July 27, 1965 R. C. MEADE 3,196,794

PIEZO-ELECTRIC FUSE DEVICE

Filed June 18, 1959

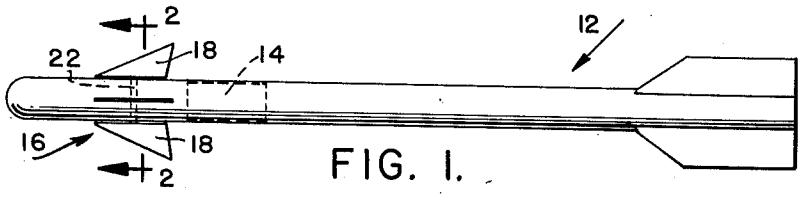


FIG. 1.

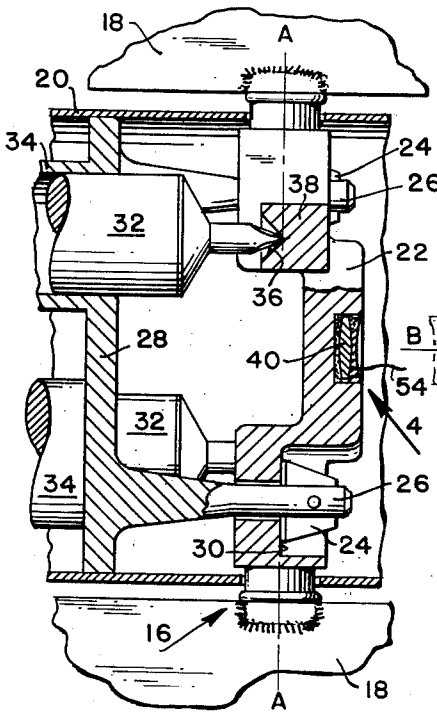


FIG. 3.

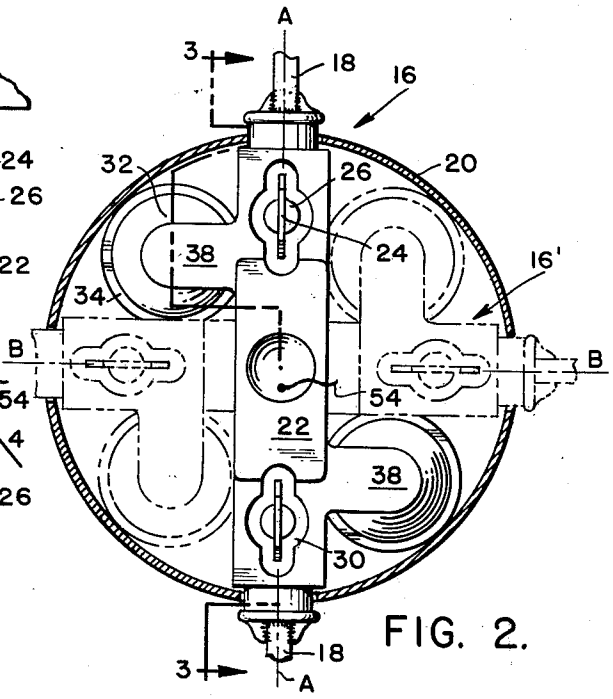


FIG. 2.

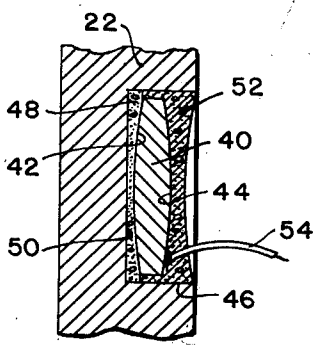


FIG. 4.

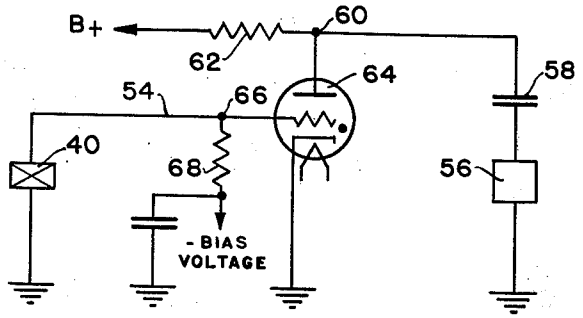


FIG. 5.

INVENTOR.
ROBERT C. MEADE

BY

V.C. Muller

ATTORNEYS.

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PIEZO-ELECTRIC FUSE DEVICE

Robert C. Meade, China Lake, Calif., assignor to the United States of America as represented by the Secretary of the Navy

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3 Claims. (Cl. 102—70.2)
(Granted under Title 35, U.S. Code (1952), sec. 266)

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

The present invention relates to impact type fuses for military missiles having explosive warheads and more particularly to such fuses for applications were it is desirable to locate the impact sensing element at a location removed from the region exposed to direct impact with a target. A particular application of the invention is in anti-aircraft missiles where it is desirable to detonate the warhead in response to impact between the target and external appendages of the missile, such as the steering and stabilization fins.

In the prior art, the elements for sensing impact are located in positions exposed to direct impact. For example, in the application referred to the element for sensing impact consists of an electrical wire which is recessed along the edge portion of each fin which is to be sensitive to target impact, the wire being separated from the fin body by some easily broken insulation material so that if the fin strikes or grazes the target the wire electrically short circuits to the fin body closing a detonation circuit. This arrangement is not entirely satisfactory because the edge portions of such external appendages are inherently vulnerable to damage during handling of the missile and therefore special precautions against damage are necessary such as attaching protective guards to the fin surfaces until the missile is to be used and testing the fuse circuit as a final step before the missile is to be used to determine whether any damage has occurred.

