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R. J. MILLER
SONIC PULSE GENERATOR
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FIG. 1

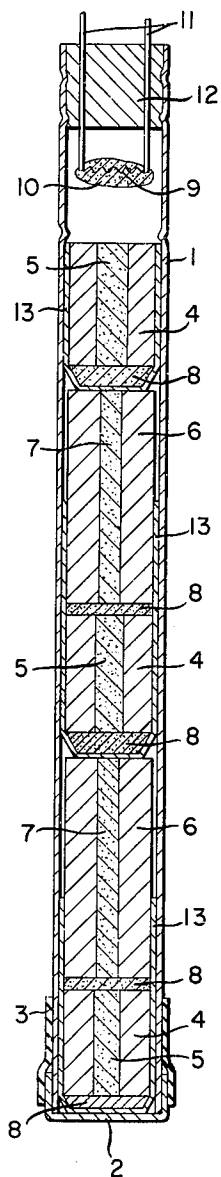
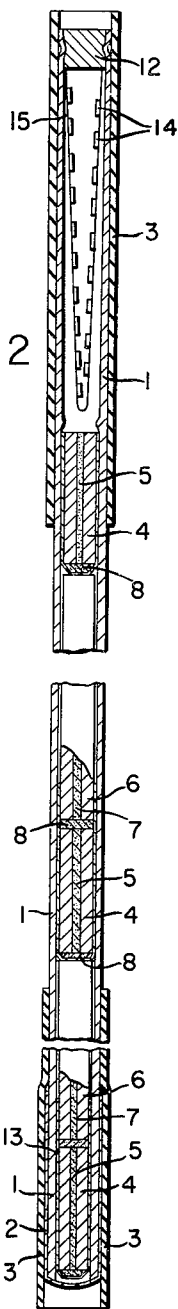


FIG. 2



INVENTOR

ROSS JAY MILLER

BY *John H. Tregning*
ATTORNEY

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3,154,013

SONIC PULSE GENERATOR

Ross Jay Miller, Pitman, N.J., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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2 Claims. (Cl. 102—1)

This invention relates to a device for generating a series of easily distinguishable sonic pulses whereby the interval between sonic pulses may be regulated.

A need exists for a sonic-pulse generating device adapted for use in calibrating the pulse-receivers of echanging systems and for rapidly measuring the velocity of sound in water at various depths and temperatures. For many purposes, it is particularly desirable to have a device which produces a series of spaced sonic pulses which can easily be distinguished and detected over background noises. For flexibility of operation, it is highly desirable that a means be provided whereby this spacing can be regulated in the field to produce a series of pulses best suited for a particular situation.

In accordance with this invention, a sonic-pulse generating device which can be field-adjusted to provide a desired spacing of pulses comprises a tubular shell, an ignition assembly sealing one extremity of the shell, a plurality of explosive pulse units disposed within the shell, a cap closing the other extremity of the shell and a sleeve securing said cap to the shell.

The term "pulse units" as used herein is meant to define a unit having sequential positioning of deflagrating compositions and detonating explosive compositions to provide spaced sonic pulses upon initiation.

A detonating explosive is defined, for purposes of this application, as an explosive composition which will release its potential energy with the development of high pressures and whose reaction rate exceeds the velocity of sound therein or about 1200 meters per second. Exemplary detonating explosives include lead azide, pentaerythritol tetranitrate (PETN), picryl sulfone, tetryl, nitromannite and the like. Lead azide is preferred due to its ease of initiation.

A deflagrating composition is defined as one which burns at a rate below the velocity of sound therein, generally at the rate of a few inches to a few feet per minute. Typical deflagrating compositions consist of stoichiometric mixtures of an oxidant and a fuel, e.g., a metal fuel. For the controlled burning rate required for the sonic-pulse generating device of the invention, the deflagrating composition will be confined in a thick-walled tube, for example, of lead or aluminum.

