TIMED IMPACT TESTER

Filed Aug. 11, 1966

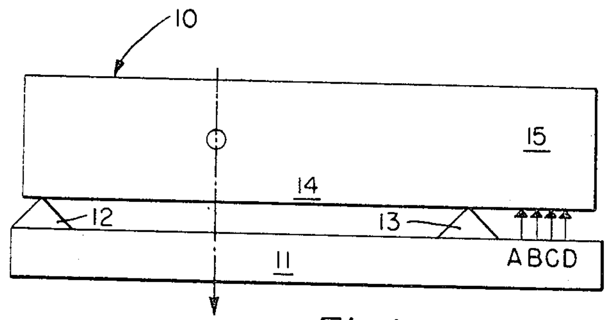

Fig. 1

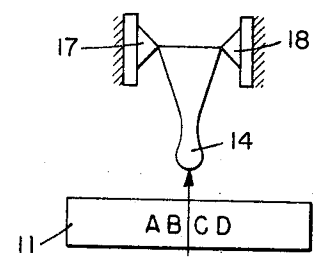

Fig. 2

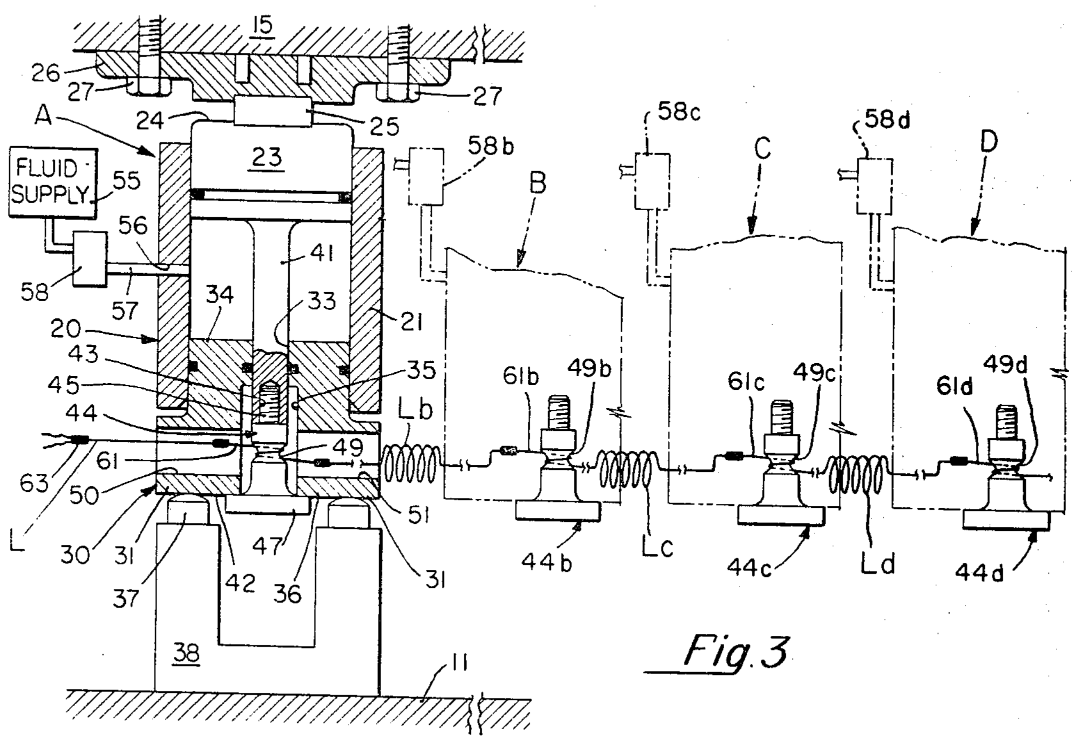

Fig. 3

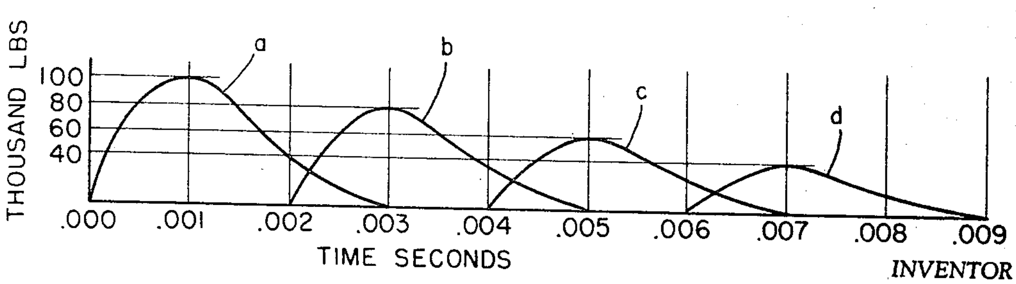

Fig. 4

INVENTOR
RICHARD H. MARVIN

BY
William R. Nolte
AGENT

United States Patent Office

3,408,852

Patented Nov. 5, 1968

3,408,852

TIMED IMPACT TESTER

Richard H. Marvin, Philadelphia, Pa., assignor to The Budd Company, Philadelphia, Pa., a corporation of Pennsylvania

Filed Aug. 11, 1966, Ser. No. 571,912
7 Claims. (Cl. 73—12)

ABSTRACT OF THE DISCLOSURE

Apparatus for delivering a series of impacts of controlled impulse at accurate time intervals. A stationary piston at one end of a cylinder engages the body to be impacted. A movable piston is secured to the stationary piston through a tension rod having a notched insert. Fluid between the pistons is raised to sufficient pressure to produce the impact force. The tension rod carries this force and the fluid is compressed. Explosive means wrapped about the notched tension rod may be detonated to rupture the rod. The time to actuate an adjacent like apparatus may be controlled by the length of the connecting fuse.

This invention relates to improved impact apparatus and more particularly, to such apparatus adapted to deliver a series of impacts of controlled impulse at accurate time intervals.

One environment in which the apparatus of the present invention finds use is in the application of a whipping test for seagoing vessels. The typical whipping test is an interpretation of wave slap on the forward keel of a hull from forces producing an essentially running load which diminishes in a forward direction. It is desired that the running load to which the ship is subjected be simulated by a number of equally spaced impulsive forces consecutively at predetermined short intervals, and lasting for a predetermined time duration. Various types of devices including rocket motor and gun type devices in which burning propellants generate an impulsive force were previously considered for use in solving this problem but were rejected as unsatisfactory in that none have been found capable of controlling the impulses within required specified times or capable of actuating the loads consecutively within the total allowable time.

