July 21, 1953 K. W. JOHNSON 2,645,931

VARIABLE DURATION SHOCK TESTING MACHINE

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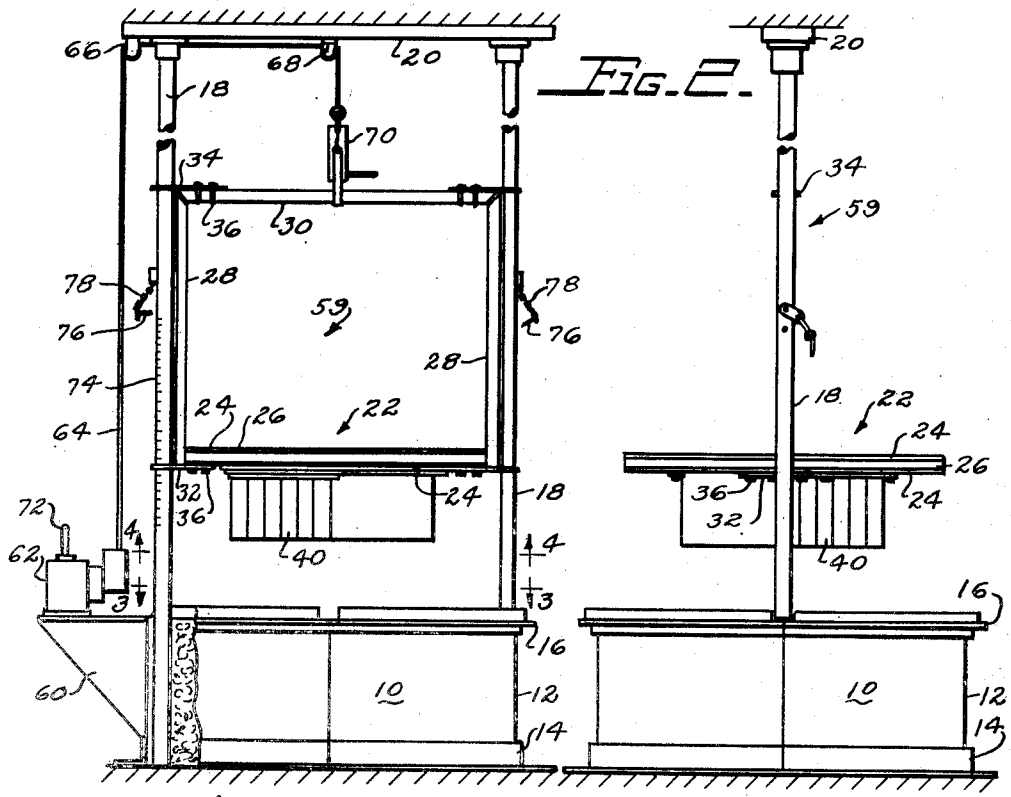


FIG. 2.

FIG. 1.

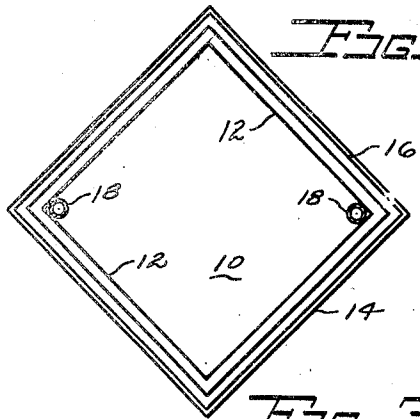


FIG. 3.

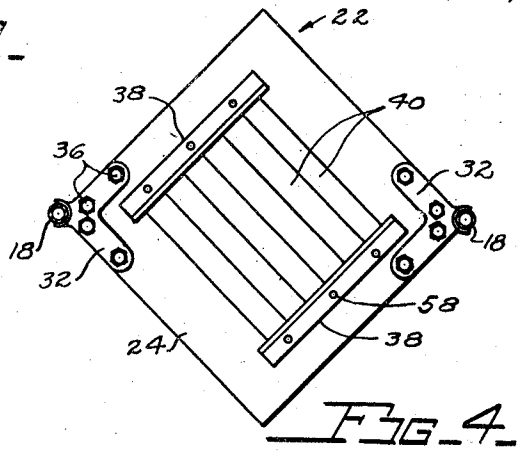
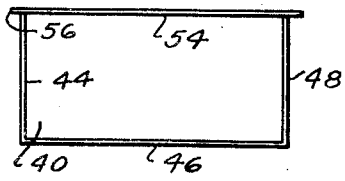


FIG. 4.

