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(71) Applicant: **Industrias el Gamo, SA**
08830 Sant Boi de Llobregat (Barcelona) (ES)

(72) Inventor: **Casas Salva, Francesc**
08830 Sant Boi de Llobregat, Barcelona (ES)

(74) Representative: **Manresa Val, Manuel et al**
Rambla de Catalunya, 32,2o 2a
08007 Barcelona (ES)

(54) Ball-trapping device with electronic detection of impact on a target and detection method used therewith

(57) It comprises an impact resistant casing (1) having a frontal opening and means for removably fastening a target (2) covering such opening, the target (2) being of a sheet material through which projectiles can go and having an external face with a depicted motive to be shot. Electronic means are provided for detecting the position of impact on said target (2), comprising an electronic camera (3) arranged to obtain successive images of a face of target (2) after each shot, an image treating unit (4) for determining the geometric centre of the projectile at each impact from a treatment of the obtained images, and a data receiving and/or retransmitting centre (6,7) for displaying the results on a viewing screen (13, 14) and/or for retransmit them through a telecommunication network.

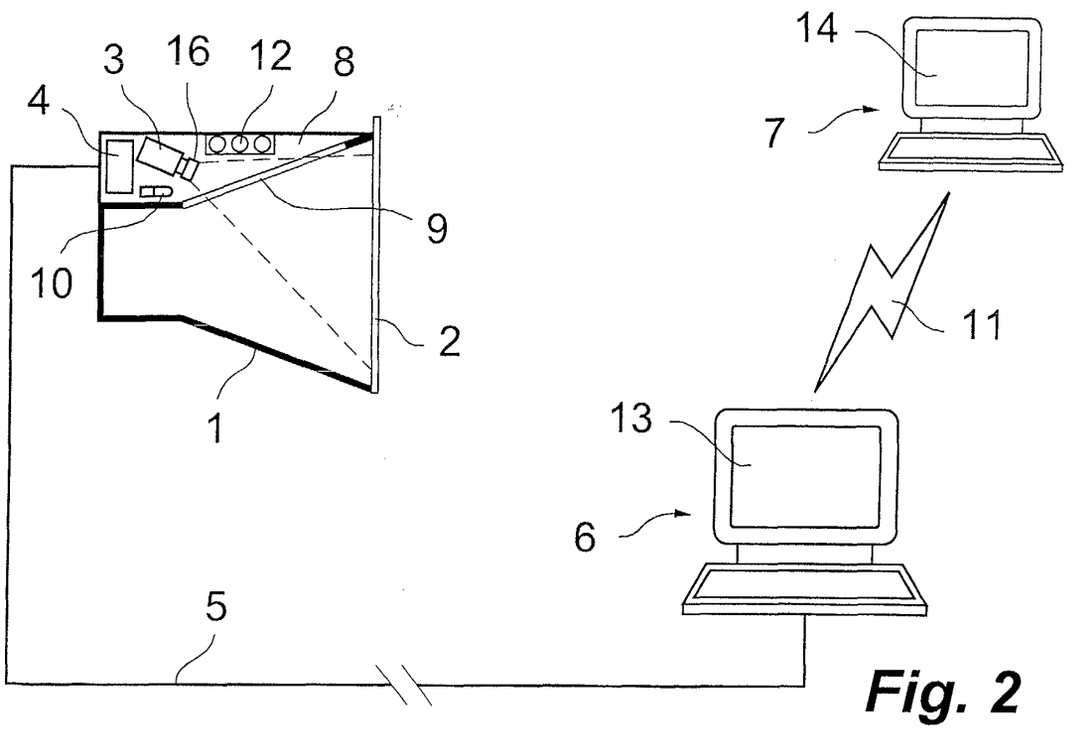

Fig. 2

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Description

[0001] The present invention refers to a ball-trapping device which has associated electronic means for accurately detecting the position of successive impacts on a target and for displaying the scores on a screen. Said electronic means can be connected to one or more remote centres for competing with other users or for participating in shooting games. The invention also refers to a method used for carrying out such detection.

[0002] The ball-trapping devices, also called ball-catching devices, are well known since certain time ago and they consist in a casing made of a material having impact strength and provided with an open front face having means for removably fastening a target covering such open face. The target is typically a sheet material, such a paperboard or stiff paper, through which the projectiles can go and on which external face a motive to be shot is depicted, such as several concentric rings around a central disk. Thus, the user may shoot the target and the projectiles, generally plastic or lead balls, are collected within the casing after crossing said sheet material. When the target is very damaged because of a large number of impacts it is replaced by a new one.

[0003] The utility model ES-A-1023727 is an example of one of such ball-trapping device which, in this case is dismountable.

[0004] The holes produced by each successive shot on the target evidence the place of the impact and the target can be visually checked for assessing the level of aim. However, for each new shot, it is necessary that the shooter physically goes close to the target for performing such check and the shooter must remind the positions of all the previous shots for discriminating the position of the last shot. This is boring and tiresome. In addition, the holes are not clean but show tears on their edges and often a new shot very close to another one modifies the hole pierced by such former shot without producing a new hole. All this makes the reading of successive impacts on the target difficult.

[0005] It has been tried to provide ball-trapping devices having means for helping to accurately determine the place of the impacts on the target.

[0006] The utility model ES-A-1001945 discloses a device in which the casing has a central face with a plurality of openings arranged according to a geometric pattern and a slot for introducing and withdrawing a sheet constituting a target, on which a series of numbers, graphics or colours have been printed which coincide with such openings and which can be seen through them. Such graphic target further comprises a printed-circuit board connected to an electronic panel which has built-up a high visibility scoreboard showing the scores. The utility model does not disclose which means are used for converting the impacts of the projectiles in electronic signals which may be handled by such printed-circuit board.

[0007] The patent ES-A-8305921 discloses a process and a device for assessing the level of aim on a target. The apparatus comprises a device to pass different printed target on a band through the open front face of a casing and two detection systems. One of those systems is kept in position close to the travel path of a target and it is used for measuring the distance from an entrance hole at the centre of the target in the direction in which the target is travelling through the apparatus. The other system is mounted on a cross sliding element and is displaceable in straight angle in the direction in which the target is travelling and it measures the distance from the hole to the centre of the target in such cross direction. The two distances are vectorially added by a computer and the result is multiplied by a calibrating factor. The end score can be displayed on a screen or printed. Such detection systems comprise orthogonally arranged photoelectric barriers.

[0008] This system only allows determining the position of a single hole on the target; therefore, it is required to replace the target after each shot. In addition, to cover the whole of the target area with said two photoelectric barriers, a great number of sensors is required which results in the apparatus having a high price. On the other hand, such great number of sensors generates a relatively high power consumption which makes unworkable to supply the device with cells or reloadable batteries, preventing its power autonomy.

[0009] The patent ES-A-2025007 let know a system for obtaining a reading of the game surface of a real target, although in this case it is an electronic machine for a darts game. The system includes two imaging digital cameras arranged at 90° from each other and each encompassing the whole of the front surface of the target where the darts are stuck. The signals of both cameras are treated in a module of a CPU to provide as a result a two dimensional image of the target with the darts stuck displayed on a viewing screen.

[0010] Although this device uses imaging electronic cameras for reading the target, the result obtained is a two-dimensional image thereof but such image does not offers the calculated position on coordinates of each successive shot.

[0011] An object of the present invention is to provide a ball-trapping device having an electronic detection of the impact on a target provided with a digital camera for taking images of the target back face, from which electronic means are able to implement a method for detecting the centre of each successive impact.

[0012] Another object of the present invention is to provide a self-powered ball-trapping device with electronic detection of the impact on a target and which can be connected to a local or remote receiving and/or retransmitting centre to display the scores and/or participate in shot games competing with other local or remote players.

[0013] Still another object of the present invention is to provide a detection method to be used with the above ball-trapping device.

[0014] These objects are achieved, according to the present invention, providing a ball-trapping device of the kind which comprises a casing, of a material having strength to the impacts, with a front face having an opening and means for removably fastening a target covering such opening. This target is typically a sheet of material through which the projectiles can go and on which external face a motive to be shot is depicted. The ball-trapping device includes electronic means associated at least partly to said casing, for detecting the position of at least one impact on said target.

[0015] Such electronic means essentially comprise an electronic camera provided with a corresponding focusing lens for taking images, an image treating unit, and a centre for data receiving and/or retransmitting, which can be associated with a viewing screen. Said electronic camera is arranged within the casing in a protected chamber formed at least partly by a transparent wall, encompassing in its focal field the back face of the target for taking images of each of successive shots after it occurs. The material of which the target is made is sufficiently opaque in order to provide a dark ambience within the casing in said back face of the target contrasting with an external natural or artificial illumination, necessary for shooting practice. Thanks to this, any hole in the target is obtained by the camera as a light spot on a dark background. Thus, the impact of each successive shot produces a new hole or a modification of a previous hole which is obtained by the image-taking camera.

[0016] The successive images obtained are handled by said image treating unit to determine the projectile geometric centre at each successive impact, the scores are displayed on said viewing screen associated with the mentioned data receiving and/or retransmitting centre and/or are retransmitted through a telecommunication network to one or more remote centres to be shown or compared to scores obtained by other remote users with which it is possible to compete.

[0017] The processing of the images obtained preferably comprises a prior step of calibrating the position of the image depending on a parameter such as a printed mark on the back face of the target or control holes and the processing is performed by means of image processing algorithms and artificial intelligence operations, and by means of comparing the images obtained with images stored in a memory associated with said image treating unit. Said algorithm comprises first storing in a memory the image obtained after a first shot; then passing the successive images obtained to a treating unit wherein a grey scale intensity comparison between each new in-coming image and the last memory-stored image is performed; and last, storing each new image resulting from comparison by rejecting or replacing the image of the former shot. From both horizontal and vertical projection of the image resulting from comparison, two vectors X and Y are obtained which are filtered with a filtering gauge depending on the kind of ammunition and shot to be detected, said filtering gauge being retrieved from an empiric database of filtering patterns. After filtering, the impact central point is determined from thresholds in the grey scale. Also, a second database is used to counterbalance the central point determined with techniques of artificial intelligence based on back-propagation neuronal networks. Such central point is obtained with reference to a corner of the image.

[0018] As the target is being used, holes and modifications (widening) of old holes are being accumulated, therefore at a given moment the target is so damaged that is hard or impossible to assess the effects of new impacts and it is necessary to replace it. For this, the method of the present invention includes a function which comprises to pick-up by means of a microphone a noise produced by each successive impact within the casing, which is an indicative that the shot did occur and that a new image of the target back face has to be obtained. The image obtained corresponding to the same shot which produced the last noise is compared as explained above with the stored image corresponding to the former shot. In the case of no difference can be seen between such two consecutive images, the system issues a warning about the convenience of replacing the target.

[0019] Preferably, the image treating unit is built-in within the casing and comprise a digital signal processor DSP having associated memories for storing images and processing them on the base of neuronal networks while said data receiving and/or retransmitting centre is a local computing centre associated with a viewing screen located close to the place from which the user is shooting. The result from the impact detection is transmitted through suitable transmitting means from the image-treating unit, within the casing, to said local computing centre. Said transmitting means can use different means such as a connecting cable, infrared rays or radio-frequency waves. The local computing centre can be any digital computer device of those generally available in the market, such as personal digital assistant PDA or a personal computer PC, which is provided, according to the cases, with a cable connecting port, an infrared receiver or a radio-frequency wave receiver.

[0020] Alternatively it is also possible that the image-treating unit is located at a place external from the casing. In this case, the treating unit preferably comprises a digital signal processor DSP having associated memories for storing images and processing them on the basis of neuronal networks, a cable connection being provided between the electronic camera and the image-treating unit. Advantageously, such external image-treating unit is integrated in a personal digital assistant PDA or personal computer PC which also carries out the functions of the data receiving and/or retransmitting centre.

[0021] The electronic camera is constituted by a CCD device having MOS technology and the power consumption of the camera and image data treating unit, when included in the casing, is relatively low. This allows

to supply electric power to such systems by means of one or more batteries or cells associated with said casing, therefore the ball-trapping device is self-powered. However, when said cable connection to the local computing unit is used, it is also possible to supply such systems through an electric line included in such cable and from the power supply of the computing unit itself. Another variation includes an input in said casing for connection to an external power supply to power supply those systems that would require it.

[0022] The invention will be more apparent from following detailed description of an exemplary embodiment with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of part of the ball-trapping device of the present invention;
Fig. 2 is a diagrammatic scheme showing the parts and connections of the ball-trapping device of the present invention;
Fig. 3 is a flow chart illustrating the method of electronic detection used with the ball-trapping device of Fig. 2.

[0023] Referring first to Fig. 1, the ball-trapping device according to the present invention has a part designed to support and show the target, which is similar to that of the conventional ball-trapping devices. This part comprises a casing 1, of a material having impact strength, with a front face provided with an opening and means for removably fastening a target 2 covering such opening. Said fastening means are, in the illustrated example, small wings 15 arranged on three edges of said opening so that they form slots in which the target 2 can slide. The target 2 is in the form of a sheet of a material through which the projectiles can go and on which external face a motive to be shot, such as several concentric rings around a central disk, is depicted.

[0024] According to Fig. 2, the ball-trapping device of the present invention further comprises electronic means for detecting the position of each successive impact on the target 2 and show the scores. A part of such electronic means can be placed in a chamber within or associated with said casing 1 and the other part is placed outside the casing 1, at a local or remote place. Preferably, the components associated with the casing 1 essentially comprise an electronic camera 3 with a focusing lens 16 for picking-up the images and an image-treating unit 4 connected to the camera 3 for electronically processing the images obtained. According to a preferred exemplary embodiment, the electronic camera 3 is arranged in a protected chamber 8 formed at least partly by a transparent wall 9, of a material such as reinforced glass, so that the camera 1 encompasses in its focal field the back face of the target 2 to pick-up after each shot successive images of said back face where new holes or modifications of previous holes are successively appearing produced by the successive impacts. However, the electronic camera could be arranged within a protected housing, linked to the casing 1 through an arm or the like, stiff enough to provide stability to the image, for encompassing in its focal field the front external face of the target and taking images of them. The image treating unit 4 comprises a digital signal processor DSP having associated memories for storing images and processing them on the basis of neuronal networks, and although it is not essential, it is advantageously located within said protected chamber 8, a compact ball-trapping device with a set of casing 1 including the electronic image pick-up and treating means 3, 4 being formed. The image-treating unit 4 is adapted to determine the geometric centre of the projectile at each successive impact from a processing of the images obtained by the camera 3 applying the method of the present invention, which will be described below with reference to Fig. 3. The electronic camera is preferably constituted by a CCD device with MOS technology.

[0025] In the illustrated example, the image treating unit 4 is connected by suitable transmitting means, such as a connecting cable 5, to a data receiving and/or retransmitting centre 6 connected to a viewing screen 13, where are displayed the results of the impact detection corresponding to each successive shot. Such data receiving and/or retransmitting centre is a local computing centre 6, such as a personal digital assistant PDA or a personal computer PC, provided with an input port for cable connection and a connection to a telecommunication network 11, such as Internet, for retransmitting said results to a remote computing centre 7 associated with a viewing screen 14, which can be, for example, another personal digital assistant PDA or a personal computer PC to which is connected another ball-trapping device with target impact electronic detection used by another remote user.

[0026] It is convenient that the local computing centre 6 is located close to the user who is shooting and for this the connecting cable 5 constitutes a cheap and reliable signal transmitting means. However, other more sophisticated wireless transmitting means can be used such as an infrared ray or a radio-frequency wave emitter associated with the casing 1, for which the personal digital assistant PDA or the personal computer PC must be provided with an infrared ray or radio-frequency wave receiving port.

[0027] According to another exemplary embodiment not shown, such image treating unit 4 is located in a place external from the box 1, for example, close to the user who is hooting, and comprises a digital signal processor DSP having associated memories for storing the images and processing the same on the basis of neuronal networks preferably integrated in a personal digital assistant PDA or a personal computer PC which also has the function of the data receiving and/or retransmitting centre 6 and/or 7 of Fig. 2. In this case, there would exist an external cable or otherwise connection between

the electronic camera 3 and the image-treating unit 4.

[0028] Additionally, the ball-trapping device includes a microphone 10 within the casing 1 to pick-up a noise produced by each successive impact. Such noise confirms the occurrence of each shot on the target and, in addition, in combination with the image corresponding to same shot it serves for determining when the target 2 is so damaged that it is necessary to be replaced, as described below in relation with the method of the invention.

[0029] It is desirable that the ball-trapping device, at least the set of the casing 1 and associated electronic image pick-up and treating means 3,4 is energetically autonomous as possible. For this it includes one or more batteries or cells 12 associated with said casing 1 for providing power supply to the systems requiring it. Alternatively, when the electronic image pick-up and treating means 3, 4 associated with the casing 1 are connected via cable 5 to a local computing centre 6, said connecting cable 5 can include an electric line for supplying the electronic means 3, 4 associated with the box 1 with electric power coming from the power supply of the local computing unit 6 itself. When the local computing unit 6 is a personal digital assistant PDA or portable personal computer PC supplied by cells or batteries, the complete system is self-powered. However, the casing 1 can include an input for a connection to an external power supply.

[0030] When, as in the example of Fig. 2, the electronic camera 3 picks-up images from the internal back face, of the target 2, said sheet material of which the target 2 is made is sufficiently opaque in order to the electronic camera 3 can differentiate said holes or modifications thereof from the light which, coming from outside, enters through them, in contrast with the rest of the sheet which remains dark. It is important to "read" the outlines of the holes, which generally have tears, folds, etc which are important to determine the shooting centre. Such reading of the outline is achieved by grey scale comparing with pre-recorded standards. To allow shooting practice with scarce light, the ball-trapping device includes an external auxiliary source of illumination (not shown) which is applied on the external face of the target. This helps as well the user's vision as the pick-up of images by the camera 3.

[0031] Thereafter, with reference to the flow diagram of Fig. 3, the detection method used according to the present invention is described in the ball-trapping devices with the electronic detection of the impact on the target above disclosed with relation to Fig. 1 and 2.

[0032] The method comprises following steps:

First, obtaining (box 30) by means of said electronic camera 3 after each shot at least one image, represented by box 31, of a face of the target 2 in which appear successive new holes or modifications of previous holes produced by successive impacts;
then, treating (box 32) by means of such image treating unit 4, the image obtained (box 31) for improving its definition and process (boxes 33-37) the treated image for determining the geometric centre of the projectile at each successive impact from obtained, treated and processed images; and
last, showing (box 38) the scores in one of such viewing screens 13, 14.

[0033] When said image-treating unit 4 is located within the casing 1, the method comprises transferring with such communication means 5 the result of treatment with such image-treating unit 4 to a data receiving and/or retransmitting unit, which is a local 6 or remote 7 computing centre.

[0034] The method comprises a step of calibrating the position of the image as a function of a parameter such as a printed mark or control holes on the target face picked-up by the camera.

[0035] When the electronic camera 3 encompasses the internal back face of the target 1, such as in Fig. 2, said algorithm comprises comparing (box 33) the obtained image (box 31), once treated, with the former image (box 41) that is to say, the last image stored in memory, according to their grey scale intensities. Each new image resulting from said comparison is stored replacing the image of the former shot.

[0036] Then, a projection (box 34) of the impact image resulting from previous comparison on image horizontal and vertical axes is performed, obtaining two vectors X and Y which are filtered with a filtering pattern depending on the kind of ammunition and shot to be detected, with the assistance of an empiric database (box 39) for retrieving such filtering patterns and counterbalancing according to former impacts (box 37). After such filtering the central point of the impact is detected (box 35) or determined from grey scale thresholds.

[0037] Last, the method comprises the use of a second database (box 40) to carry out a relocation of the central point (box 36) determined in the former operation, using techniques of artificial intelligence (frame 42) based on neuronal networks of back-propagation type, said point being obtained with reference to a corner of the image.

[0038] It must be pointed out that, although steps of boxes 34-37 are shown in Fig. 3 in a sequential manner, the operations are carried out simultaneously and interlinked.

[0039] The method of the present invention includes a function for determining when the target 2 is so damaged that it is necessary to replace it. This function comprises the steps of: picking-up by means of a microphone 10 a noise produced by each successive impact within the casing 1; comparing (box 33 in Fig. 3) the image obtained (box 31) corresponding to same shot that produced last noise with the image stored corresponding to the former shot (box 40); and in case that a given level of difference is not assessed between such two consecutive images, 3 issue a warning about the con-

venience to replace the target 2.

[0040] One skilled in the art could easily devise several variations and/or modifications without being out of the scope of the invention as it is defined in the claims appended.

Claims

1. Ball-trapping device with electronic detection of the impact on the target of the kind comprising a casing (1) made of a material having impact strength and with a front face having an opening and means for removably fastening a target (2) covering such opening, the target (2) being in the form of a sheet material through which the projectiles can go, on which external face a motive to be shot is depicted, electronic means being provided for detecting the position of at least one impact on said target (2), **characterized in that** said electronic means comprise an electronic camera (3) having a focusing lens for picking-up images, an image treating unit (4), and a data receiving and/or retransmitting centre (6,7) susceptible to be associated with a viewing screen (13, 14), said electronic camera (3) being arranged to encompass in its focal field a face of the target (2) and to obtain after each shot successive images of said face on which new holes or modifications of previous holes produced by successive impacts appear, said image treating unit (4) being adapted for determining the geometric centre of the projectile at each successive impact from a treatment of the obtained images, and said data receiving and/or retransmitting centre (6,7) being adapted for displaying the results on said viewing screen (13, 14) and/or retransmit them through a telecommunication network.

2. Ball-trapping device according to claim 1, **characterized in that** said electronic camera (3) is housed in a protected chamber (8) associated with the casing (1) and encompasses in its focal field the internal back face of the target (2) through a transparent wall (9).

3. Ball-trapping device according to claim 1, **characterized in that** said electronic camera is housed in a protected chamber associated with the casing (1) and encompasses in its focal field the external front face of the target (2) a support of said chamber being stiff enough to provide stability to the image.

4. Ball-trapping device according to claim 1, **characterized in that** it includes a microphone (10) within the casing (1) to pick-up a noise produced by each successive impact, said noise in combination with the image corresponding to same shot serving to determine when the target (2) is so damaged that it is necessary to replace it.

5. Ball-trapping device according to claim 1, **characterized in that** such image treating unit (4) is integrated in a protected chamber (8) associated with the casing (1) and comprises a digital signal processor DSP with associated memories for storing images and processing them based on neuronal networks.

6. Ball-trapping device according to claim 5, **characterized in that** such data receiving and/or retransmitting centre (6, 7) is a local computing centre (6) having an associated viewing screen (13) located close to a user who is shooting, means being provided for transmitting the results of said image treatment from the image treating unit (4) in the box (1) to said local computing centre (6).

7. Ball-trapping device according to claim 6, **characterized in that** said transmitting means comprise a connection cable (5) for connecting to said local computing centre (6), the local computing centre (6) being selected from a group including a Personal digital assistant PDA and a personal computer PC, in each case provided with an input port for connecting the cable.

8. Ball-trapping device according to claim 6, **characterized in that** said transmitting means comprise an infrared ray emitter to said local computing centre (6), the local computing centre (6) being selected from a group including a Personal digital assistant PDA and a personal computer PC, in each case provided with an infrared ray receiving port.

9. Ball-trapping device according to claim 6, **characterized in that** said transmitting means comprise a radio-frequency waves emitter to said local computing centre (6), the local computing centre (6) being selected from a group including a Personal digital assistant PDA and a personal computer PC, in each case provided with a radio-frequency waves receiver

10. Ball-trapping device according to claim 1, **characterized in that** said image treating unit (4) is located at a place outside the casing (1) and comprises a digital signal processor DSP with associated memories for storing image and treating them based on neuronal networks, memories an external connection, such as via cable, between the electronic camera (3) and the image treating unit (4) being provided.

11. Ball-trapping device according to claim 10, **characterized in that** the image treating unit (4) is integrated in a personal digital assistant PDA or per-

sonal computer PC which also acts as a data receiving and/or retransmitting centre (6, 7).

12. Ball-trapping device according to any one of preceding claims, **characterized in that** it includes one or more batteries or cells (12) associated with said casing (1) for providing power supply to the systems requiring it, thereby the ball-trapping device is energetically autonomous.

13. Ball-trapping device according to claim 7, **characterized in that** said connection cable (5) includes an electric line, those systems in the ball-trapping device requiring it being supplied with power from the power supply of said local computing centre (6) itself.

14. Ball-trapping device according to any of claims 1 to 11, **characterized in that** said casing (1) includes an input for connection to an external power supply to supply with power the systems of the ball-trapping device requiring it.

15. Ball-trapping device according to any of claims 6 to 11, **characterized in that** said local computing centre (6) is connected to a remote computing centre (7) through a telecommunication network.

16. Ball-trapping device according to any one of the preceding claims, **characterized in that** said electronic camera is constituted by a CCD device having MOS technology.

17. Ball-trapping device according to claim 2, **characterized in that** said sheet material of which the target (2) is made is sufficiently opaque in order that the electronic camera (3) can differentiate said holes or modifications thereof by the light coming from outside, which enters through them, in contrast with the rest of the dark sheet.

18. Ball-trapping device according to any one of the preceding claims, **characterized in that** it includes an external auxiliary illumination source which is applied on the external front face of the target (2).

19. Method of detection applicable to a ball-trapping device having electronic detection of the impact on a target, the ball-trapping device being of the type comprising a casing (1) of a material with strength to the impacts, having a front face provided with an opening and means for removably fastening a target (2) covering said opening, the target (2) being in the form of a sheet material through which the projectiles can go, on which external face a motive to be shot is depicted, electronic means being provided for detecting the position of at least an impact on said target (2), **characterized in that** it comprises following steps:

a) obtaining, by means of an electronic camera (3) provided with a system of focusing lens arranged within the casing (1), at least one image of one face of the target (2) after each shot, on which face successive new holes or modifications of previous holes produced by successive impacts appear;
b) treating, by means of an image treating unit (4), the images obtained for improving its definition and processing the treated images for determining the geometric centre of the projectile at each successive impact from the obtained, handled and processed images; and
c) displaying the results in a viewing screen (13, 14).

20. Method, according to claim 19, **characterized in that** it comprises transferring, using communication means (5), the result of said treatment carried out by said image treating unit (4), which is located within the casing (1), to a data receiving and/or retransmitting centre, which is a local (6) or remote (7) computing centre.

21. Method, according to claim 19, **characterized in that** said processing of the treated images is carried out through image treatment algorithms and artificial intelligence operations, and by comparing the obtained images with images stored in a memory associated with said image treating unit (4).

22. Method, according to claim 21, **characterized in that** it comprises a prior step of calibrating the position of the image as a function of a parameter such as a printed mark on the target face picked-up by the camera (3) or target control holes.

23. Method, according to claim 19, **characterized in that** the electronic camera (3) encompasses the internal back face of the target (1) and said algorithm comprises first storing in a memory the image obtained after a first shot; then passing the successive obtained images to a treating unit in which comparing their intensity in grey scale between each new in-coming image and the last image stored in the memory; and last, storing each new image resulting from comparison rejecting the image of the former shot.

24. Method, according to claim 23, **characterized in that** it comprises making a projection on horizontal and vertical axes of the image of the impact resulting from said comparison, thereby obtaining two vectors X and Y which are filtered with a filtering pattern depending on the kind of ammunition and shot to be detected, with the assistance of an em-

piric database for retrieving said filtering patterns and counterbalancing according to former impacts, and **in that** after said filtering the central point of the impact is determined from thresholds in the grey scale.

25. Method, according to claim 24, **characterized in that** it comprises the use of a second database to carry out a relocation of the central point determined with techniques of artificial intelligence based on neuronal networks of the back-propagation kind, said point being obtained with reference to a corner of the image.

26. Method, according to claim 19, **characterized in that** the electronic camera (3) encompasses the external front face of the target (1) and said algorithm comprises first storing in a memory the image obtained after a first shot; then passing the successive obtained images to a treating unit in which black points are compared between each in-coming image and the last image stored in the memory; and storing each new image resulting from comparison rejecting the image of the former shot.

27. Method, according to claim 26, **characterized in that** it comprises to make a projection on horizontal and vertical axes of the image of the impact resulting from said comparison, thereby obtaining two vectors X and Y which are filtered with a filtering pattern depending on the kind of ammunition and shot to be detected, with the assistance of an empiric database for retrieving said filtering patterns and counterbalancing according to former impacts, and **in that** after said filtering the central point of the impact is determined from thresholds in the grey scale.

28. Method, according to claim 27, **characterized in that** it comprises the use of a second database to carry out a relocation of the central point determined by techniques of artificial intelligence based on neuronal networks of the back-propagation kind, said point being obtained with reference to a corner of the image.

29. Method, according to claim 19, **characterized in that** it includes a function for determining when the target (2) is so damaged that it is necessary to replace it, comprising following steps:

1) picking-up by means of a microphone (10) a noise produced by each successive impact within the casing (1);
2) comparing the image obtained corresponding to same shot that produced last noise with the image stored corresponding to the former shot; and in case that a given level of difference is not assessed between said two consecutive images,
3) issue a warning about the convenience to replace the target (2).

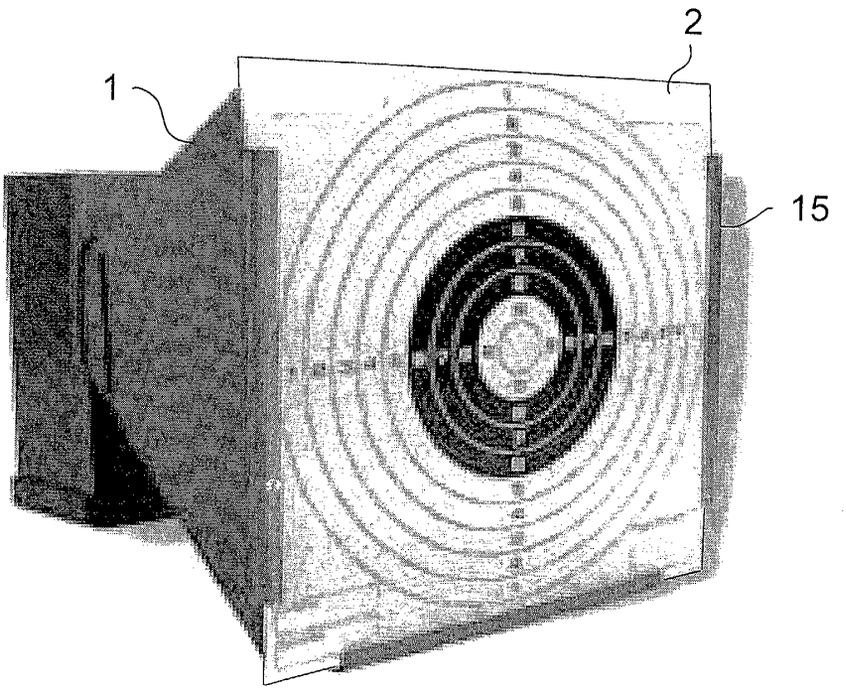

Fig. 1

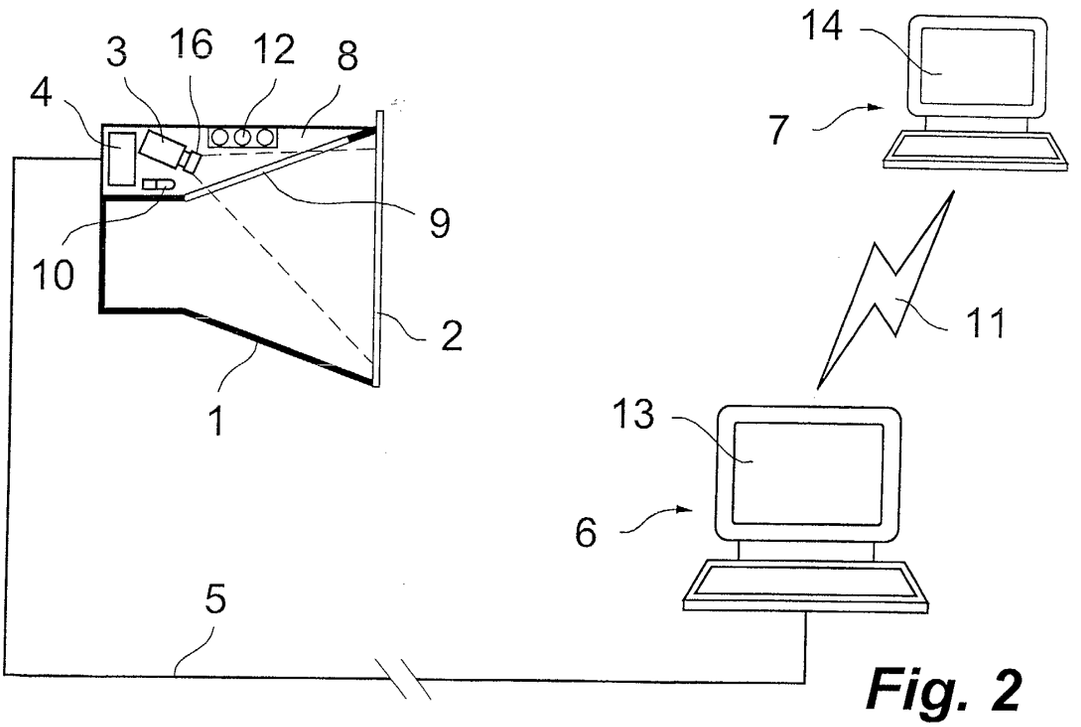

Fig. 2

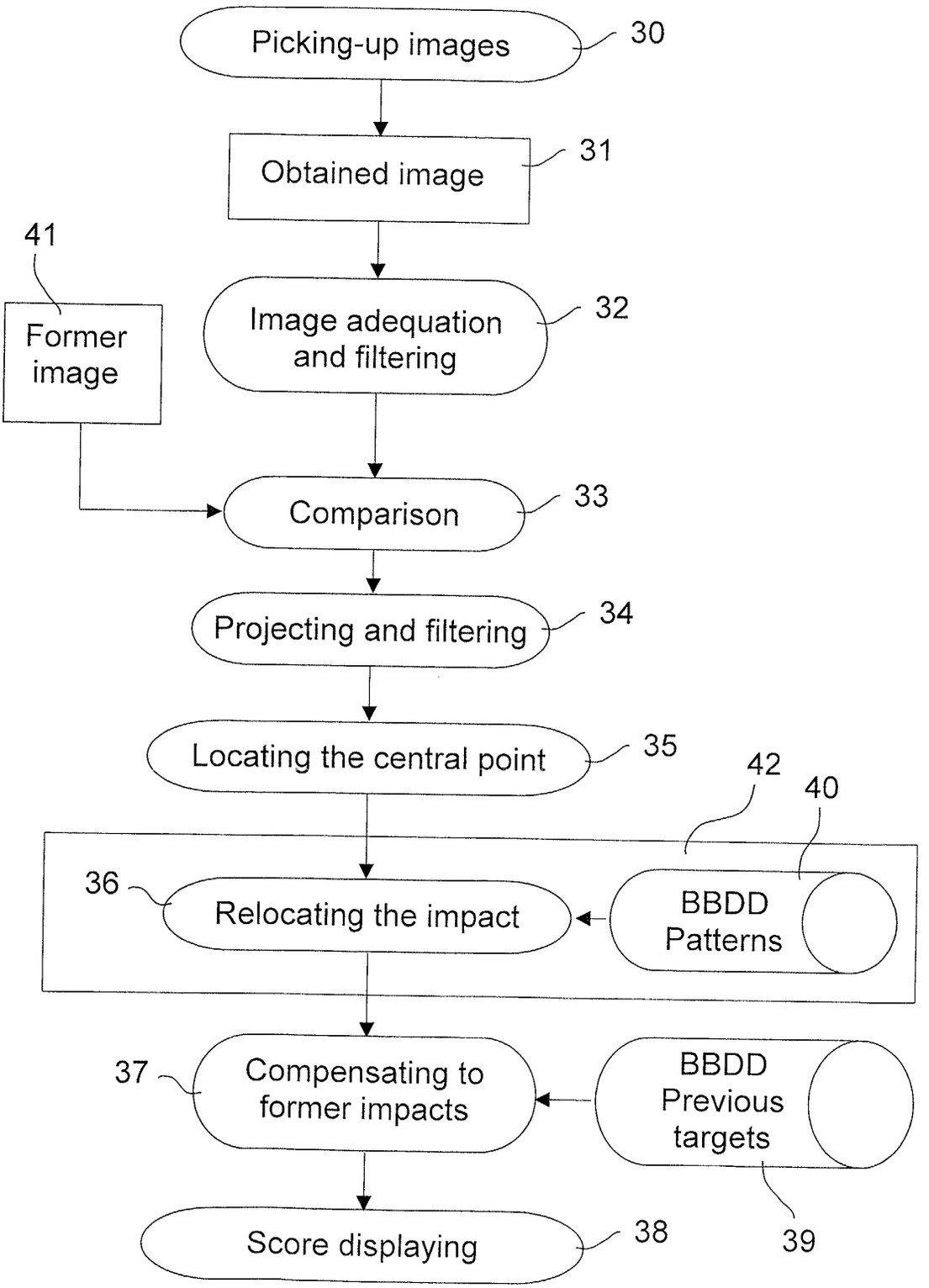
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Fig. 3