Sept. 12, 1950 D. E. HUDSON ET AL 2,521,918

DECELEROMETER

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FIG. 1

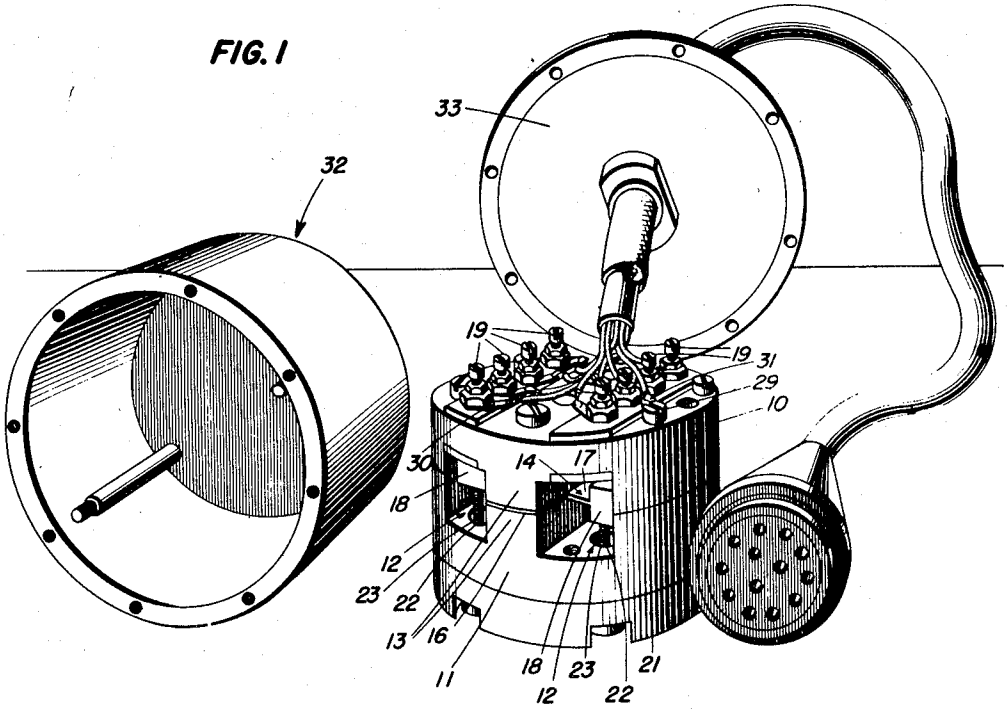

FIG. 2

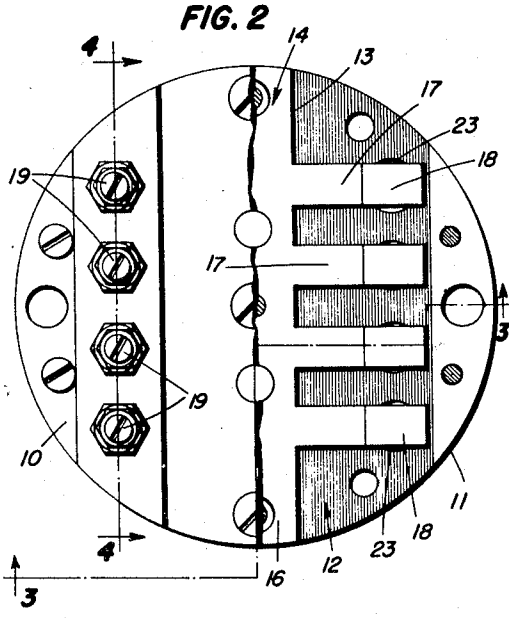

FIG. 3

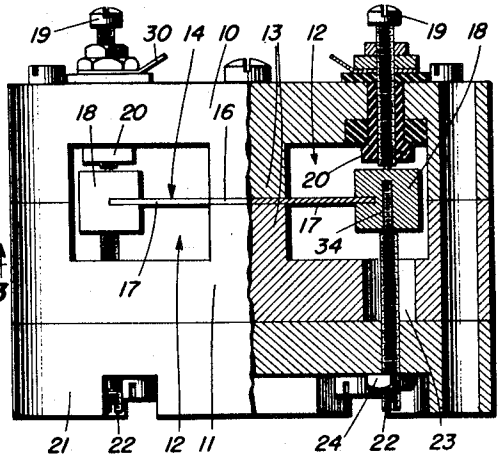

