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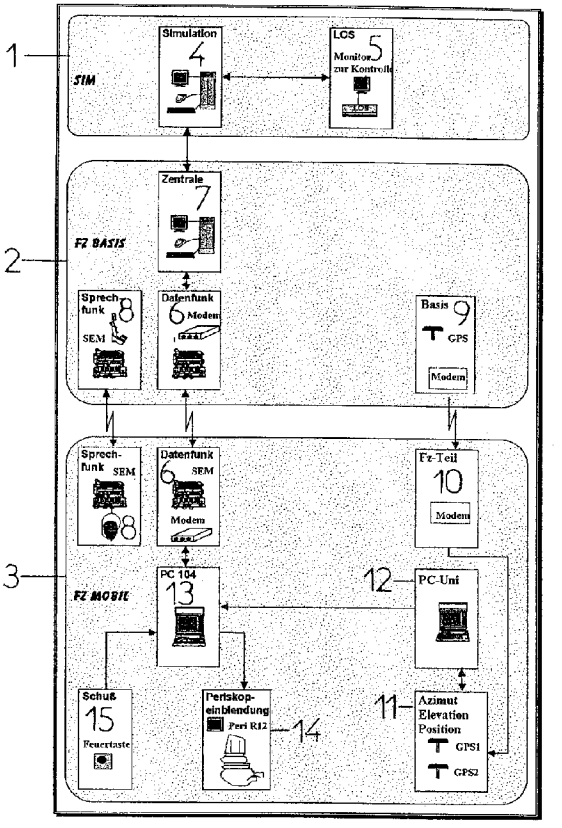
(54) **PROCEDE ET DISPOSITIF DE SIMULATION DE COMBAT AVEC AU MOINS UN SYSTEME D'ARMES MOBILES FONCTIONNANT EN CONDITIONS REELLES DANS UN ENVIRONNEMENT OU SUR UN TERRAIN, AINSI QU'AVEC UN SIMULATEUR QUASI FIXE**

(54) **METHOD AND DEVICE FOR SIMULATING FIGHTS WITH AT LEAST ONE MOVABLE WEAPONS SYSTEM ACTUALLY OPERATING IN AN ENVIRONMENT OR ON A TERRAIN AND WITH A QUASI STATIONARY SIMULATOR**



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(57) L'invention concerne un procédé de simulation de combat avec un système d'armes mobiles fonctionnant en conditions réelles dans un environnement ou sur un terrain, et avec un simulateur quasi fixe. Après traitement des données transmises par le simulateur et reçues par le système d'armes par l'intermédiaire d'un ordinateur de bord, une image de la cible simulée peut être produite et introduite dans un système optique à l'intérieur du système d'armes ou bien dans un système de visée optronique devant l'arrière-plan réel, au moyen de: la détermination continue extrêmement précise de la position et de la direction du système d'armes fonctionnant librement; la détermination de l'angle de l'arme ou d'une ligne de visée d'un appareil de visée et pointage dans l'espace; la transmission télémétrique et l'actualisation en continu des positions, des opérations de tir et des données de défaillance entre le simulateur et le système d'armes en fonctionnement; et la transmission au simulateur de la position et de la direction du système d'armes en fonctionnement, y compris de l'angle de l'arme déterminé ou de la ligne de visée d'un appareil de visée et pointage, et d'une opération de tir ainsi que d'un signal de défaillance. Par suite, un combat peut être simulé dans lequel, à la différence des simulateurs connus, le système d'armes fonctionnant en conditions réelles reçoit, sous forme de représentation visuelle devant l'arrière-plan réel, l'image de l'ami ou de l'ennemi simulés. L'invention permet à des troupes réellement en exercice sur le terrain de s'associer à des troupes simulées par un ordinateur, ces dernières étant rendues visibles pour les servants du système d'armes réel. Grâce à l'insertion de troupes simulées dans les systèmes optiques de systèmes d'armes réels, les troupes réellement en exercice peuvent non seulement détecter l'action de troupes amies ou ennemies mais également les voir et ainsi les soutenir ou les combattre.

