March 23, 1971 B. D. GARBER 3,572,244

UNDERWATER FIRING DEVICE

Filed July 20, 1967 2 Sheets-Sheet 1

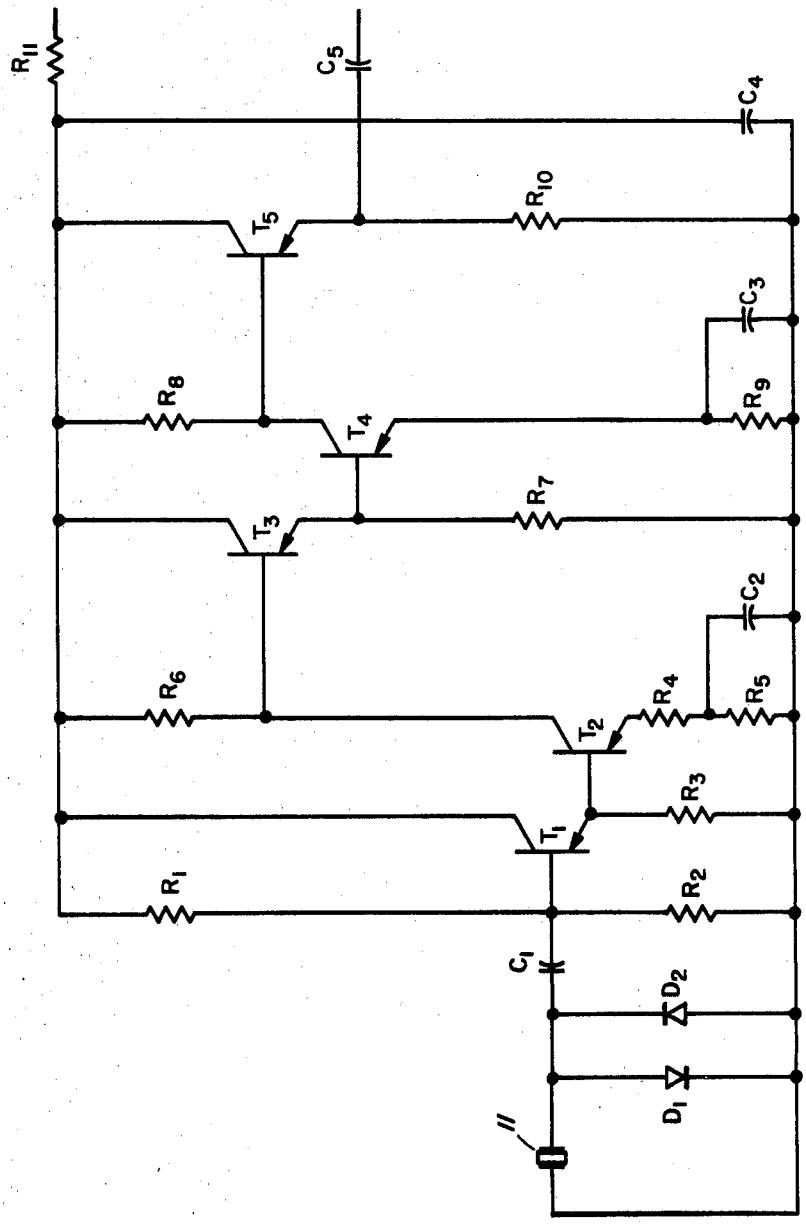


FIG. 1

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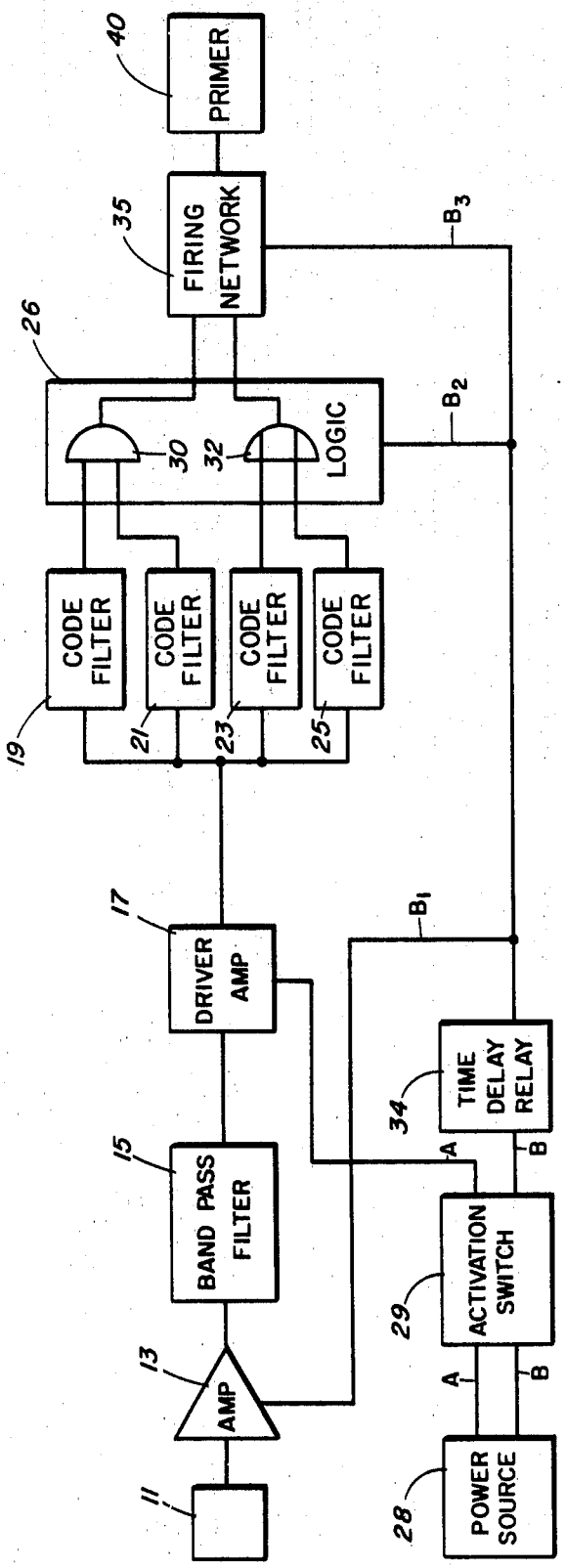


FIG. 2

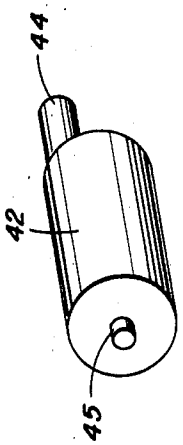


FIG. 3

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UNDERWATER FIRING DEVICE

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ABSTRACT OF THE DISCLOSURE

A miniature underwater firing device which can be carried by a swimmer and be set off by remote acoustic coded signals. A receiver circuit comprising a hydrophone, amplifiers, a band pass filter, parallel connected narrow band code filters, logic circuitry and an acoustic relay connected in the signal path.

BACKGROUND OF THE INVENTION

This invention relates to underwater demolition firing devices and more specifically to miniature acoustic demolition firing devices which are remotely actuated.

Acoustic underwater demolition firing devices are known in the art. Previously demolition firing devices have been developed which operate in response to coded acoustic signals to fire an explosive primer. One device in particular comprised a hydrophone, a preamplifier, a band pass filter, driver and logic circuitry, narrow band filters, and an acoustic relay in the signal path. When a predetermined coded acoustic signal was picked up by the hydrophone and passed through the series of amplifiers, filters and logic circuitry, an acoustically actuated relay was activated causing a charged capacitor to discharge an electrical firing pulse into an explosive primer thereby achieving demolition of the device from a remote location. Although satisfactory in many applications, underwater firing devices of the type described were too large and bulky to be carried by an individual swimmer. The hydrophone, filters and battery, for example, were much too large for a small package demolition device of the size which could be readily carried by a swimmer. In addition to the disadvantage of the size of prior art devices for the intended use by individual swimmers, the sensitivity of the receiver circuitry described above was less than desirable. Until the present invention there were no satisfactory underwater acoustic demolition firing devices available which could be easily handled by an individual swimmer.

