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Brenner

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[54] **OPTICAL TARGET SENSOR**

[75] Inventor: **Charles Herbert Brenner,** Scottsdale, Ariz.

[73] Assignee: **Motorola, Inc.,** Franklin Park, Ill.

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[52] **U.S. Cl.** ..... **102/70.2 P,** 244/3.16

[51] **Int. Cl.** ... **F42c 13/02,** F42c 11/06, F42c 15/40

[58] **Field of Search** ..... 102/70.2 P; 244/3.16, 3.17

[56] **References Cited**

UNITED STATES PATENTS

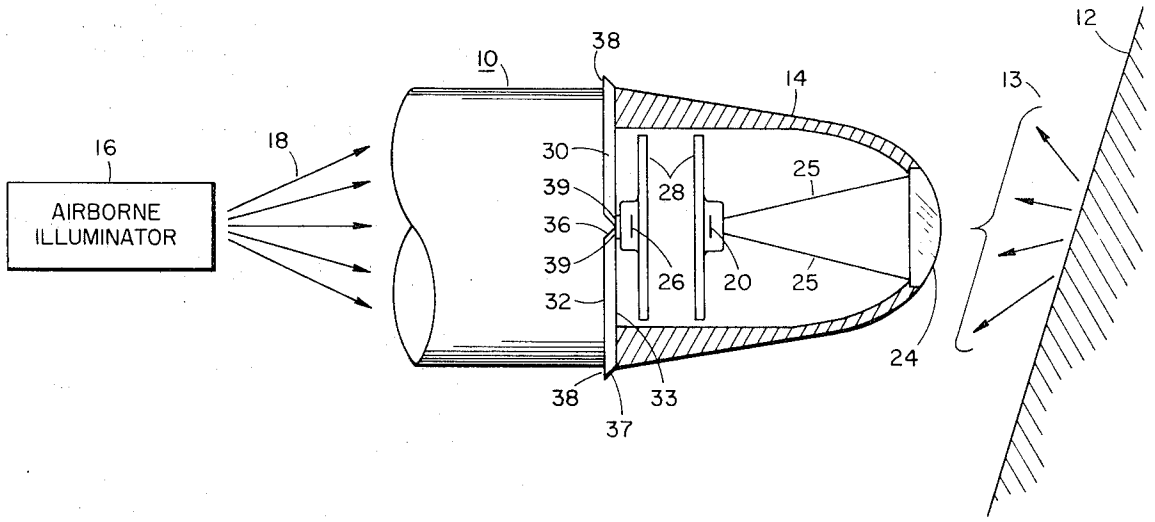
3,527,167	9/1970	Morse	102/70.2 R
3,129,424	4/1964	Rabinow	102/70.2 P
3,538,506	9/1968	Wiley, Jr.	102/70.2 R
3,040,661	6/1962	Ross	102/70.2 P
3,455,243	7/1969	Martin	244/3.16

Primary Examiner—Samuel Feinberg
Assistant Examiner—Thomas H. Webb
Attorney—Mueller & Aichele

[57] **ABSTRACT**

An optical target sensor mounted on a projectile, produces a fuzing signal when two light sensitive devices which are mounted on the projectile sense light pulses which are separated by a fixed time interval. One of the light sensors is mounted to be exposed to light pulses which are projected towards and beyond the projectile by an illuminator. The other light sensor is mounted to be exposed to the illuminator light which is reflected from the general target area. The range at which a fuzing signal occurs is controlled by setting the time difference required between the two pulses. No radiation occurs from the target sensor because it receives its signals as a result of radiation from the illuminator. The light projector or illuminator may comprise a pulsed laser.