In the preferred embodiment of this invention, the detonating explosive is also contained as an axial core in a thick-walled tube to insure propagation from the deflagrating composition in a tube. A layer of deflagrating composition of essentially the outside diameter of the tubing may be interposed between each length of said tubing to provide additional insurance that propagation from core to core will occur. When this embodiment is used, the pulse unit preferably includes a thin-bottomed container to hold the components in proper sequence. In this embodiment, a layer of deflagrating composition is contained within and adjacent the bottom of the container, a length of thick-walled tubing containing a detonating explosive is adjacent this layer, and a second layer of deflagrating composition covers this thick-walled tube. The open end of the capsule will be fastened to the tube containing the deflagrating composition, for example by crimping or adhesive. No length of deflagrating composition need be positioned between the ignition assembly and the first detonating charge.

In order to describe the instant invention in greater

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detail, reference is made to the accompanying drawings in which FIGURES 1 and 2 are sectional elevations of representative preferred embodiments of the sound-generating device of this invention.

The adjustable sonic pulse generating device shown in FIGURE 1 includes as components thereof, a shell 1, a cap 2 in contact with and closing one extremity of the shell, a sleeve 3 of an elastic composition covering the joint between cap 2 and shell 1, a first thick-walled tube 4 having a central core 5 of a detonating explosive, a second thick-walled tube 6 containing a deflagrating composition 7 and layers 8 of the deflagrating composition. The tubes 4, loose deflagrating composition and a portion of the tube 6 are contained in a thin-bottomed container 13. The ignition assembly in this particular unit consists of a high-resistance bridge wire 9 surrounded by a coherent bead of an ignition composition 10 and attached to, and held in position by, lead wires 11 which in turn are held in place by, and pass through, a sealing plug 12 of resilient material.

In FIGURE 2, which is a partially sectional view of the device of this invention, the elements are as in FIGURE 1 with the exception that the ignition assembly consists of a string 15 of percussion-sensitive compositions 14 and the portion of shell 1 surrounding this particular ignition assembly is adapted to collapse upon the percussion sensitive charges at a predetermined hydrostatic pressure with sufficient force to effect ignition of at least one of the percussion sensitive pellets. A protective sleeve 3 of elastic material surrounds the collapsible portion of the shell.

When the ignition assembly is actuated, as, for example, by the passage of an electric current in the case of an electric ignition assembly or by the impact of the shell walls on percussion-sensitive compositions in the case of the pressure actuated assembly, a series of sonic pulses is produced, each pulse corresponding to the detonation of an individual charge of detonating explosive 5. No sonic pulse is produced by the burning of the deflagrating composition 7. The spacing of the pulses, i.e., the time interval or delay between successive pulses, is directly dependent upon the time required for each length of deflagrating composition filling the axial bore of the heavy-walled tube to burn from one end to the other, and this length of time is directly dependent upon the length of the deflagrating composition in the thick-walled tube, i.e., the length of the axial bore of the thick-walled tube.

In order to illustrate the present invention in greater detail, reference now is made to the following examples.

Example 1

Ten sound generating units were assembled as shown in the drawing. The shell of each was of commercial bronze and was 28.5 inches long with an outer diameter of 0.313 inch and an inner diameter of 0.250 inch. The cap was 1.75 inches long of identical material to the shell and was formed such that it was integrally closed at one end and its outer diameter was 0.336 inch and the inner diameter 0.315 inch. This cap was fitted over one end of the shell and the joint sealed in place by a 2-inch long, 0.25-inch inner diameter, 0.0625-inch thick sleeve of a polyvinyl chloride tubing. Into a 1.0-inch long inner capsule of aluminum (outer diameter, 0.240 in., inner diameter, 0.222 in.) having one end integrally closed, a layer of 0.4 grains of a 25/35/40 magnesium/barium peroxide/selenium mixture was loaded. Immediately above this charge, a one-inch long thick-walled lead tube having an outer diameter of 0.217 inch and containing as its central core lead azide drawn to a loading of 20 grains per foot was inserted and pressed into place by a 100 pound force exerted through a press pin. Another thin layer consisting of 0.4 grains of the 25/35/40 mag-

