73/167, 5, 12; 221/233, 257

[56] **References Cited**

UNITED STATES PATENTS

2,462,922	3/1949	Temple	221/232 X
3,444,733	5/1969	Curchack	73/167

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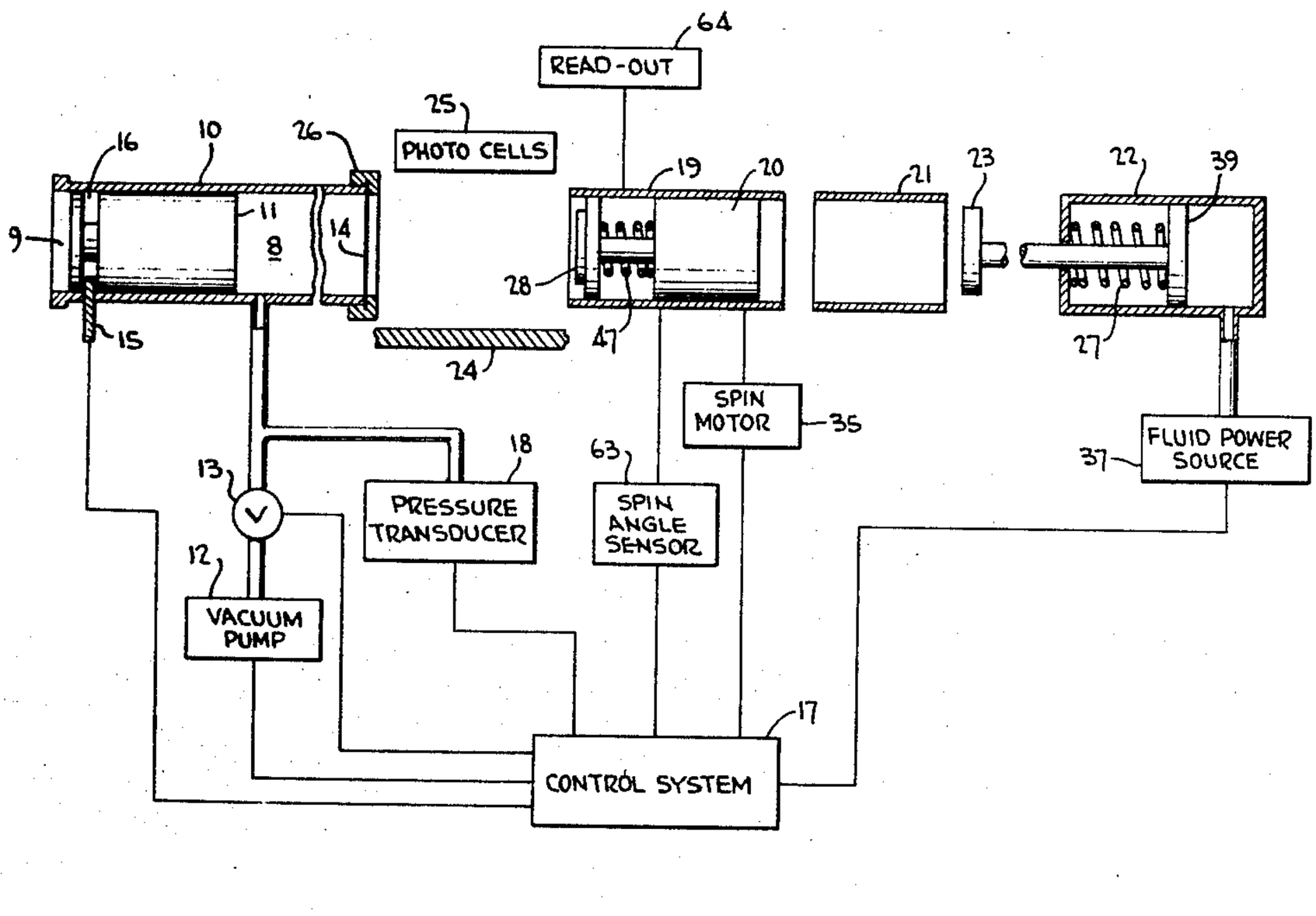
ABSTRACT: Projectile component testing. A modified projectile, containing components to be tested, is accelerated by means of a vacuum air gun into a spinning tube where it is set in spinning motion while simultaneously being decelerated. Deceleration is accomplished by means of a hydraulic mitigator capable of imparting rotational spin to the projectile while applying a predetermined rate of deceleration. The system is designed for rapid production line testing by means of a control system which starts the spin tube in motion and releases the projectile when a predetermined pressure has been established within the air gun. The control system also terminates the spin and actuates a fluid operated component to replace the mitigator to its start position within the spin tube. In order to provide a check on the polarity of power supplies being tested, a spin angle sensor is provided to transmit a signal for release of the projectile only when the spin tube is in a predetermined angular orientation.