(57) The invention concerns a method of simulating fights which comprises a movable weapons system, which can actually operate in an environment or on a terrain, and a quasi stationary simulator. After preparation of data transmitted by the simulator and received by the weapons system via an on-board computer, a simulated target-object image can be generated and inserted into a lens system inside the weapons system or into an optronic sight arrangement in front of the real background by means of: highly accurate continuous determination of the position and direction of the freely operating weapons system; determination of the weapon angle or a line of sight of an aiming and sighting apparatus in space; continuous telemetric transmission and up-dating of positions, firing events and failure data from the simulator to the operating weapons system; and transmission to the simulator of the position and direction of the operating weapons system including of the weapon angle determined or the line of sight of an aiming and sighting apparatus and of a firing event and a failure signal. As a result, a fight can be simulated in which, unlike with known simulators, the weapons system actually operating receives the simulated friend or foe as a visual display in front of the real background. The invention enables troops actually on exercise on the terrain to be associated with simulated troops, the simulated troops being rendered visible for the crew of the real weapons system. Owing to the insertion of simulated troops into the lens systems of real weapons systems, the troops actually on exercise can not only detect the action of friendly or enemy troops but also see the latter so that they can support or fight them.

ABSTRACT

The invention relates to a method of battle simulation with a mobile weapon system operating in real terms in an environment or terrain, and a virtually stationary simulator. By means of a high-precision continuous determination of position and direction of the freely operating weapon system and detection of the weapon angle or of an aiming line of a sighting or target appliance in space, and continuous telemetric transmission and updating of position, firing result and miss data from the simulator to the operating weapon system and transmission of the position and direction of the operating weapon system including the determined weapon angle or the aiming line of a sighting or target appliance and of a firing result and of a miss signal to the simulator, after processing of the data transmitted by the simulator and received by the weapon system by an on-board computer, a simulated target image is generated, which is superimposed in an optical system internal to the weapon system or an optronic sighting device in front of a real background. In this way it is possible to organise a duel battle simulation, whereby in contrast to what is known, the weapon system operating in real terms

receives the simulated opponent or neighbours in front of a real background as a visual display. By means of the invention, troops operating in real terms in the terrain and troops simulated by a computer can be successfully linked, the simulated troops being rendered visible to the crew of real weapon systems. The troops exercising in real terms, by means of the superimposition of simulated troops in the optical systems of real weapon systems, can not only trace the effect of friendly or hostile troops, but in addition can see them and thus support them or combat them.

Method and Device for Combat Simulation with at least one Mobile Weapon system operating in Reality in an Environment or Terrain, and with a virtually stationary Simulator

The invention relates to a method and to an associated device for combat simulation with at least one mobile weapon system operating in reality in an environment or a terrain, and a virtually stationary simulator.

Battlefield simulators for realistic training in specific tactical situations making use of computer displays are known. In this case for example troops exercising in reality in the terrain, their tasks and movements are coupled with troop or battle vehicles simulated by a computer, in order in this way to display neighbours or opponents. In the case of known devices, the troops exercising in reality can in fact track the effect of friendly or opposing troops, but cannot see them visually and support or combat them. Until now it has not been possible to render the simulated troops visible to the crews of real weapon systems. For this reason it has until now been necessary to separate battles with real and simulated troops from one another, so that

substantial limitations in the system and execution of exercises result.

It is therefore the object of the invention to indicate a method and a device for carrying out the method for battle simulation with a mobile weapon system operating in reality in an environment or terrain, and a virtually stationary simulator, which permits the actual sight and the activities of simulated troops to be displayed visually to the exercising real troops, so that the efficiency and realism of battlefield exercises or the like executed on this basis are increased.

