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(54) Title: FIELD SIMULATOR FOR AIR DEFENSE MISSILE SYSTEMS

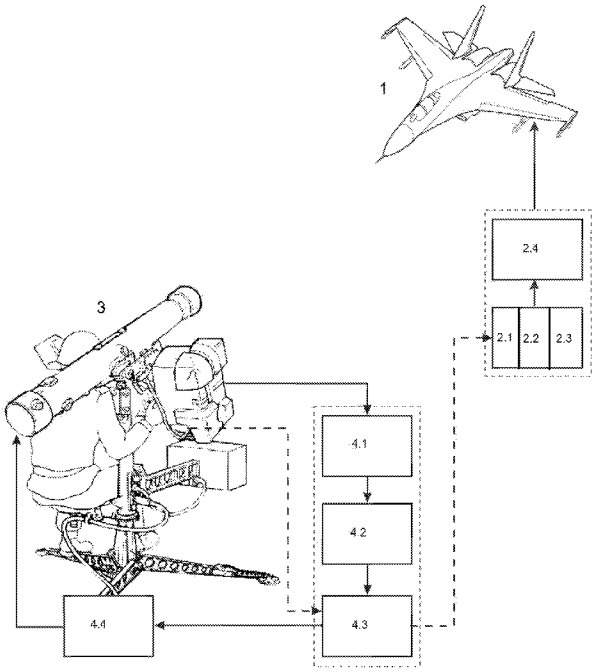

FIG. 1

(57) Abstract: The field simulator is comprised of two parts: a shooting device (3) and a target (1), on which the training equipment is mounted. The target comprises a satellite navigation system (2.3), controller (2.2), modem (2.1) and smoke generator (2.4). The shooting device comprises a satellite navigation system (4,2), on video tracking - digitization system, microprocessor, modem (4.3) and pyrotechnic shooting simulation (4.4). The shooting device controller has a program, calculating the target's movement. The shooting device controller activates the pyrotechnic charge after receiving the data about the simulated shot. The target movement calculating program, knowing the coordinates of the shooting device and the target during the shoot, calculates the theoretical projectile and target coordinates after the shot. If the target and projectile coordinates match, the shot is considered successful, then the target controller turns on the smoke generator and the smoke inform about the hit.

WO 2020/202059 A1

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FIELD SIMULATOR FOR AIR DEFENSE MISSILE SYSTEMS

FIELD OF THE INVENTION

The invention belongs to the sphere of field simulators for air defense systems, and, more particularly, to field simulators for air defense personnel, which can be mounted on air defense systems aircrafts or other flying objects.

BACKGROUND OF THE INVENTION

Various tools are used to train air defense personnel. Virtual computer simulators are often used (e.g. RBS-70 Training System), which train personnel in target detection, tracking and destruction operations. To simulate a real target, a "sleeve" type target, which is pulled by a transport plane, is often used for live-fire training. To hit the target, expensive combat missiles are used. Moreover, in this case, the target differs significantly from the real objects both in its shape and in its flight parameters, and during the training there is a real danger to both the transporting aircraft and the piloting crew. Also, remote-controlled aircrafts are used for real-fire training, which are very expensive and are destroyed during a successful shot. In this case, the training process is dangerous, expensive and inefficient.

This issue is addressed by using a virtual computer simulator. The virtual computer simulator is described in patent document US5194006A (published on 16-03-1993). During the operation of this simulator, it is possible to create a virtual target, set the direction, speed and other parameters of such a target, simulate the shooting process and see the downing of the target on the screen of a smart device. Patent document US20080206718A1 (published on 28-08-2008) also describes a virtual computer simulator similar to the BRS70 Training system, which creates a virtual target that can have various shapes. Under this method, the simulator also simulates the actual shooting and calculates whether the target has been hit or not. The problem is that such a simulator is very different from shooting in natural conditions: training takes place in computer classrooms where there are completely different environmental influences on the operator (air temperature, wind, etc.), unnatural target detection conditions, psychological tension, and so on.

Patent document US3882496A (published on 06-05-1975) describes a system for detecting a real target and allows determining the predicted coordinates of a target at a specific time. The system consists of a weapon, a laser beam source, and a radar that are mounted on separate devices. This system is designed to determine the exact

location of a target at a specific time; it does not simulate shooting with a real weapon itself.

