

[54] **PULSED-ENERGY DETONATION
SYSTEM FOR ELECTRO EXPLOSIVE
DEVICES**

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[22] Filed: **July 31, 1969**

[21] Appl. No.: **849,256**

[52] U.S. Cl. **102/18, 114/221 R, 340/4 R**

[51] Int. Cl. **F42b 22/30**

[58] Field of Search **89/1 A, 1 M; 102/8, 10, 18,
102/19.2; 114/221, 235; 340/12, 4**

[56] **References Cited**

UNITED STATES PATENTS

2,985,837	5/1961	Ruehlemann et al.	102/70.2 X
3,105,170	9/1963	Palmer	315/183
3,229,158	1/1966	Jensen	320/1 X

3,230,506	1/1966	Hellund	340/4 E X
2,397,209	3/1946	Schaelchlin	89/1 A X
2,411,787	11/1946	Hammond, Jr.	102/8
2,937,611	5/1960	Schaelchlin et al.	114/221
3,040,658	6/1962	Maltby	102/19.2 X
3,060,883	10/1962	Herbst et al.	102/10

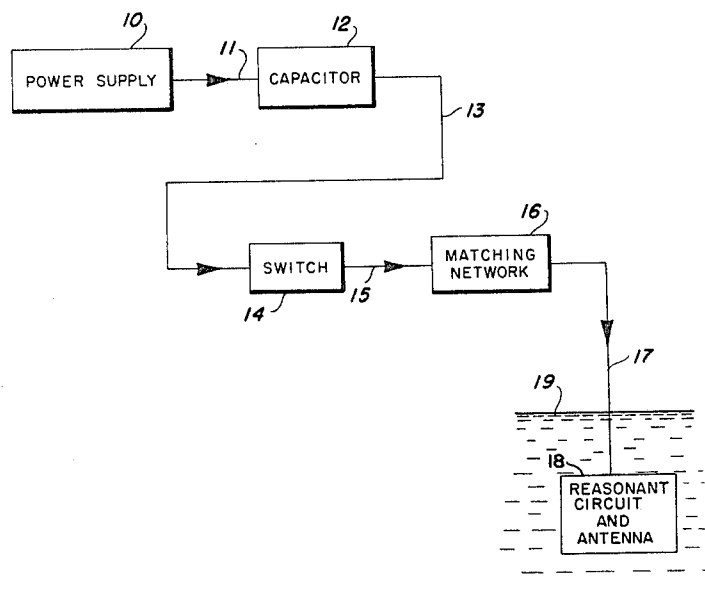
Primary Examiner—Samuel W. Engle

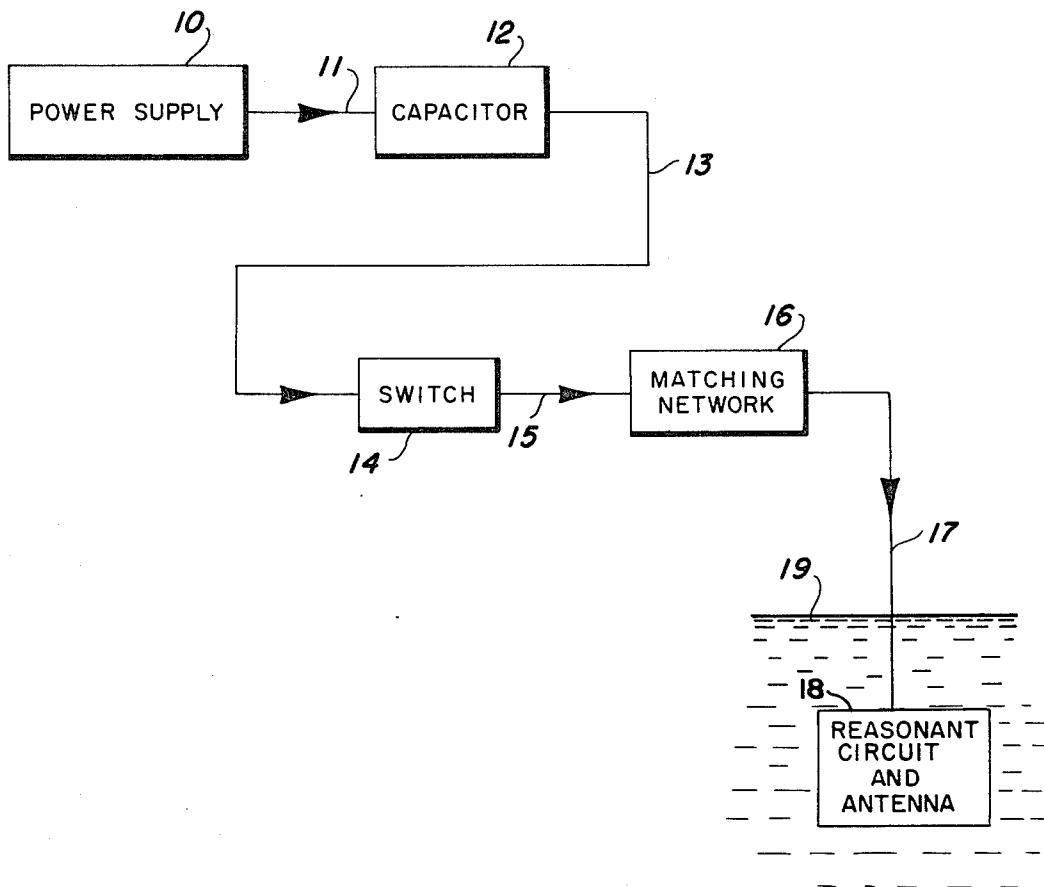
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[57] **ABSTRACT**

