

United States Patent

[11] 3,567,951

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[21] Appl. No. 815,689
[22] Filed Apr. 14, 1969
[45] Patented Mar. 2, 1971
[73] Assignee the United States of America as represented
by the Secretary of the Navy

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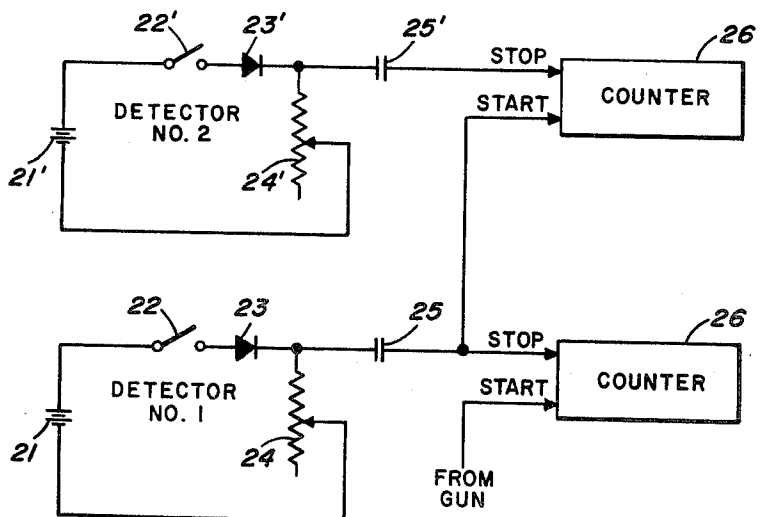
[54] LASER PROJECTILE DETECTION SYSTEM 3 Claims, 2 Drawing Figs.

[52] U.S. Cl..... 250/222,
250/209, 356/28, 324/178
[51] Int. Cl..... G01p 3/68
[50] Field of Search..... 250/221,
222, 220, 219 (X), 219 (WM), 209, 217; 356/28;
324/70 (B), 178

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ABSTRACT: The present invention is directed to a system which measures the ejection time and muzzle velocity of a gun. The system utilizes a laser whose beam is split and then directed across the projectile ejection path to two photodetectors. When the gun is triggered, a projectile is fired and a first counter is activated. When the projectile leaves the gun barrel it breaks the first light path between the laser and the first photodetector and turns off the first counter. Simultaneously, it initiates a second counter which is deactivated when the light path to the second photodetector is broken by the projectile.



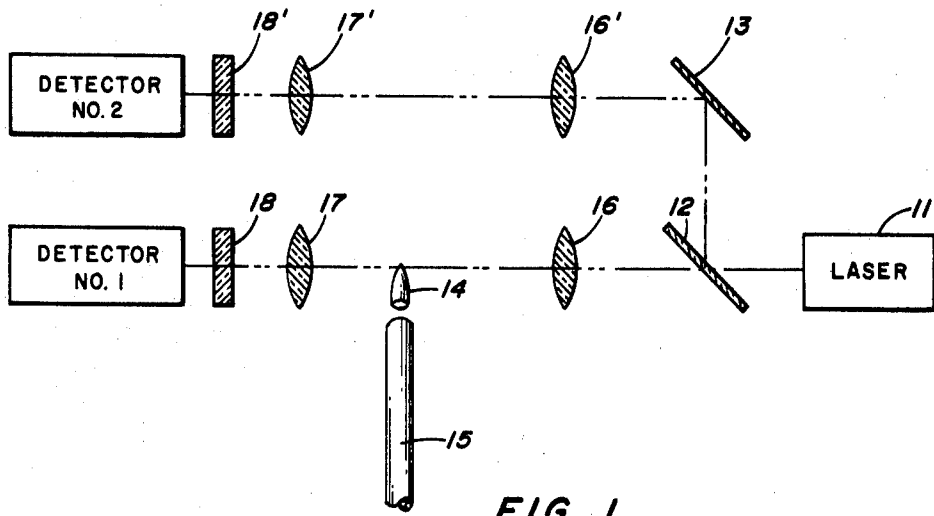


FIG. 1

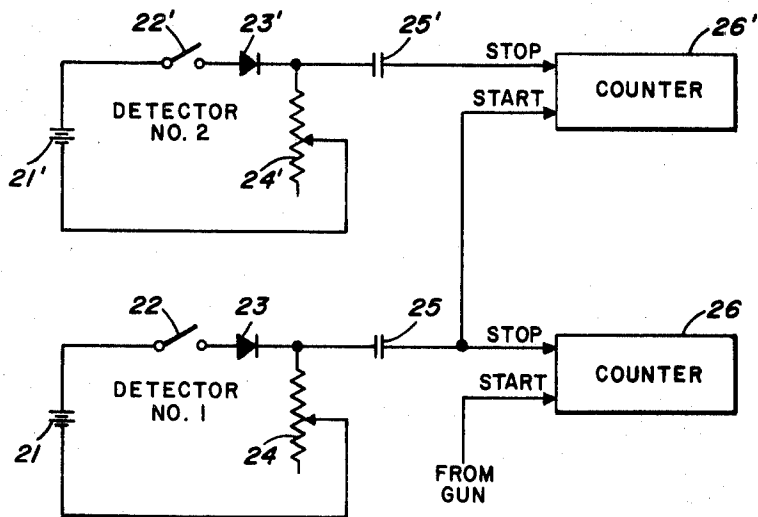


FIG. 2

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LASER PROJECTILE DETECTION SYSTEM

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United State of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is directed to the field of ballistic measurements. More particularly, it is directed to a system for measuring the muzzle velocity and ejection time of a gun.