It is an object of the present invention to provide a fuse of the impact type wherein the impact sensing element may be physically removed from the region exposed to direct impact.

A further object is to provide a fuse of the impact type which is less vulnerable to damage than fuses heretofore available.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a side elevation of a guided missile which employs the present invention;

FIG. 2 is an enlarged sectional view along line 2—2 of FIG. 1, which for purposes of simplicity, shows only one of the two pairs of control fins in full line, the other pair of fins being shown in phantom;

FIG. 3 is a section taken along line 3—3 of FIG. 2;

FIG. 4 is an enlarged section of a detail indicated by arrow 4 in FIG. 3, and

FIG. 5 is a schematic diagram of electrical circuitry within the guided missile of FIG. 1.

Referring to the drawing, a guided missile 12, FIG. 1, carrying an explosive warhead 14 has a steering fin mechanism best seen in FIGS. 2 and 3, which includes a steering fin member 16, an integral structural element supported for rotation about axis A consisting of fin portions 18, 18 which are disposed outside of the missile outer casing 20 and an operating shaft portion 22 disposed within the space enclosed by the casing, it being understood that there is a like steering fin member 16' shown in phantom

which rotates about axis B which is perpendicular to axis A. The mechanism which operates and supports steering fin member 16 per se forms no part of the present invention, such mechanism including knife blades 24 carried by posts 26 extending from a frame 28, which blades bear againsth recessed surfaces 30 formed on steering fin member 16, the knife blades acting as fulcrums against pressure exerted by pistons 32 which slide in cylinders 34 formed in frame 28, and which pistons engage conical recesses 36 provided in projecting lever arms 38 formed on steering fin member 16, to provide the torque to operate the steering fins. A conventional piezo-electric disc 40, best seen in FIG. 4, made of some suitable piezo-electric material such as barium titrate which generates an electrical signal across its opposite silver coated faces 42 and 44, in response to stresses within the disc, is retained in a recessed zone 46 formed in the steering fin member 16 by means of a layer of conductive cement 48 disposed between the bottom surface 50 of the recessed zone 46 and disc face 42 and a layer of epoxy resin 52 or other suitable non-conductive adhesive having sufficient strength and hardness to mechanically couple stresses from steering fin element 16 to piezo-electric disc 40 poured over disc face 44 and into the clearance existing between the disc and the side walls of the recessed zone. Any electrical signal generated by piezo-electric disc 40 across disc faces 42 and 44 is picked off by the conductive cement 48 which electrically connects disc face 42 to the missile body and hence electrical ground and an electrical lead 54 soldered to silver coated disc face 44, which leads to electrical circuitry to be hereinafter described.

In accordance with the present invention explosive warhead 14 is detonated if fin portions 18 strike or graze a target. Upon thusly striking or grazing the target severe vibrations in the nature of high frequency stresses occur throughout steering fin member 16 which stresses are mechanically coupled to piezo-electric disc 40 generating an electrical signal across disc faces 42 and 44. Explosive warhead 14 is detonated in response to such electrical signal by means of an electrical circuit shown schematically in FIG. 5, a conventional detonation arrangement including an electrical detonator 56 and an energy storage capacitor 58, the capacitor constituting the source of potential for firing the detonator. Detonator 56 and capacitor 58 are connected in series between ground and a terminal 60. The network for charging capacitor 58 includes the missile B+ power source and a current limiting resistor 62 connected between the B+ power supply and terminal 60, resistor 62 serving to limit the current through the detonator while capacitor 58 charges to the voltage of the B+ power supply. A conventional normally non-conductive thyratron type tube 64 with its plate connected to terminal 60 and its cathode connected to ground is adapted to become conductive when the voltage level of the electrical signal generated by the piezo-electric disc 40, connected between the control grid terminal 66 of tube 64 and ground overcomes a bias voltage from the missile's negative bias voltage source also applied to terminal 66 through resistor 68, which resistor also serves as a load resistor for piezo-electric disc 40, resulting in thyratron tube 64 becoming conductive in response to the stresses accompanying fin impact with the target and providing a low resistance path for the energy stored in capacitor 58 to fire detonator 56. It is apparent that in contradistinction to prior art devices where the sensing element is physically located on the edges of the fins, piezo-electric disc 40, the sensing element of the present invention is within the protective covering of casing 20 where it is less susceptible to damage in handling and the special precautions against fuse damage heretofore necessary are obviated.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An impact type fuse for a missile warhead comprising: a structural element of the missile exposed to direct impact with a target, a piezo-electric device mechanically coupled to said structural element and adapted to generate an electrical signal in response to vibrations which accompany the impact of said structural element with a target, an electric circuit within said missile adapted to detonate the warhead in response to said electric signal, and an outer missile casing forming an enclosed space within said missile and wherein said structural element extends through said casing, being disposed in part outside of the missile where it is exposed to direct impact with a target and disposed in part within said enclosed space and wherein said piezo-electric device is disposed within said enclosed space.

2. The fuse of claim 1 wherein said structural element is a steering fin having an operating shaft extending through said casing, and said piezo-electric device is carried by a portion of said shaft disposed within said enclosed space.

3. The apparatus of claim 1 wherein said electric circuit includes a thyratron type tube having a control grid and a cathode, a source of biasing voltage connected to said control grid and to said cathode, said piezo-electric device being connected to said control grid and to said cathode in such manner that the effect of said source of biasing voltage is overcome and said thyratron type tube becomes conductive in response to a predetermined level of electric signal generated by said piezo-electric device.

References Cited by the Examiner

UNITED STATES PATENTS

2,894,457 7/59 Severance ---------- 102—70.2

BENJAMIN A. BORCHELT, *Primary Examiner.*

CHESTER L. JUSTUS, *Examiner.*