The object of the invention is achieved by a method according to the features of patent claim 1 and by a device for carrying out the method according to patent claim 9, the sub-claims comprising at least appropriate designs and further developments.

The most essential basic idea of the invention resides in the fact that a simulated target image is generated, which is superimposed on existing optical systems or optronic viewing appliances of the real weapon systems of real troops, so that these real troops are capable of experiencing and following in a realistic way the activities of the simulated troops. In development of the basic idea of the invention, the target image is

shown correct for distance, dimension, position and event as a target silhouette in the optical system of the real vehicle or of the real weapons system.

According to a further basic idea of the invention, due to the fact that the precise positioning of the virtual target is decisive for highly precise detection of the sight and the direction of the observation and targeting means, a highly precise measurement of position and azimuth-elevation direction of the weapon system is carried out, preferably by the usé of a cross-correlated differential GPS and supplementary or alternative detection of the azimuth-elevation direction from a gyroscope system.

By means of the resultant continuous high-precision determination of position and direction of the freely-operating weapon system and determination of the weapon angle or an aiming line of a viewing or target appliance in space and the corresponding continuous telemetric transmission and updating of position, shot result and miss signal from the simulator to the operating weapon system, and transmission of the position and direction of the operating weapon system inclusive of the determined weapon angle or the aiming line of a viewing or target appliance in space, of a shot result or of a miss signal to the simulator, an on-board computer located in the

weapon system, using position and direction of the weapon system, is capable of generating the simulated target image, and as already mentioned, of superimposing it in the optical system internal to the weapon system, or the existing optronic viewing device.

Display of the target object is effected at a dimensionally correct size in dependence on the distance of the object and the sight line to the observer, i e. to the weapon system. In addition, there is a horizontal movement of the object in the eye-piece of an optical system used for example, depending on the object direction, relative to the direction of view of the optical system. Likewise, the vertical movement of the object is ensured in the eye-piece in dependence on the vertical movement of the optical system.

By virtue of the fact that, according to a further basic idea of the invention, optical sight conditions or sight lines between movable weapon system and simulator are continuously calculated, it is possible to generate the target image in dependence on the real viewing conditions, the terrain structure and weather conditions.

In a further embodiment of the invention, by means of the mutual transmission of position, shot results and miss signal or information, training can be provided in mutual

combat in the manner of a duel. In this way a total two-sided duel situation with two-sided combat between a simulated and a real weapon system is possible utilising the information for transmitting shots and direct hits.

The representation of missing a target is effected on the simulator side by variation of the tactical symbol shown there and in the optical system or in the optronic viewing device of the weapon system in the real vehicle by an alteration of the object image shown on video.

The calculation of sight lines necessary for an optimum battle simulation is effected with a digitised terrain model and may be executed externally by the simulator, the sight calculations being transmitted to the real weapon system by means of telemetric devices. Alternatively, the calculation of sight lines can also be carried out in the operating mobile weapon system, and then in an advantageous way delays in data transmission by radio are eliminated and in all the precision and rapidity relative to the concrete sight angle of the respective optical system of the real weapon system, can be increased.

According to the invention, the high-precision determination of position and direction of the freely operating weapon system and detection of the weapon angle

or an aiming line of a sighting or target appliance in space is effected either by use of a cross-correlated differential GPS or by a combination of the latter with a detection of azimuth and elevation direction of the weapon by means of a gyro system, e.g. by taking in data from the fire control system.

In a special embodiment of the invention, two GPS receivers are located along the axis of the bore of a weapon of the mobile weapon system. The data so detected inclusive of the elevation direction of the weapon which is detected alternatively or supplementarily, are transmitted to the on-board computer of the weapon system, which then undertakes determination of position and direction in azimuth and elevation according to algorithms known per se. If due to reception disturbances in the GPS system, data disappear periodically, according to the invention it is possible to interpolate and/or combine the absolute measuring system with an incremental measuring system, e.g. acceleration sensors for detection of the movement and position at any moment of the weapon system.