8 Claims, 2 Drawing Figures



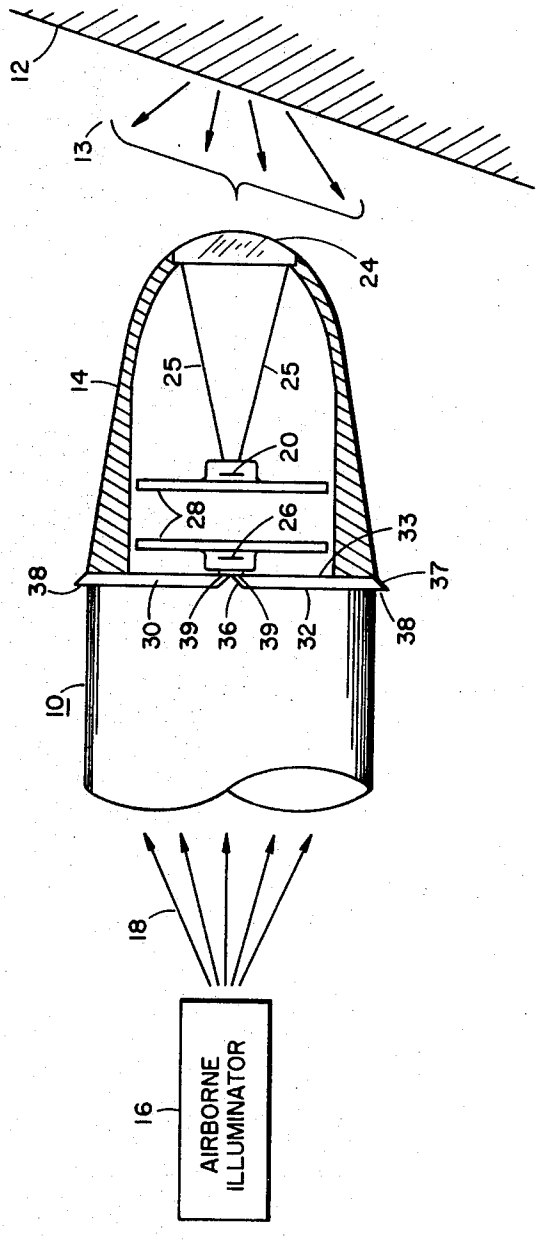


Fig. 1

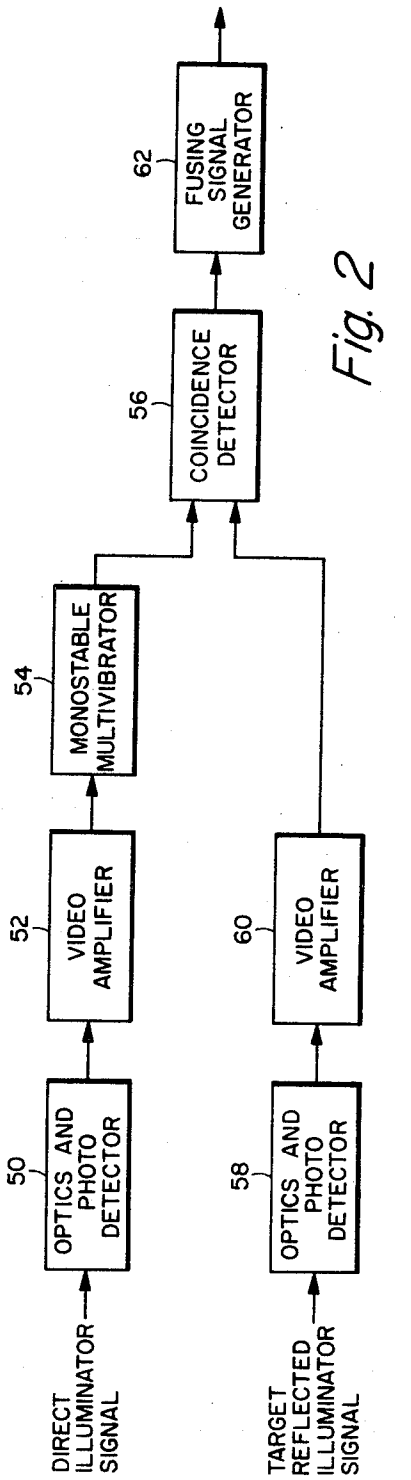


Fig. 2

INVENTOR.
Charles H. Brenner

BY

ATTY'S

OPTICAL TARGET SENSOR

BACKGROUND

This invention relates to an optical target sensor to be mounted on a projectile which will produce a fuzing signal while the projectile is still in flight and at a predetermined distance from the target. Typically, the fuzing signal is used to detonate the explosive charge contained within the projectile body.

In accordance with the prior art, a radio transmitter and receiver are mounted on a projectile. The transmitter transmits a radio wave in a forward direction towards the target and the radio wave is reflected back to the projectile upon reflection from the target. In a known manner, the fuzing signal is produced when the time lag of received reflected waves with respect to the transmitted waves indicates that the projectile is a given distance from the target. The prior art called a target sensor or a proximity fuze if a safing and arming device and detonator are included, is costly, complicated, bulky and requires a large battery since the battery must supply power to both the transmitter as well as the receiver. Furthermore, jamming waves due to other radiation sources in the area may cause a fuzing signal to be produced when the projectile is a long way from the target. Furthermore, each projectile transmits its own wave which may be received by another projectile, whereby the projectile may produce a fuzing signal before the desired distance to the target is reached.

It is the object of this invention to provide single target sensor that can be carried on a projectile such as a shell or rocket which will produce a fuzing signal at a desired distance in front of a target without actively radiating any energy.

It is a further object of this invention to provide such a target sensor that is simpler, less costly, more reliable and harder to jam than known such target sensors.