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FIG. 4

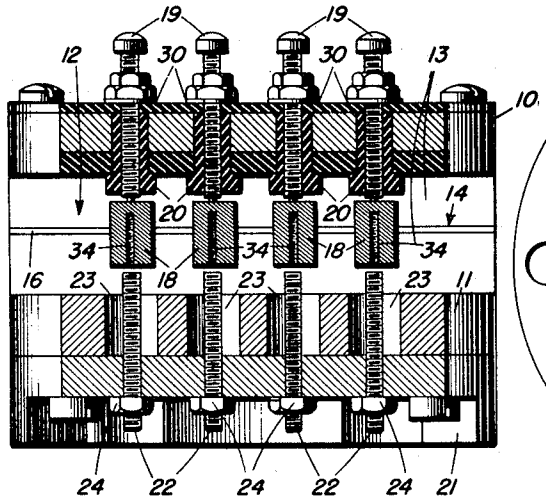

FIG. 5

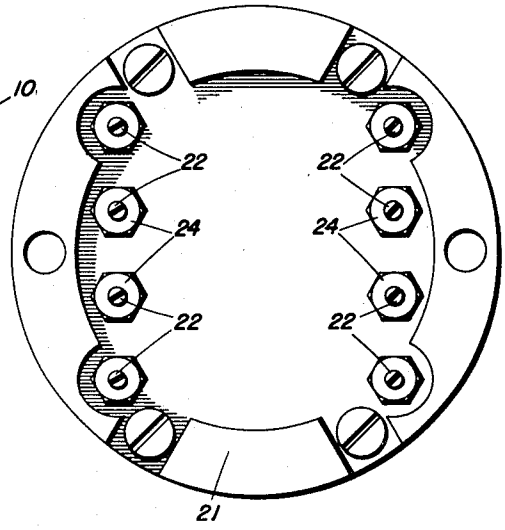

FIG. 6

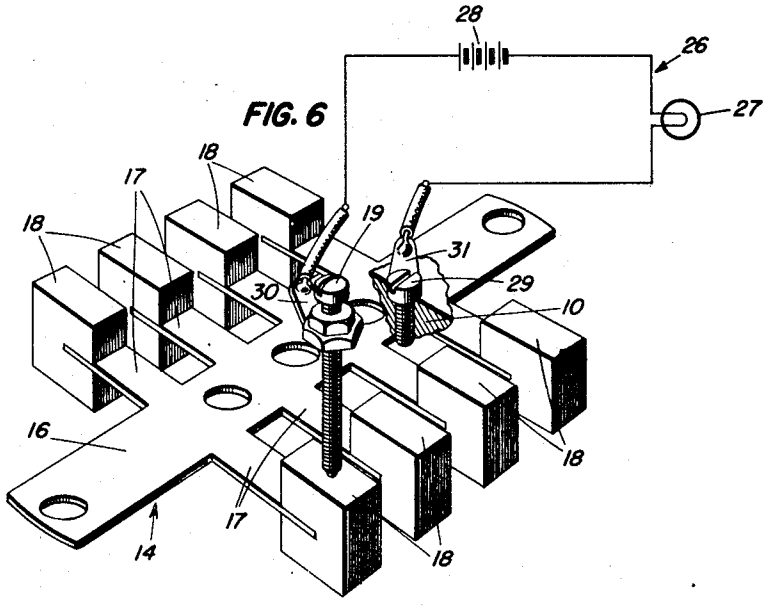

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FIG. 7

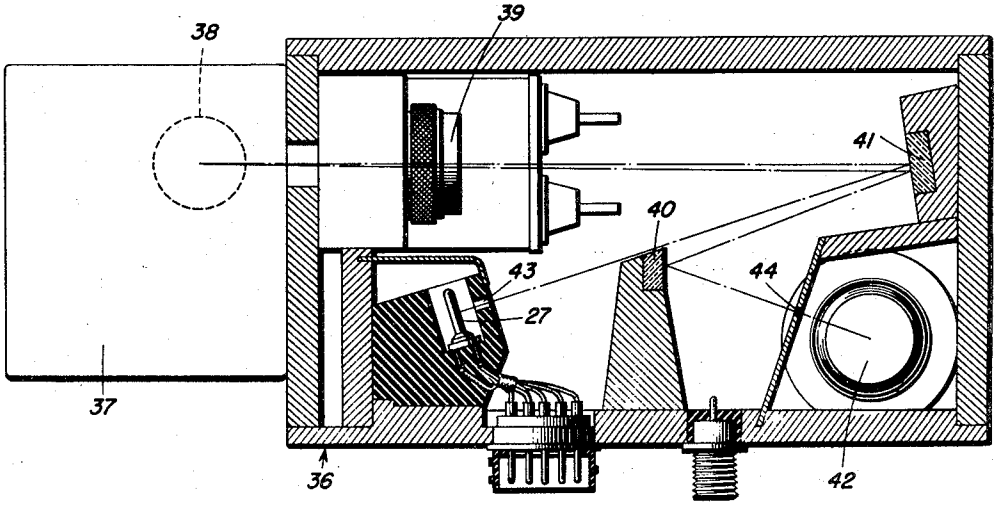

FIG. 8

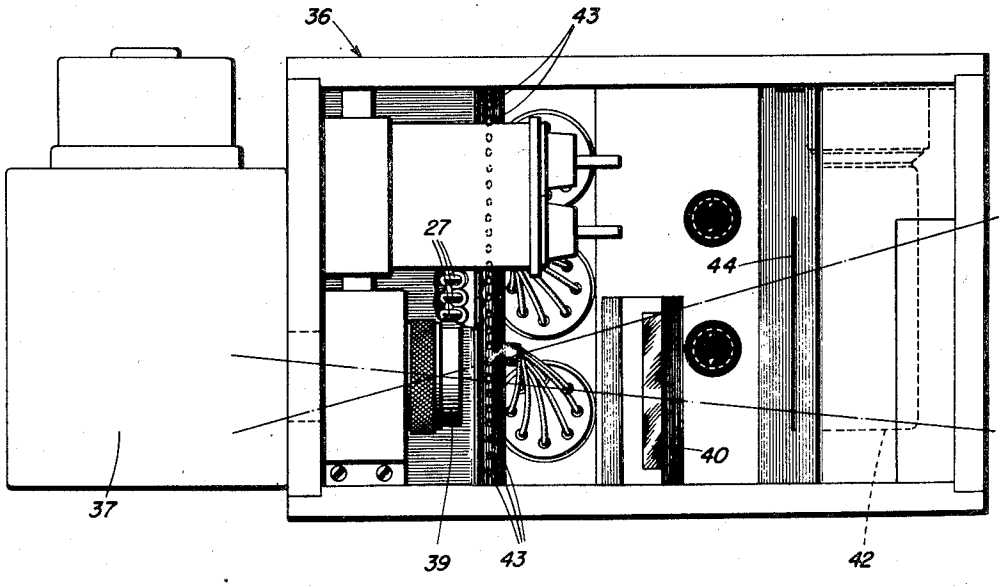

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FIG. 9

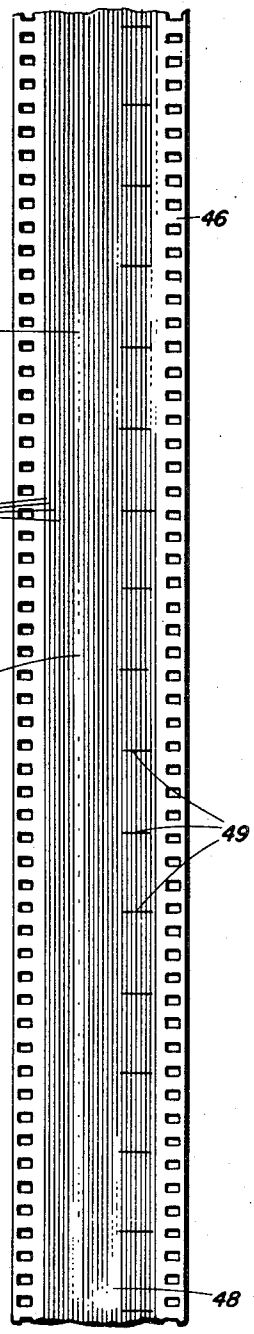
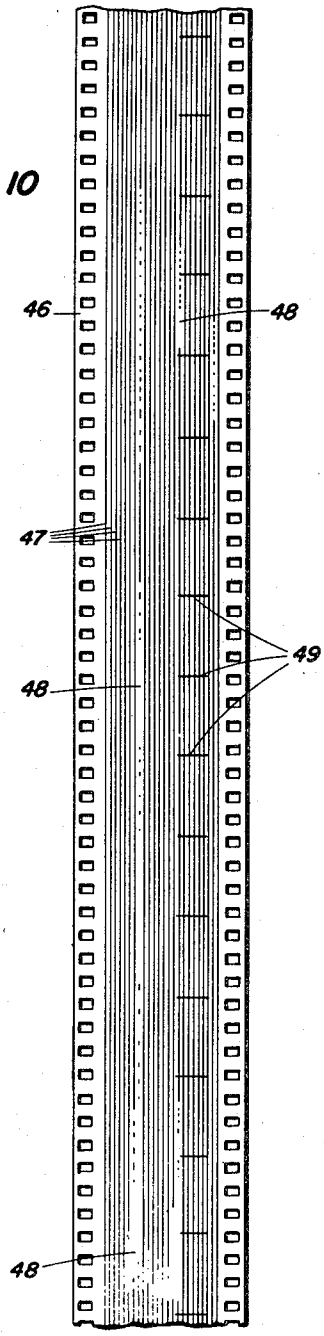


FIG. 10



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UNITED STATES PATENT OFFICE

2,521,918

DECELEROMETER

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Application October 24, 1945, Serial No. 624,294

1 Claim. (Cl. 264—1)

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This invention relates to instruments for measuring the deceleration of moving bodies and, particularly, to decelerometers for measuring the rate of change of velocity of projectiles, bombs, torpedoes, and the like upon impact with water or solid objects.

When an ordnance missile strikes its target or some dense medium, such as water, through which it must pass to reach the target, the deceleration accompanying the impact imposes a great mechanical strain upon the body of the missile as well as upon its internal components. The hull of an aircraft torpedo, for example, must be constructed strongly enough to withstand water impacts without becoming distorted; likewise, the engine used to propel the aircraft torpedo through the water must be sturdy in its design and secure in its mounting to prevent any undesirable displacement thereof or of any of its components due to deceleration forces set up by water impacts.

It can be readily seen that a factor which greatly influences the design of an ordnance missile is the deceleration it will be expected to encounter in its normal use. While the deceleration in any particular case can be found by several known empirical methods, the values arrived at by these methods are only rough approximations at best, and designs based on such values may suffer as a consequence. It is to the improvement of methods of measuring the deceleration of ordnance missiles on impact with various targets that the present invention is particularly addressed.

Accordingly, a primary object of this invention is to provide an instrument capable of measuring the deceleration accompanying the force of impact of an ordnance missile upon water or solid objects.

Another object of the invention is to provide a decelerometer which will measure true values of deceleration of a moving body, notwithstanding the occurrence of deceleration components perpendicular to the axis along which the deceleration is measured.

A further object of the invention is to provide a decelerometer capable of furnishing permanent photographic records of the decelerations measured.

Other and ancillary objects and advantages will become apparent from a study of the accompanying specifications and drawings in which:

Fig. 1 is a perspective view of a partially disassembled decelerometer representing a preferred embodiment of our invention;

Fig. 2 is a plan view of the body portion of the decelerometer with one-half of the cap broken away;

Fig. 3 is a half-sectional, half-elevational view taken along line 3—3 of Fig. 2;

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Fig. 4 is a sectional view taken along line 4—4 of Fig. 2;

Fig. 5 is a bottom view of the body portion of the decelerometer;

Fig. 6 is a perspective view of the spider spring and weight members shown in section in Fig. 4; also illustrated, diagrammatically, is one of the electrical circuits employed in the decelerometer.

Fig. 7 is a sectional view of the recording camera employed with the decelerometer of the invention;

Fig. 8 is a plan view of the recording camera with the cover removed;

Figs. 9 and 10 are illustrations of typical photographic records obtained by the decelerometer.

Referring now particularly to Figs. 1, 2, 3, and 4, it is seen that the decelerometer body comprises two thick juxtaposed discs 10 and 11 containing complementing channels, which define chambers 12 and partition 13. A spider spring 14, shown in detail in Fig. 6, comprising a central web 16 and laterally extending cantilever spring arms 17, is clamped by its central web between the two coacting halves of partition 13. The spring arms 17 which project into the chambers 12, carry electrical conducting weight members 18 positioned for engagement with a corresponding number of contact screws 19. The latter are threadably mounted to disc 10 but electrically insulated therefrom by suitable insulators 20. In addition to functioning as electrical contacts, screws 19 are adjustable to exert a predetermined load upon weight members 18, thereby setting up a restoring force in spring arms 17 which are distorted by such load, thus permitting the conditions in which the several weight members 18 are separable from their corresponding contact screws under different and predeterminable forces. The utility of this arrangement will appear hereinafter when the operation of our decelerometer is discussed.

The disc 11 which constitutes the lower body member of the decelerometer is secured to a base plate 21. Arresting bolts 22 project into chambers 12 through clearance holes 23; one such bolt terminates in proximity of, but not normally engaging, each of the respective weight members 18. Adjustment nuts 24 are provided to maintain the arresting bolts 22 in their proximate positions in relation to weight members 18.