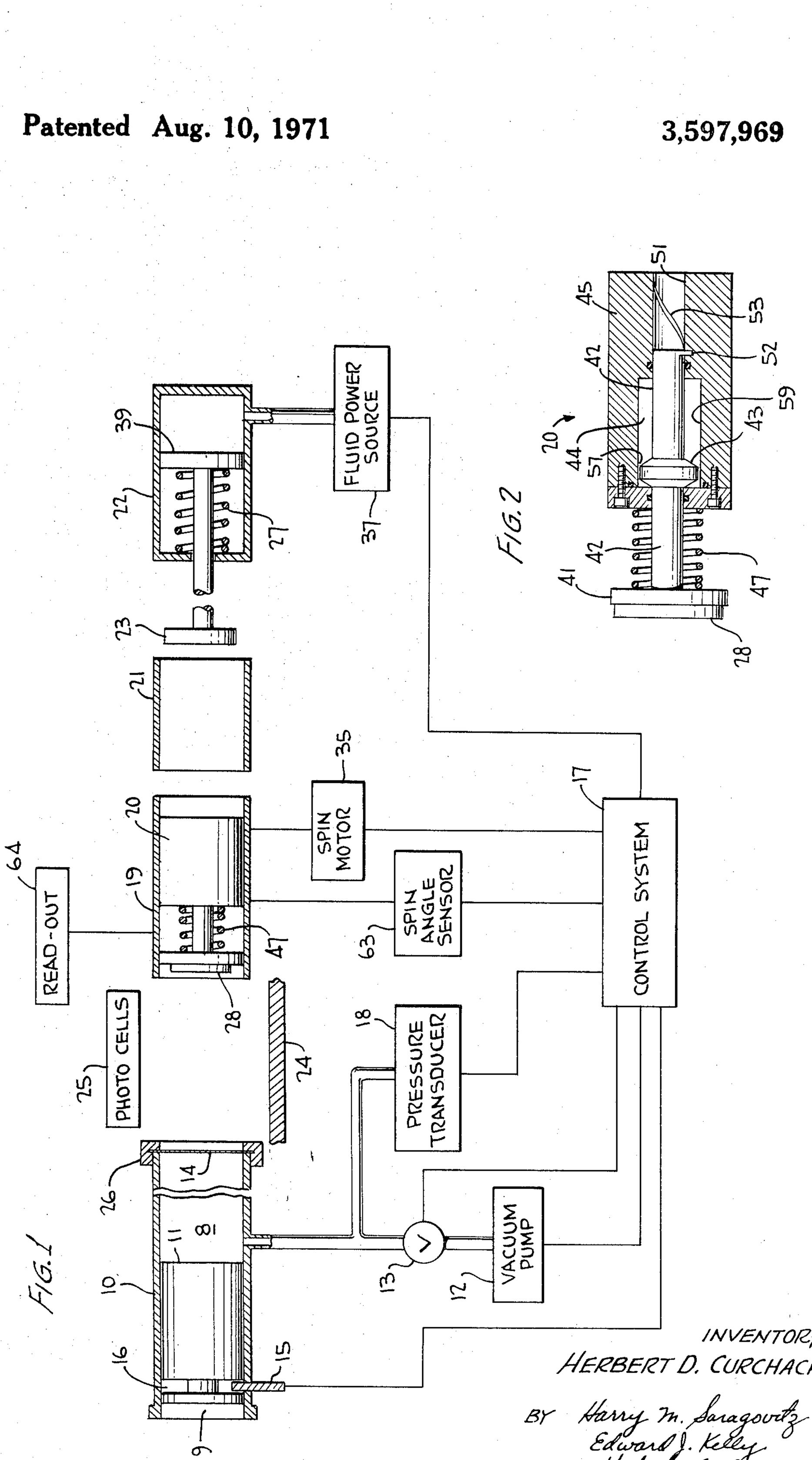


FIG. 1

FIG. 2

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DYNAMIC TESTER FOR PROJECTILE COMPONENTS

RIGHTS OF THE GOVERNMENT

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for simulating the linear and angular acceleration to which projectiles are subjected in rifled artillery weaponry, and more particularly to an improvement in the artillery simulator disclosed in U.S. Pat. No. 3,444,733 issued to Curchack on May 20, 1969.