SUMMARY

In accordance with this invention, the projectile carries two photosensitive devices, and means are mounted on the projectile to cause light from in front of the projectile to be applied to one of the photosensitive devices and other means are mounted on the projectile to cause light from in back of the projectile to be applied to the other photosensitive device. A light source which may be a pulsing laser projects light in a manner so that the projectile and the target are illuminated by the light provided by the laser. When the light pulse which hits the target and is reflected back to the projectile has the desired time delay with respect to the light that hits the projectile directly from the light source, the target sensor produces an output. The distance from the target that the target sensor produces a fuzing signal is dependent on the time delay required between the two light pulses. By varying the required time delay, fuzing signals can be produced when the projectile is several hundred feet to only a few feet from the target. The only electronics necessary on the projectile are two receivers and a coincidence detector and fire pulse generator, whereby the electronics on the projectile are simple and inexpensive.

DESCRIPTION

The invention will be better understood upon reading the following description in connection with the accompanying drawing in which:

FIG. 1 illustrates the target sensor of this invention as being in operation, and

FIG. 2 is a block diagram of a circuit for use on the projectile as shown in FIG. 1.

A projectile **10** is shown in flight towards the target area **12.** The front part of the projectile **10** which contains the target sensor **14,** is shown in cross section to illustrate the apparatus carried thereby. The projectile body **10** which carries the explosive charge (not shown) is shown partly in section and most thereof is broken away since the invention does not depend on the projectile portion **10** or on its contents. A light source **16** which may be a laser projects light beams **18** which may be in the ultraviolet, visible, or infrared wave length region, having a pulse width which may be only a few nanoseconds to several microseconds wide and pulse repetition rate of 10 pulses per second or greater towards the projectile **10** and beyond the projectile **10** towards the target area **12.** The light beams **18** have a spread such that the projectile **10** is in the beam while the projectile takes its curved path towards the target and the target area is also illuminated by the beam **18.** Therefore, as will be more fully disclosed, the back of the projectile **10** and the target area **12** are illuminated by the laser device **16** and light pulses reflected by the target area illuminates the front of the projectile which contains the target sensor **14.** As shown in the drawing, the laser **16** is said to be airborne. When airborne, the projectile and the means for projecting it will also be carried by the airborne vehicle. However, the light source and the projectile projecting means may be stationary or may be mounted on a land or sea vehicle.

The projectile **10** carries two optical systems, one for receiving the light reflected from the target area **12** and one receiving the light directly from the laser **16.** A light sensitive detector **20** is used to detect the reflected light **13** from the illuminated target area **12.**

A lens **24** and optical reflecting cone **25** which are both coaxial with the projectile **10** extends through the forward end of the target sensor **14** and concentrates light on the light sensitive photodetector **20.** The inner surface of the cone **25** may be plated with light reflecting material which efficiently reflects the light of the wavelength of the beam **18** and the photodetector **20** is chosen to be sensitive to this wave length of light. While the cone **25** does not project an image on the light sensitive device, it does act as an efficient light collector.

Another light sensitive photodetector **26** is mounted centrally on the projectile **10** but behind the photodetector **20.** The photodetectors **20** and **26** are separated from each other by opaque walls **28.** A light collector **30** for the direct illumination **18** has cylindrical shape and operates similar to a periscope of revolution. The flat top portion **33,** flat bottom portion **32,** conical section **36** at the center of light collector **30** and the tapered outer edge **37** are all reflectively coated by a material which is highly reflective at the wavelength emitted by the illuminator **16.** The only regions of the light collector **30** which are not reflectively coated is a small toroidal region **38** where the direct light **18** enters and a small circular region **39** centered on the axis of the projectile and located on the top side of the light collector **30** where light leaves and is incident on the photodetector **26.** The outside edges **38** of the collector **30** are not covered with light reflecting material whereby

light from the back of the projectile **10** hits the exposed surface **38** and the light is directed, after multiple reflections to the photodetector **26.** As noted, the edges of the light collector **30** extend beyond the outside of the diameter of the projectile body so that light from the laser **16** will reach the photodetector diode **26.**

