ACOUSTIC CANNON

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an acoustic device that emits repetitive sonic pulses capable of dispersing or incapacitating a biological target. More particularly, a planar array of multiple acoustic pulse sources cooperates to generate highly focused pulses of high intensity sonic energy over a small area.

2. Description of the Related Art

Military and law enforcement personnel have a need for non-lethal weapons. Such weapons are useful in riot control to disperse a hostile crowd. In sniper and hostage situation, a non-lethal weapon provides a means to neutralize a hostile target without collateral damage to hostages, bystanders or property. In combat, a non-lethal weapon is useful to neutralize sentries and warning devices. Since the weapon produces casualties, rather than fatalities, each hit removes three opponents, the injured and a two-person rescue squad, from the combat zone instead of the one person removed by a fatality.

High intensity sound pulses have a debilitating effect on biological targets. Humans become disoriented by exposure to sonic pulses exceeding a threshold of pain of about 150 decibels (dB). Eardrum rupture occurs at about 190 dB, the threshold for pulmonary injury is about 200 dB and the onset of lethality is about 220 dB.

U.S. Pat. No. 3,557,899 to Longinette et al. discloses a parabolic reflector that focuses and transmits a continuous sound at a frequency of between 8 kilohertz (kHz) and 13 kHz. Within this frequency range, sound attenuates rapidly and the disclosed device is believed effective only at close ranges. The U.S. Pat. No. 3,557,889 patent discloses utilizing the device in close proximity to a riot or in enclosed areas, such as a bank vault.

U.S. Pat. No. 4,349,898 to Drewes et al. discloses a sonic weapon to destroy buildings and disable personnel. A plurality of tubes each conduct a continuous sound generated by a jet engine. Rotating fans at the ends of the tubes create pulsed sound of a desired frequency. The fan speeds are set such that each tube has a pulse sound frequency two times the frequency of a preceding tube leading to an additive effect of sound waves referred to as a parametric pump. The disclosed device appears heavy and requires careful alignment of a number of large apparatus for operation.

There remains, therefore, a need for a portable acoustic weapon capable of dispersing or disabling biological targets at distances of up to 100 meters that does not suffer from the disadvantages of the prior art discussed above.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide an acoustic device capable of dispersing or incapacitating a biological target. One feature of the invention is that the device has a planar array of simultaneously actuated acoustic pulse sources. Interaction between the sonic pulses forms a Mach disk. A second feature of the invention is that the device is actuated by either a shock tube or detonation of an explosive chemical mix.

Among the advantages of the invention are that the Mach disk is a compact packet of sound that may be accurately fired to minimize harm to hostages, bystanders and property. The Mach disk effectively incapacitates or disperses a biological target with a minimal threat of lethality. The acoustic device is relatively lightweight and is readily transported by an infantry vehicle and operated by a single person.

In accordance with the invention, there is provided an acoustic cannon that has a plurality of acoustic sources arranged in a planar array about a central point. Each of the plurality of acoustic sources has an input end and an output end. The input end receives a sonic pulse and the output end transmits a sonic output. A sonic pulse generator is coupled to each of the input ends and a timing mechanism is coupled to the sonic pulse generator such that the sonic pulse is received by each of the input ends at substantially the same time and is of substantially the same frequency and duration. The combination of the planar array and the parameters of the sonic output effectively generates a Mach disk.

The above stated objects, features and advantages will become more apparent from the specification and drawings that follows.

IN THE DRAWINGS

FIG. **1** shows in cross-sectional representation a single sonic source as known from the prior art.

FIGS. **2**A and **2**B illustrate the acoustic cannon of the invention.

FIG. **3** illustrates in cross-sectional representation an acoustic cannon in accordance with a first embodiment of the invention

FIGS. **4**A through **4**E graphically illustrate the generation of a sonic pulse through the use of a shock tube.

FIG. **5** illustrates in cross-sectional representation an acoustic cannon in accordance with a second embodiment of the invention.

FIG. **6** graphically illustrates the relationship between frequency content of the sonic pulse and directivity.

FIG. **7** graphically illustrates the relationship between frequency contained in the sonic pulse and attenuation.

FIG. **8** graphically illustrates the relationship between pulse range and peak pressure measured in decibels.

DETAILED DESCRIPTION

FIG. **1** illustrates in cross-sectional representation a muzzle portion **12** of an acoustic device **10** as known from the prior art. A sonic source (not shown) generates a pressure wave **16** that is transmitted along an interior bore **14** and emitted from an output end **18** as spherically expanding sound waves **20**. The spherically expanding sound waves **20** diffuse rapidly. The prior art acoustic device has limited value as a weapon. The strength of the pressure wave **16** drops to below useful values within a very short distance and time. Additionally, the spherically expanding sound waves **20** diffuse over a broad area rendering target selectivity difficult or impossible.

The disadvantages of the prior art are resolved by an acoustic cannon in accordance with the present invention. FIG. **2** schematically illustrates a portion of the acoustic cannon of the invention in Front (FIG. **2**A) and Side (FIG. **2**B) Views. Acoustic sources **22** terminate at an output end **24**. Interior bores **26** extend from output ends **24** to input ends **28** that are adjacent to a sonic pulse generator **30**. A timing mechanism **32** controls the rate and duration of generated sonic pulses. In a first embodiment of the invention, the sonic pulses are generated by detonation of an explosive mix and a fuel storage chamber **34** is provided to house required quantities of the additional explosive mix, or explosive mix precursors.