nesium/barium peroxide/selenium ignition mixture was loaded immediately above this cylinder, and, above this mixture, a 10-inch long thick-walled tube having an outer diameter of 0.217 inches and containing a central column of a 1.2/49.4/49.4 boron/red lead/dibasic lead phosphite slow-burning composition was placed. The heavy-walled tube was then seated by a contoured explosive press pin. The aluminum shell was crimped about the heavy-walled tube. The above procedure was followed to prepare nine more of the preassembled units. Three of these units were loaded into the outer shell in the order shown in the drawing. A circumferential crimp was made about the portion of the shell immediately above the last inserted unit. An open space of 1.5 inches was allowed between the uppermost pulse unit and a conventional electrical ignition assembly. After the rubber plug holding the ignition assembly was in place, three peripheral crimps were made in the shell wall to seal in the plug.

One of the thus assembled devices was lowered to a depth of six feet into a testing pond filled with cold water at a distance of three feet from a piezoelectric gage connected to a conventional oscilloscope through a 100-foot coaxial cable. When the device was actuated by applying electric current to the lead wires, the pressure-time curve observed on the oscilloscope indicated that the maximum sound level at 3 feet obtained from each charge was 130 decibels (re: 1 microbar) and the pulses were generated at 27 second intervals. The overall functioning of the device was 54 seconds.

The device was retrieved after firing; measurements showed that the shell was uniformly expanded to an outer diameter of 0.365 inch and that no rupture occurred in the shell or cap wall or in the polyvinyl chloride tubing.

Another of the devices was disassembled in the field by rolling the end of the sleeve engaging the cap back about half its length and removing the cap from the shell. The preassembled pulse units were removed, and the thick-walled tubes cut such that the length of the one uppermost in the shell was three inches, the second, six inches, and the third, ten inches. The units were replaced in the shell and the lengths cut from the heavy-walled tubes inserted below the last of the units to fill the remaining volume. When the unit was tested by the procedure described above, the pressure-time curve observed on the oscilloscope indicated that the maximum sound level obtained from each charge was 130 decibels (re: 1 microbar) and that the pulses were generated at 7.7, 15.4, and 27.2 second intervals. The overall functioning time for the unit was 50.3 seconds.

The device was retrieved; measurements indicated that the shell was not ruptured and expansion of the shell was uniform.

The sound produced upon actuation of the device of this invention is in the form of a series of "pings" free from secondary reverberations and separated by a delay interval in accordance with the desired spacing. The assembly functions well in water at temperatures ranging from the freezing point to the boiling point of water. When assemblies as described herein are fired in air, the sound level is of lower intensity and the shell is expanded further than is observed for an identical shell in water. A unit satisfactory for use in accordance with this invention may rupture when fired in air due to the lesser confinement offered by air, thus the wall strength required is that which will resist rupture when the assembly is submerged in water, regardless of the depth of the water.

The lack of violence of the assembly is apparent. Adjustment of the delay interval between individual pulses may be made simply and easily with no need for extensive tooling.

Alternatively, the ignition assembly may be of the pressure-responsive type such as the type wherein an ignition charge is actuated by collapse of the shell 1 onto a percussion-sensitive composition as in FIGURE 2 or where-

in the hydrostatic pressure acting on a piston forces a spring onto a percussion-sensitive composition in ignitive relationship to the core of explosive composition in the sonic pulse generating device as is taught in copending application Serial Number 64,087.

A restricting means such as crimp or a baffle may be provided between the uppermost cylinder and the ignition assembly to prevent damage of the ignition assembly during dismantling of the device.

The sequential firing action of the detonating explosive charge is effected by means of a delay train of the desired interval provided between each of the successive charges. These trains comprise the length of deflagrating composition, e.g., boron and red lead, silicon and red lead, or barium peroxide and selenium among others, in a thick-walled tube such as of lead or aluminum. When the deflagrating composition is thus confined, it is preferred to provide a thin layer 8 of the same or equivalent deflagrating composition at each end of the thick-walled tube to facilitate the ignition of the small core of deflagrating composition and the initiation of the small core of high velocity detonating explosive. The provision of such layers eliminates the need for great precision in aligning the respective small diameter cores of deflagrating and detonating composition. The components of the device of this invention may be preassembled for convenience in handling in thin-bottomed container 13 e.g., of aluminum, which may be inserted into the outer shell. The deflagrating compositions should function in the bottom of each of the preassembled shells to insure reliable propagation of the series.