2. Description of the Prior Art

In the prior art there are a number of systems which are utilized for measuring the velocity of a gun. Some of these systems utilize two sources of incoherent light and two photodetectors. After the fired projectile leaves the gun, it interrupts the path of light between the first light source and the first photodetector thereby activating a counter. As the projectile moves beyond this point, it breaks the light path between the second photodetector and light source to stop the counter.

This system has a number of inherent disadvantages which prevent its use in measuring muzzle velocity and ejection time. In the first instance, the firing of the gun will cause a burst of light to be emitted from the muzzle which will prematurely trigger the photodetectors and prevent the photodiodes from accurately detecting a break in light as the projectile leaves the muzzle. In addition, the firing of the gun causes ionized particles to be ejected from the gun as the projectile leaves the muzzle. These particles can scatter the light from the incoherent sources and prevent it from reaching the detector. This can prematurely trigger the counting circuit and result in inaccurate readings. Smoke generated by the firing of the gun will have a similar effect.

Yet another disadvantage of the system is that the incoherent light source has a wide beam and while a lens may be used to narrow it, the beam will still have a significant width. Thus, the projectile will move out of the muzzle a finite distance before the light beam between the first source and diode is broken, thereby introducing another unwanted inaccuracy in the measurement.

In addition, in measurements of muzzle velocity of a rapid fire gun, it is desirable that the velocity of a number of consecutive projectiles be measured and arranged. The wide incoherent beam, the ejected particles and the light from the blast render the incoherent light system useless.

Another system in the prior art utilizes two inductance coils through which a projectile is fired. The first coil is located near the muzzle. As the bullet passes through this coil, the inductance change that is set up triggers a counter. When the bullet passes through the second coil which is adjacent to the first, the change in inductance turns the counter off.

This system likewise is unsuitable for measurement of muzzle velocity and ejection time. In this system each of the coils has a finite length and it is difficult to determine at what point along this length the requisite inductive change is set up. This in turn will introduce an inaccuracy in the reading of the muzzle velocity. In addition, the muzzle of the gun will vibrate as the projectile is fired and this will set up an inductive change in the coils. In addition, this system cannot be used with rapid fire guns because the succeeding projectiles will set up inductive changes in coils which will prematurely trigger the counters.

SUMMARY OF THE INVENTION

The inventive system can accurately measure the muzzle velocity and ejection time of any gun. The system utilizes a laser to obtain an extremely narrow beam of light. The laser beam is a coherent source of light and the system is not af-

ected by the light generated by the firing of a gun or by the particles emitted from the barrel. The system can be used to measure the velocity of rapid fire guns with firing rates of 10,000 or more rounds per minute. In addition, the system is capable of measuring the elapsed time between firing and ejection of the projectile from the gun barrel. If required, the laser and detector can be placed far to the left or the right of the ejection path and a single photodetector utilized.

In the inventive system a laser beam is passed across the firing path of a gun at two points to two photodetectors. When the gun is triggered a first counter is turned on. When the projectile leaves the gun barrel, it breaks the first light beam and simultaneously turns off the first counter and turns on a second counter. When the projectile breaks the second beam, it turns off the second counter.

It is an object of the present invention to provide a new and improved system for measuring gun firing velocity.

It is a further object of the present invention to provide a system which is capable of accurately measuring the muzzle velocity and ejection time of rapid fire guns.

It is a still further object of the present invention to provide a system for measuring muzzle velocity and ejection time which is unaffected by the light or particles generated in the firing of a gun.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic of the inventive measuring system; and FIG. 2 shows the circuitry utilized by the inventive system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As seen in FIG. 1, the inventive system utilizes a laser 11 whose beam is directed along two parallel paths by a beam splitter 12 and a mirror 13. These beams are directed across the path taken by a projectile 14 fired from a gun 15. Each of the beams is focused on the center of the projectile path by lenses 16 and 16'. The beams are then expanded by lenses 17 and 17' and passed through optic filters 18 and 18' to photoelectric detectors No. 1 and No. 2.

In order to obtain the most accurate reading of ejection time possible, laser 11 is so located that the front of projectile 14 will break the light path to detector No. 1 when the back is being ejected from the gun.