Patent document US4577962A (published on 25-03-1986) describes equipment and method for aiming and firing at a real object. By this method, a laser radiation source and a laser-sensitive detector that captures the beam reflected from the target are mounted on the weapon. After at least two laser shots, the computer program calculates the predicted position of the target and the distance at the time the simulated shot is fired. This method is designed to aim and prepare for a real shot, predicting whether such a shot would hit a real target. However, this method does not fully simulate either a real missile launch or a real target downing that would be visually visible in field conditions during training.

Thus, there is a need for an air defense field simulator that maximally simulates real shooting conditions and is safe, inexpensive, and effective.

The technical solution presented in this description maximally simulates real shooting conditions and is safe, inexpensive and efficient.

SUMMARY OF THE INVENTION

When using this field simulator, the shooting training fully corresponds natural shooting operations: both the shooting device and the target can be real aircrafts and air defense systems. The field simulator consists of two parts: a shooting device and a target on which the training equipment is mounted. The target must have the following functional parts: a satellite navigation system, a controller, a modem and a smoke generator. The shooting device must have the following parts: a satellite navigation system, an in-sight digitization system, a controller, a modem and a pyrotechnic cartridge for simulating a shot. The controller of the shooting device must have a program that calculates the movement of the target. The mode of operation of the field simulator is based on the interaction of the shooting device and the target with the help of modems. The controller of shooting device, upon receiving information about the simulated shot, activates the pyrotechnic charge. The program that calculates the movement of the target, knowing the coordinates of the shooting device and the target during the shot, calculates the estimated coordinates of the projectile and the target after the shot. If the coordinates of the target and the projectile match, the shot is considered successful, then the target controller turns on the smoke generator and the smoke reports the hit.

The benefit of this simulator is that shooting training with training equipment fully correspond natural shooting operations: the pyrotechnic cartridge simulates the launch

of a missile and the smoke generator simulates downing of the target. Both the target and the shooting device can be any real objects on which the training equipment can be mounted. It is an inexpensive and safe method of shooting training: the target is not destroyed or damaged, and is completely safe for the crew of an aircraft or other flying object. Shooting training can be carried out at any time and there is no need to go to remote training grounds that require special permits for real-fire. In addition, it is possible to train not only the personnel servicing the missile complex, but also the pilots of the aircraft during the shooting training.

SHORT DESCRIPTION OF DRAWINGS

Fig. 1. Schematic diagram of a field simulator, showing the structural elements of the simulator and interaction thereof, wherein 1 is the target; 2 are parts of the simulator mounted on the target; 2.1 are modems; 2.2 is the controller; 2.3 is the satellite navigation system; 2.4 is the smoke generator; 3 is the shooting device; 4 are parts of the simulator mounted on the shooting device; 4.1 is the controller; 4.2 is the satellite navigation system; 4.3 is the modem; 4.4 is the pyrotechnic cartridge for shot simulation.

The figure shown is more illustrative, the scale, proportions and other aspects do not necessarily correspond to a real technical solution.

DETAILED DESCRIPTION OF THE INVENTION

The training of air defense personnel uses virtual computer simulators or "sleeve" type targets, which are towed by means of a transport plane. However, virtual simulators are very different from shooting in natural conditions; shooting at "sleeve" type targets is dangerous, expensive and also different from shooting at real targets. Thus, there is a need for an air defense field simulator that maximally simulates real shooting conditions and is safe, inexpensive, and effective. The invention maximally simulates real shooting conditions and is safe, inexpensive and efficient.

This description provides a field simulator for defense personnel that can detect, aim at, and shoot at a target. During a virtual shot, the real shot is simulated by audio and visual means, and during a successful shot, the downing of a real target is simulated by visual or audio means.

This description is about a field simulator for air defense missile systems. The field simulator consists of two parts (Fig. 1):

1. The target (1).

2. The shooting device (3).

Training equipment is mounted on the target and shooting device. The following describes the construction and operation of the field simulator described in the present invention.

The target can be a moving or a stationary object on which the equipment needed for the simulator can be placed. The target can be an aircraft in the air: an airplane, a helicopter, a remotely piloted aircraft of the required dimensions, or other autonomously or remotely piloted object. The target can also be an object on the ground or on the water: a civilian, an industrial or a military vehicle (a car, a military machine, a ship) or any other object, whether manned, autonomous or uncontrolled.

