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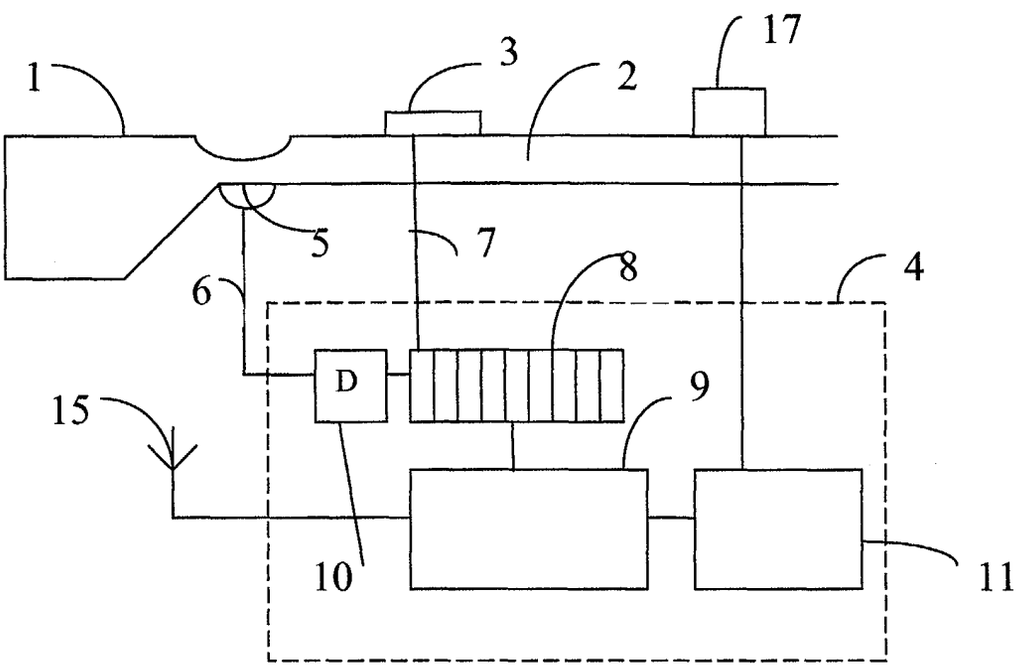
(54) **Device and method for evaluating the aiming behaviour of a weapon**

(57) The present invention relates to a device and method at a direct fire weapon comprising means (3) for continuously sensing and registering the angular motion of the weapon or weapon sight, means for detecting fire of the weapon, and processing means (4) arranged to upon detection of fire of the weapon extract data relating to the aiming behavior from the registered angular motion for a given time interval before and after firing.

Fig 4



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Description

TECHNICAL FIELD

[0001] The invention relates to a device at direct fire weapon and a method for evaluating weapon aiming behavior when shooting at a real target.

PRIOR ART

[0002] It is important in training of a gunner to train the aiming behavior a time period before and just after trigger pull. There exist today laser based shooting simulator systems which are mounted on weapons and which are capable of tracking the aiming of the weapon in a dedicated shooting training situation. The simulator is then set in a "tracking mode", and the deviation between an aiming point and a target is measured and registered. This requires a dedicated target to measure. Further, it is impossible to predict the exact time of fire and therefore the system has to measure the target all the time. Thus, the tracking of the aiming of the weapon can not be used in combat training situations. This is a major drawback. The gunner is much more stressed in these situations than in a dedicated shooting training situation, which is most likely reflected in the aiming behavior.

[0003] EP 0 961 913 shows a missile firing simulator for training firers in the firing of missiles and immersing them in a virtual space and offering them different scenarios. The fire station of the missile has a three-dimensional position sensor positioned within the launch tube. This sensor makes it possible to determine the movements of the firing station during the fire exercise. The 3D position sensor sends the data relating to these movements to the central unit, which analyses them and derives there from the effects on the simulated flight.

[0004] The above described system for evaluation of a missile flight path requires a virtual designated target and is not intended for use in combat training.

[0005] EP 0 985 899 describes a compact video image recording device mountable on a gun. The device is useful for recording video images before and after firing of the gun and is mounted on the gun such that the viewing area of the camera includes the target area of the gun. A typical application for the device is a gun carried by police officers, wherein it can be desirable to have a video record which would show the scene as viewed by the police officer at the time the gun was fired. The device is arranged so as to repeatedly store video image data within a semiconductor memory within the video recording device and in response to detection of discharge of the weapon, preserving in said memory video image data stored preceding and subsequent discharge of the weapon. This device is intended to record the general judgment of the police officers rather than the tracking of the aiming procedure of the gun.

