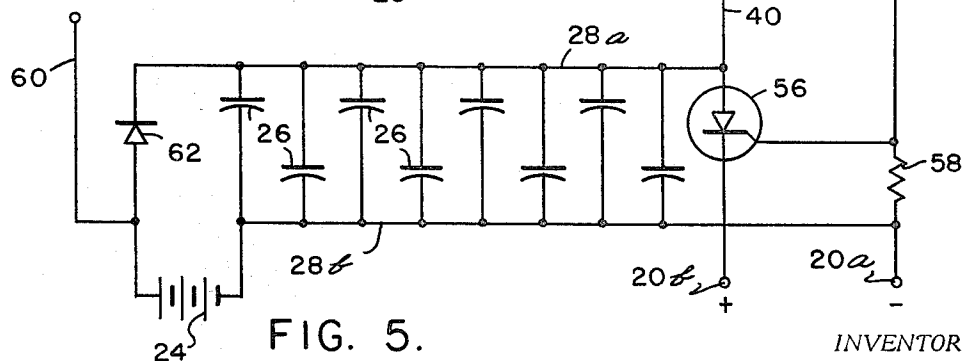


3,395,640

Filed May 17, 1967



INVENTOR.
JAMES W. TAYLOR
BY MICHAEL F. OGLO
ROY MILLER
ATTORNEYS.

1

3,395,640

SEA WATER TRIGGERED ELECTRICAL
ENERGY SOURCEJames W. Taylor, Pasadena, Calif., assignor to the United
States of America as represented by the Secretary of 5
the NavyFiled May 17, 1967, Ser. No. 640,451
5 Claims. (Cl. 102—16)

ABSTRACT OF THE DISCLOSURE

An integrally housed electrical power source is adapted to be automatically triggered by a sequence of events consisting of pulling a lanyard and immersion in normally saline ocean water. The housing contains a small thermal battery wired to charge a bank of capacitors. The thermal battery is of the type activated by a percussion cap and is mounted in the housing with the percussion cap confronting a seawater port. In the initial (locked) condition of the device, a spring loaded hammer is locked in place in the seawater port by a locking pin through an aperture in a portion of the hammer which projects from the exterior of the housing. When the locking pin is removed from its aperture, by pull of the lanyard, the spring impells the hammer against the percussion cap and activates the thermal battery, which in turn charges the capacitor bank. A seawater conductivity switch is disposed in the housing and is connected in an electronic relay circuit for discharging the capacitors through the output terminals of the device. This serves to trigger the device's output in response to the entry of water into the interior of the housing after the device is immersed. The entire structure is arranged for exceptional compactness.

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.

This invention relates to a long shelf-storage life electrical power source for firing a squib, and more particularly to such a device which is automatically triggered by a sequence of events consisting of pulling a lanyard and immersion in normally saline ocean water.

A typical use for the present type of device is the initiation of the propelling means of an aerial or ship launched torpedo. (A type of torpedo propulsion engine which requires initiation by means of a squib is a monopropellant fueled external propulsion engine.) The lanyard which performs the first event of the triggering sequence is attached to the structure of the aircraft, or to other structures from which the torpedo separates prior to water entry.

In certain hitherto known torpedoes having squib started propulsion engines, it has been the practice to employ an automatically triggered source consisting of a seawater battery which communicates with the ocean through a port which is opened by the pull of the lanyard. Such systems have not proved entirely satisfactory under all conditions of operation and particularly where low temperatures or low salinity has been present, and also where high shock or vibration may be present. A stringent requirement for such devices is that they be compact and packageable within envelope dimensions which are easy to mount in a torpedo hull.

An object of the invention is to provide an automatically triggered electrical power source, of the type described, which is rugged and highly dependable under all conditions of operation.

Another object, is to provide a device in accordance with the preceding objective which has compact envelope

2

dimensions which are convenient for mounting in connection with a torpedo.

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 the subject of the invention, certain portions being cut away and the parts being shown in their initial (unarmed) position;

FIG. 2 is a section taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged central section of an upper portion of FIG. 1 taken along section lines 3—3, FIG. 4, and with the parts shown in their position after the device is armed by removal of the locking pin;

FIG. 4 is a reduced section taken along lines 4—4, FIG. 3; and

FIG. 5 is the electric circuit diagram showing the interconnection of electrical components in the device of FIG. 1.

Referring now to the drawing and in particular to FIG. 1. The subject of the invention is an automatically triggered electrical power source 10. The device 10 is shown mounted in the pressure hull 12 of a torpedo. Power source 10 comprises a cylindrical housing 14 having its inner end closed by integral end wall 14a, and closed at its outer end by a removable closure 16 secured to the housing by screws. The housing has a shouldered portion 14b adjacent its outer end which is shaped to conform to a matching opening 18 in the pressure wall 12. An electrical outlet connection member 20 extends through and projects from the inner end wall. The projecting portion of the outlet connection 20 contains a negative terminal pin 20a and a positive terminal pin 20b.