For proper functioning of the device, the closure means must provide confinement of the explosive charges which will not rupture upon detonation of the detonating explosive when the device is immersed in water. Rupture of the shell or the closure means would result in escape of the gases resulting from the decomposition of the explosive charges with the formation of oscillating gas bubbles. These oscillating bubbles then would form the well-known bubble pulse thus obscuring the clarity of the desired sonic pulse. Preferably, the material used for the cap 2 will be the same as that used for the shell 1, i.e., thin-gauge copper, commercial bronze, another copper alloy, aluminum or a like metal, or a plastic. Other metals or plastics having sufficient structural strength may be used as well. The thickness and structural strength of the cap and shell must be such that they will not rupture upon detonation of the explosive charge when the assembly is submerged to avoid the formation of bubble pulses from gaseous products. Obviously, the requisite thickness and structural strength of the shell and cap will depend upon the explosive loading, with the greater explosive load requiring the thicker shell. In general, it has been found that with explosive loadings of 0.5 to 28 grains per foot the shell wall will have a thickness of 0.005 to 0.03 inch. At thickness less than 0.005 or greater than 0.03 inch, loading and crimping of the shell is more difficult, the thinner shell being too fragile and the thicker shell too resistant to crimping. The length of the shell depends naturally upon the size and number of explosive charges and the number and length of deflagrating compositions to be incorporated in the unit.

The sleeve 3 of an elastomeric material should provide a waterproof seal between the shell body and cap, and should exhibit a pronounced resistance to removal. The sleeve may be applied readily by lubricating the shell and cap, e.g., by wetting, and slipping the elastic sleeve over the end of the shell and the cap by pushing until it reaches the position substantially as shown in the drawing. The sleeve may be easily removed e.g., by rolling one of the ends back upon itself for about half of its length.

The elastic material of which the sleeve is formed may be any composition which will offer resistance to distortion under stress and which will at least partially return to its original configuration after distortion within its elastic limits. Exemplary elastic substances include nat-

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ural rubbers, polyisobutylene rubbers, chloroprene, acrylonitrile-butadiene elastomers, polyvinyl chloride, butadiene-styrene copolymers and the like. The use of these particular elastomeric compositions is in no wise critical to this invention, however, and the sleeve may be prepared of any elastic composition of any chemical composition which possesses the desired mechanical characteristics. The combination of the cap and sleeve of elastic material closing the end of the shell provides the waterproof, non-rupturable closure needed in the sonic pulse generator.

As stated, for proper functioning of the device, the explosive charge must be properly confined. The metal tube 4 will contain as a continuous central core a detonating explosive 5 in an amount insufficient to rupture the walls of the external shell upon its detonation, when the device is submerged in water. Any detonating explosive which will propagate a detonation in diameters under 1/4 inch can be used.

The outer diameter of the tube 4 containing the detonating explosive 5 and the inner and outer diameters of container 13 must be such that this tube will be held snugly in shell 1 leaving a substantially negligible open space between the tube and the shell. If the tube does not fit snugly, the acoustical properties of the unit may be detrimentally affected, e.g., reverberations may occur causing undesirable sonic disturbances. The tube is constructed of a material which is nonreactive with the detonating explosive. Ductile metals such as lead, aluminum, tin, silver, copper, magnesium and their ductile alloys may be used and are preferred. Various polymeric materials or plastics of the requisite strength also may be used.