The following functional parts must be placed on the target (1):

1. (2.1).
2. The controller (2.2).
3. The satellite navigation system (2.3).
4. The smoke generator (2.4).

Other functional parts that complement the said system may also be placed on the target.

The modem is a device that transmits information between the target and the shooting device. The target must have a radio-controlled modem, but there may be a modem controlled by a different principle.

The controller is an electronic device consisting of a microprocessor, short-term and long-term memory modules, power supply or other parts common to controllers. The controller may be a microcomputer, a mini-computer, a computer or another device consisting of the aforementioned parts and capable of performing the functions assigned to it. The controller must be able to receive signals from the target satellite navigation system and the target modem, and must be able to transmit signals to the modem and the smoke generator, and may perform other functions necessary to ensure operation of the field simulator.

The satellite navigation system is such a system that allows to determine the coordinates of an object, its speed and direction. This can be a Global Positioning System (GPS), Beidou, Galileo, GLONASS, IRNSS, QZSS or another system.

The smoke generator or other means for visual or audible feedback is such a device that consists of a vessel and the chemicals contained in the vessel. When the controller turns on the smoke generator, chemicals are activated, an exothermic reaction occurs,

and smoke production begins. Instead of a smoke generator, another visual or audible signal may be used to inform about the target being hit.

The shooting device (3) may be a stationary or mobile device used in the military industry to detect, aim at and fire at a target. When training air defense personnel, the shooting device may be a laser-targeted mobile missile short-range air defense system RBS-70 or another air defense system. When developing the described outdoor simulator, additional equipment is installed without invasion into the structure of the shooting device. The following functional parts of the field simulator must be placed in or near the barrel of the shooting device (Fig. 1):

1. The controller (4.1).
2. The satellite navigation system (4.2).
3. The modem (4.3).
4. The pyrotechnic cartridge for shot simulation (4.4).

Other functional parts that complement the said system may also be placed on the shooting device.

The controller is an electronic device consisting of a microprocessor, short-term and long-term memory modules, power supply or other parts common to controllers. The controller may be a microcomputer, a mini-computer, a computer or another device consisting of the aforementioned parts and capable of performing the functions assigned to it. The controller of the shooting device must be able to receive signals from the satellite navigation system of the shooting device and the modem of the shooting device, and must be able to transmit signals to the modem of the shooting device and pyrotechnic charge, and may perform other functions necessary to ensure the operation of the field simulator. The controller of the shooting device must have a program that calculates the movement of the target. For example, when training air defense personnel and using a mobile missile short-range air defense system RBS-70 or any other system, the controller must have a computer program for calculating the ballistics of the combat missile.

The satellite navigation system is such a system that allows determining the coordinates of the object, its speed and direction. This can be a Global Positioning System (GPS), Beidou, Galileo, GLONASS, IRNSS, QZSS or another system.

The modem is a device that transmits information between the target and the shooting device. The shooting device must have a radio-controlled modem, but there may be a modem controlled by a different principle.

The pyrotechnic cartridge for shot simulation is a mixture of chemicals which, when activated, give rise to exothermic reactions which give off heat, light, gas, smoke and / or sound.

In order to use the field simulator for air defense missile systems described herein, the shooting device must have a monitor, a target location device, an in-sight image digitization system (e.g. a video camera), and shooting equipment. The shooting device may have other components normally found in commercial shooting devices (image stabilization system, equipment required for the operator to sit down, etc.).

The control (4.1), the satellite navigation system (4.2) and the modem (4.3) together with the digitization system, the monitor and the target location device of the shooting device mounted at the shooting device comprise the control unit.

Operation of the described field simulator is based on interaction between the shooting device and the target. A simulated shot is fired during the training. The simulated shot means that a real shot does not take place, but the program in the controller, knowing the coordinates and movement of the shooting device and the target, calculates the theoretical movement of the projectile fired during the simulated shot. Since the invention described herein is a field simulator, real shots do not take place and all shots are simulated shots, so the term "shot" will continue to be used, bearing in mind that this is not a real shot but a simulated shot.