The artillery simulator disclosed in the Curchack patent unites the features of a gas gun and a low inertia spinner in a single test apparatus to simulate the linear and angular accelerations experienced in rifled artillery weaponry. Difficulties are encountered in adapting the invention disclosed in the Curchack patent to production line testing of projectile components, such as power supplies and fuzes, in rapid succession. The purpose of this invention is to overcome these difficulties and to provide an artillery simulator capable of testing large numbers of projectile components in rapid succession.

It is therefore a primary object of this invention to provide a test apparatus for simulating the linear and angular accelerations experienced in rifle artillery weaponry.

Another object of this invention is to provide a test apparatus which is fully automated and capable of testing projectile components in rapid succession.

SUMMARY OF THE INVENTION

Briefly, in accordance with this invention, a modified projectile, containing components to be tested, is accelerated by means of a vacuum air gun into a spinning tube where it is set in spinning motion while simultaneously being decelerated. Deceleration is accomplished by means of a hydraulic mitigator capable of imparting rotational spin to the projectile while applying a predetermined rate of deceleration. The system is designed for rapid production line testing by means of a control system which starts the spin tube in motion and releases the projectile when a predetermined pressure has been established within the air gun. The control system also terminates the spin and actuates a fluid operated component to replace the mitigator to its start position within the spin tube. In order to provide a check on the polarity of power supplies being tested, a spin angle sensor is provided to transmit a signal for release of the projectile only when the spin tube is in a predetermined angular orientation.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a diagrammatic representation of a complete system embodying the principles of the present invention.

FIG. 2 is a cross-sectional view of one embodiment of a mitigator for use in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will be understood more readily by referring to FIG. 1 which shows the entire system in diagrammatic form. Acceleration gun 10 containing projectile 11 is provided with a quick-change diaphragm assembly 26 including a thin diaphragm 14. The acceleration gun is powered by means of vacuum pump 12 through valve 13 which is actuated by control system 17. Projectile 11 is fired out of acceleration gun 10 by creating a partial vacuum in the forward portion 8 of the acceleration gun, thereby causing atmospheric pressure to act at the rear 9 of the projectile. Restraining pin 15 is located within groove 16 of projectile 11 to prevent the projectile from being fired until a predetermined pressure has been established within the accceleration gun. Pressure transducer 18 detects this predetermined pressure and transmits a signal to control system 17 which in turn shuts off valve 13 and withdraws pin 15 to permit the projectile to be fired.

Upon withdrawal of pin 15, projectile 11 pierces membrane 14 and impacts surface 28 of mitigator 20, thereby displacing mitigator 20 from spin-catch tube 19. Mitigator 20 ultimately comes to rest in mitigator-catch tube 21 after striking platform 23 of hydraulic mitigator replacement means 22. Projectile 11 comes to rest within spin-catch tube 19 which has already been set in spinning motion by means of spin motor 35. The precise moment at which the spin motor is activated depends upon a predetermined pressure within region 8 of acceleration gun 10, which pressure is detected by pressure transducer 18 and transmitted as an electrical signal to control system 17.

Spin-catch tube 19 is caused to spin for a predetermined time in the manner more fully described in the previously mentioned Curchack patent. During the flight period of the projectile its velocity is measured by means of photocells 25 in a well-known manner as also described in the Curchack patent.

At the termination of the spin period for the spin-catch tube, fluid power source 37, which may be hydraulic or pneumatic, is activated by a signal from control system 17 to displace piston 39, thereby inserting platform 23 into mitigator-catch tube 21. Mitigator 20 is thus replaced to its normal position within spin-catch tube 19 and projectile 11 falls out onto a support member 24 where it is removed by an operator. The entire cycle is then repeated with the replacement of a new projectile 11 and a new membrane 14. At the start of a new cycle, restraining pin 15 and platform 23 are automatically replaced to their original starting positions in response to signals from control system 17. Since the entire system is fully automated, it is possible to test a great number of projectile components under production line techniques.

Referring now to FIG. 2, 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 a fluid of a predetermined known viscosity and the entire chamber defined by bore 59 is fluid sealed by means of suitable O-rings or gaskets. The portion of shaft 42 which extends outside of housing 45 is provided with enlarged flange or plate 41 having a rubber surface 28 firmly secured thereto.