[0006] GB 2 141 810 shows an apparatus for training a gunner. The apparatus comprises a viewing device which fits over the eyepieces of a gun sight. The viewing device is arranged to combine the images from both eyepieces to be viewed by a video camera linked to the viewing device. The image viewed by the camera together with pictorial information representing the operation of the gunner's controls and the movement of the gun is transmitted to an instructor who is able to view on a display precisely the same scene as viewed by the gunner together with the additional information indicating how he is operating the gun controls and how the gun is moving. Further, a recorder is provided to enable playback and analysis of the training exercise.

[0007] The gunner manipulates controls in order to produce x and y demand signals, wherein the x demand signal denotes the desired rate of change of azimuth of the gun and the y demand signal denotes the desired rate of change of elevation of the gun. Said demand signals are fed to a gun servo arranged to execute the demanded changes in azimuth and elevation. The above mentioned pictorial information is a pictorial representation of said x and y demand signals.

[0008] The video camera of GB 2 141 810 can be used in combat training. However, analyzing the video film in order to evaluate the aiming behavior is heavy and time consuming.

[0009] In GB 2 141 810 the coordinate data x,y could be analyzed in order to evaluate the aiming behavior. However, this solution is only applicable for gun types having a servo motor controlling the aiming of the weapon wherein the gun is arranged with controls producing electrical signals for controlling said servo motor. The solution also requires that the platform is stationary.

[0010] One object of the invention is to provide a simple way of evaluating the aiming behavior which is applicable also for weapon types not controlled with a servomotor and both in dedicated shooting training and in combat training.

SUMMARY OF THE INVENTION

[0011] This is achieved with a device at a direct fire weapon comprising means for continuously sensing and registering the sensed angular motion of the weapon or weapon sight, means for detecting fire of the weapon and processing means arranged to upon detection of fire of the weapon extract data relating to the aiming behavior from the registered angular motion for a given time interval before and after firing. The device is easy to install on the weapon. Further, the device can be designed to be small and light-weighted, which is important as the device should have as little physical influence on the weapon as possible.

[0012] The means for continuously sensing and registering angular motion of the weapon are in one embodiment of the invention arranged to sense angular velocity and/or acceleration and comprise for example a gyro, an accelerometer or another type of motion sens-

ing device. Preferably, the motion sensing and registering device is arranged to deliver data from which at least velocity and acceleration data is directly extractable and from which position data can be derived using known integration methods. A characterizing feature of the means for sensing angular motion is that the sensed motion is not related to the actual target engaged. After fire of the weapon on the other hand, a hit point can be determined, to which the extracted data can be related. For example, there are known laser based weapon simulator units arranged to provide the coordinates for a hit point of simulated ammunition upon fire of the weapon. Thus, in an embodiment in accordance therewith, the weapon is provided with a laser based weapon simulator of the above mentioned type, arranged to provide the coordinates for the hit point. The processing means can then be arranged to extract position data from the data relating to the aiming procedure using known integration methods and to relate the extracted position data to the determined hit point.

[0013] In accordance with another embodiment of the invention, the processing of the data includes evaluation of at least the acceleration data for example in order to get a numerical value which grades the aiming performance of the gunner.

[0014] The means for detecting fire of the weapon can be arranged to detect trigger pull or sense discharge of a shot.

[0015] The invention also relates to a method for evaluating the aiming behavior when shooting at a real target according to claim 10. A real target is defined as a non-virtual target, thus a target which is not computer or video generated. The real target is physical, can be movable and is for example a player (soldier, vehicle etc) participating in combat training.

SHORT DESCRIPTION OF THE DRAWING

[0016]

Fig 1 shows a gun according to a first embodiment of the invention provided with means for registering aiming procedure,

Fig 2 shows a first example of a display arranged to display data from the aiming procedure of the gun in fig 1,

Fig 3 shows a second example of a display arranged to display data from the aiming procedure of the gun in fig 1,

Fig 4 shows a gun according to a second embodiment of the invention provided with means for registering aiming procedure,

Fig 5 shows a first example of a display arranged to display data from the aiming procedure of the gun in fig 4,

Fig 6 shows a second example of a display arranged to display data from the aiming procedure of the gun in fig 4.