The superimposition according to the invention of the simulated object or objects correct in position, size and position, and in dependence on execution of the visibility calculation, is carried out in front of the

real background of the weapon system operating in the terrain or the like, the background terrain view being maintained by the optical system internal to the weapon system or by the optronic sighting device.

According to an embodiment of the invention, superimposition of a generated video monitor image showing the target image into the beam path of a weapon's optical system, e.g. a periscope, is undertaken. It is ensured that the surfaces visible in the eye-piece are totally covered by the monitor image, so that the simulated target image is movable over the entire surface visible in the eye-piece.

Alternatively it is possible, particularly in optronic viewing systems, to link the video signals of the target image with the image of the real background, and to display them on an on-board viewing system, e.g. a monitor.

In order to improve the visibility of the target image, particularly in critical sight conditions, with respect to the real background, in one embodiment of the invention it is proposed to adapt the brightness of the target image on the monitor, i.e. visibly in the eye-piece, in dependence on the environmental brightness.

According to the invention, there is used for exact display of the target image an on-board computer which in addition to the actual calculation of the parameters for superimposition of the symbol and of the symbol output (target image), also has the task of communication with a calculating unit for evaluating the GPS data and communication with the bi-directional data transmission telemetry unit, which maintains the connection with the simulator.

In a special embodiment of the invention, which is based as a mobile weapon system on a battle tank, the turret direction of the real vehicle, the position of the real vehicle, the elevation of the sighting direction, which corresponds to the elevation of the barrel of the weapon, the height of the real vehicle above normal zero, the position of the simulated vehicle (simulator), the height of the simulated vehicle above normal zero, the distance between real vehicle and simulated vehicle, the angle at which the real vehicle sees the simulated vehicle, and the sight connection between the real vehicle and simulated vehicle are evaluated.

The turret direction and the position of the real vehicle as well as the elevation of the sight direction and the height of the real vehicle above normal zero are provided by the calculating device which evaluates the GPS data.

A display of the target image in the optical system of the weapon system, i.e. of the real vehicle, is provided according to the invention when there is a sight connection due to the completed viewing calculation, the turret angle in the battle tank embodiment, within for example ± 4°, corresponds to the angle at which the real vehicle sees the simulated vehicle, and the elevation angle, within for example ± 4°, corresponds to the angle at which the real vehicle sees the simulated vehicle.

According to the invention communication between simulator and mobile weapon system are effected via the aforementioned bi-directional data transmission telemetry units, which serve for transmitting and receiving position, firing results, miss signals and viewing information.

In all, it is possible with the method according to the invention and with the associated device, successfully to link a so-called live simulation with a virtual simulation. In the live simulation, crews are present in real vehicles, ships or the like and move in a real terrain, or in a real environment. The terrain itself is instrumented. The simulated proportion is substantially restricted to the simulation of the effect of the weapon.

In virtual simulation, the crews are located in or in front of a simulator, which realistically represents a weapon system. The battlefield itself is synthetic. A plurality of simulators can be coupled together, the crews fighting against one another or in common against a computer-generated enemy. In the above mentioned coupling according to the invention of live situation with real situation, an additional interchange and reconciliation of information, such for example as condition of the real vehicle, position of the real vehicle in the real terrain, firing command of the real vehicle, condition of the simulated vehicle, position of the simulated vehicle in the digital terrain, beginning and end of the theoretical view from the real vehicle to the simulated vehicle, direction and movement of the body of the real vehicle and fire command of the simulated vehicle are undertaken. By means of these data which represent a minimum configuration, it becomes possible both for the simulated vehicle to be informed of the activities of the real vehicle, and for information to be passed in the reverse direction, so that the real weapon system, i.e. the real vehicle, continuously obtains data relating to the simulated vehicle, which in addition appears optically in front of a real background.