FIG. 5.



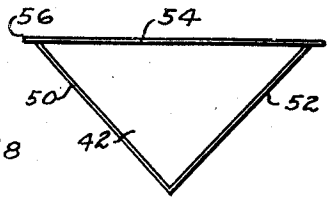


FIG. 6.

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VARIABLE DURATION SHOCK TESTING MACHINE

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3 Claims. (Cl. 73—12)

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

1

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

This invention relates to shock testing machines and has special reference to a shock testing machine in which the duration of the shock is controllable.

Electronic and similar equipment must often be used in situations where it is subjected to severe shock, and the shock to which such equipment is subjected may vary not only in intensity but also in duration.

It is therefore an object of this invention to provide a laboratory machine which may be set up to simulate shock conditions comparable to those to which the equipment is subjected in actual practice.

Another object is to provide a machine of this character which may be highly effective for the purpose stated but may be built at a very low cost in time and material.

Other objects and advantages will be apparent from a consideration of the following specification considered with reference to the drawings, wherein:

Fig. 1 shows the complete test machine in front elevation.

Fig. 2 shows the same machine in side elevation.

Fig. 3 is a horizontal section taken on the line 3—3 of Fig. 1 showing a top plan view of the sand box.

Fig. 4 is a horizontal section taken at 4—4 of Fig. 1 showing a bottom plan view of the work table.

Figs. 5 and 6 show several types of impact members whereby the duration of the shock is controlled.

Like reference characters refer to like parts throughout the several views.

In the drawing, a box 10 for holding sand or other granular material is of square plan view and comprises four side plates 12 joined at the corners of the box and reinforced around the bottom by lengths of angle iron 14 and around the top by lengths of angle iron 16. Tubular columns 18 extend upwardly from two diagonally opposite corners of the box and are preferably welded to the side plates. A beam 20 extends across the upper ends of the columns 18 and is rigidly secured thereto.

A work table 22 comprises two metal plates 24 with a plywood layer 26 between. Tubular posts 28 are fastened to the table at opposite corners

2

and extend upwardly alongside the columns 18. A horizontal rail 30 is joined at its ends to the tops of the posts 28 preferably by welding. Corner brackets 32 and 34 are secured to the underside of the table 22 and the upper side of the rail 30 respectively by bolts 36. Brackets 32 and 34 carry guides for directing free fall of the table along the columns 18.

Carried on the underside of the table 22 by clamping bars 38 are one or more blocks 40 or one or more wedges 42. The blocks and wedges may be made of wood, preferably maple, with the wearing surfaces faced with a relatively thin plate of sheet steel as at 44, 46, 48, 50 and 52, and with a much thicker steel plate 54 across the top. The plates 54 extend beyond the ends of the blocks and wedges to provide lips 56 which the clamps 38 engage in fastening the blocks or wedges 42 to the bottom of the table 24. Bolts 58 which hold the clamps 38 to the underside of the table 22 are loosened temporarily while sliding the desired number of blocks 40 or wedges 42 into place between the clamps 38 with the lips 56 under the clamps. The bolts 58 are then tightened to hold the blocks 40 or wedges 42 securely to the underside of the table. The table 22, posts 28, rail 30 and the wedges or blocks 40, 42, and their clamping mechanism may collectively be referred to as the carriage 59.

A bracket 60 fast on the box 10 supports a hoist 62. The cable 64 of the hoist passes over pulleys 66 and 68 to a release 70 which may be tripped manually to allow the table 22 to fall freely. Control lever 72 is provided for raising or lowering the table to the desired height. One of the columns 18 is calibrated as at 74 to indicate the height to which the table has been raised. Bolts 76 are suspended on chains 78 and may be inserted through openings in columns 18 into openings in posts 28 to forestall accidental dropping of the table.

In order to simplify the calculations incident to the operation of the machine, the carriage 59 shall at all times carry a load of 100 pounds, i. e., the equipment under test plus any dead weight on the table shall equal 100 pounds. Any mounting accessories for holding the equipment under test, such as fixtures, racks and the like should be of steel angle iron since rigidity is very important and any yielding will affect the results. Since no one fixture may be used for all classes of equipment tested, no fixture is shown. However, any fixture which is to be used must be designed so that its natural period of resonance is not within the frequency range of the test.

