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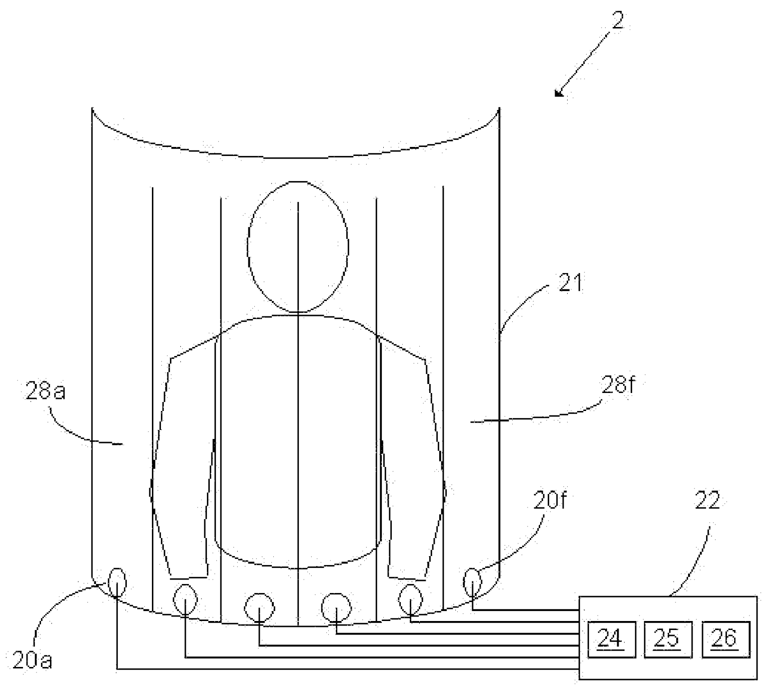
(54) Shooting target system for automatic determination of point of impact

(57) The object of the invention is to provide a cheap and compact shooting target system which is able to automatically retrieve information relating to the point of impact of a projectile in a target. The object is achieved by a shooting target system comprising:
- a target (11; 21; 31) composed by a material in which shock waves arise and propagate when hit by a projectile;
- a first shock sensor (10a; 20a; 30a) arranged to detect said shock waves;
- at least a second shock sensor (10b-c; 20b-f; 30b-d) arranged at a distance from said first shock sensor, and
- calculation means (12; 22; 32) for determining at least a first time-delay between the detections of the shock wave by the first and the at least second sensor, and for calculating information relating to the point of impact of the projectile in the target based on said at least first time-delay.

Fig 2A



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Description

TECHNICAL FIELD

[0001] The invention relates to a shooting target system according to the preamble of claim 1, and a method for automatically retrieving information relating to the point of impact of a projectile in a target according to the preamble of claim 7.

BACKGROUND ART

[0002] In both civil and military firearm shooting training, there is often a desire to detect quickly and automatically where a fired shot has hit. In some applications it is sufficient to determine whether a particular shot has hit or missed an intended target and in other applications there is a desire to determine precisely where in the target region the projectile hit, i.e. to determine the point of impact of the projectile in the target region.

[0003] One known method for automatically determining whether a shot has hit or missed a target is to attach a shock sensor to the target and monitor the output from the sensor. If the sensor detects vibrations with an amplitude bigger than a predetermined threshold value in the target material, a projectile can be assumed to have hit the target and a "hit" can be confirmed. Such sensing devices for live fire, as opposed to for example sensing devices for laser simulation, must be protectively mounted, usually along the bottom edge of the target.

[0004] There are also several known methods for automatically determine the actual point of impact of a projectile in a target region. Most methods employ a plurality of acoustic sensors, i.e. microphones, to detect either the sonic boom caused by a supersonic projectile, or the sound waves generated when the projectile hits the target.

[0005] One way of utilizing the sonic boom caused by supersonic projectiles for determining the point of impact in a target region is disclosed in US patent No. 5 920 522. The point-of-impact indication system described therein includes an array of acoustic sensors disposed in the vicinity of the target plane, not all lying on one straight line, which sensors detects the sonic booms generated by the supersonic projectiles used in the shooting exercise. Based on the outputs from the sensors, the shock wave time-delay for each sensor can be determined. This information is then used to determine the trajectory of the projectile and a point of impact in the target region can be estimated based on the determined projectile trajectory.

[0006] This method is associated with several drawbacks. For example, it only works when using firearms having a muzzle velocity exceeding the speed of sound since the projectiles must have a supersonic speed when approaching the target; the "point-of-impact determination" is not a determination of the actual point of impact but a point-of-impact prediction based on the projectile trajectory when approaching the target; a large number of microphones is required to be able to determine the point of impact of projectiles hitting a three dimensional (3D) target, in which case the projectiles can approach the target from a wide range, both horizontal and vertical; a lot of computational power is required to first calculate the projectile trajectory based on the sensor outputs and then calculate the presumed point of impact in the target.

[0007] One way of determining the point of impact of a projectile in a target region utilizing the sound waves generated when the projectile hits the target is disclosed in, e.g., the background portion of the European patent application No. 1 058 083. By arranging a plurality of microphones in a non-straight line in front of the target region and by determining the run-time difference of a sound wave originating from the impact of the projectile in the target between the different microphones, the point of impact can be calculated using geometrical regularities. One common microphone arrangement for this purpose is a T-shaped configuration having three aligned microphones arranged in parallel with the target plane, and a fourth microphone centrally arranged at a distance in front of the target. EP 1 058 083 discloses a refinement of such a detection system which comprises a plurality of T-shaped microphone configurations so as to increase the accuracy of the point-of-impact determination.

[0008] This method also requires a large number of acoustic sensors for determining the points of impact in a 3D target of projectiles coming from a wide range of directions in both azimuth and elevation. In close combat training for example, there is often a desire to be able to determine the point of impact of projectiles incident on a 3D target from azimuth angles varying with up to 180°, and angles of elevation varying with approximately 90°. The large number of acoustic sensors required in such a target system increases not only the size of the detection system, but also very much the complexity of the calculation algorithms needed to determine the point of impact.

