May 20, 1969 F. P. JOHNSON 3,445,808

SMALL ARMS LOCATOR

Filed April 5, 1968

Fig. 1.

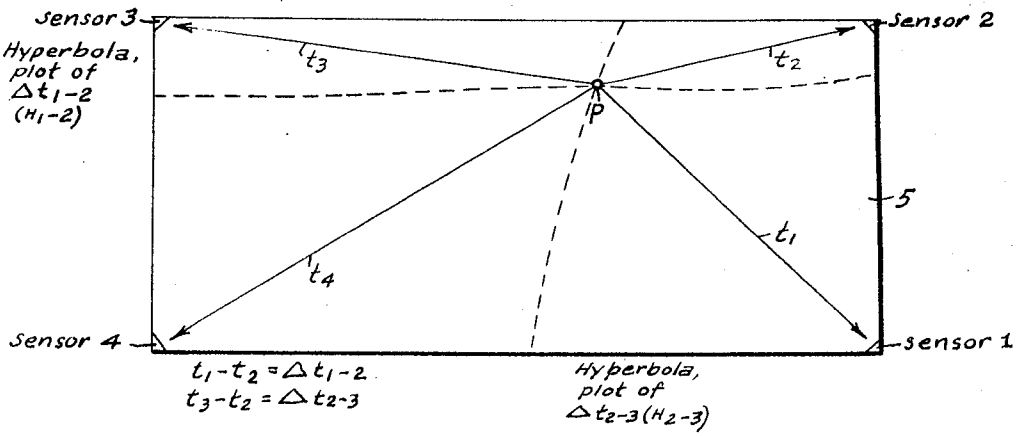


Fig. 2.

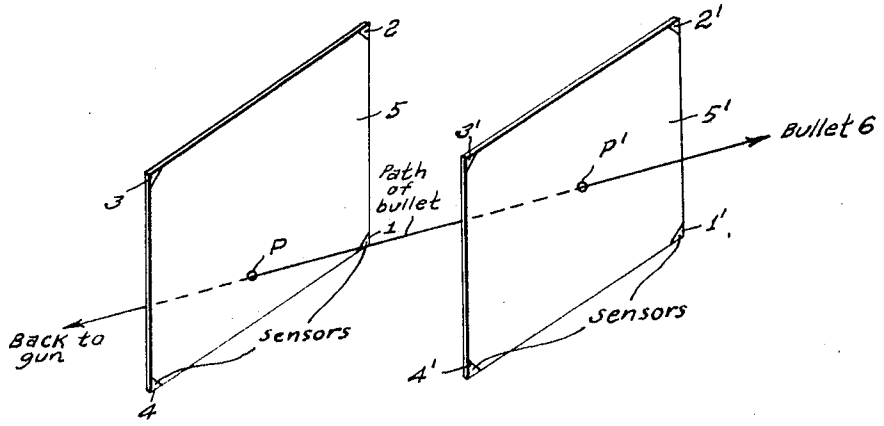
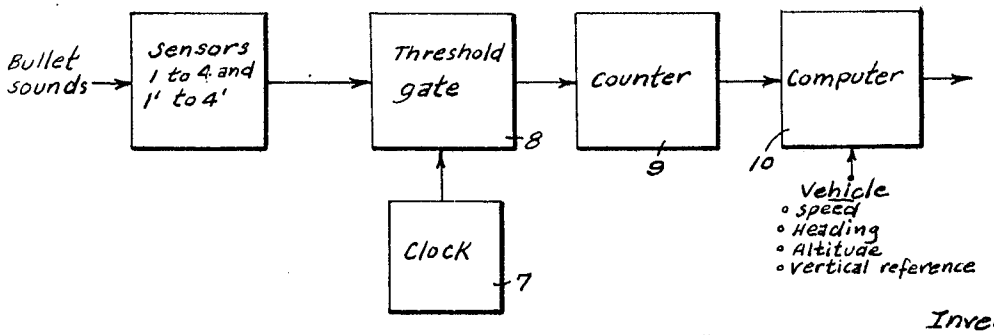


Fig. 3.



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United States Patent Office

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3,445,808

SMALL ARMS LOCATOR

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Int. Cl. G01s 3/80
U.S. Cl. 340—16 5 Claims

ABSTRACT OF THE DISCLOSURE

The direction of a bullet is ascertained by comparing the points at which it passed through two planes. Each point is pinpointed instantly by comparing the time element required for a sound, generated as the bullet passes through the plane, to reach various microphones at preselected points in each plane.

BRIEF SUMMARY

Direction finders, comprising audio sensors, microphones or other energy sensors, have been used in various groupings to indicate the direction of a source of sound or energy generator. However, such direction finders have enjoyed only limited utility. In a given setting, such as in a battle, many sounds may be generated simultaneously, such as guns firing, projectiles exploding, etc., thereby making it impossible or difficult to isolate a particular sound-source. Perhaps only one gun has found its target (your helicopter) and that gun should be pinpointed instantly for counterfire purposes or evasive action.