During the training, the operator detects the target and aims at the target by the shooting device in the usual manner. When the shooting device is aimed at the target, the shot is fired. The video camera captures information about the targeting process and the launch of the shot. The firing information is transmitted to the controller on the shooting device. Upon receiving a shot signal, the controller activates the pyrotechnic charge on the firing device or its barrel. When the pyrotechnic charge is activated, an explosion occurs, which releases heat, light, gas, smoke and / or sound. The explosion more accurately imitates real shooting conditions. In this way, the shot is simulated not only in the control of the shooting device, but also provides visual and / or audible feedback to the operator or other personnel involved in the shooting training.

The controller of the shooting device has the coordinates of the shooting device, which are invariable in the case of a stationary shooting device. With the help of radio communication, the controller of the shooting device continually receives the coordinates of the target. Therefore, the coordinates of both the shooting device and the target are known during the shot. A program that calculates movement of the target, e.g. computer program for calculating the ballistics of a combat missile, continually

tracking the target and evaluating its movement characteristics, calculates the distance from the shooting device to the target. This program also calculates theoretical coordinates of the projectile and the target after the shot, by evaluating movement characteristics of the projectile and the target. If the target, taking into account the flight speed of the combat missile and the set distance from the firing position to the target, is maintained in the target of the device for the required time and both the coordinates of the target and the projectile coincide, the shot is considered successful. The modem of the shooting device transmits information about the launch of the shot by radio to the controller of the target. In the event of a successful shot, the controller of the target automatically activates the smoke generator or other visual or audible means on the target that inform the operator about the hit. The real target is not destroyed or damaged; flight crew pilots are not vulnerable during training. Thus, for each shot, the pyrotechnic charge in the barrel of the firing device is activated and heat, light, gas, smoke and / or sound are emitted, and for a successful shot, the smoke generator at the target is activated, resulting in smoke or other visual or audible means. In this way, the visual, audible and psychological environment close to that present in real shooting is maintained. During the training, while using the described field simulator, it is possible to train not only the personnel servicing the missile complex, but also the pilots of the aircraft crew, who can learn to operate the aircraft and avoid shots of air defense systems.

When the shooting operator detects the target with the shooting device, aims at it and fires a shot, the field simulator starts automatically. Operation of the described field simulator can be divided into the following stages:

- The controller (4.1) of the shooting device activates the pyrotechnic charge (4.4) on the shooting device.
- The camera of the shooting device transmits information about the launch of the shot to the controller (4.1) of the shooting device.
- The controller (4.1) of the shooting device records the firing time and coordinates.
- The controller (4.1) of the shooting device records the coordinates of the target received by radio during the firing of the shot.
- The program of the controller (4.1) of the shooting device calculates the theoretical movement of the target and the projectile.

- If the target is maintained for the required time in the gun sight of the device, the coordinates of the target and the coordinates of the projectile / missile coincide at a specific point in time, the shot is considered successful.
- In the event of a successful shot, the controller (4.1) of the shooting device transmits a hit signal to the controller (2.2) of the target via modems.
- The controller (2.2) of the target activates the smoke generator (2.4) of the target.
- The smoke generator (2.4) of the target generates smoke or other visual or audible means on the target that provide feedback to the personnel involved in the shooting training.

The outdoor simulator can be used for laser-guided air defense systems (e.g. RGS70), infrared-guided air defense systems (e.g. Stinger, Grom) and/or other air defense systems.

The described simulator can be used during training to train staff in a variety of situations. As a specific example, but not limited to, such field simulator can be used to train air defense personnel during training sessions. In this case, the field simulator consists of any type of aircraft (airplane, helicopter, remotely piloted aircraft of the required dimensions, etc.) equipped with GPS navigation system, radio modem, controller smoke generator, and laser-targeted air defense complex (e.g. RBS-70), or other air defense complex equipped with pyrotechnic charge for shot simulation, satellite navigation system (GPS), in-sight image digitization system (e.g. video camera), radio modem, controller, and computer software for calculation of combat missile flight ballistics. During the shot, the controller activates the pyrotechnic charge in the barrel of the shooting device, at the same time the coordinates of the target are transmitted to the controller of the shooting device by radio communication and the distance from the shooting device (e.g. RBS-70) to the air target is calculated by evaluating the external ballistic characteristics of the combat missile. During each shot, the pyrotechnic charge on the air defense complex is activated, and in the event of a successful shot, the smoke generator on the aircraft is automatically turned on, which visually informs the shooting operator or other personnel participating in the training about the hit. In this way, the operator works with the missile complex in conditions close to a real combat, both from an environmental and psychological point of view.