Electrical circuits 26, one of which is shown graphically in Fig. 6, connect each of the respective contact screws 19 with a light source 27. All such electrical circuits 26 are connected in parallel with an electrical power supply 28 and a common ground post 29 and each is energized as long as its contact screw 19 and weight member 18 are in engagement. Contact screws 19 and ground posts 29 are connected to their circuits 26 by means of terminals 30 and 31 respec-

tively. The entire decelerometer assembly is enclosed in a case 32 provided with a cover 33.

Calibration of the spring arms to determine the force required to break contact between weight members 18 and contact screws 19 is accomplished in the following manner. Base plate 21 is detached from disc 11; this operation likewise removes arresting bolts 22 from their positions adjacent weight members 18. A small screw (not shown) is then threaded into the tapped socket 34 which is provided in each of the weight members 18, and a balance pan is suspended therefrom. These operations are, of course, performed individually for each spring, and the desired weight, representing the deceleration necessary to break contact between the weight member 18 and its contact screw 19 is placed in the balance pan, and contact screw 19 is adjusted until it just breaks contact with the weight member 18.

Reference is now made additionally to Figs. 7 and 8. The camera shown generally at 36 comprises essentially a motor 37 for moving photographic film 38, an optical system 39 and mirrors 40 and 41. The light sources 27 are arranged in an evenly spaced row transversely of the case in such manner that light from each may be trained on the film in the form of a spot, and formed into a trace by the movement of the film, each trace occupying its own film area. An additional single light source 42 capable of furnishing a uniformly interrupted beam of light is also included in the camera case. An example of such an interrupted light source suitable for use with our decelerometer is the "Strobotron" stroboscope controlled by a multivibrator described on page 531 of "Theory and Applications of Electron Tubes," Second Edition, by Herbert J. Reich, published by McGraw-Hill Book Company, Inc. Frequencies of the multivibrator should be of the order of 100 cycles per second. A small orifice 43 directs the light rays from each light source 27 to the mirror 41, whence they are reflected and directed through the optical system 39 to moving photographic film 38. In like manner, slit 44 directs the interrupted light rays from light source 42 to the photographic film 38 by means of mirrors 40 and 41 and optical system 39.

In Figs. 9 and 10 the films 46 there depicted represent actual records obtained in deceleration tests on aircraft torpedoes using the decelerometers of the present invention. The fine longitudinal lines 47 on the films are traces of the several light sources 27 from three decelerometers disposed parallel to the three axes of the aircraft torpedo. The discontinuities, as 48, in these lines resulted from de-energization of the electrical circuits 26 by movement of the weight members 18 away from contact screws 19 under deceleration. Transverse lines 49 were recorded by the interrupted light rays from light source 42 and provide a ready and accurate means for measuring the length of time during which electrical circuits 26 are de-energized.

Operation of the decelerometer will now be described as it may be used to measure the deceleration of an aircraft torpedo upon impact with the water. Each contact screw 19 is made to engage its corresponding weight member 18 and the spring arms 17 are calibrated as previously described. When the torpedo is released, both light sources 27 and 42 are energized; at the same time, electric motor 37 begins to operate, causing photographic film 38 to move past optical system 39 for exposure. As long as the torpedo is falling freely, all contact screws 19 are in engagement with weight members 18, thereby maintaining electrical circuits 26 in a closed condition and permitting light sources 27 to function. Light source 42 functions independently of circuits 26. Traces of light sources 27 and periodic transverse lines 49 corresponding to the intermittent flashes of light source 42 are thus recorded on the moving film 38.

As the torpedo decelerates upon water impact, weight members 18, moving relative to the torpedo under their own inertia, break contact with screws 19, de-energizing electrical circuits 26 in sequence according to the tension placed on the several spring arms 17 by the contact screws 19. If the deceleration is great these circuits may be broken virtually simultaneously, but, thereafter, as the deceleration is decreased the contacts will close in the order determined by the tension in spring arms 17. The points on the photographic film at which the several electrical circuits are opened and closed furnish the data from which the deceleration may be computed.

While what has been described is particularly illustrative of a presently preferred embodiment of our invention, it is not intended that the scope of the invention be limited thereto but that it embrace any modifications and changes which fall within the true spirit of the invention, as covered by the claim, occurring to those skilled in the art.

We claim:

A decelerometer comprising a pair of body members defining confronting channels separated by mating ridges, a spider spring including a web portion clamped between said ridges, cantilever springs extending laterally from said web portion into said channels, weights carried by the free ends of said springs, adjustable means for applying loads on said springs in addition to said weights, and means for detecting movement of said springs beyond their deflections as determined by said weights and said adjustable load applying means.

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