A cylindrically shaped thermal battery 22 is centrally disposed within housing 14 near its inner end. Battery 22 has a percussion cap 24 disposed at the center of its upper face. Thermal battery 22, is of a conventional type, which is completely inert until its percussion cap is fired, and then momentarily produces a predetermined voltage output of the order of 28–38 volts, which lasts for several seconds duration. A particular advantage of the use of the thermal battery is its almost unlimited shelf storage life due to the inert nature of all its component materials prior to the action of firing the percussion cap. Suitable commercially available batteries include the model CAP-6107 produced by Eagle-Picher Company of Joplin, Mo., and the model EW-NP-3 produced by Eureka Williams Company of Bloomington, Ill. Other types of percussion cap activated batteries which have long shelf storage lives are known, and may be employed as an alternative to the thermal type battery. Eight individual cylindrically shaped, tantalum capacitors 26, FIG. 2, are arranged in a circle in the annular space between the housing wall and the thermal battery. Capacitors 26 each have one electrode terminal projecting from its upper end faces, and another electrode terminal projecting from its lower face. Batteries 26 are connected in parallel circuit by a positive bus wire 28a connecting the upper face terminals, and a negative bus wire 28b (not shown) connecting the lower face terminals. The bus wire 28a shown in the drawing, is of nickel ribbon stock. Potting material 30 is flowed into the space around the battery and capacitors, and is also molded to form an annular ledge portion 30a (best shown in FIG. 1) above the capacitors. This construction leaves a well 32 formed above the face of battery 22 containing the percussion cap. A conductivity switch assembly 34 is affixed to the top of the annular ledge 30a by suitable pins 35 molded into the potting. As best shown in FIG. 3 taken in conjunction with FIG. 4, switch assembly 34 is of a stacked construction consisting of upper, intermediate,

and lower annular members 36, 38 and 40. Upper member 36 is of an insulation material, such as fiberglass sheet laminate, having an annular conductive element 36a of copper cladding formed on its lower face adjacent its inner periphery. Lower member 40 is similarly formed, but with its annular conductive element 40a formed on its upper face. The intermediate member 38 has a larger diameter inner opening and serves to space the confronting conducting elements 36a, 40a. The conductive element 36a and 40a have outwardly extending tabs 36b and 40b for connection to electric lead wires 42 (only one is shown in the drawing), which extend vertically downward through small drilled holes through the stacked switch elements and into the potting material, where they are connected to the leads from other potted electronic components. The inner periphery of the annular conductive elements are spaced slightly inward from the inner edge of members 36 and 40, so that they cannot be shorted together by presence of an object in well 32.

Referring now to FIG. 1 taken in conjunction with FIG. 3, closure 16 has a central aperture of port 44. A cylindrically shaped hammer 46 consists of a shank portion 46a adjoining its outer end, and a shouldered portion 46b adjoining its inner end. Shank portion 46a is adapted to slidingly fit within port 44, and is provided with an O-ring 47 along its periphery to produce a watertight seal. A C-ring 48 is affixed about the periphery of shouldered portion 46b close to the inner end of the hammer. The inner end face of the hammer contains a striking surface 46c, which is shaped to impact and fire the percussion cap 24. A helical compression spring 50 is disposed about the hammer between the inner surface of closure 16 and C-ring 48. A locking pin aperture 52 extends diametrically through shank portion 46a near its outer end. In the initial, or locked, condition of device 10 shown in FIG. 1, the hammer is locked in a spring cocked condition by means of a locking pin 54 disposed in aperture 52. The arrangement is such that spring 50 is tightly compressed in this position.

The electric circuit connections of the electrical components of device 10 will now be described with reference to FIG. 5. The output terminals of battery 24 are connected to positive bus 28a and to negative bus 28b. Negative bus 28b is connected to the negative output terminal 20a of device 10. Positive bus 28a is connected to the positive output terminal 20b of device 10 through the anode to cathode path of a silicon-controlled diode 56. Conductivity switch assembly 34 has one of its conductive elements connected to the positive bus 28a and its other conductive element connected to circuit ground through a dropping resistor 58. The high side of the dropping resistor is connected to the gate of silicon controlled diode 56. A test lead terminal 60 is provided to enable placing a test charge on the bank of capacitors. A diode 62 is series connected between the positive output of the battery and the positive bus wire to prevent discharge of the capacitors through the battery in the event of a short circuit therein. Silicon-controlled diode 56, resistor 58, and diode 62 are suitably disposed in the potting 30 within housing 14.