The target sensor **14** is normally located at the front of the projectile **10.** For complete fuzing system a battery and safe arming device would be added but they are not described because they are not pertinent to this disclosure. The electronic equipment that is necessary for the target sensor **14,** is located in the volume between the two walls **28.** The electronics required for the target sensor **14,** shown by the typical block diagram in FIG. **2,** is not critical in that many known electronic devices are useable. The output of an optics and photodetector circuit **50,** which may include the photodiode **20,** is applied to a video amplifier **52.** The video amplifier **52** produces its fixed maximum output upon application thereto of a small signal and this output is not increased by an amplitude above a small value of the input signal. The output of the video amplifier **52** is a rectangular wave form since the reflected light received from the target area **12** is a pulse form. This pulse may be applied to a monostable multivibrator **54.** As will be noted, for certain purposes, the multivibrator **54** may be omitted. The output of the monostable multivibrator **54** is applied to one input of a coincidence detector **56.** The output of the optics and photodetector circuit **58** which may include the photodiode **26** is applied to a video amplifier **60** which is like the video amplifier **52** whose output is applied to the other input of the coincidence detector **56.** When two pulses are coincident in the coincidence detector **56,** the coincidence detector **56** activates a fire pulse generator **62.**

As noted above, the monostable multivibrator **54** may be omitted in which case the output of the video amplifier **52** is applied directly to an input of the coincidence detector **56.** When the monostable multivibrator is omitted, a pulse directly from the laser **16** and the same pulse reflected by the target at **12** are supplied to the coincidence detector **56.** For example, if the illuminator **16** has a pulse with duration of 10 nanoseconds, pulse coincidence occurs when the projectile **10** is approximately 5 feet slant range from the target area **12.** If slant ranges from the target of about 300 feet are desired the monostable multivibrator **54** is included between the video amplifier **52** and the coincidence detector **56.** This monostable multivibrator **54** is adjusted to produce a pulse duration of about 600 nanoseconds. When the leading edge of the reflected pulse is coincident with the leading edge of the pulse produced by the multivibrator **54,** the pulse coincidence detector **56** activates the fuzing generator **62.**

While the projectile **10** is shown as a right cylinder, it can be of any shape that projectiles may take. While the laser illuminator **16** and therefore the projector for the target sensor **14** is normally on the airborne launch vehicle it could be located on other airborne vehicles. While the light collector **30** that collects the direct rays **18** is shown permanently deployed beyond the surface of the projectile **10,** the light collector could be deployed after launch or be located at the rear end of the projectile **10.**

What is claimed is:

1. In a projectile exploding system including means for transmitting light pulses to a projectile and to a target,

an explosive projectile portion for travelling toward said target having a charge carrying portion and a front or nose portion, said front or nose portion including:

two photosensitive devices,

an opaque member between said photosensitive devices,

a hollow cone extending from the front of said nose portions towards one of said photosensitive devices, the large end of said cone being towards said front,

a transparent layer extending across the rear of said front portion, said other photosensitive device being in light transfer relation to the center of a side of said transparent layer, the edges of said transparent layer extending beyond said charge carrying shell portion,

both sides of said transparent layer except for said center of said side of said center of said side of said transparent layer and an annular portion of the other side of said transparent layer being coated with a light reflective layer,

the uncovered portion of said other side of said transparent layer being shaped and positioned to receive light from behind said charge carrying shell portion,

and means on said projectile to explode said charge upon light being exposed to both of said photosensitive devices.

2. The invention of claim **1** in which the center of said other side of said transparent layer is formed to direct light to said second photosensitive device.

3. The invention of claim **1** in which a laser producing pulsed light is provided to project light towards the back of said projectile whereby light from said laser is applied to said second photosensitive device and light reflected from a target is applied to said one photosensitive device.

4. In a projectile exploding system including means for transmitting light pulses to a projectile and to a target,

an explosive projectile portion for travelling toward said target including:

two light sensitive devices on said projectile portion,

means on said projectile portion for receiving light pulses transmitted from said transmitting means at a particular instant and applying same to one of said light sensitive devices,

means on said projectile portion for receiving light pulses transmitted from said transmitting means at said particular instant but after reflection from said target and applying same to the other of said light sensitive devices,

means for developing a first signal upon receipt of a direct light pulse by said one of said light sensitive means,

means for developing a second signal upon receipt of a reflected light pulse by said other one of said light sensitive means,

time delay means for receiving said first signal and for developing a third signal in response thereto after a predetermined time delay,

coincidence means for receiving said third and said second signals and developing an output signal

when said third and said second signals coincide, and

means responsive to said output signal for generating a firing signal.

5. The system according to claim **4** wherein said time delay means comprises a monostable multivibrator.

6. The system according to claim **4** wherein said means for receiving said light pulses transmitted from said source comprises a rearwardly directed optical system, and

wherein said means for receiving said pulses of light reflected from said target comprises a forwardly directed optical system.

7. The system according to claim **6** wherein said rearwardly directed optical system comprises a circular prism having a peripherally circular light receiving surface and a centrally circular light directing surface, and said forwardly directed optical system comprises an optical lens.

8. The system according to claim **4** wherein said two light sensitive devices comprise two photosensitive diodes spaced axially from each other and including an opaque surface between them.

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