It is an object of this invention therefore to provide improved apparatus for producing impulses which avoid one or more of the disadvantages of the prior art arrangements and which can be precisely controlled.

It is another object of this invention therefore, to provide an improved impact apparatus for generating a series of controlled impulsive forces during predetermined time intervals.

It is a further object of this invention to provide an improved impact apparatus for storing a plurality of impulsive forces which may be triggered consecutively for immediate utilization and within an overall allowable time.

In accordance with the invention the impact apparatus is positioned to apply an impulsive force against the test body and comprises energy container means having movable means secured against relative movement by connecting means. A fluid medium is supplied to the container means with means for regulating its pressure. The connecting means resists the pressure and cooperates under stress to compress the fluid medium. Explosive charge means are suitably wrapped around the connecting means. Upon detonation the connecting means are ruptured and an impulsive force is applied by the apparatus to the test body.

For a better understanding of the present invention together with other and further objects, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing FIG. 1 is a schematic representation of a test body which is subjected to a series of impacts by apparatus of the present invention consisting of a plurality of energy storage cells;

FIG. 2 is a front elevational view of the test body shown in FIG. 1 and showing lateral supports on each side of the body;

FIG. 3 is a vertical sectional view partially schematic, through one of energy cells of the apparatus and showing the same connected in series to other like units;

FIG. 4 shows a force-time graph representing an illustrative application of peaking forces of the energy storage units to the test body over a given time relationship.