The shock machine itself should be mounted on a suitable concrete base and leveled before being put into use.

With the machine thus conditioned for use, it is possible to subject electronic equipment within the weight range of 1 to 100 pounds to shocks of reproducible magnitude in the laboratory, thereby determining the suitability of electronic equipment or any other equipment within this weight range for use in service conditions where severe shock may be encountered.

By assembling a selected number of blocks **40** or wedges **42** on the underside of the table **22**, thus creating various areas it will be possible to apply a shock of any desired duration within the limits of the machine. In this connection it is noted that a wedge shaped area formed of several wedge shaped blocks **42** may penetrate the said several inches before stopping the carriage, thus providing a shock of relatively long duration, while another area made up of blocks **40** of flat surfaces on the underside will stop the carriage with a very shallow penetration of the granular material, thus providing a shock of very short duration. For consistent results the granular material should be leveled and raked once before each drop with a rake having teeth approximately six inches long spaced about two inches apart.

With the desired acceleration and the time duration known, the unknown factors, the height of the drop necessary, the number of blocks, and the spacing of the blocks may be calculated.

The equation $F=Ma$ (Force=Mass x acceleration) indicates that a body can have uniform acceleration only when the net force acting on it is uniform. The net force acting on a falling body, however, is not uniform for two reasons: (1) the force of gravity varies with the geographical location and (2) the frictional resistance of a body moving through air increases rapidly with the speed of the body. However, if the body does not fall far, the variation in the force of gravity along its path is very slight. Also, in falling a short distance, a body does not acquire sufficient speed for the air resistance to affect it appreciably.

Inasmuch as the variations in the net external force acting on a body of relatively small surface when falling but a few feet is very small, it is customary to assume that the force is constant. In the equation $F=Ma$ it is therefore assumed that gravity acceleration is constant.

When the table **22**, carrying the equipment being tested, is dropped from a predetermined height, the acceleration a may be determined by the equation:

$$a=\frac{V_2-V_1}{t}$$

wherein,

V_1=the initial velocity at the point of contact of the blocks **40** with the granular material,

V_2=the final velocity at point of maximum penetration when the velocity is zero,

t=time which is dependent on the distance of penetration in the granular material necessary to stop the table and is controlled by the selection of the area on the underside of table **22** made up of blocks **40** or wedges **42**.

V_1 may be determined by the equation

$$V_1=\sqrt{2gh}$$ wherein,

g=gravity (acceleration) and

h=height of free fall of table.

Having thus described an embodiment of my invention, I claim:

1. In a variable duration shock testing machine, a box for holding granular material, said box having the top side open, a bed of said granular material in said box, columns extending vertically from said box, a carriage including a horizontally disposed work table movable vertically along said columns, guide means on said carriage in vertically sliding engagement with said columns for maintaining free fall of said carriage along said columns, means to raise said carriage to a selected height connected thereto, means to suspend said carriage at said selected height associated therewith, trip means to release said carriage for free fall, and a plurality of impact members mounted on the underside of said table in side by side relation, the members being individually separable therefrom whereby shock duration may be varied.

2. In a variable duration shock testing machine, a sand box open on top, guide columns extending upwardly from said box, a carriage including a table above said sand box for supporting the work to be tested, guide means on said carriage in sliding engagement with said columns for directing free fall of said carriage with respect to said sand box, means to suspend said carriage at a selected height above said sand box, means associated with the suspending means to trip said means to drop said carriage upon the sand in said box, and impact means on the underside of said work table comprising a plurality of blocks in side by side relation, and clamping means for separably fastening said blocks to the bottom of said work table whereby shock duration may be varied.

3. In a variable duration shock testing machine, an open top sand box, a carriage including a table above said sand box for supporting the work to be tested, guide means on said sand box and corresponding guide means on said carriage for directing free fall of said carriage toward said box, means to suspend said carriage at a selected height above said box, means to trip the suspending means to drop said carriage upon the sand in said box, and impact means on the underside of said work table which consists of a plurality of wedges, and means for fastening said wedges, points downward to the underside of said work table.

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