In describing the operation of power source device 10, it will be assumed that it is carried in a torpedo about to be dropped from an aircraft and with the looped portion 54 of the locking pin attached to a portion of the aircraft structure through a lanyard line. Upon dropping the torpedo from the aircraft, the lanyard pulls pin 54 out of aperture 52, releasing hammer 46. The force of the compressed spring 50 impels the hammer 46 out of seawater port 42 and into well 32 where the hammer striking surface 46c impacts and fires the percussion cap 24 of the battery. The spring 50 holds the hammer in the bottom of well 32. In this position the outer end of the hammer clears the sea water port leaving same open to admit sea water into the interior of the housing. Actuation of the percussion cap activates battery 22 charging the bank

of capacitors 26. At this point the anode to cathode path of silicon controlled diode 56 is open since no voltage is applied to its gate, and therefore the positive charge of the capacitor bank is not applied to terminal 20b. When the torpedo enters the water and sea water flows in through port 44, and because of the salinity of sea water, the presence of the first few drops of sea water between the annular conductive elements 36a and 40a provide a low resistance path from the positive bus 28a to the high side of resistor 58. The resulting positive voltage at the high side of resistor 58 is sufficient to turn "on" the silicon-controlled diode providing a low impedance path from bus 28a to output terminal 20b. The silicon controlled rectifier circuit therefor acts as an electronic relay applying the charge stored in the capacitor bank across output terminals of device 10. In the illustrated utility of a torpedo, the output of device 10 is applied to the squibs for starting a monopropellant fueled external propulsion engine.

The automatically triggered electrical power source, in accordance with the present invention, has been exhaustively tested under the most severe of possible environmental conditions, including low salinity, low temperature, and high shock conditions, and has been found to have exceptionally high dependability.

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. A sea water immersion triggered electrical power source, for use in providing impulse energy to a submersible equipment upon water entry, said power source comprising:
 - (a) a cylindrical housing having inner and outer ends closed by respective end walls and adapted to be carried by said submersible equipment with its outer end exposed to ambient sea water when the equipment is immersed, the outer end wall having an axially aligned sea water inlet port,
 - (b) electrical output terminal means extending through the housing wall,
 - (c) a percussion cap activated electrical battery disposed adjacent the inner end of said housing with the percussion cap striking surface confronting the sea water port,
 - (d) a hammer adapted to be disposed in sea water port to close same and an associated resilient means for urging said hammer out of said sea water port into impact with the striking surface of the battery,
 - (e) releasable means accessible from the exterior of the housing for securing the hammer in said sea water port against the urge of the resilient means,
 - (f) a seawater conductivity switch disposed inside the housing in a floodable space communicating with said seawater port, and
 - (g) an electrical circuit from the output of the battery to the output terminal means adapted to deliver the impulse energy of the battery to output terminal means after the battery is initiated and in response to closing of said sea water conductivity switch.
2. Apparatus in accordance with claim 1,
 - (h) said hammer having a cylindrical shank for slidably engaging the periphery of the sea water port and having means forming a collet at its inner end, and said resilient means comprises a compression spring disposed about said shank with one of its ends engaging the inner surface of the end wall and the other engaging the collet,
 - (i) said releasable means for securing the hammer comprising a locking pin disposed in a transverse aperture through a portion of the shank which is adapted to project from the outer face of the end wall of the housing when the spring is under compression.

5

3. Apparatus in accordance with claim 1,
 (j) said electrical circuit including storage capacitor means adapted to be charged by the battery upon initiation and an electronic relay circuit adapted to derive its operating power from the capacitor means and operable to close a discharge circuit through the output terminal means. 5
 4. Apparatus in accordance with claim 1,
 (k) said housing forming a floodable space between the outer end wall and the confronting end of the battery, 10
 (l) said sea water conductivity switch comprising a pair of axially spaced annular metal plates supported in said floodable space in concentric alignment about the housing axis.
 5. Apparatus in accordance with claim 1,
 (m) said battery contained in a cylindrical housing of

6

- a diameter less than that of the power source housing, and
 (n) said storage capacitor means comprising a bank of tantalum type capacitors arranged in the annular space between the battery and the cylindrical wall of the housing.

References Cited

UNITED STATES PATENTS

2,831,430	4/1958	Robertson <i>et al.</i>	102—16	X
2,967,481	1/1961	Semon <i>et al.</i>	102—16	
2,974,558	3/1961	Fogal <i>et al.</i>	102—16	
3,143,964	8/1964	Young	102—16	
3,252,417	5/1966	Johnson	102—16	

15 BENJAMIN A. BORCHELT, *Primary Examiner.*V. R. PENDERGRASS, *Assistant Examiner.*