The invention comprises a technique and apparatus for destroying electro-explosive devices such as underwater mines by subjecting them to intense electromagnetic radiated fields. A unique arrangement of a capacitor which discharges into a resonant circuit including an antenna is used to generate the high energy field by pulse techniques.

1 Claim, 1 Drawing Figure





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PULSED-ENERGY DETONATION SYSTEM FOR ELECTRO EXPLOSIVE DEVICES

STATEMENT OF GOVERNMENT INTEREST

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.

BACKGROUND OF THE INVENTION

It has been known for some time that squibs, electroexplosive devices (EED'S), some booster charges, and other ordnance materials are susceptible to damage from radio frequency fields. A great effort has been extended to analyze and determine the exact nature of these effects. This effort has been expanded significantly since many previous mishaps which had been accredited to other causes have now been found to be due to radio frequency hazards.

One method which has been attempted to remove radio frequency hazards is radio silence. Another method attempted is the use of desensitized EED'S, such as low impedance (1 amp, 1 watt), squibs. Neither of these methods have appreciably met the desired criteria of safety.

If high power radio frequency or very low frequency radio transmitters were available to develop high intensity electromagnetic fields in water, for example, the probability of mine destruction would be very good, especially in the case where long electrical leads are connected to the mines. However, when calculations are made for losses due to the antennas and water, it becomes apparent that a transmitter of the type required using continuous transmission operation would be impractical to construct. Furthermore such a transmitter would not be capable of mobile operation. If instead of attempting continuous operation, pulsed-energy techniques are utilized, the required transmitter powers can be obtained.

SUMMARY OF THE INVENTION

A pulsed-energy detonation system for electro-explosive devices is disclosed. According to the concept of the invention, electro-explosive devices are detonated by subjecting them to intense electromagnetic radiated fields. A capacitor is discharged into a resonant circuit including an underwater antenna to generate the high-energy field by pulse techniques. The system can develop high-energy radio frequency pulses of, for example, 10^8 to 10^{10} watts yielding a field strength range of 30,000 watts/meter² to 250 watts/meter² at distances of fifteen to thirty meters in brackish waters.

STATEMENT OF THE OBJECTS OF THE INVENTION

An object of the present invention is to provide a pulsed-energy detonation system which can be used against electro-explosive devices.

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 drawing wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

The FIGURE is a schematic drawing of the pulsed-energy detonation system of the present invention wherein the electro-explosive device comprises an underwater mine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing, an AC or DC power supply 10 is connected by means of an electrical lead 11 to a variable capacitor 12. The capacitor operates to store electrical energy and to discharge such energy to the conventional resonant circuit and underwater antenna 18 shown immersed in a liquid 19. A switch 14 is connected in series with the capacitor 12 by means of an electrical lead 13. Switch 14 functions to inject the stored electrical energy from capacitor 12 into the liquid 19 for propagation therein. Switch 14 is connected by means of an electrical lead 15 to a conventional matching network. The output of the matching network 16 is connected by means of an electrical lead 17 to the conventional resonant circuit and underwater antenna 18.

In operation, a source of electrical energy such as AC or DC power supply 10 charges capacitor 12. When switch 14 is closed, the energy stored in the capacitor is discharged to the underwater antenna 18. The electrical energy received at the antenna 18 is then converted into electromagnetic energy. This electromagnetic energy is then propagated through the medium 19 in which an underwater mine, for example, is located.

The capacitance of the capacitor 12 may be varied to change the strength of the electrical pulses as desired. Also frequency modulation may typically be accomplished by controlling the interval between pulses such as by controlling the frequency of the basic power supply 10.