SUMMARY OF THE INVENTION

The general purpose of the present invention is to provide a miniature underwater acoustic demolition firing device having high sensitivity, capable of being easily handled by individual swimmers and of being actuated remotely in response only to a predetermined coded signal.

It is an object of the present invention to provide a novel miniature underwater demolition acoustic firing device.

It is another object of the invention to provide an improved underwater demolation firing device.

The above and other objects are attained by an acoustic firing device having a small hydrophone, band pass filter, and D.C. battery with parallel connected split-ring ceramic disc filters connected electrically to the rest of the acoustic signal receiving circuitry and explosive primer actuating means. An improved preamplifier circuit connected to the hydrophone output and the use of parallel connected ceramic filters enable the receiver to have increased sensitivity over larger prior art devices. The present firing device is therefore greatly reduced in size but at the same time maintains increased sensitivity over prior art underwater acoustic firing devices.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and attendant advantages will be readily appreciated as the same becomes better understood by the accompanying drawings wherein:

FIG. 1 is schematic circuit diagram of an amplifier used in one embodiment of the invention;

FIG. 2 illustrates a block diagram of the electrical circuit of the invention;

FIG. 3 is a perspective view illustrating the housing of one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows in detail the preamplifier **13** illustrated in block form in FIG. 2 while FIGS. 2 and 3 are referred to for a general illustration of the invention. In FIG. 2, a hydrophone **11** is shown electrically connected to an acoustic signal receiver which actuates an explosive primer **40** when the appropriate coded signal is received. The entire electrical circuit of FIG. 2 including the hydrophone **11**, power source **28** and primer **40** are contained entirely within a small housing such as the one illustrated in FIG. 3.

The incoming acoustic signal is picked up by the hydrophone **11** and amplified by the preamplifier **13**. Amplifier **13** is designed to have high sensitivity to the frequency signals in the acoustic range of the band pass filter **15**. Filter **15** rejects frequency signals outside the frequencies of interest and passes signals within the band width to driver amplifier **17**.

The driver **17** is connected to code filters **19**, **21**, **23** and **25** which are parallel connected split ring ceramic disc filters and are narrow band filters for resonant frequencies F1, F2, F3 and F4 respectively. The transmitted and code filter frequencies are pre-selected so that code filters **19** and **21** will each pass one of two required frequencies F1 and F2 to actuate the relay in firing network **35**. When both frequencies F1 and F2 are passed simultaneously by filters **19** and **21**, AND gate **30** in the logic network **26** is biased on thereby passing an activation signal to firing network **35**. The unit will not actuate, however, if a signal frequency F3 or F4 is passed by either code filter **23** or **25**. OR gate **32** in the logic network is biased on in the presence of signals F3 or F4 if they are of comparable signal strength to signals F1 and F2. A signal passing through OR gate **32** thereby prevents the acoustically activated relay **35** from being activated by unauthorized parties or if safing of the device is desired. When relay **35** is activated, a charged capacitor (not shown) in the acoustically actuated relay network **35** discharges an energy pulse to the primer **40**.

Logic network **26** contains transistorized active elements and diode detector circuitry coupled to the ceramic disc filters.

D.C. power is supplied to the acoustic signal receiver from the power source **28** which may, for example, contain a grounded center tap 10.8 volt battery made up of 8 Mallory mercury cells. Positive voltage may be supplied over line A through an activation switch **29** to the driver **17** and similarly negative voltage may be provided to amplifier **13** over line B–B1, to logic network **26** over line B–B2 and firing network **35** over line B–B3.

Activation switch **29** initiates timed elay relay **34**. After the predetermined time delay provided by relay **34** has elapsed, the demolition firing device is in condition to receive the acoustic underwater signals.

The device illustrated in block diagram in FIG. 2 is completely housed in the miniature container shown in FIG. 3. An aluminum shell **42** contains all of the demolition receiver circuitry with the exception of the hydrophone which is contained in cylinder **44** and the activation switch (not shown) which may be located on the shell **42** near the hydrophone end. An end coupler **45** is provided for the output of the device. The dimensions of the firing device housing may be approximately 2 inches in diameter for the shell **42** with an overall length including cylinder **44** between 6 inches and 11 inches. Prior art devices used for the same purposes have been larger by a factor of 20, thereby making it very difficult for an individual swimmer to handle.