PREFERRED EMBODIMENTS

[0017] In fig 1 a gyro 3 is mounted onto the barrel 2 of a gun 1. The shown gun 1 is a rifle but the invention is also applicable to other types of weapons, such as vehicle mounted guns like tank guns, anti-tank missiles or any type of device where aiming is critical. The weapon can also be provided with a laser based shooting simulator.

[0018] The gyro 3 is mounted on the gun 1 in such a way that the motions in aiming of the gun are sensed. At least acceleration data from the gyro is fed to a processing unit 4 but also velocity data could be fed to the processing unit 4. In another example the gyro is substituted with an accelerometer or another type of sensor delivering data from which at least acceleration data can be extracted.

[0019] Means are provided (not shown) for sensing pull of a trigger 5 of the gun or for sensing discharge of a shot. In one example, the pull of the trigger is directly detected from the firing system. In that case a signal from the firing system indicating pull of the trigger is fed to the processing unit 4. In another example discharge of a shot is detected for example by using a chock sensor or flame sensor or a combination of both. In that case a signal from the sensor(s) indicating discharge of the shot is fed to the processing unit 4 upon discharge.

[0020] In the example shown, the processing unit 4 is arranged at the gun 1, in which case the gyro 3 and the means for sensing the pull of the trigger are connected to the processing unit 4 by means of electrical wires 6,7. In another example the processing unit is arranged in a cloth such as a vest or harness worn by the gunner. In that case the gyro and means for sensing the pull of the trigger or discharge are connected to a transmitter arranged to transmit the data to the processing unit for example by way of radio communication. In another example, the processing unit at least in part is arranged in a central unit to which a number of gunners communicate. This example will be more described below.

[0021] The processing unit 4 comprises a first in-first out register 8 arranged to repeatedly store the gun motion data received from the gyro 3. In response to detection of trigger pull/discharge of the gun, simulated or real, the content of the register 8 is preserved in a memory 9. In order to preserve data both preceding and subsequent trigger pull/discharge of the gun, there is a predetermined delay 10 between the detection of trigger pull/discharge and the preserving of the register content in the memory 9. The size of the register 8 and the delay time D are for example chosen such that data stored ten seconds before the trigger pull/discharge and two seconds subsequent the trigger pull/discharge is preserved. The time interval between stored registered data is for example 0.05-0.5 seconds.

[0022] The data of the memory 9 is processed in an evaluating unit 11. In a simple example, the evaluating unit 11 is arranged to evaluate only acceleration data in

an x direction and in a y direction. However, the acceleration data is a good indicator of the aiming performance as the acceleration is relatively independent of the movement of the target. Further, it is an established fact that in order to perform well in the aiming procedure, the acceleration should be decreasing before trigger pull/discharge. Other parameters such as velocity could be used but are of less importance to the performance. In one example, an evaluation algorithm of the evaluation unit comprises determining whether the following two conditions are fulfilled. First it is determined if the acceleration is monotonically decreasing within a first time period before the trigger pull/discharge. The first time period extends for example between ten and two seconds before trigger pull/discharge. If the acceleration is monotonically decreasing, the first condition is fulfilled. Secondly, it is determined if a preset acceleration value is exceeded within a second time period around the trigger pull/discharge. The second time period extends between two seconds before and two second after trigger pull/discharge, for example. If the preset acceleration value is not exceeded, the second condition is fulfilled. If the two conditions are fulfilled, the evaluation unit is arranged to generate a signal indicating that the aiming behavior was OK. On the other hand, if only one of the conditions or none of them is fulfilled, the evaluation unit is arranged to generate a signal indicating that the aiming behavior was NOT OK. In the example shown wherein the processing unit is arranged at the gun, the OK signal is fed to a green lamp 12 at the gun and the NOT OK signal is fed to a red lamp 13 at the gun. Thereby the gunner gets direct feed-back on the aiming behavior.

[0023] Ideally, the starting point for the first time period is at discovery of the target. In order to determine when the target was discovered, the evaluation unit is arranged to find a peaking maximum value in the acceleration data. This peak most likely represents the time of discovery of the target.

[0024] In an extended embodiment, the evaluation unit is also arranged to determine the time period between discovery of the target and discharge of the gun. A time difference is then calculated between the time of the peak in acceleration data and the time of the trigger pull/discharge. In the example wherein the processing unit is arranged at the gun, data related to the time difference can be fed to a display 14 mounted at the weapon giving the gunner a direct feed-back regarding the aiming time.