Another specific example may include, but is not limited to, the use of such field simulator to shoot at military or civilian ships or other floating crafts on the water that are equipped with the above equipment.

Another specific example may include, but is not limited to, the use of such field simulator to shoot at moving or stationary targets on the ground on which the aforementioned equipment is mounted.

In order to illustrate and describe the present invention, the most preferred embodiments are described above. It is not an exhaustive or restrictive description intended to determine the exact form or embodiment. The above description should be considered as an illustration rather than as a limitation. Obviously, many modifications and variations can be apparent to those skilled in the art. An embodiment is selected and described so that those skilled in the art can best understand the principles of the present invention and the best practice for different embodiments with different modifications to suit a particular use or implementation. It is intended that the scope of the invention is defined by the definition appended thereto and its equivalents, in which all the above terms have the broadest meaning, unless otherwise indicated.

Modifications may be made to the embodiments described by those skilled in the art without departing from the scope of the present invention, as defined below.

CLAIMS

1. Field simulator for air defense missile systems having a target detection device and an actual or simulated shooting device
characterized in that construction of the simulator consists of two parts, one mounted on a target and another on the shooting device, both sending data to each other;
the target is equipped with a satellite navigation system, a controller, a modem and a smoke generator,
and the shooting device is equipped with a satellite navigation system, an in-sight image digitization system, a controller, a modem and a pyrotechnic charge.

2. Field simulator for air defense missile systems according to claim 1, characterized in that the controller of the shooting device contains a program for calculating the movement of the target.

3. Field simulator for air defense missile systems according to claim 1, characterized in that the target may be any moving or stationary object on which training equipment can be mounted.

4. Field simulator for air defense missile systems according to claim 3, characterized in that during a shooting training, a real aircraft or other object that is not destroyed or damaged may be used as a target.

5. Field simulator for air defense missile systems according to claim 1, characterized in that the shooting device may be any moving or stationary shooting device in which the training equipment can be mounted.

6. Field simulator for air defense missile systems according to claim 1, characterized in that the satellite navigation and in-sight image digitization systems, the controller and the modem together with the video camera, the monitor and the target location device of the shooting device installed in the shooting device comprise a control unit.

7. Field simulator for air defense missile systems according to claim 1, characterized in that data is transmitted between the target and the shooting device by radio signals via modems.

8. Method of operation of a field simulator for air defense missile systems, characterized in that it comprises the following stages of operation:
   - The controller of the shooting device activates the pyrotechnic charge on the shooting device.
   - The camera of the shooting device transmits information about the shot to the controller of the shooting device.
   - The controller of the shooting device records the shooting time and coordinates.
   - The controller of the shooting device records the coordinates of the target received by radio signal at the moment of the shot.
   - The program of the controller of the shooting device calculates theoretical movement of the target and the projectile.
   - If the target is maintained for the required time in the gun sight of the device, and the coordinates of the target and the coordinates of the projectile / missile coincide at a specific point in time, the shot is considered successful.
   - In the event of a successful shot, the controller of the shooting device transmits a hit signal to the controller of the target.
   - The controller of the target activates the smoke generator of the target.
   - The smoke generator of the target generates smoke or other visual or audible means on the target that are visible to the personnel involved in the shooting training.

9. Method of operation of a field simulator for air defense missile systems according to claim 8, characterized in that the program in the controller of the shooting device calculates theoretical movement of the projectile or the missile, evaluates actual movement of the target and compares whether the coordinates of the target and the projectile coincide.

10. Method of operation of a field simulator for air defense missile systems according to claim 8, characterized in that an explosive charge explodes during a shot, imitating an actual shot,
    and smoke is generated by the smoke generator after a target is hit.