A variety of ignition assemblies can be sealed into the shell, for example, as shown in FIGURE 1, by means of a resilient plug 12 of conventional design used in electric blasting caps, through which the customary lead wires 11 are introduced. Suitable ignition assemblies include a bridgewire and bead arrangement, a bridgewire inserted into a loose mass of ignition composition, an "exploding" bridgewire, and an arc-firing system in which the bridgewire is omitted. The ignition assembly may be actuated via lead wires extending to a source of electric current at the surface of the water or attached to a water-actuated wet battery or to a pressure-sensitive battery which will fire the charge at a predetermined depth. An electric current of approximately 1.5 amperes is sufficient to initiate the ignition means involving a bridge wire. The ignition assembly alternatively may be of the hydrostatic pressure-responsive type wherein initiation of a percussion-sensitive charge in response to shell collapse or a piston-actuated spring is sufficient to actuate the detonating explosive composition.

In many cases the time interval desired between individual pulses will be known sufficiently in advance to permit the appropriate delay to be incorporated during the initial fabrication of the device. However, in other cases, it is most desirable to have the capability of fixing the delay in the field to meet special requirements. Such capability is provided by the device of this invention. In accordance with one mode, the device as shipped to the user will contain a plurality of pulse units loaded within the shell in normal arrangement, each of the units having the lengths of heavy-walled tubing containing the deflagrating composition corresponding to the maximum delay visualized. The user, if he wishes to change the time interval between any or all of the pulses, simply removes the elastic sleeve to release the end cap, withdraws the pulse units as required to effect the desired change, cuts the thick-walled tube containing the deflagrating composition to a length corresponding to a desired interval, and reinserts the pulse units in the same order as withdrawn. The cut-off portions of the thick-walled tubing are then inserted to complete the filling of the shell and insure proper positioning of the units, and

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the cap and sleeve are replaced. In another mode, the shell and standard or pre-cut pulse units are shipped separately and the assembly is prepared in the field. Obviously, in lieu of using the cut ends of heavy-walled tubing to fill out the interior of the shell, any inert material or plug may be used.

It will be obvious to those skilled in the art that many modifications in the design and use of the sonic-pulse generating device of the present invention are possible without departure from the scope of the present invention. It is intended therefore to be limited only by the following claims.

What is claimed is:

1. A watertight device for generating a series of easily distinguishable sonic pulses under water, which can be field adjusted to regulate the interval between the sonic pulses and which comprises a cylindrical shell, an ignition assembly sealing one end of the shell, a plurality of individually removable contiguous sonic pulse units disposed within the shell, a removable cap closing the other end of the shell, and a removable sleeve of elastic material peripherally engaging the exterior of the cap and the shell and sealing the joint therebetween, each of said pulse units consisting essentially of a thin-bottomed cylindrical container open at the end nearest said ignition assembly and in snug peripheral engagement with the interior wall of said shell, a first layer of loose deflagrating explosive disposed within the container and covering its thin bottom, a first thick-walled tube peripherally engaged by the interior wall of said container and having an axial bore filled with detonating explosive which is in contact with said first layer, a second layer of loose deflagrating explosive essentially of the diameter of said container in contact with said detonating explosive, and a second thick-walled tube peripherally sealed to the interior wall of said container and having an axial bore filled with deflagrating explosive which is in contact with said second layer, said second thick-walled tube extending outside said container through its open end, the quantity and distribution of the detonating explosive being such that its detonation will not rupture the device when it is immersed in water.

2. A watertight device for generating a series of easily distinguishable sonic pulses under water, which can be field adjusted to regulate the interval between the sonic pulses and which comprises a tubular shell, an ignition assembly sealing one end of the shell, a plurality of individually removable sonic pulse units disposed within the shell, a removable cap closing the other end of the shell, and a sleeve of elastic material peripherally engaging the exterior of the cap and the shell and sealing the joint therebetween, each of said individually removable pulse units comprising a tubular container open at the end nearest said ignition assembly and closed at the other end by a thin wall and, in sequence from said thin wall, a first thick-walled tube peripherally engaged by the interior wall of said container and having an axial bore filled with detonating explosive and a second thick-walled tube in snug peripheral engagement with the interior wall of said container and having an axial bore filled with deflagrating explosive, the exterior of said container being in snug peripheral engagement with the interior wall of said shell, and the quantity and distribution of detonating explosive being such that its detonation will not rupture the device when it is immersed in water.

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