The system of the invention can be constructed to develop high-energy radio frequency pulses of, for example, 10^8 to 10^{10} watts yielding field strengths of 30,000 watts/meter² to 250 watts/meter² at distances of from 15 to 30 meters in brackish waters. 100 watts/meters has been established as being hazardous for even the safest EED'S since many detonate in fields of less than 90 milliwatts/meter.

By using pulsed-energy techniques, transmitter powers of from 10^8 to 10^{10} watts are possible. For example, a 30,000 joule system could be built to deliver 3×10^8 watts which would give a spherical radiated field at thirty meters of approximately 250 watts/meter².

By way of example, a 60 microfarad capacitor with a peak voltage rating of 9 KV could be used in this system. In order to acquire a 500 joule system, the capacitor would be charged to 8.2 KV to offset the 25 percent dump efficiency of the capacitor switch as its worst practical case. If the system impedance is matched and all desired design criteria are met, such a system will ring at or above 100 KC. For a ringing frequency of 100 KC the pulse power will be:

$$W = (5 \times 10^2 \text{ joules}) / 10^{-5} \text{ second} = 5 \times 10^7$$

watts.

If a 40 db antenna attenuation is assumed, for example, the power available from the load, W_A , would be reduced by a factor of 100 (40 db) and hence would become:

$$W_A = (5 \times 10^7) / 10^2 = 5 \times 10^5 \text{ watts.}$$

The above calculations are based on the use of the half-wave antenna system approximately fifteen meters long and having a worst case loss of 40 db.

Assuming a target range of 5 meters, the power density would be reduced by spherical dispersion, if no antenna directivity is considered, to:

$$P = W / 4\pi R^2 = (5 \times 10^5) / 4\pi (5)^2 = 1.6 \times 10^3 \text{ watts/meter}^2,$$

where W is the power in watts available from the source, and R is the range in meters.

If the liquid in which the antenna is submerged comprises brackish water, it will offer an attenuation of 1 db per meter and therefore, for a five meter range, the attenuation would be 5 db or a reduction factor of 3.16. This attenuation would further reduce power density at five meters to:

$$P_5 = 1.6 \times 10^3 / 3.16 = 512 \text{ watts/meter}^2.$$

In a typical case, this power density would probably be more than necessary and thus as much as, for example, a 7 meter range could be used.

Calculations for a seven meter range give a value of: $P_7 = 163 \text{ watts/meter}^2$ which is well above the established 100 watts/meter² hazardous level.

Seven meters, for example, represents a distance from the antenna system of approximately a quarter wavelength for the chosen frequency. If a smaller system were chosen, any variations in losses could place the EED so close to the antenna as to yield the system impractical by damaging the antenna.

As a secondary check, the energy density at seven meters is calculated as follows:

$$E_7 = \text{joules} / 4\pi R^2 = 5 / 490 (7)^2 = 8.17 \text{ millijoules/meter}^2.$$

Since the attenuation of water for seven meters is approximately 7 db or a reduction factor of five, the final field density is equal to:

$$E_7 = 8.17 \times 10^{-3} / 5 = 1.63 \text{ millijoules/meter}^2.$$

If this amount of energy were induced into an average EED, the probability of detonation would be

greater than 99.7 percent according to known information. An energy of 1.79 millijoules induced into the EED would yield a probability greater than 99.993 percent.

Thus, it can be seen that a new and novel method of detonating underwater mines by subjecting them to intense electromagnetic fields has been disclosed. The unique arrangement of a capacitor which discharges into a resonant circuit including an underwater antenna is used to generate the high fields by pulse techniques. If conventional RF generating equipment were used, the space considerations would be impractical for generating signals having the power necessary. By using pulse energy techniques from a charged capacitor, the system becomes entirely feasible. By selectively triggering a switch, the capacitor energy is dumped into a resonant circuit including an antenna. The resultant electromagnetic signal from the antenna is propagated through the water.

Although the preferred embodiment is directed towards the detonation of underwater ordnance, it is obvious that the inventive concept of detonating electro-explosive devices is equally applicable to such devices located in air or underground.

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. Apparatus for detonating electro-explosive devices which are susceptible to detonation by intense electromagnetic radiated fields comprising:

- a. a source of electrical energy;
- b. said source including variable capacitor means for storing said electrical energy;
- c. switch means in series with said variable capacitor means;
- d. resonant circuit means including antenna means located in the vicinity of the devices which are to be detonated;
- e. said resonant circuit means being connected to said source of electrical energy and said switch means by a matching network;
- f. said switch means being operable to discharge the stored energy in said variable capacitor means to said resonant circuit means to thereby generate pulsed intense electromagnetic fields.

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