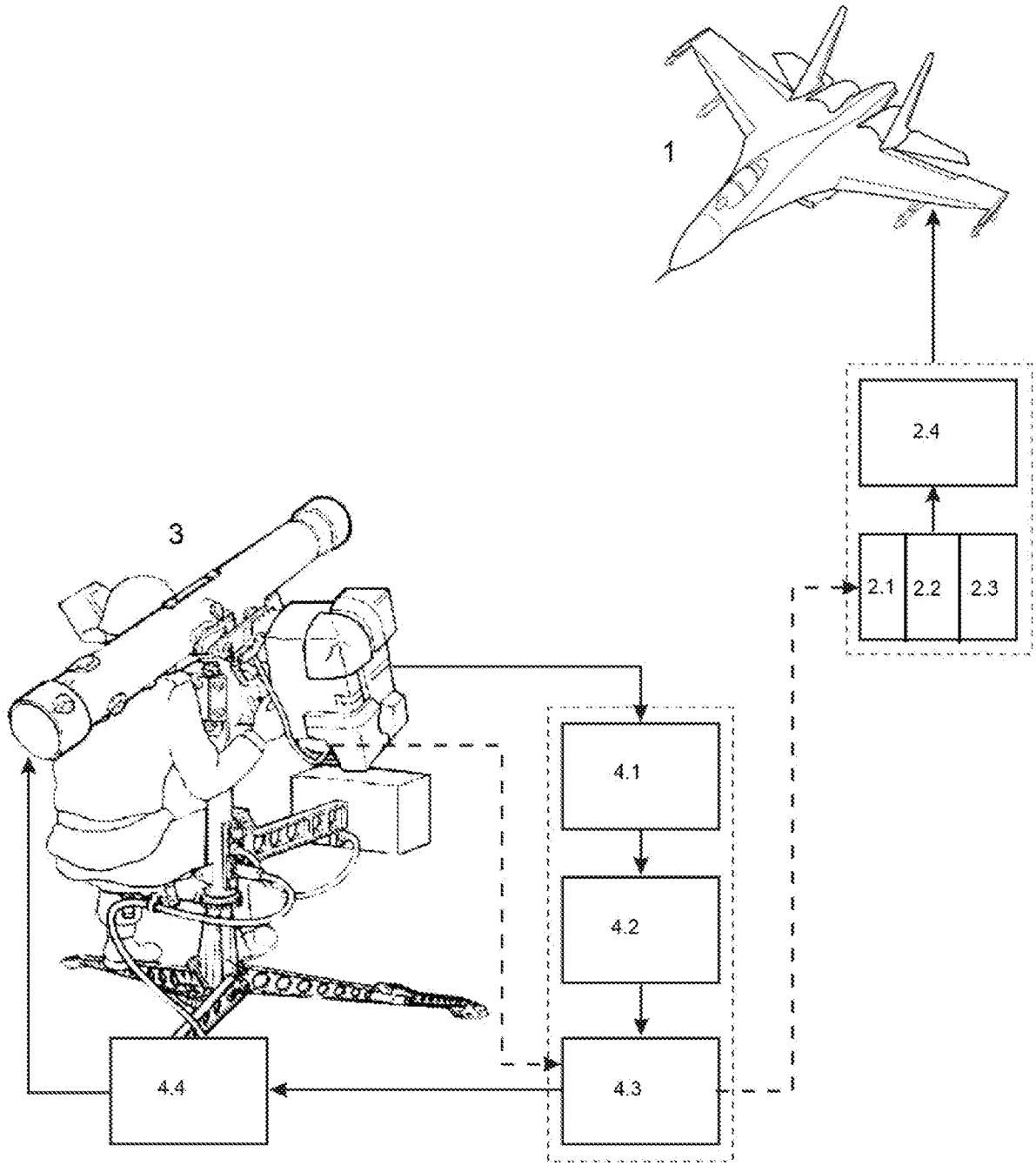

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. F41G7/00 F41G7/22 F41H11/02 G09B9/00 F41A33/00
F41A33/04 F41G3/26
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F41G F42D G09D F41H G09B F41A

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/121687 A1 (PADAN NIR [IL]) 22 December 2005 (2005-12-22)	1,3-5,7
Y	page 27, line 16 - page 34, line 13; figures 5,6 page 37, line 18 - page 39, line 27 page 15, line 20 - page 16, line 21; figure 1 page 11, line 14 - line 17	2,6,8-10

Y	US 5 228 854 A (ELDRIDGE MORTON T [US]) 20 July 1993 (1993-07-20) column 4, line 44 - column 6, line 32; figure 1 column 9, line 63 - column 10, line 32; figure 7 column 7, line 1 - column 8, line 13; figures 3,4	1-10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2020	18/09/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kaleve, Abraham

1

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/053141

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2 224 260 A1 (AAI CORP [US]) 1 September 2010 (2010-09-01) paragraph [0048] - paragraph [0054]; figure 2 paragraph [0071] -----	1-7

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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