[0025] For training purposes, it may also be desirable for the gunner or an instructor to study the data from each aiming procedure after a combat or shooting exercise. In one example, the memory 9 is sized to contain data from all aiming procedures during a combat or shooting exercise. After the exercise, the data of the memory 9 can then be loaded into a tracking equipment of the central unit or transmitted thereto for example by way of radio communication via an antenna 15. In another example, wherein the capacity of the memory 9 is smaller, the data of the memory 9 is transmitted to the central unit each time new data enters the memory 9.

[0026] Another use of the OK/NOT OK indications or numerical values from the evaluation is to use these indications or values together will all aiming procedure data from one or several guns in a log and then for an evaluator or trainer to quickly do statics or sort out which aiming procedures to study further.

[0027] In fig 2, the tracking equipment comprises a display 16 arranged to show the data from each aiming procedure as a diagram, wherein the y axles denote the x and y acceleration data, respectively and wherein the x axles denotes time. In fig 3 the x-axle denotes the acceleration data in the x direction and the y axle denotes the acceleration data in the y direction.

[0028] In fig 4 the gyro 3 is mounted onto the barrel 2 of the gun 1. The gyro 3 is mounted on the gun 1 in such a way that the motions in aiming of the gun are sensed. Position, velocity and acceleration data from the gyro is fed to the processing unit 4. Also a laser based shooting simulator 17 is mounted onto the barrel of the gun. The shooting simulator can be of known type. In one example suitable for heavy weapons, the shooting simulator is arranged to scan an area in front of the simulator with a laser beam. Target systems are provided with reflectors arranged to reflect the laser beam. Upon detection of a reflected beam, the shooting simulator unit 17 is arranged to process the beam received in order to determine a hit point. A signal representing the hit point is feed from the shooting simulator unit 17 to the evaluation unit 11.

[0029] In the example shown, the processing unit 4 is arranged at the gun 1, in which case the gyro 3 and the means for sensing the pull of the trigger 5 are connected to the processing unit 4 by means of electrical wires 6,7. The processing unit 4 comprises the first in-first out register 8 described above arranged to repeatedly store the gun motion data received from the gyro 3. In response to detection of trigger pull/discharge of the gun, simulated or real, the content of the register 8 is preserved in the memory 9. In order to preserve data both preceding and subsequent trigger pull/discharge of the gun, the delay 10 function can be used.

[0030] The data of the memory 9 is processed in the evaluating unit 11. In accordance with this example, the evaluating unit 11 is arranged evaluate the position data of the memory. The evaluation includes using the above mentioned determined target hit point and relate all position data of said memory to said hit point. Also here, the starting point for evaluating data could be at discovery of the target.

[0031] For training purposes, it may be desirable for the gunner or an instructor to study the position data from each aiming procedure after a combat or shooting exercise. In fig 5, the display 16 at the central unit is arranged to show the data from each aiming procedure as a diagram, wherein the y axles denote the x and y

position data, respectively and wherein the x axles denotes time. In fig 6 the x-axle denotes the position data in the x direction and the y axle denotes the position data in the y direction. The aiming procedure is in the embodiment of fig 6 preferably shown as motion picture display, wherein the aiming point can be followed.

[0032] The invention is not restricted to the above described examples. For example, the evaluation unit can be arranged in the central unit instead of distributed at the shooter and in another example, an evaluation unit is arranged both at the gun and in the central unit.

Claims

1. Device at direct fire weapon (1) comprising
   - means (3) for continuously sensing and registering the angular motion of the weapon or weapon sight,
   - means for detecting fire of the weapon, and
   - processing means (4) arranged to upon detection of fire of the weapon extract data relating to the aiming behavior from the registered angular motion for a given time interval before and after firing.

2. Device according to claim 1, wherein the processing means (4) further are arranged to extract position data from the data relating to the aiming procedure for the given time interval and to relate the extracted position data to a determined hit point.

3. Device according to claim 2, comprising a laser based weapon simulator unit (17) arranged to provide the coordinates for the hit point.

4. Device according to claim 1, **characterized in that** said processing means (4) are arranged to continuously store signals relating to the registered angular motion in a memory (8,9).

5. Device according to claim 4 **characterized in that** said memory (8,9) is arranged to contain at least the most recently received signals including at least the signals received within a time period equal to the given time interval.

6. Device according to claim 5 **characterized in that** said memory (8,9) is arranged to continuously store the received signals as memory data and discard the data falling outside the time period equal to the given time interval.

7. Device according to claim 1, **characterized in that** said processing means (4) are arranged to feed the extracted data to a display unit (16).

8. Device according to claim 1, **characterized in that** the processing means (4) are arranged to extract velocity data from the data relating to the aiming procedure for the given time interval.