In the normal operation of this device, mitigator 20 is located within spin-catch tube 19 and is rotating when it is suddenly struck by projectile 11. The force of projectile 11 against surface 28 of mitigator 20 causes shaft 42 to be pushed into housing 45. Because region 44 is filled with fluid, the force exerted against piston 43 by the projectile is partially transmitted to housing 45. A small space 57 is provided between piston 43 and bore 59. As force is exerted against piston 43, some of the fluid in region 44 flows through space 57 thereby allowing piston 43 to be further depressed into housing 45. It will be appreciated that the magnitude of linear deceleration provided by mitigator 20 is controllable by simply varying the diameter of bore 59 or by changing such other parameters as the density of the fluid within region 44 or the size of space 57. The easiest parameter to change is, of course, the density of the fluid. Thus the rate of fluid flow from right to left will determine the rate and magnitude of the force which is transmitted to housing 45 and, consequently, the deceleration force on projectile 11. Spring 47 is designed to return the piston to its ready position and does not have sufficient resistance to materially affect the deceleration force applied to projectile 11 upon impact.

As was previously mentioned, at the time of impact mitigator 20 is located within spin-catch tube 19 and is spinning at a very rapid rate. Projectile 11, on the other hand, is not spinning at the time of impact. Because it is desirable to start projectile 11 spinning as soon as possible, mitigator 20 is

designed to impart some of its rotational spin to projectile **11**. This is accomplished by causing some of the force created by spinning mass **45** to be exerted through shaft **42** upon non-spinning projectile **11**. The force created by spinning mass **45** is coupled to shaft **42** by a pin **52** which extends from shaft **42** into housing **45** and is located within a helical groove **53**. The purpose of the helical groove is to provide a gradual transmission of force from housing **45** to shaft **42** rather than an instantaneous force. If pin **52** were merely located within a slot rather than a helical groove it is very likely that the shear force on pin **52** would break the pin. A more detailed explanation of this feature can be found in applicant's copending application entitled Hydraulic Mitigator, Ser. No. 7,928, filed Feb. 2, 1970.

The details of electrical readout **64** are fully described in the aforementioned Curchack patent. The arrangement disclosed therein has one disadvantage in that a test battery or power supply which is faulty because of reversed polarity would go undetected by the former readout system. In order to detect such faults in power supplies a spin angle sensor **63** is provided. The spin angle sensor transmits a signal to control system **17** whenever spin-catch tube **19** is in a predetermined angular orientation. Control system **17** is then programmed to release restraining pin **15** only upon receiving the appropriate signal from spin angle sensor **63**. By mathematically calculating the time which would be required for projectile **11** to reach spin-catch tube **19**, one can determine the appropriate release time such that projectile **11** will always have the same angular orientation will respect to spin-catch tube **19** at its time of arrival. Consequently, any reverse polarity at readout **64** would be indicative of a faulty power supply.

It will be appreciated from the foregoing description that this invention provides a novel artillery simulator which is capable of rapid and efficient production line testing of projectile components.

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

I claim as my invention:

1. An artillery simulator for testing projectile components under firing conditions comprising:

a. projectile means having a hollow portion for containing test components;

b. vacuum acceleration means for accelerating said projectile to a desired velocity;

c. restraining means located within said acceleration means for restraining said projectile until a predetermined vacuum has been created with said acceleration means;

d. a spin-catch tube positioned to receive said projectile upon its emergence from said acceleration means;

e. mitigator means normally positioned within said spin-catch tube to provide a predetermined amount of deceleration to said projectile upon impact;

f. a spin motor for rotating said spin-catch tube in response to a predetermined signal;

g. a mitigator-catch tube positioned to receive said mitigator upon its emergence from said spin-catch tube;

h. mitigator replacement means responsive to a predetermined signal for displacing said mitigator from said mitigator-catch tube and replacing it in said spin-catch tube, whereby said projectile is caused to fall onto a support located between said accelerator and said spin-catch tube; and

i. a control system responsive to the pressure levels within said accelerator for removing said restraining means, activating said spin motor for a predetermined time, and activating said mitigator replacement means.

2. The artillery simulator of claim **1** wherein said vacuum acceleration means comprises means for reducing the pressure in the forward region of said projectile, thereby causing atmospheric pressure to propel said projectile.

3. The artillery simulator of claim **1** wherein said mitigator replacement means comprises a fluid actuated piston assembly for driving said mitigator back into said spin-catch tube.

4. The artillery simulator of claim **1** further comprising a spin angle sensor for sensing the angular orientation of said spin-catch tube and transmitting a signal to said control system whenever said spin-catch tube is in a predetermined angular orientation.

5. The artillery simulator of claim **4** wherein said restraining pin is released only in response to a signal from said spin angle sensor.

6. The artillery simulator of claim **1** wherein said mitigator comprises means for applying a predetermined deceleration force and imparting a spin force to said projectile.