[0009] Moreover, both the above methods for determining the point of impact of a projectile in a target suffer from the following drawbacks: The microphone frames or setups must be placed on the ground in front of the target making the target system delicate and cumbersome to move. In close combat training, the microphones may be stepped upon or even tripped over; The microphones must be very accurately aligned and spaced, both to each other and to the target, since only a small misplacement could cause a large error in the point-of-impact determination; Acoustic sensors and the peripheral equipment required in acoustic detection systems are costly.

SUMMARY OF THE INVENTION

[0010] It is an object of the present invention to provide a cheap and compact shooting target system which is able to automatically retrieve information relating to the point of impact of a projectile in a target.

[0011] This object is achieved by a shooting target system comprising:

- a target composed by a material in which shock waves arise and propagate when hit by a projectile;
- a first shock sensor arranged to detect said shock waves;
- at least a second shock sensor arranged at a distance from said first shock sensor, and
- calculation means for determining at least a first time-delay between the detections of the shock wave by the first and the at least second sensor, and for calculating information relating to the point of impact of the projectile in the target based on said at least first time-delay.

[0012] By utilizing shock sensors in order to retrieve information relating to the point of impact of a projectile in a target, the sensors can be attached directly to the target and the target system can thus be made very compact. Furthermore, conventional shock sensors available in the market can be used to implement the invention, thus minimizing the manufacturing cost of the target system.

[0013] Another advantage of the target system according to the above is that it is well suited for determining the point of impact of a projectile in three dimensional targets.

[0014] The target material may be any material in which shock waves arise and propagate upon an impact of a projectile but preferably the target material is some metal, some plastic compound, ceramic or fibreglass.

[0015] In one embodiment of the shooting target system, the target is "shredded" to form a comb-shaped target. That is, the target comprises at least one slit substantially dividing the target into at least two target strips which are held together by a portion connecting the substantially separated target strips, i.e. a connection portion forming the "base" of the comb. For example, the target may comprise a plurality of vertical slits extending from the bottom of the target to a distance from the top of the target, leaving a horizontal connection portion at the top of the target. By placing a shock sensor at or near the bottom of each target strip, the shock sensor disposed at the bottom of the particular target strip hit by a projectile will be the first sensor to detect the shock wave generated by the projectile impact and propagating in the longitudinal directions of the target strip. Thereby, the horizontal location of the point of impact of the projectile can be determined by simply registering which one of the sensors that is the first to detect the shock wave. The exactness of horizontal location determination of the point of impact is of course depending on the width of the target strips. The shock wave front propagating in the opposite direction is spread to the other target strips by the connection portion. The sensor located at the neighbouring target strip, which sensor is located closest to the first sensor detecting the shock wave from a propagation distance point of view, will be the next sensor to detect the shock wave, and the shock wave run-time difference between the two sensors is used to calculate the vertical location of the point of impact.

[0016] That is, by utilizing a "shredded" shooting target, the equation system that needs to be solved in order to determine the point of impact is reduced by one dimension, substantially reducing the computational power needed by the target system to calculate the point of impact of the projectile. Furthermore, a shredded target as described above prolongs the shock wave propagation path, i.e. the distance the shock wave have to travel in the target material, between the different sensors, thereby reducing the demands on the response time of the shock sensors and the electric circuit processing the shock sensor signals.

[0017] It is a further object of the present invention to provide a method for automatically retrieve information about the point of impact of a projectile in a shooting target. This object is achieved by a method comprising the steps put forth in the characterizing portion of claim 7.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig.1A illustrates a first embodiment of a shooting target system according to the invention.

Fig. 1B illustrates the shooting target system shown in Fig. 1A in greater detail, and the way the shock waves which arise and propagate in the target material due to the impact of a projectile in the target is used to retrieve information about the point of impact of the projectile.

Fig. 2A illustrates second embodiment of a shooting target system according to the invention.

Fig. 2B illustrates the shooting target system shown in Fig. 2A in greater detail, and the way the shock waves which arise and propagate in the target material due to the impact of a projectile in the target is used to retrieve information about the point of impact of the projectile.

Fig. 3 shows yet another embodiment of a shooting target system according to the invention.

DETAILED DESCRIPTION

[0019] Fig. 1A illustrates a first embodiment of the shooting target system 1 according to the present invention. The target system 1 comprises three shock sensors 10a-c arranged to detect a shock wave arising and propagating in the target material upon impact of a projectile (not shown) in the target 11. The target system 1 further comprises calculation means 12 connected to each sensor 10a-c and arranged to receive measurement signals there from. When a shock wave in the target material is detected by the sensors 10a-c, each sensor sends a signal indicating that a shock wave has been detected to the calculation means 12. The calculation means 12 is arranged to calculate the point of impact of the projectile in the target 11 based on the run-time difference of the shock wave between the different sensors 10a-c, as will be described in more detail below. In this embodiment, the target 11 is a three dimensional (3D) target comprising a uniformly curved metal sheet forming the envelope surface of a cylinder split in two pieces along its central axis, which metal sheet is painted to give the impression of an enemy soldier. It should, however, be appreciated that the principle of determining the point of impact of a projectile in a target described below is equally applicable to a flat, two dimensional target.