The amplifier illustrated in FIG. 1 provides improved sensitivity over prior art underwater demolition firing devices. The preamplifier used in connection with the logic circuitry and other receiver elements shown in FIG. 2 has been found to provide up to 12 db greater sensitivity than similar prior art devices.

An input signal received at hydrophone **11** passes through capacitor **C1** to the base of input transistor **T1** for first stage amplification. Diodes **D1** and **D2** are oppositely poled voltage limiting diodes connected in parallel with the input hydrophone **11**. Transistor **T1** has its base connected to voltage divider resistor **R1** and **R2** and its emitter connected to resistor **R3**. The output signal from transistor **T1** is passed to transistor **T2** from the emitter of transistor **T1** and the base of transistor **T2** for the first stage amplified output.

Transistor **T2** is connected to second stage amplifiers **T3** and **T4** from the collector of transistor **T2** to the base of transistor **T3**. The emitter of transistor **T2** is connected to an RC network comprising resistor **R4** in series with parallel connected resistor **R5** and capacitor **C2**.

The emitter of transistor **T3** and base of transistor **T4** are connected to resistor **R7** in the second stage and the emitter of transistor **T4** is coupled to parallel connected resistor **R9** and capacitor **C3**.

The amplified output signal is derived from transistor **T5** at the emitter connected capacitor **C5**. The emitter is also connected to resistor **R10**. A filter capacitor **C4** is connected between the common wire and resistor **R11**.

D.C. current is supplied through resistors **R11** and **R1** to the base of transistor **T1**, through resistors **R11** and **R6** to the collector of transistor **T2** and base of transistor **T3**, through resistors **R11** and **R8** to the collector of transistor **T4**, and through resistor **R11** to the collectors of transistors **T1**, **T3** and **T5**.

From the foregoing description of a preferred embodiment of the invention, it is apparent that a new and improved miniature underwater demolition acoustic signal firing device has been developed which can be easily carried by a single swimmer, activated remotely by coded acoustic signals, and which is improved in sensitivity and size limitations from similar pror art devices. It should be understood, of course, that the embodiment disclosed is merely illustrative and not intended to limit the scope of the invention. Reference should be made to the appended claims, therefore, rather than the specification as indicating the scope of the invention.

What is new and desired to be secured by Letters Patent of the United States is:

1. A miniature underwater demolition firing device comprising in combination, housing means containing therein:

means for receiving acoustic signals and for generating electrical representative signals thereof;

amplifier means electrically coupled to said acoustic signal receiving means for amplifying said electrical representative signals in a predetermined frequency range;

a plurality of split ring ceramic disc narrow band filters coupled to said amplifier means, each of said ceramic filters resonant to a different predetermined frequency;

an acoustically actuated relay network;

a source of electrical energy for providing a firing pulse upon said relay network being actuated; and

multiple input logical gating means connected between said ceramic disc filters and said relay network for passing an actuation signal to said relay network in response to the reception of predetermined coded frequency signals by said acoustic receiving means.

2. The apparatus of claim **1** further comprising in said housing means,

an activating switch electrically connected to said source of electrical energy, and

time delay means coupled between said activating switch and said relay network for delaying said firing pulse a given amount of time after the reception of said predetermined coded signals.

3. The apparatus of claim **1** further comprising an explosive primer connected electrically to said relay network.

4. The apparatus of claim **1** wherein said ceramic disc filters are connected in parallel; and said amplifier means includes a transistorized preamplifier connected to said acoustic receiving means, said acoustic receiving means being a hydrophone, a band pass filter connected to the preamplifier, and a driver amplifier connected between said band pass filter and each of said ceramic disc filters.

5. The apparatus of claim **2** wherein said housing means is a cylindrical-like shaped container which is approximately 2 inches in diameter and between the range of 6 inches to 11 inches in length.

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