BALLISTIC IMPACT SENSING AND DISPLAY SYSTEM

BACKGROUND OF THE INVENTION

Several techniques are known for detecting the impact of a ballistic projectile and for remotely indicating the point of impact. The following U.S. Patents are hereby referenced as being typical of the known prior art relevant to the present invention: Nos.

2,934,346: Mongello
2,916,289: Zito
2,973,964: Zito
3,022,076: Zito
3,627,323: Bozich et al.
3,678,495: Gilbert
3,707,699: Sanctuary
3,778,059: Rohrbaugh et al.

The referenced prior art provides a variety of methods for detecting and displaying ballistic impact events. These prior art systems, however, each have drawbacks relating to their complexity, accuracy, or maintenance requirements. Specifically, the systems disclosed by Bozich and Gilbert require a large number of sensors to maintain reasonable accuracy of impact location across the target area. The Zito system uses only three sensors, however, it incorporates a complex electromechanical plotter to display the impact location. The Rohrbaugh system utilizes linear transducers which restricts its versatility in adapting to varied target area sizes, especially where very large target areas are involved. The Mongello system incorporates an orthogonal matrix of indicators to display the impact location; however, it requires a corresponding matrix of orthogonal sensor straps to detect the impact location. The straps limit the adaptability of the system, and require continued maintenance.

OBJECTS OF THE INVENTION

Being thus aware of the limitations of the systems provided in the prior art, it is therefore an object of the present invention to provide an improved ballistic impact sensing and display system which is simple, maintenance free, and which provides a direct visual indication of the impact point relative to the location of the impact sensors.

It is a further object of the present invention to provide an impact display system which is uniformly accurate across the target area.

It is a further object of the present invention to provide a visual indication of the sector by which a projectile passed the target if it missed the target area.

It is a further object of the present invention to provide a ballistic impact sensing and display system which is readily adaptable to a wide variety of target sizes and sensing mediums.

SUMMARY OF THE INVENTION

A plurality of sensors located about the target area detect the impact of a ballistic projectile by generating electrical signals in response to the passage of the shock wave propagating radially outward from the point of impact. Each sensor signal is amplified, filtered, level detected, and latched to provide parallel digital signals with a single leading state transition corresponding in time to the passage of the leading edge of the propagating shock wave past the associated sensor. The digital sensor signals are gated with a clock signal, the frequency of which is proportional to the speed of propagation of the shock wave in the impact medium. The gating is terminated when the shock wave has passed all sensors. The resulting gated clock bursts are are counted by a plurality of counters which in turn drive families of display buses arranged along hyperbolic curved lines. Indicators bridging the intersection points between display buses provide the means of visual indication of the impact point compartment within the display plane. Additional indicators, activated upon the counters reaching a preset counting limit, provide a visual indication of the sector by which target area missed projectile passed the target area.

DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a ballistic impact in the target plane and the resulting propagating wave with sensor activation sequence.

FIG. 2 depicts the mathematical reconstruction of the target impact point in the display plane using intersecting hyperbolic curves.

FIG. 3 is a logic diagram of the preferred embodiment of the invention.

FIG. 4 depicts the display plane and shows impact area quantization compartments and target area miss sectors.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is based on the principle that a ballistic projectile traveling at supersonic speed creates a shock wave which propagates uniformly and radially outward from the projectiles path of flight; and on the principle that a ballistic projectile, whether subsonic or supersonic, upon impacting a target, creates a shock wave which propagates uniformly and radially outward from the impact point within the target medium. Sensors located within the target plane detect the passage of the shock wave. Recording the time differential between activation of the sensors permits location of the impact point to be reconstructed by the use of lines of constant time difference among the sensors.

FIG. 1 depicts such a target impact situation with four sensors designated A, B, C, and D located symmetrically about the target within the X-Y plane. A ballistic projectile impacting at a point, designated P, creates a shock wave within the target plane which propagates radially outward at velocity V_p. Each sensor responds to the passage of the shock wave by generating electrical signals which are subsequently processed to produce a digital signal transition coincident with the passage of the leading edge of the shock wave past the associated sensor within the target plane. The exact time of projectile impact is not immediately known; however, the differential time of arrival of the shock wave at the sensors is known. Referring to FIG. 1. Sensor A detects the shock wave first, followed next by sensor D. Since sensors A and D are vertically separated within the target plane, the time differential between their activation by the shock wave is designated as Delta-Ty. It is therefore known that the impact occurred at some location within the target plane such that the difference in propagation times from point P to A and P to D was Delta-Ty. Such a location determination is not yet exact since there is a family of points, described mathematically as a pair of hyperbolic curves, which satisfy the single time differential condi-