[0020] Fig. 1B illustrates how vibrations or shock waves caused by the impact of a projectile in the target 11 will propagate in the target material in a concentric pattern. A projectile is here assumed to have hit the target in the point indicated by an 'X'. The outermost shock wave, i.e., the first shock wave arising in the target material due to the impact of the projectile, is indicated by reference numeral 13. The sensor 10a is closest to the point of impact X and will hence be the first sensor to register the shock wave 13. When the sensor 10a detects the shock wave 13, it sends a signal to the calculation means 12 which starts a timer 14 upon reception of said signal. In the same way, the sensors 10b and 10c sends respective signals to the calculation means 12 when the shock wave 13 reaches them (illustrated in dashed lines). When the signal from the sensor 10b is received by the calculation means 12, the timer 14 is read and the value Δt_{ab} of the timer, which value Δt_{ab} is indicative of the run time difference of the shock wave 13 between sensor 10a and 10b, is stored in a memory or storage means 15 within the calculation means 12. The same thing is performed when the calculation means 12 receives the signal from sensor 10c, resulting in a second timer value Δt_{ac} indicative of the run time difference of the shock wave 13 between the sensors 10a and 10c. Alternatively, the shock wave run-time difference between the sensors 10b and 10c can be used as a second timer value. The "run time difference" of the shock wave between two sensors can hence also be expressed as the time-delay between the detections of the shock wave by said two sensors. That is, the value Δt_{ab} represents the time-delay between the detection of the shock wave by the first sensor to detect the shock wave and the second sensor to detect the shock wave, while the value Δt_{ac} represents the time-delay between the detections of the shock wave by the first sensor to detect it and the third sensor to detect it. By utilizing the time-delays between the detections of the shock wave by the sensors 10a-c as well as known parameter values, such as the speed of sound in the target material which corresponds to the velocity of shock wave propagation in the target 11, and the shock wave propagation distances between the sensors 10a-c, a calculating unit 16, such as a CPU, calculates the point of impact X using standard physics and well-known geometry. Shock wave propagation distance shall in this context be construed as the distance the shockwave has to propagate in the target material between two points.

[0021] The result of the calculation may be any information relating to the point from which the shock wave originates, i.e. the point of impact of the projectile, such as an angle and a distance from a reference point in the target, or the coordinates for the calculated point of impact.

[0022] Although the shooting target system 1 in Figs. 1A and 1B comprises three shock sensors, a person skilled in the art appreciates that two shock sensors are sufficient to retrieve some information about the point of impact of the projectile. If only two shock sensors are used, an exact point of impact cannot be determined since the system is under-determined (the calculation means needs two time differences in order to determine two coordinates for the point of impact). However, a shooting target system comprising only two shock sensors (yielding one shock wave run-time difference) is able to determine a line along the target 11, along which line the projectile must have hit the target. This point-of-impact information may be sufficient for certain shooting training applications.

[0023] The parameter values needed to calculate the point of impact except for the run-time difference of the shock wave between the sensors detecting it, such as the speed of sound in the target material and the propagation distance between the shock sensors, are preferably stored in the storage means 15 of the calculation means 12. The calculation means 12 may also comprise a user interface that allows a user to change these parameter values needed to calculate the information related to the point of impact so as to allow the same calculation means 12 to be used with different targets composed by different materials and/or shaped differently, and/or to allow repositioning of the shock sensors at a target so as to optimize sensor readings.

[0024] The speed of sound in an aluminium or other metal target is approximately 5000 m/sec which means that the shock wave travels approximately 10 cm in 0,02 ms. The shock sensors 10a-c should be separated by a distance ensuring that the electronic circuit of the calculation means 12 can distinguish the different sensor signals from each other. The exactness of the point-of-impact determination depends on the accuracy of the timer value readings. For example, a timer reading accuracy of $\pm$ 0,01 ms corresponds to a point-of-impact uncertainty of $\pm$ 5 cm. The point-of-impact uncertainty will henceforth synonymously be referred to as the "target system resolution" and a point-of-impact uncertainty of $\pm$ 5 cm thus corresponds to a target system resolution of 5 cm.

[0025] As aforementioned, shooting targets, and especially shooting targets used in military shooting exercises, often depicts fictitious enemy soldiers. A target system resolution of 5 cm, which is fully possible to achieve with the target system according to the present invention, is thus sufficient to determine which part of the "body" that is hit by an incident projectile. The indication means receiving the result of the point-of-impact determination can thus be arranged to visually or aurally indicate to the marksman that a shot has hit the "left leg", the "right arm", the "head" etc. This may be achieved by associating each target coordinate or different target regions with a part of the body in a look-up table located in the calculation means 12 or the indication means of the shooting target system.

[0026] Gusts of wind and rain may strike the target 11 and give rise to vibrations in the target material which undesirably may be registered by the sensors 10a-c and taken for an incident projectile by the calculation means 12. To avoid this problem, the calculation means is preferably arranged to compare the output signals from the chock sensors 10a-c with a predetermined threshold value and ignore signals indicative of chock waves or vibrations with amplitudes below a certain limit value. To further minimize the risk of calculating the "point of impact" based on shock waves or vibrations that are not caused by a projectile hitting the target 11, the calculation means 12 may be arranged to ignore all output signals from the shock sensors that are not within a predetermined amplitude interval, which interval is characteristic of shock waves caused by a projectile impact on the target. Yet a further alternative is to analyze the variation of the sensor signal amplitude in time and only calculate the point of impact for those shock wave signals having an amplitude-time signature that matches a predetermined amplitude-time signature which is characteristic of shock waves originating from a hit by a projectile. For example, the amplitude of consecutive shock waves originating from a projectile impact rapidly decrease in amplitude while the amplitudes of consecutive shock waves originating from gusts of wind most likely will fluctuate randomly. That is, the calculation means 12 may comprise logic that, by studying the amplitude of a plurality of consecutive shock waves, is able to distinguish shock waves or vibrations originating from a projectile impact from other non-projectile generated shock waves.

[0027] Fig. 2A illustrates another embodiment of the shooting target system according to the invention. The shooting target system 2 comprises the same components as the target system 1 described above with reference made to Figs. 1A and 1B and similar components are denoted by reference numerals having the same units digits. However, the target 21 is "shredded" to form a comb-shaped target. That is, the target 21 comprises a plurality of slits 27 substantially dividing the target into a plurality of elongated target portions 28a-f. In this embodiment, the slits are vertically arranged and extend from the bottom of the target 21 to a distance from the top of the target, thereby forming a plurality of vertically elongated target portions 28a-f, henceforth referred to as target strips, that are held together by a horizontal "connection portion" 29. A shock sensor 20a-f arranged to detect shock waves/vibrations in the target material is disposed at each target strip 28a-f. Preferably, the sensors 20a-f are disposed at or close to the ends of the target strips 28a-f. For the sake of clarity, not all of the slits 27, the target strips 28a-f and the sensors 20a-f have been provided with reference numerals. The same is valid for all the figures referred to hereinafter.

[0028] In Fig. 2A, as in the embodiment shown in Figs. 1A and 1B, the target 21 is illustrated as a bended metal sheet. The principle of determining the point of impact in a "shredded" target, as will be further described below, is, however, equally applicable to a flat shooting target.

[0029] Fig. 2B illustrates how vibrations or shock waves caused by the impact of a projectile on the shredded target 21 are propagating in the target material.

[0030] Once again, an imagined point of impact of a projectile in the target 21 is illustrated by the symbol 'X'. When a target strip (in this case target strip 28b) is hit by a projectile, shock waves arise and propagate in the longitudinal directions of the target strip. This is illustrated by a concentric pattern close to the point of impact and dashed lines illustrating the continued propagation path of the shock wave further away from the point of impact. When the outermost shock wave, i.e. the first shock wave arising in the target material due to the impact of the projectile, reaches the sensor located closest to the point of impact, which in this particular case is sensor 20b, the sensor transmits a signal to the calculation means 22 whereupon a timer 24 is started. The shockwave front propagating in the opposite direction reaches the connection portion 29 through which the vibrations/shock waves are further spread to all target strips 28a-f. The shock sensors neighbouring the shock sensor disposed on the target strip hit by the projectile, in this case shock sensors 20a and 20c, will be the next sensors to detect the shock wave since the propagation distance from the point of impact to these sensors is shorter than the propagation distance to the other sensors (except for sensor 20b). As soon as sensor 20a or 20c detects the shock wave, a signal indicating that the shock wave has been detected by a second sensor is sent to the calculation means 22 whereupon the timer 24 is stopped and a timer value Δt, indicating the run time difference of the shock wave between the first sensor to detect it and the second sensor to detect it, is obtained. In a similar way as described above with reference to Figs. 1A and 1B, the point of impact X is then calculated by the calculation unit 26 by utilizing the value Δt and known physical and geometrical parameters, such as the speed of sound in the target material, and the shock wave propagation distance between the sensors for which the run time difference of the shock wave has been determined.

[0031] By dividing the target into a plurality of target portions by means of slits, the shock wave propagation path between the different shock sensors is prolonged, reducing the demands on the response time of the shock sensors and the electronic circuit processing the sensor signals. It also reduces the demands on the computational power of the calculation means since only one target coordinate needs to be calculated in order to establish the point of impact of the projectile. In, e.g., the embodiment shown in Figs 2A and 2B the horizontal location for the point of impact is automatically given since the calculation means "knows" that the projectile must have hit the target somewhere along the vertical strip on which the sensor that was the first to detect the shock wave is disposed (given that the calculation means is arranged so as to be able to distinguish signals from different sensors). Hence, a shredded shooting target eliminates one dimension from the geometrical environment of the target and the calculation means 22 only needs to calculate the vertical coordinate for the point of impact based on the run time difference of the shock wave between the different sensors. The width of the vertical strips may vary in dependence of the demand on the target system resolution. In high precision shooting exercises finely shredded targets may be used while roughly shredded targets may be sufficient for other applications. If wide target strips are used and a more exact determination of the horizontal coordinate for the point of impact than the width of the strips is desired, it is possible to make use of the run-time difference of the shock wave to a third shock sensor. For example, as illustrated by the dashed lines in Fig. 2B, the shock wave propagation distance from the point of impact X to the sensor 20c is slightly shorter than the propagation distance from the point of impact to the sensor 20a. Therefore, the sensor 20c will detect the shock wave slightly before sensor 20a. This time-delay indicates that the projectile has hit the right-hand side of the target strip 28b and, based on the magnitude of the time-delay, the calculation means can calculate the horizontal coordinate for the point of impact.

[0032] If a projectile hits the target 21 in the middle of a slit or hits the connection portion 29 right between two target strips, the shock wave will reach two sensors at substantially the same time. In such a case, the signal from the third sensor detecting the shock wave can be used to obtain a timer value indicative of the run time difference of the shock wave between the first two sensors and the third sensor, and hence used to calculate the point of impact of the projectile on the target. As aforementioned, two sensors are however sufficient to retrieve some information related to the point of impact even in such an event. For example, if the target only comprises one vertical slit dividing the target into two vertical target strips, each having a shock sensor disposed at its lower end, and a shock wave would reach the two sensors at the same time, the calculation means can establish that a projectile has hit the target somewhere along a vertical line right between the two sensors, i.e. in the middle of the slit or in the middle of the connection portion.

[0033] Fig. 3 illustrates another embodiment 3 of the shooting target system according to the invention in which the target 31 is not only painted but also shaped to resemble an enemy soldier. The contour of the target 31 is shaped to resemble the silhouette of a human being and the target material is curved in three dimensions to form a realistic "front half" of an imagined enemy solider having a 180° target area. Such 3D shooting targets are commonly used in military shooting training exercises. In accordance with the embodiment shown in Figs. 2A and 2B, the target 31 comprises a plurality of vertical slits 37 dividing the target 31 into a plurality of target strips 37a-d, connected through a common connection portion 39. A shock sensor 30a-d is disposed at or near the lower end of each target strip. By taking into account the shock wave propagation distance between the different sensors and the speed of sound in the target material, the point of impact of a projectile can be calculated by the calculation means 32 as explained above. As mentioned in connection with the description of the embodiments shown in Figs. 1A-B and 2A-B, the calculation means 32 comprises at least a timer 34 for determining the run-time difference(s) of the shock waves between the shock sensors 30a-d, storage means 35 for storing the read timer values, and a calculation unit 36 for performing the calculations needed to determine the point of impact of an incident projectile based on the measured run-time difference(s).

[0034] It should be appreciated that the shredded targets 21, 31 illustrated herein also could be horizontally or otherwise "shredded", and that the different target portions 28a-f, 29, 38a-d, 39 could have any conceivable shape and size.

[0035] As mentioned above, one of the purposes of the slits 27, 37 is to prolong the propagation distance of the shock wave between the sensors 20a-f, 30a-d. A person skilled in the art would appreciate that this purpose can be achieved in many other ways and that the particular solution employing slits, shown herein, is just one possible way of doing so.

[0036] It should also be appreciated that a target of a shooting target system according to the invention can comprise a combination of several separate targets 11, 21, 31. For example, one roughly shredded target with, e.g., only two target strips with associated sensors may represent the "head" of a target depicting an enemy soldier, while a finely shredded target with many more target strips may constitute the upper body of the combined target, and yet another separate roughly shredded target may constitute the legs. In such case the sensors arranged to detect the shock waves propagating in the different targets may either be connected to separate calculation means or common calculation means.

[0037] Figs. 1-5 all illustrate targets 11, 21, 31 with a 180° target area. This implies that, theoretically, a projectile can hit the outermost part of the side of the target from an angle of 90°, pass through the target, and hit the outermost part of the other side of the target. This scenario would yield two shock wave propagation centres in the target which erroneously could be regarded as two projectile impacts by the detection system. However, knowing the target dimensions, the speed of the projectile, the positions of the shock sensors, and the speed of shock wave propagation in the target material, the calculation means can comprise logic capable of detecting such events and arranged to ignore shock waves caused by a projectile hitting the target a second time. These parameter values, and other known or obtainable parameter values needed to determine the point of impact of a projectile in a target, or needed to optimize the method of determining the point of impact according to the invention can be stored in the calculation means to which they may be inputted through a user interface.

[0038] The shock sensors 10a-c, 20a-f, 30a-d are preferably piezoelectric accelerometers and they are preferably mounted onto the targets 11, 21, 31 in a way that protects them from being hit by incident projectiles. For example, the shock sensors may be disposed at the bottom of the targets, as illustrated in the figures, and the targets may be located behind a bullet-proof bank or wall extending over the bottom part of the targets, sheltering the shock sensors from incident projectiles. Piezoelectric accelerometers suitable to use as shock sensors when implementing the present invention is easily obtainable in the market, making it easy to replace one or several sensors in the shooting target system if they should brake.

[0039] The targets 11, 21, 31 may be composed by any material in which shock waves/vibrations arise and propagate when hit by a projectile. In order for the shock waves to be detected by the shock sensors, it is important that the material does not absorb the vibrations to such a big extent that the amplitude of a shock wave is too small to be detectable when reaching the sensors. For example, the targets may be composed by metal, plastic, ceramic or fibreglass. It is also important that the target surface does not comprise too many sharp edges since sharp edges tend to convey the vibrational energy out from the target. Otherwise, the targets in the shooting target system according to the invention may have any conceivable size and shape. It should also be appreciated that any weapon and any ammunition can be used with the shooting target system according to the invention, as long as the projectiles fired by the weapon creates detectable shock waves in the target material when hitting the target.

[0040] Furthermore, the shooting target system 1, 2, 3 according to the invention preferably comprises hit indication means (not shown) for indicating the point of impact, or the information relating to the point of impact, in the target 11, 21, 31 to the user shooting at it. The hit indication means may be arranged to receive the result of the point-of-impact calculation from the calculation means 12, 22, 32 and visually or aurally indicate to the user if, and/or where, he or she has hit the target. The indication means may be a separate device arranged to receive the point-of-impact result from the calculation means, or form an integral part of the calculation means. The storage means 15, 25, 35 or additional storage means (not shown), may also be arranged to receive the results of the point-of-impact calculations from the calculation means and store the results for later evaluation of shooting exercises. This may be achieved by e.g. providing the calculation means with a communication interface, such as a USB or WiFi interface, allowing information to be transferred from the calculation means to, e.g., a portable computer device.

[0041] The detailed disclosure of the embodiments of the shooting target system according to the invention given herein should only be construed as illustrative and exemplary and merely serves the purpose of providing a full and enabling disclosure thereof. Accordingly, it is intended that the invention should be limited only by the scope of the claims appended hereinafter.

Claims

1. A shooting target system (1; 2; 3) comprising

- a target (11; 21; 31) composed by a material in which shock waves arise and propagate when hit by a projectile, and
- a first shock sensor (10a; 20a; 30a) arranged to detect said shock waves,

characterized in that said shooting target system further comprises:

- at least a second shock sensor (10b-c; 20b-f; 30b-d) arranged at a distance from said first shock sensor, and
- calculation means (12; 22; 32) for determining at least a first time-delay between the detections of the shock wave by the first and the at least second sensor, and for calculating information relating to the point of impact of the projectile in the target based on said at least first time-delay.

2. Shooting target system according to claim 1, further comprising at least a third shock sensor arranged at a distance from said first and second shock sensor, the calculation means (12; 22; 32) further being arranged to determine at least a second time-delay between the detection of the shock wave by said at least third sensor and either of the first or the second sensor, and for calculating the point of impact of the projectile in the target based on said first and at least second time-delay.

3. Shooting target system according to claim 1 or 2, wherein the target material is metal, plastic, ceramic or fibreglass.

4. Shooting target system according to any of the preceding claims, said shooting target system further comprising indication means for visually or aurally indicating the result of the calculation performed by the calculation means (12; 22; 32).

5. Shooting target system according to any of the preceding claims, wherein the target (21; 31) comprises means (27; 37) for prolonging the shock wave propagation distance between said sensors (20a-f; 30a-d).

6. Shooting target system according to any of the preceding claims, wherein the target comprises at least one slit substantially dividing the target into at least two target strips (28a-f; 38a-d) held together by a connection portion (29; 39), the sensors (20a-f; 30a-d) being disposed at the at least two target strips.

7. A method for automatically retrieving information relating to the point of impact of a projectile in a target (11; 21; 31), **characterized by**:

- detecting the shock wave arising and propagating in the target material upon an impact of a projectile in said target at a first and at least a second point of the target;
- determining at least a first time-delay between the detections of the shock wave at the first and the at least second point of the target;
- calculating information relating to the point of impact of the projectile in said target based on said at least first time-delay.

8. Method according to claim 7, further comprising the steps of:

- detecting said shock wave at at least a third point of the target;
- determining at least a second time-delay between the detections of the shock wave at the at least third point of the target and any of the first or the second point of the target;
- calculating the point of impact of the projectile in the target based on the at least first and second time-delay.

9. Method according to claim 7 or 8, further comprising the step of visually or aurally indicating the information related to the point of impact to the user shooting at the target.

10. Method according to any of the preceding claims, wherein the points at which the shock wave is detected are located at different target strips (28a-f; 38a-d) partially separated by one or several slits (27; 37) and connected at the beginning of the target strips by a connection portion (29; 39) through which a shock wave caused by a projectile impact in one target strip (28a-f; 38a-d) can propagate to the other target strip(s).

Fig 1A

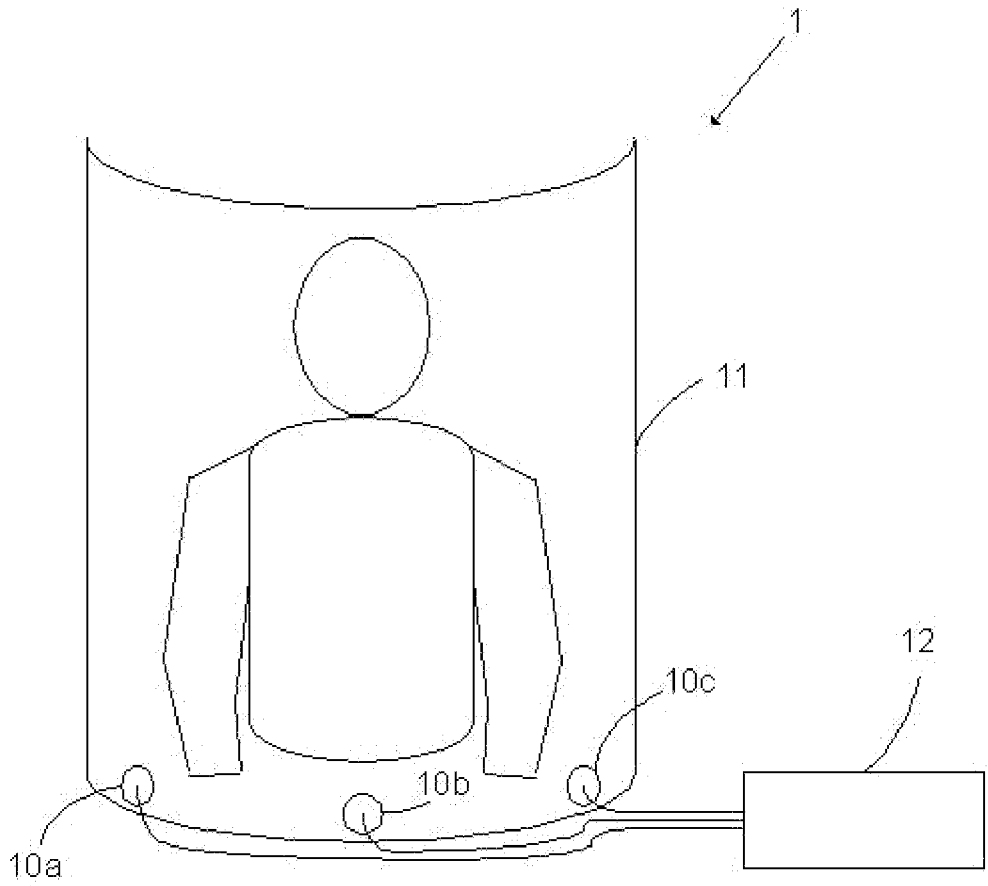


Fig 1B

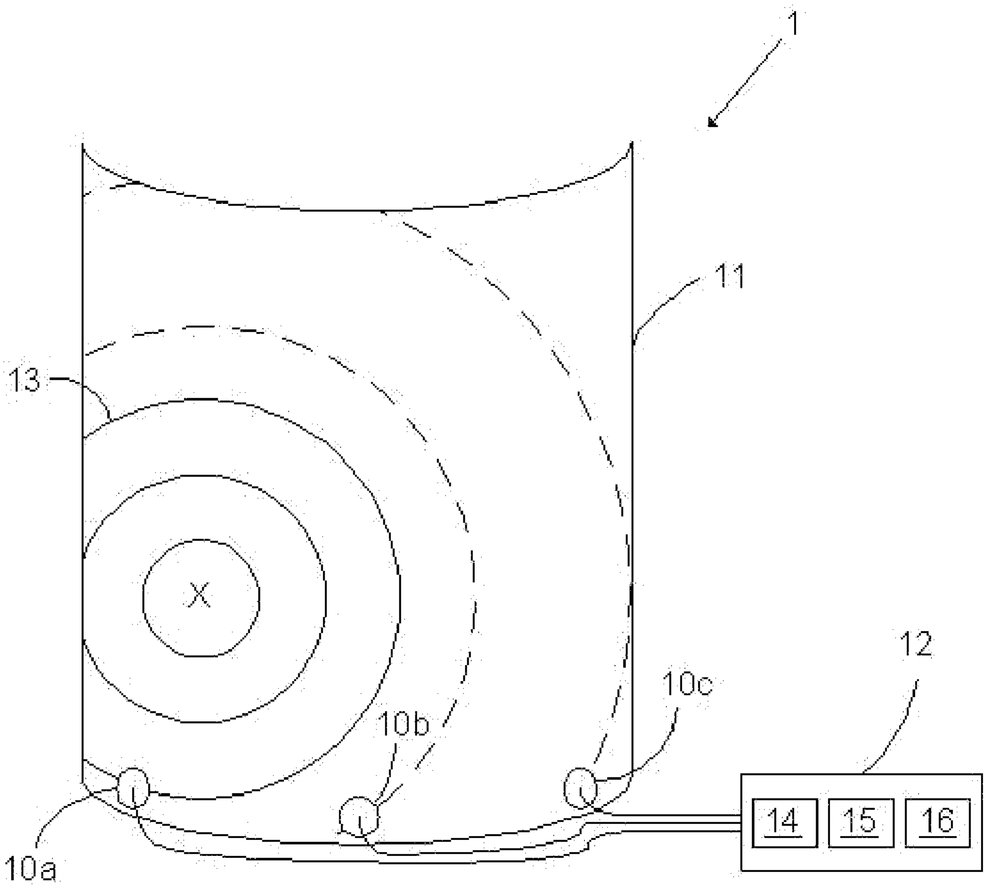


Fig 2A

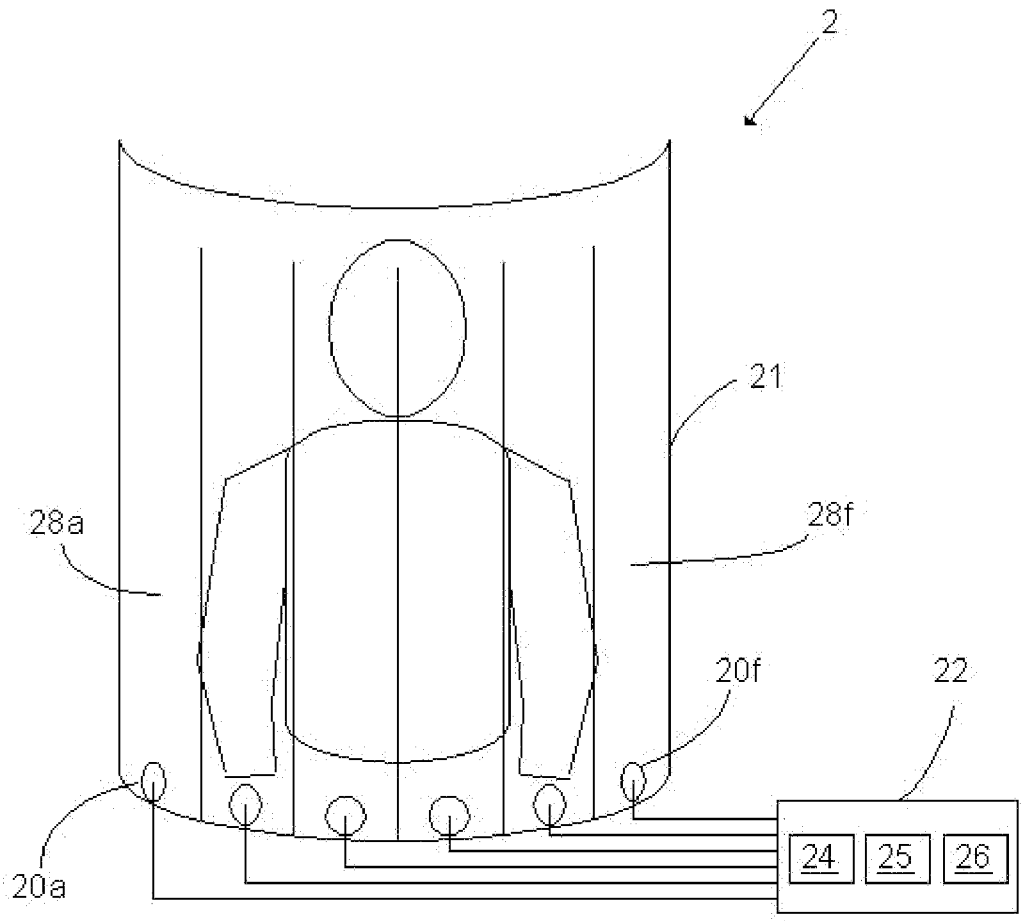


Fig 2B

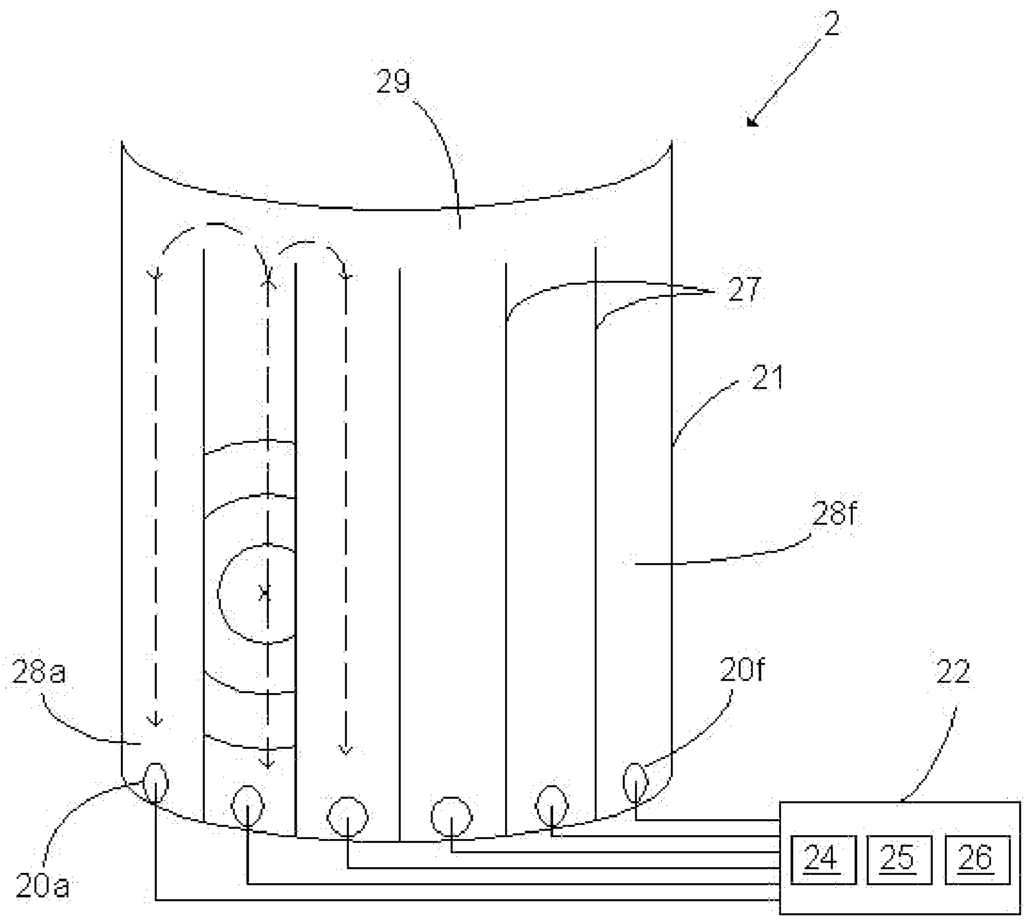
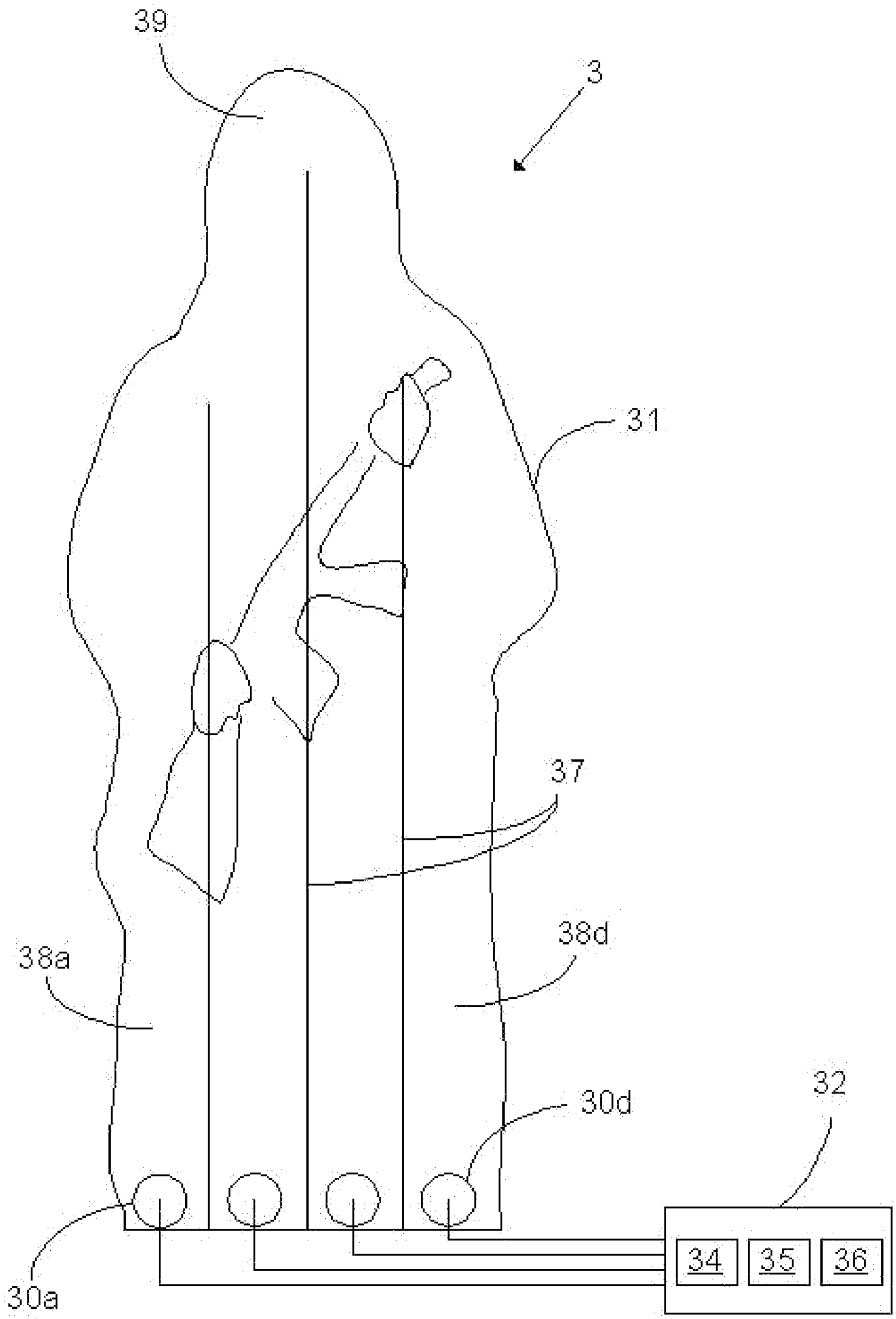


Fig 3



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EUROPEAN SEARCH REPORT

Application Number
EP 07 11 6964

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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F41J

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	15 February 2008	Menier, Renan

CATEGORY OF CITED DOCUMENTS

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