This invention helps pinpoint the direction from which came an object that has found its mark and scored a hit.

IN THE DRAWING

FIGURE 1 is a diagrammatic illustration of the time differential principles involved;

FIGURE 2 is a diagrammatic illustration of the path a bullet passing through two planar sound-producing objects;

FIGURE 3 is a block-diagram of the computer system of the invention.

DETAILED DESCRIPTION

Sensors **1**, **2**, **3** and **4** are placed at predetermined locations relative to a substantially planar object or sheet **5**. As exemplary, four sensors, more or less, may be audio sensors or microphones and the sheet may be rectangular, four by eight feet.

An object, such as a bullet, strikes sheet **5** at point P and generates concentric sound waves progressing toward the sensors. The sound reaches the sensors at the same instant only if the bullet struck the center of the sheet. Otherwise, the time of arrival of the sound at the various sensors is different. A difference in the time of sound arrival at sensors **1** and **2** can be expressed as

$$t_1 - t_2 = \Delta t_{1-2}$$

This time difference, Δt_{1-2}, will not, by itself, locate the point of peneration P. It will describe a locus of points, hyperbola H_{1-2}, that will contain the point P. The time difference between sensors **2** and **3** will describe a second locus of points, hyperbola H_{2-3}, that will intersect H_{1-2} at P. Time data from sensor combination **3–4** and **4–1** can be used to correlate this location.

In FIGURE 2 two spaced apart sheets **5** and **5'** are illustrated. Sheet **5'** has sensors **1'** to **4'** at its corners corresponding with sensors **1** to **4** at the corners of sheet **5**. These sheets should preferably be parallel to simplify computations. The bullet **6** penetrates these sheets at points P and P'. A straight line interconnecting these points, when traced back to the ground or jungle below, indicates approximately where the bullet came from.

FIGURE 3 indicates the well-known pieces of electronic equipment used to bring out the desired data from the equipment described above. The sounds from the bullet are detected by the sensors **1–4** and **1'–4'**. The output of the senors is fed into computer means including the output of clock **7**, threshold gate **8**, counter **9** and computer **10**. Computer **10** also may receive data as to vehicle (helicopter) speed, heading, altitude and vertical reference. The computer may correlate the data fed thereinto and computes the gun location data so that the pilot or gunner can pinpoint the gun position instantly for evasive or counterfire action. Theoretically it should be possible to feed the gun location data directly into gun control equipment on the vehicle which would automatically train the vehicle gun on the gun position from which the bullet came and quickly initiate counterfire. However, such system goes beyond the scope of the present system.

Sheets **5** and **5'** are shown for purposes of illustration of the principles involved. These sheets may be separate elements carried by a vehicle. Of course they may be used in the area of a stationary gun emplacement on the ground. In such installation the sheets could be placed in vertical planes so that a projectile coming in on a near-horizontal path would penetrate the sheets successively and the invention would pinpoint sniper or enemy gunfire ahead as it comes dangerously close.

In some installations there need be no separate sheets as such. For example, in a plane or helicopter, the skin of the craft, when pierced by a bullet, will generate the sounds as it passes through the belly and the top of the craft. Microphones, properly positioned relative to these parts of the skin of the craft, will detect the sounds as previously described.

I claim:

1. The method of determining the direction of a passing object comprising placing a first plurality of energy sensors at preselected points substantially in a first plane, placing a first substantially planar object substantially in said first plane, placing a second plurality of energy sensors substantially in a second plane, placing a second substantially planar object substantially in said second plane, using said first sensor to determine the location at which said passing object passed through said first plane, using said first sensors to determine the location at which said passing object passed through said second plane, and comparing the locations in the planes to determine the direction of the passing object.

2. Apparatus for determining the direction of a passing object comprising a first plurality of energy sensors placed at preselected points substantially in a first plane, a first substantially planar object substantially in said first plane, a second plurality of energy sensors substantially in a second plane, a second substantially planar object substantially in said second plane, computer means con-

nected to said first sensors and said second sensors to indicate the location of said passing object as it passes through said first and second planes and to compare the locations to thereby determine the direction of the passing object.

3. Apparatus as in claim 2 wherein said energy sensors comprise microphones, sensitive to energy waves generated as said passing object passes through said planar objects.

4. Apparatus as in claim 3 wherein said energy sensors comprise four microphones, substantially in each plane, substantially at the corners of a pair of rectangles.

5. Apparatus as in claim 2 wherein said first and second planes are substantially parallel.

References Cited

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RICHARD A. FARLEY, *Primary Examiner.*

U.S. Cl. X.R.

181—.5; 340—6

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,445,808 Dated 20 May 1969

Inventor(s) FRED P. JOHNSON

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 53, "sensor" should be -- sensors -- ;
Column 2, line 55, "first" should be -- second -- .

SIGNED AND
SEALED

SEP 2 - 1969

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents