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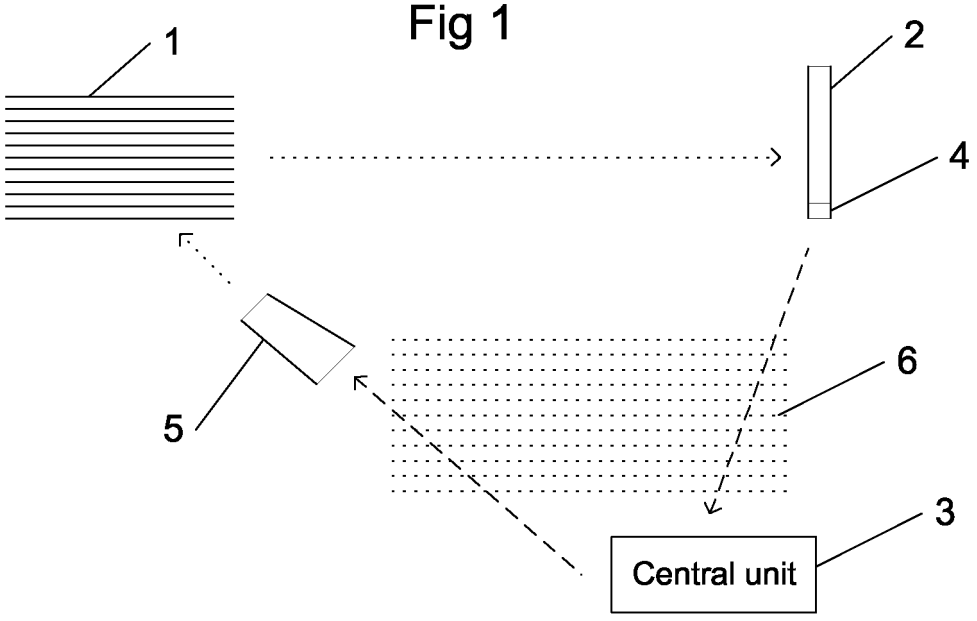
## (54) A shoot-back unit and a method for shooting back at a shooter missing a target

(57) The present invention relates to a shoot-back unit (5). The shoot-back unit comprises a laser transmitter arranged to transmit a laser beam simulating fired ammunition and a control unit arranged to control the laser transmission of the laser transmitter. The shoot-back unit is characterized in that it comprises means arranged to sense firing of a weapon and a radio receiver arranged to receive hit information and in that the control unit is arranged to, upon sensing firing of the weapon, control the laser transmission in response to the received hit information.

The invention further relates to a method for shooting back with simulated or live ammunition at a shooter missing a target.

Fig 1

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## Description

### TECHNICAL AREA

**[0001]** The present invention relates to a shoot-back unit comprising a laser transmitter arranged to transmit a laser beam simulating fired ammunition, and a control unit arranged to control the laser transmission of the laser transmitter.

**[0002]** The present invention further relates to a method for shooting back at a shooter missing a target with simulated ammunition, comprising transmitting a laser beam toward said shooter in response to detection of a registered miss.

### STATE OF THE ART

**[0003]** In military combat training is it usual to let the soldiers use laser based weapon simulators at least in the first steps of shooting training. This reduces the training costs due to a decreased need for ammunition but also from the fact that the safety requirements at training are much lower using laser instead of live ammunition. Shooting with live ammunition is mainly used in late stages of training when the shooters have already exercised aiming behavior.

**[0004]** In order to increase the realism in practice, even in laser based training, the shooter should be exposed to stress during aiming and shooting. Accordingly, it is known to make the shooter vulnerable to shoot back fire in laser based shooting training as well as in training with live ammunition. The shoot back fire is provided by a shoot back system arranged at the target. The shoot-back system is arranged to simulate the counter fire from a hostile weapon system. When the target registers a miss, it is arranged to activate a laser transmitter mounted in the shoot-back system to emit a laser beam towards the shooter who fired the shot missing the target. A laser detection system on the shooter is then activated and the shooter is eliminated. Alternatively, the shooter is provided with a hit evaluation system activated upon detection of laser radiation and arranged to evaluate the hit and provide a hit result. The hit result is for example elimination, severe damage (or serious injury if a person) or small damage (or small injury if a person).

**[0005]** The performance of the shoot back target systems used today is satisfactory for shooting at smaller distances. For longer distances however, the required laser energy is high, leading to problems with power consumption and eye safety. Further, it is difficult to correctly direct the laser transmitter to the shooters position without spreading the laser radiation such that there is a risk that it hits shooters at other positions.

### DESCRIPTION OF THE INVENTION

**[0006]** One object of the present invention is to eliminate or at least decrease the problems mentioned above in order to provide a satisfactory shoot back function also for shooting at longer ranges.

**[0007]** This has been achieved according to one embodiment of the present invention by means of a shoot-back unit comprising a laser transmitter arranged to transmit a laser beam simulating fired ammunition, and a control unit arranged to control the laser transmission of the laser transmitter. The shoot-back unit is characterized in that it comprises means arranged to sense firing of a weapon and a radio receiver arranged to receive hit information. The control unit is then arranged to, upon sensing firing of the weapon, control the laser transmission in response to the received hit information. Preferably, the control unit is arranged to activate the laser transmitter upon reception of near miss information.

**[0008]** The shoot-back unit is intended for use in shooting practice, for example on a training field with a plurality of shooting sites. A target device is then associated to each shooting site. The shooting sites can be arranged on a line after each other and the target devices can be arranged on another line at a distance from the shooting site line equal to the shooting distance. The shoot-back units are arranged near the shooting sites. Each shoot-back unit is preferably arranged in relation to the associated shooting site such that the laser transmitter of the shoot-back unit is pointing at the associated shooting site. Alternatively, several shooting sites could share one shoot back unit if the laser transmitter or the shoot-back unit itself for example is provided with means for angular movement.

**[0009]** One advantage of the shoot-back unit according to the present invention is that the shoot-back feature is still accomplished with laser but without the drawbacks of the prior art. Accordingly, the equipment at the shooter (e.g. a soldier or a tank) arranged for reception of the shoot back fire of the prior art shoot-back units does not have to be amended. The shoot-back unit according to the present invention can be used with no modifications of the equipment of the shooter.

**[0010]** In accordance with one preferred embodiment of the invention, the shoot-back unit comprises means for sensing the presence/absence of the weapon at a shooting site associated to the shoot-back unit. The means for sensing the presence/absence of a shooter includes for example an IR sensor.

**[0011]** In accordance with another preferred embodiment of the invention, the means arranged to sense firing of a weapon comprises at least one microphone. In one embodiment this is provided by letting the control unit be arranged to compare a signal from the at least one microphone to a reference signal and to determine if a shot has been fired based on said comparison. For example, the control unit can be arranged to compare at least one component of a frequency spectrum of the signal from the at least one microphone to at least one component of a frequency spectrum of the reference signal and to determine if a shot has been fired based on said comparison. The reference signal is for example based on at

least the distance to the weapon, the weapon type and the ammunition type.

**[0012]** The present invention also relates to a shooting training system comprising a target device arranged to detect fired live or simulated ammunition and a shoot back unit according to the above, wherein the target device comprises a radio transmitter arranged to broadcast a firing result message based on the detected ammunition. In detail, the target device is arranged to, based on the detected ammunition, determine at least a near miss or hit and at least if a near miss is determined, to broadcast the firing result message via the radio transmitter. In an example wherein the target device is intended for practice with live ammunition, the target device comprises preferably a non contact hit scoring system arranged to detect near miss of live ammunition. In an example wherein the target device is intended for practice with simulated ammunition, the target device comprises preferably a laser target system arranged to detect reception of laser radiation simulating ammunition and based on said detection determine at least a hit or near miss.

**[0013]** The target device and shoot-back unit are preferably nodes within a radio network. In one preferred embodiment the network also comprises a node associated to a central unit. The firing result message can then be transmitted through the network to the central unit arranged to further process the information in the message and to form an amended firing result message for transmission through the radio network to the shoot-back unit.

**[0014]** The present invention also relates to a method for shooting back at a shooter missing a target with simulated or live ammunition, comprising the following steps

a) detecting presence of the shooter at a shooting site,
b) detecting firing of a shot from said shooting site,
c) evaluating a radio message originating from said target so as to determine if the firing resulted in a near miss, and
d) if a near miss is determined, transmitting a laser beam towards said shooting site.

## BRIEF DESCRIPTION OF DRAWING

**[0015]**

Fig. 1 shows schematically a training field with a shooting site, a target device and a shoot-back unit according to one example of the invention.

Fig. 2 shows block diagram over the shoot-back unit in fig 1.

Fig. 3 shows a flow chart of one example of a process in a control unit in the shoot-back unit in Fig. 2.

Fig. 4 shows schematically an alternative training field with a plurality of shooting sites, target devices and shoot-back units.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0016]** In fig 1, a shooting site 1 is located at a given distance from a target 2. The distance is for example between hundred and five thousand meters. The shooting site 1 is a shooting site for a player such as a tank, a soldier etc. The target 2 can be designed either for live ammunition (for simulated ammunition) conventionally in the form of laser radiation, or for both. There are preferably three possible results from the shooting with the live or simulated ammunition, namely hit, near miss and far miss.

**[0017]** In the case wherein the target 2 is designed for live ammunition, hit is detected by sensors arranged at the target. The hit sensors are for example arranged to detect a shock in the target material resulting from the hit. Alternatively, the hit sensors can be thermal sensors arranged to detect heat produced when the ammunition hits the target. For detection of a near miss the target can be provided with a non-contact hit scoring system. There exist today audio based non-contact hit scoring systems arranged to detect sound waves from ammunition passing the target within a predetermined distance. Ammunition passing the hit scoring system within said predetermined distance is then regarded as a near miss. The far miss is not detected at all.

**[0018]** In the case wherein the target is designed for simulated ammunition it comprises a plurality of detectors arranged to detect the reception of laser radiation. The location of the received laser radiation is in one example determined by the target, for example by determining at which detector(s) the radiation was received. The location of the received laser radiation is then processed for determining where the hit location would have been for live ammunition. The processing of the location of the received laser radiation is in one example (not shown) processed by a processing unit at the target. The processing involves taking into account such factors as will affect the trajectory before, after and at the instant of firing. It would for example taking into account that the live ammunition would follow a ballistic trajectory, which means that factors such as the type of ammunition used and the distance between the shooting site and the target should be accounted for. Alternatively, the location of the received laser radiation is transmitted to a central unit 3 (which will be described in detail below) and the hit evaluation is performed in the central unit 3.

**[0019]** In one example, wherein the target is of the type that can be lowered, the target is arranged to perform the lowering action upon detection of a hit. A target of this type can be used in combination with either a target for live ammunition or a target for simulated ammunition.

**[0020]** Irrespectively of whether live or simulated ammunition is used, a radio transmitter 4 at the target is

arranged to broadcast a message at least when a near miss is detected but possibly also when a hit is detected (a far miss is rarely detected). The message includes information related to the status of the target (hit or near miss) preferably also information related to an identity of the target. In one example, a radio receiver 7 (see fig 2) of a shoot-back unit 5 is arranged to receive the radio message directly via a radio network 6.

**[0021]** In Fig. 1, the shoot-back unit 5 is located in relation to the shooting site 1 such that a laser transmitter 8 located in the shoot-back unit 5 will hit a player (tank, soldier etc) on the shooting site but not players on nearby shooting sites. This implies that no other shooting sites are located in a symmetry axis of a laser beam from said laser transmitter within a predetermined distance from the shoot-back unit. The shoot-back unit is located outside a shooting area associated to the shooting site and outside shooting areas associated to adjacent shooting sites. This is especially to advantage when live ammunition is used, as the shoot-back unit does not run the risk of being damaged. However, it is also to advantage when simulated ammunition is used as the shoot-back unit otherwise can obstruct the laser radiation simulating the ammunition. Further, the distance between the shooting site and the shoot-back unit is such that a laser transmitter with eye-safe radiation can be used; characteristically the distance between the shooting site and shoot-back unit is five to fifty meters.

**[0022]** The shoot-back unit 5 comprises the radio receiver 7, an IR sensor 9, a microphone 10, a control unit 11 and the laser transmitter 8. The IR sensor 9 is arranged to sense absence or presence of a player on the shooting site. In one example the laser transmitter 8 is capable of altering between a "sensor mode" and a "transmission mode", and accordingly an IR sensor in a separate unit is not required. The microphone 10 is arranged to receive an audio signal for use in detecting if a shot has been fired from the shooting site 1. The radio receiver 7, as described above, is arranged to receive the message indicating near miss or hit from the central unit 3 or directly from the target 2 via the radio network 6.

**[0023]** The control unit 11 is arranged to receive a presence/absent signal from the IR sensor 9, the audio signal from the microphone 10 and the hit or near miss information of the radio message received by the radio receiver. The control unit 11 is arranged to process the audio signal in order to determine if a shot has been fired from the shooting site 1. In a simple example the processing of the audio signal involves determining when the the audio signal exceeds a predetermined level corresponding to the level provided when firing a shot from a distance equal to the distance between the shoot-back unit and the shooting site with chosen ammunition and weapon type. In one example an amplitude of the audio signal is compared to a reference amplitude. In order to improve the result from the processing, at least one component of a frequency spectrum of the sensed firing is compared to at least one component of a reference frequency spectrum. The reference frequency spectrum is, as discussed above, determined based on at least the distance between the shoot-back unit and shooting site and chosen ammunition and weapon type.

**[0024]** The control unit 11 is further arranged to evaluate the information of the received radio message in order to determine if it indicates a near miss. In one example, the control unit 11 is arranged to activate the laser transmitter upon reception of near miss information if the IR-sensor indicates presence of a player on the shooting site and if a shot has been detected from the shooting site 1 within a predetermined time period before reception of the near miss message. In a case wherein the information in the received radio message contains information related to the identity of the target, the control unit is arranged to evaluate the target identity and only to accept the message if the target identity coincides with a prestored identity.

**[0025]** The laser radiation emitted by the laser transmitter 8 is detected by player mounted sensors on a player present at the shooting site 1. In a simple example the detection of laser radiation indicates that the player is eliminated, and accordingly means are activated informing the player that it has been eliminated. To be more precise, in a case wherein the soldier is the player, the player is informed and in another case wherein the player is for example a tank, the soldier associated to the tank is informed about the elimination. In an extended example, the radiation from the laser transmitter is modulated with the information that a near miss has occurred. The player unit is then arranged to receive that information via the sensors and to determine a result of the shoot back, such as elimination, damage etc. Means are then activated informing the soldier in accordance with the result.

**[0026]** In fig 3, an example of a process in the control unit 11 includes the step of measuring 12 a signal from the IR-sensor with a predetermined time interval. The control unit 11 starts processing 14 the audio signal from the microphone when the presence of a player at the shooting site 1 has been detected 13. When the processing 14 of the audio signal indicates that a shot has been detected 15, the reception 16 of a message via the radio receiver is awaited for a predetermined time period. If a radio message has not been received within said time period, the shot probably resulted in a far miss and the process goes back to the step of processing 14 the audio signal. If a radio message has been received within said time period, the content of the message is determined 17. This determination may include evaluating the target ID. If the message is determined 18 to contain near miss information for an acceptable target ID, the laser transmitter 8 is activated 19. If the message does not contain near miss information, it is determined that a hit has occurred. This ends the process.