Referring to FIG. 2, each of the detectors is comprised of a battery 21, 21', an on-off switch 22, 22', a light-activated diode 23, 23' and a variable resistor 24, 24' all connected in series. The output of the first detector is connected through a capacitor 25 to counters 26 and 26'. The output of the second detector is connected through capacitor 25' to counter 26'. Oscilloscopes can be utilized in place of counters 26 and 26'.

In operation, switches 22 and 22' are closed to activate detectors No. 1 and No. 2. Filters 18 and 18' are operative to prevent all light, which is not of the frequency of light emitted by the laser 11, from reaching diodes 23 and 23' and initially no current will flow through them. The bias on diodes 23 and 23' as set by variable resistors 24 and 24' is such that they will not be biased on by the small amount of light which has the same frequency as the laser and which is found in the testing area or is generated by the blast of the gun utilized.

Laser 11 is turned on next and its beam is directed through beam splitter 12 and mirror 13, lens 16, 16', 17, 17' and filters 18, 18'. The light from the laser will bias on diodes 23 and 23' to cause a direct current flow in the detector circuits. Capacitors 25 and 25' prevent this current from reaching counters 26 and 26'.

The counters are now set to zero and the gun is triggered by an electrical pulse which also triggers the first counter 26. This action causes a projectile to be ejected. When the rear of the projectile leaves the gun barrel, the front breaks the light path

from the laser to detector No. 1 and stops current flow in he detector circuit. When the rear of the bullet passes the detector, current flow is again initiated. This action causes a sharp pulse to be sent from the detector through capacitor 25. This pulse turns off counter 26 and turns on counter 26'. The reading on counter 26 is used as a measurement of the projectile ejection time.

As the projectile proceeds along the ejection path, its front breaks the light path from the laser to detector No. 2. The light path resumes when the rear of the projectile passes through. As in the operation of detector No. 1, this action causes a sharp pulse to pass through its associated capacitor 25'. This pulse is operable to turn off counter 26'. The reading recorded by counter 26' is then utilized together with the known distance between the two laser light paths to calculate the muzzle velocity of the gun. If a more accurate reading is desired, the system may be moved until the first beam passes directly over the muzzle of the gun.

Since a laser operates about a single wave length, its use together with its wave length filter insures that the system will not be affected by the light generated by the blast. In addition, some gun powder compositions generate a large amount of smoke. The use of a laser with its coherent light output insures that the light beam will not be scattered by the smoke particles and will therefore reach the detector.

In a destructive test environment, they use a laser because of its coherency, facilitates the placement of the laser and the detector at a greater distance from the gun barrel than hitherto possible. Similarly, where space considerations do not allow this placement, the second detector can be replaced by a mirror which directs the second beam to the photodiode 23 of the first detector. The bias on the diode is then varied by resistor 24 to adjust for this condition. The output of the single detector triggers the counter on and off through a pulse-steering circuit and a multivibrator.

For rapid fire guns, the most accurate reading of muzzle velocity is best obtained by measuring the muzzle velocity of a number of consecutively fired particles and taking an average. With the inventive system this can be achieved by dividing the reading on the second counter by the number of projectiles fired. In one test, an Optics Technology, Inc. Model 170 He-Ne laser with a 6328A wave length was used together with 6328A filters and United Detector Technology PIN-10 photodiodes. The recovery times of the detectors was 5.5 mm. seconds. This facilitated the use of the system with guns having rapid fire capability of over 10,000 rounds per minute. An even greater rapid fire capacity can be obtained by use of a laser having a shorter wave length.

Thus, it is seen that a new and improved system for measuring ejection time and muzzle velocity of a gun has been provided. The inventive system provides highly accurate measurements and is not affected by the testing environment.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

We claim:

1. A system for measuring the muzzle velocity of a gun comprising:

a source of coherent light mounted adjacent to the muzzle of said gun and operative to direct a first and second beam of coherent light across the projectile path of said gun;

a first photodiode, a first direct current source and a first adjustable impedance connected in series;

a second photodiode, a second direct current source and a second adjustable impedance connected in series;

said first photodiode being operative to receive said first beam of coherent light and said second photodiode being operative to receive said second beam of coherent light;

filtering means mounted immediately adjacent to both said photodiodes for passing only that light which has the frequency of said coherent light source;

first counting means electrically connected to said first and second photodiodes for activation by the passage of a projectile, ejected from said gun, through the first beam of coherent light and deactivation by passage of the projectile through the second beam of coherent light;

a first capacitor connected between said first counting means and said first photodiode; and

a second capacitor connected between said first counting means and said second photodiode.

2. A system as in claim 1 wherein said source of coherent light comprises:

a laser for generating coherent light;

a beam splitter mounted to receive the coherent light generated by said laser;

a reflecting mirror mounted adjacent to said beam splitter; and

said beam splitter being operative to divide the generated coherent light and to pass said first beam of coherent light and to reflect said second beam of coherent light to said mirror.

3. A system as in claim 2 further comprising second counting means connected to said first capacitor, whereby the output of said second counting means provides a measure of the ejection time of said gun.