9. Device according to claim 1, **characterized in that** the processing means (4) are arranged to extract acceleration data from the data relating to the aiming procedure for the given time interval.

10. Method for evaluating weapon aiming behavior when shooting at a real target, **characterized in**
    - continuously sensing and registering the sensed angular motion of the weapon or weapon sight,
    - detecting fire of the weapon,
    - upon detection of fire of the weapon, extracting data relating to the aiming behavior from the registered angular motion for a given time interval before and after firing, and
    - process the extracted data to a numerical format suitable for display and comparison with other shooting performances.

11. Method according to claim 10, **characterized in that** the processing of the data includes displacing the data values such that the origin of coordinates lies in a determined hit point.

Fig 1

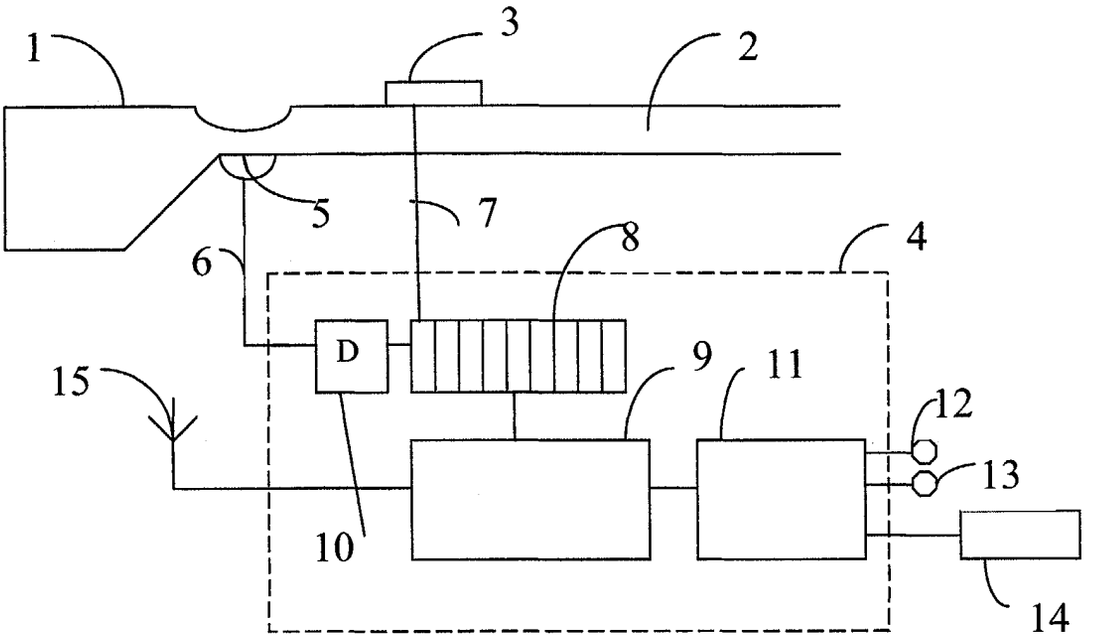


Fig 2

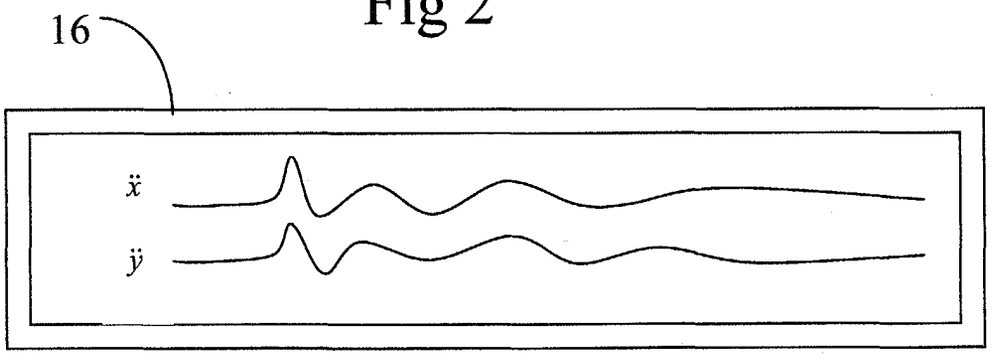


Fig 3

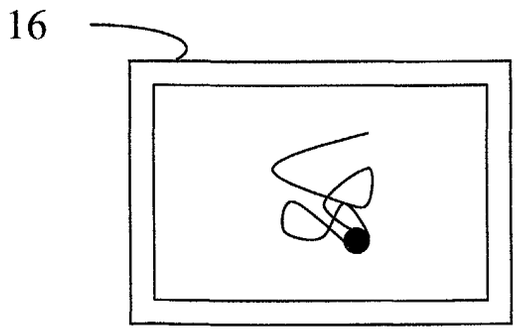


Fig 4

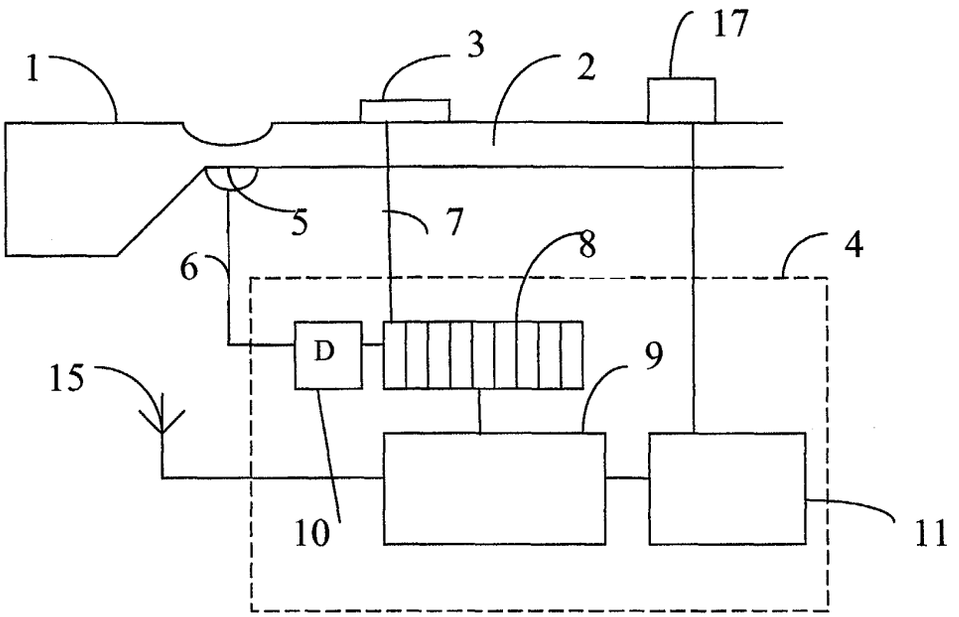


Fig 5

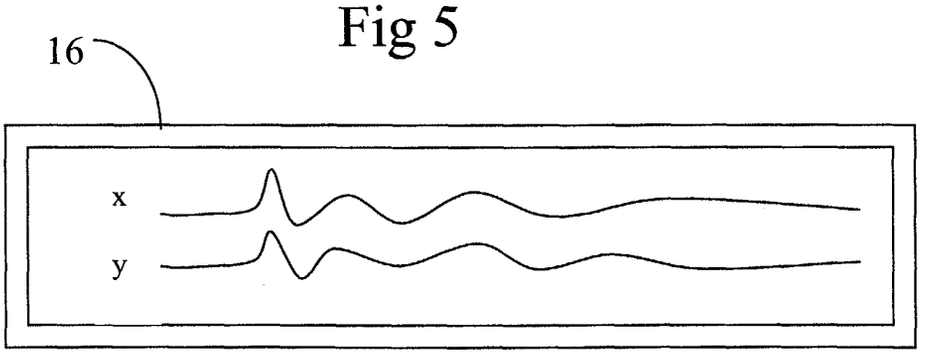
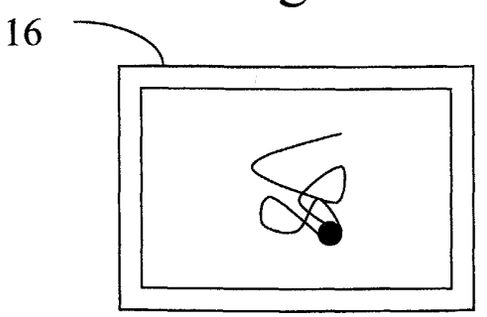


Fig 6



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EUROPEAN SEARCH REPORT

Application Number
EP 04 07 5955

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 991 043 A (AHLEN HANS ET AL) 23 November 1999 (1999-11-23) * column 6, line 7 - line 18 * * column 8, line 25 - column 10, line 48 * -----	1,2,4-9, 11,12	F41G3/00

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F41G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 August 2004	Messelken, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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31-08-2004

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