**[0027]** In fig 4 a training field is shown with a plurality of shooting sites 1a, 1b, 1c, 1d each site with an associated target 2a, 2b, 2c, 2d and shoot back unit 5a, 5b, 5c,

5d.

## Claims

1. A shoot-back unit (5) comprising a laser transmitter (8) arranged to transmit a laser beam simulating fired ammunition, and a control unit (11) arranged to control the laser transmission of the laser transmitter (8), **characterized** i n that the shoot-back unit (5) comprises means (10) arranged to sense firing of a weapon and a radio receiver (7) arranged to receive hit information and in that the control unit is arranged to, upon sensing firing of the weapon, control the laser transmission in response to the received hit information.

2. A shoot-back unit according to claim 1,**characterized in that** the control unit (11) is arranged to activate the laser transmitter (8) upon reception of near miss information.

3. A shoot-back unit according to claim 1, **characterized in that** it comprises means (9) for sensing the presence/absence of the weapon at a shooting site associated to the shoot-back unit.

4. A shoot-back unit according to claim 3, **characterized in that** the means (9) for sensing the presence/absence of a shooter includes an IR sensor.

5. A shoot-back unit according to claim 1, **characterized in that** the means (10) arranged to sense firing of a weapon comprises at least one microphone.

6. A shoot-back unit according to claim 5, **characterized in that** the control unit (11) is arranged to compare a signal from the at least one microphone to a reference signal and to determine if a shot has been fired based on said comparison.

7. A shoot-back unit according to claim 6, **characterized in that** the control unit (11) is arranged to compare at least one component of a frequency spectrum of the signal from the at least one microphone to at least one component of a frequency spectrum of the reference signal and to determine if a shot has been fired based on said comparison.

8. A shoot back unit according to claim 6, **characterized in that** the reference signal is based on at least the distance to the weapon, the weapon type and the ammunition type.

9. A shooting training system comprising a target device (2) arranged to detect fired live or simulated ammunition and a shoot back unit (5) according to one of the claims 1-8, **characterized in that** the target device (2) comprises a radio transmitter (4) arranged to broadcast a firing result message based on the detected ammunition.

10. A shooting training system according to claim 9, **characterized in that** the target device (2) is arranged to, based on the detected ammunition, determine at least a near miss or hit and at least if a near miss is determined, to broadcast the firing result message via the radio transmitter.

11. A shooting training system according to claim 9, **characterized in that** the target device (2) comprises a non contact hit scoring system arranged to detect near miss of live ammunition

12. A shooting training system according to claim 9, **characterized in that** the target device (2) comprises a laser target system arranged to detect reception of laser radiation simulating ammunition and based on said detection determine at least a hit or near miss.

13. A shooting training system according to claim 9 **characterized in that** the target device (2) and shoot-back unit (5) are nodes within a radio network (6).

14. A method for shooting back at a shooter missing a target with simulated or live ammunition, comprising transmitting a laser beam toward said shooter in response to detection of a registered miss, **characterized by** the following steps

    a) detecting presence (12, 13) of the shooter at a shooting site,
    b) detecting firing (14, 15) of a shot from said shooting site,
    c) evaluating (17, 18) a radio message originating from said target so as to determine (18) if the firing resulted in a near miss, and
    d) if a near miss is determined (18), transmitting (19) a laser beam towards said shooting site.

Fig 1

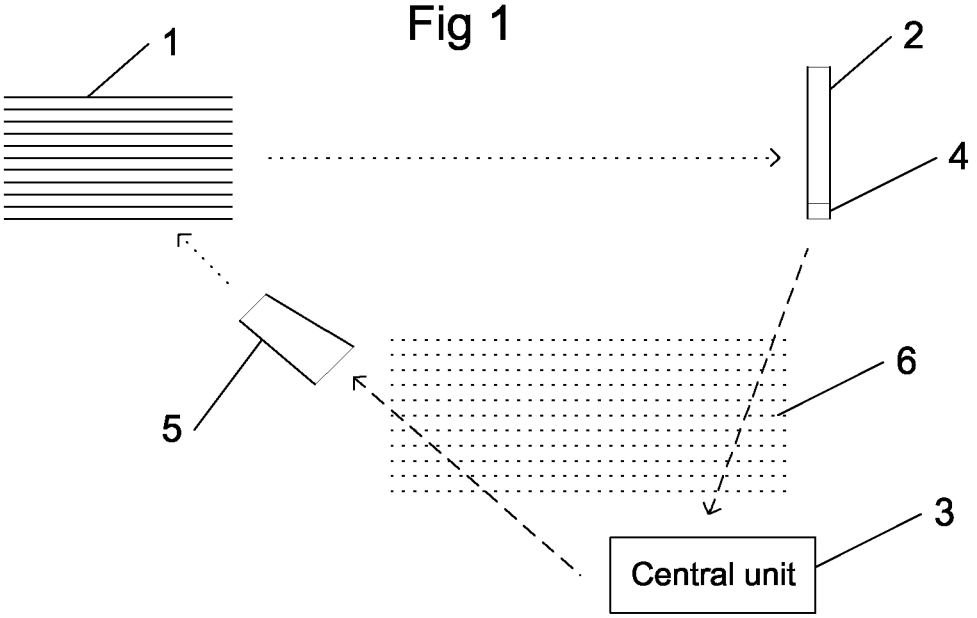

1
2
4
5
6
3
Central unit

Fig 2

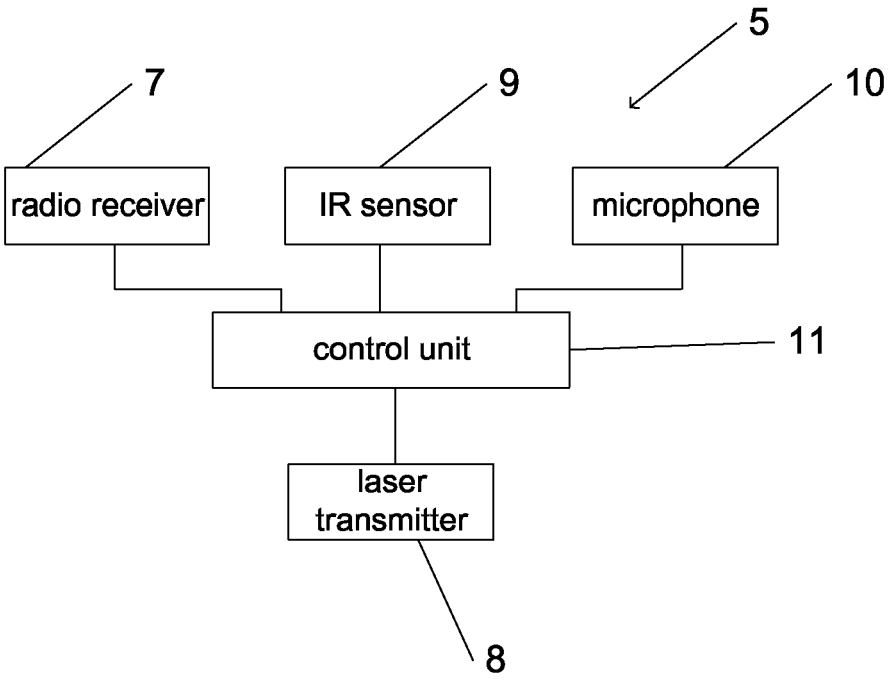

5
7
9
10
radio receiver
IR sensor
microphone
control unit
11
laser transmitter
8

Fig 3

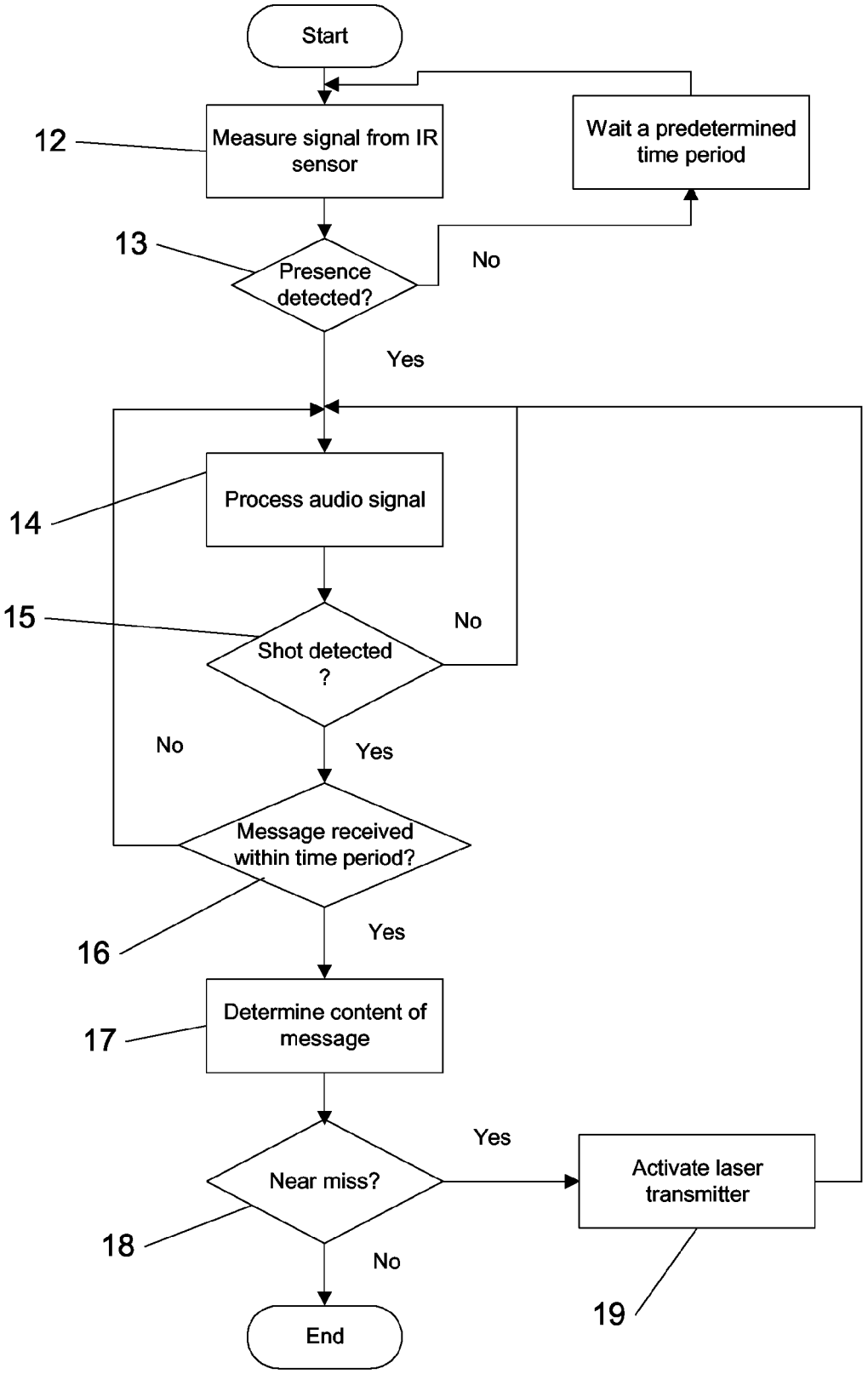
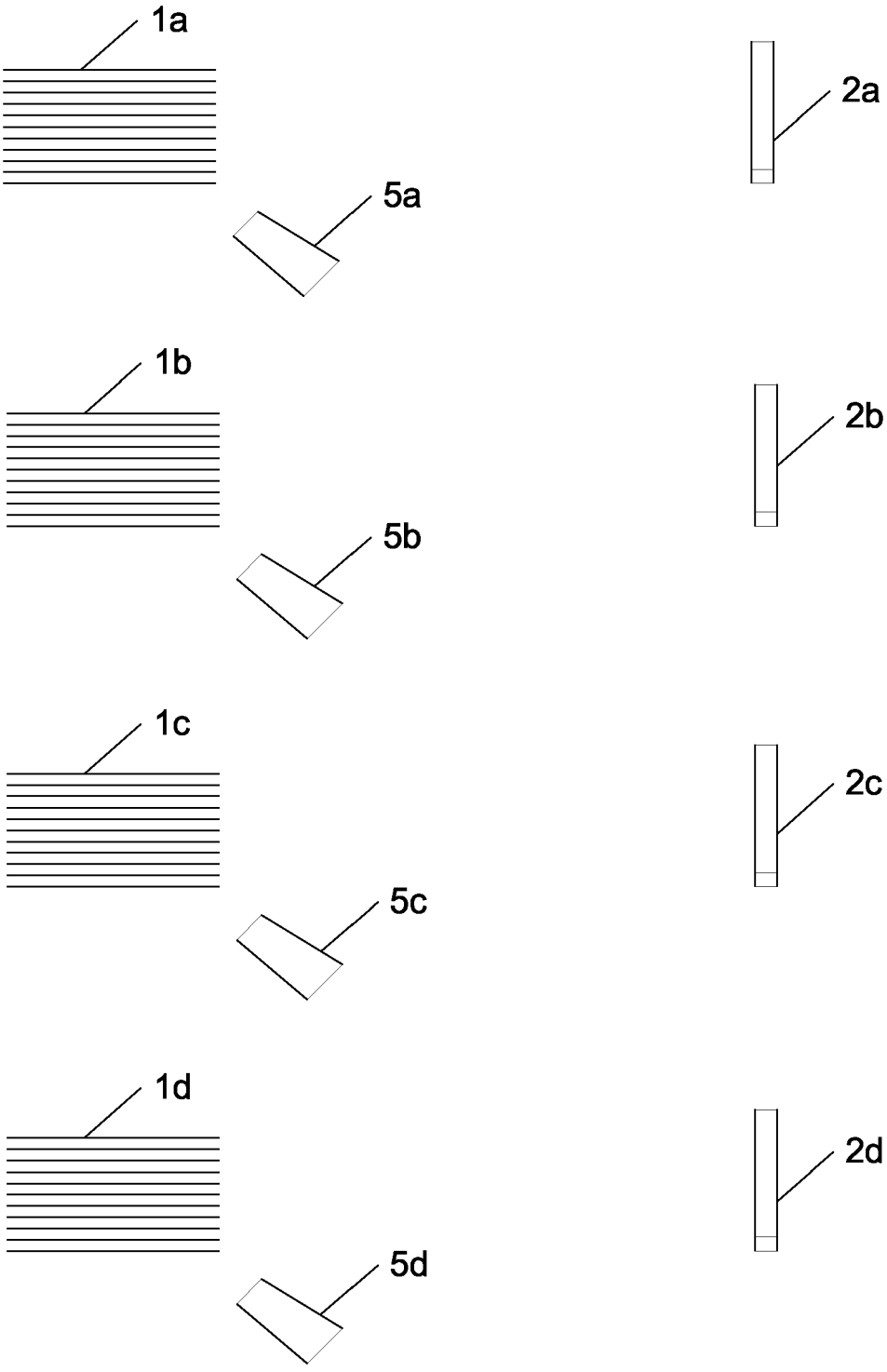

Start
12
Measure signal from IR sensor
Wait a predetermined time period
13
Presence detected?
No
Yes
14
Process audio signal
15
Shot detected ?
No
No
Yes
Message received within time period?
16
Yes
17
Determine content of message
Yes
Near miss?
Activate laser transmitter
18
No
19
End

Fig 4



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Application Number
EP 06 11 1968

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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| The Hague | 26 September 2006 | Blondel, François |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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# EUROPEAN SEARCH REPORT

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X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

T : theory or principle underlying the invention
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D : document cited in the application
L : document cited for other reasons

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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