Referring to FIG. 1 of the drawing, there is shown a test body **10**, which may be in the form of a seagoing vessel, supported on a test bed **11**, at load bearing supports **12, 13** along the length of its keel **14**. The forward portion **15** of the vessel and its keel extend in cantilever relation to fixed support **13**. A plurality of energy cells, A, B, C, D, are interposed between the cantilevered portion of the keel and the test bed **11**, and suitably arranged to apply forces simulating an essentially running load due to wave slap when travelling in a forward direction. As seen in FIG. 2 the vessel is shown supported in a vertical position by means of side supports **17, 18** disposed on opposite sides of the body and above the energy cells applied to the keel **14**.

In the present instance each of the energy storage devices A, B, C, D, may be identical and for purposes of simplicity only energy storage cell A is illustrated in detail. As seen in FIG. 3 energy device A is positioned in place between keel **15** of the test body **10** and the test bed **11**. It comprises container means **20** which includes a cylinder **21** and a stationary piston **23** received within its upper end. The top surface **24** of the piston extends beyond the top edges of the walls of the cylinder and is secured to a high response flat load cell **25**. the load cell is in turn secured to a fitting **26** which is bolted by bolts **27** to the keel **15** of the test body. The load cell **25** is of conventional construction and is used to measure the forces transmitted to the vessel. A movable piston **30** is positioned within the bottom open end of the cylinder and it includes shoulder portions **31** which extend laterally of the cylinder and beneath the bottom edges of the cylinder. The latter piston includes an axially aligned aperture **33** which opens from its top surface **34** and joins a slightly enlarged bore **35** which in turn extends to the bottom surface **36** of the movable piston. A plurality of shock absorbers **37** carried by a yoke member **38**, resting on test bed **11**, engage the under surface **36** of the movable piston. Connecting means comprising an axially aligned rod **41**, and receiver means in the form of a rupture bolt **44** secure the movable piston **30** against movement. Axial rod **41** extends from the bottom surface **42** of stationary piston **23** and passes through the aforementioned aperture **33** in the movable piston and into the bore **35**. The lower end of the rod includes an internally threaded portion **43** which receives the threaded shaft portion **45** of the tension rupture bolt **44**. The bolt includes a head **47** of greater diameter than the bore **35** and engages the bottom surface **36** of the movable piston. The bolt **44** moreover includes an undercut portion **49** along the length of its shaft which is in line with transverse apertures **50, 51** passing through the lower portion of the movable piston **30** and opening into the aforementioned vertical bore **35**.

A suitable supply of a fluid medium **55** under pressure such as hydraulic fluid F may be introduced into the cylinder **21** through aperture **56** within its sidewall by conduit means **57**. The latter is shown as including a pressure regulator device **58**. The pressure of the hydraulic fluid between upper stationary piston **23** and lower piston **30** may be raised to a sufficient level to produce the maximum impact force applied through the load cell **25** and fitting **26** on the keel **15**. The connecting means **19** comprising tension rod **41** and rupture bolt **44** carries this force while the hydraulic fluid is compressed within the cylinder. Since the rupture bolt **44** is reduced in cross-section as at **49**, upon increase in pressure within the cylinder the bolt becomes loaded under tension practically to its ultimate tensile strength.

A length of explosive charge material **61** is wrapped around the receiver means at the notched portion of the tensile rupture bolt **44**. One end of the length **61** extends within the transverse aperture **50** of the movable piston and the other end is received in the oppositely located bore **51**. A length of fuse material L is shown connected to the explosive charge material **61** within bore **50** and the fuse L may be initiated by an electric initiator as at **63**. When the fuse L and explosive charge **61** are detonated the notched rupture rod **44** is ruptured by virtue of its high initial stress and the shock of detonation. The load on the keel **15** will initially be the peak impact force. The force will reduce as the movable piston **30** allows the hydraulic fluid F to expand. As seen in FIG. 4 the force-time relationship designated by curve *a* is essentially triangular. The peak force is dependent upon the maximum fluid pressure. The duration of the applied force is dependent upon the volume and compressibility of the fluid F and the mass of the stationary piston **23** and cylinder wall **21**.

A series of impact testors A, B, C, D, of the above description may be linked according to this invention with lengths L*b*, L*c*, and L*d* of detonating fuse material to produce a series of forces and impulses of controlled magnitude at precise sequential time increments. The impulses so generated could thereby simulate a running load to which a seagoing vessel is subjected. By assigning a line pressure, for example, of 5,000 lbs./in.^{2} to the storage cylinder A and using pressure regulators **58*b***, **58*c***, **58*d***, to respectively supply 4000, 3000, and 2000 lb./in.^{2} to the other cylinder (B, C, D) shown connected schematically in series to cylinder A, substantially identical energy storage cylinders may be used. When so supplied with pressure the rupture bolts **44*b***, **44*c***, and **44*d*** of the energy cells would be undercut in their respective notched portions **49*b***, **49*c***, **49*d*** so that each would be stressed in tension an amount approaching the threshold of its ultimate tensile strength. The above pressures when applied to the respective cylinders would produce impulsive forces of a magnitude of 100,000; 80,000; 60,000; and 40,000 lbs./sec. as seen in FIG. 4.

It is observed that the length of fuse material L*b* interconnects explosive charge **61** wrapped around bolt **44** to explosive charge **61*b*** wrapped around bolt **44*b***. In a similar manner length L*c* interconnects the other end of explosive charge **61*b*** to one end of explosive charge **61*c*** wrapped around bolt **44*c***. Thereafter length L*d* is connected to the opposite end of explosive charge **61*c*** and connects the same to charge **61*d*** encircling rupture bolt **44*d***. In each case the explosive charge material encircles the bolts at their necked down portions of reduced cross section. The time required to actuate the successive energy cells A, B, C, and D, is accurately controlled by each of the lengths, L, L*b*, L*c*, and L*d*, since the detonation rate is directly proportional to its length and is obtainable through calibration.

While there has been described what at present is considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit of the scope of the invention.

What is claimed is:

1. An impact apparatus for a test body, comprising in combination, energy storage container means secured to said body, movable means cooperating with said energy storage container means to contain a fluid medium therein, means connecting said movable means to said container means, means for supplying a fluid medium under pressure to said container means, explosive charge means, said connecting means having receiver means for said explosive charge means, and means for initiating said explosive means to rupture said connecting means, whereby said fluid medium expands and generates an impulsive force which is transmitted by said container to said test body.

2. In the impact apparatus as set forth in claim **1** wherein said movable means cooperating with said energy storage container means constitutes a piston.

3. In the impact apparatus as set forth in claim **2** wherein said means connecting said movable means to said energy storage container means includes tension rod means passing through said piston.

4. In the impact apparatus as set forth in claim **3** wherein said tension rod means comprises a rod extending from said energy storage container means and partially through one end of said piston and a bolt including a notched portion entering and bottoming on the other end of said piston and threadedly connected to said rod.

5. In the impact apparatus as set forth in claim **4** wherein said explosive charge means associated with said connecting means is received within the notched portion of said bolt.

6. In impact apparatus for a test body, comprising in combination, a plurality of energy storage container means each secured to said body and comprising movable means cooperating with said container means to contain a fluid medium therein, means connecting said movable means to each said container means, means for supplying a fluid medium under pressure to each said container means, explosive charge means, said connecting means having receiver means for said explosive charge means, and means linking the explosive charge means of each said energy storage container means in series to detonate the same at precise sequential time increments to rupture said connecting means, whereby said fluid medium in each of said energy storage container means expands and generates an impulsive force which is transmitted by said container means to said test body.

7. In the impact apparatus as set forth in claim **6** wherein the connecting means of each said energy storage means includes a rupture bolt having a shank portion reduced in cross section an amount such that when said fluid medium under pressure is supplied to said cylinder means the same causes said rupture bolt to be loaded in tension an amount approaching the ultimate tensile strength of the rupture bolt.

References Cited

UNITED STATES PATENTS

3,200,706	8/1965	Kinard	89—1
3,064,464	11/1962	Black et al.	73—12
2,997,025	8/1961	Ottestad et al.	121—38
2,883,910	4/1959	Nessler	89—1.5

RICHARD C. QUEISSER, *Primary Examiner.*

VICTOR J. TOTH, *Assistant Examiner.*