The coupling of live simulation with virtual simulation according to the method and associated device according

to the invention, leads on the one hand to cost economies and on the other hand to obtaining the necessary acceptance due to the greater realism.

Of particular advantage is the supplementary simulated view of neighbours and opponents in front of a real background, so that no restriction of the design of the scenario is necessary.

As coupling of simulation systems of different hierarchical planes is possible, in addition command and auxiliary personnel can be eliminated, and trainees on several levels can be trained simultaneously.

The invention will be explained in more detail in the following with reference to the description of embodiments given by way of example, and making use of Figures. Shown are:

Figure 1: a block diagram of the device for carrying out the battle simulation method in a first embodiment;

Figure 2: an extended device for battle simulation according to a second embodiment;

Figure 3: a block diagram for showing the high-precision position and angle determination on the mobile weapon system operating in reality in the terrain;

Figures 4a and 5b: illustrative views of activities and events in a duel between simulator (red) and real weapon system (blue);

Figure 5: a view through the optical system internal to the weapon system of the operating weapon system in front of a real background.

With the aid of Figure 1, which illustrates a block circuit diagram of the device according to the invention, a first embodiment will be explained.

The device according to the first embodiment consists substantially of two components, i.e. the simulation area 1, and the vehicle area, which comprises the stationary vehicle base 2 and the mobile portion 3 of the vehicle.

The data are transmitted in a predetermined protocol on a wave guide channel between the simulation area 1 and the stationary vehicle base 2, the vehicle base 2 and the mobile portion 3 of the vehicle intercommunicating via a radio channel, i.e. telemetrically.

In the first embodiment according to Figure 1 a personal computer is provided as a simulation computer 4, which contains the corresponding software portions of the simulation, which are necessary for illustrating the position and for triggering the viewing computer 5. In the embodiment shown, the viewing computer 5 is located in the simulation area 1, the results of the viewing line computer 5 passing via the simulation computer 4 to the vehicle base 2 and from that point passing via a modem to the bi-directional data transmission telemetry unit 6, which is present both in the vehicle base 2 and also in the mobile portion of the vehicle 3, and thus are available to the mobile weapon system operating in the terrain.

Alternatively, with correspondingly powerful bi-directional data transmission telemetry units 6, the result of the simulation can also be sent from the simulation computer 4 to the mobile portion 3. A central computer 7 processes the data supplied by radio, i.e. via the bi-directional data transmission telemetry units 6, determines visibility data and returns the result to the vehicle, so that at that point superimposition of a simulated target image becomes possible.

Voice radio units 8 known per se serve to regulate the radio traffic between vehicle base 2 and the mobile portion 3. A stationary GPS station 9, whose position has been determined with high precision, serves as a reference source for a satellite-supported DGPS position-finding method, known per se.

The relevant data from the reference GPS station 9 are transmitted via a corresponding modem and using a radio channel to a receiver 10 in the mobile portion 3. The GPS aerials of the GPS receiver 11, located for example along the bore axis at the mouth-piece of the weapon and on the weapon shield of a weapon, serve to determine azimuth and elevation of the weapon and the position of the weapon system, co-operating with the GPS reference data. By means of a first on-board computer 12, a high-precision measurement of position and direction in the azimuth of the weapon system, and detection of the elevation direction are undertaken on the basis of the DGPS information.

The position-finding system used involves a cross-correlated differential GPS, which permits precise determination of the co-ordinates of the sight in the range of about 3 cm in real time.

By means of locating the GPS receivers 11 along the axis of the bore on the turret of the mobile portion 3, precise determination of the observation and firing direction is possible in a range of about 7.5 points in real time.

In addition, the elevation direction of the weapon can be detected by means of an inclinometer (see Figure 2) and the azimuth can be obtained from an in-vehicle navigation system or from a gyro system. The latter data then pass to the first on-board computer 12 (Figure 2).

The positional and directional data determined by the first on-board computer 12 are passed to a second on-board computer 13, which in turn communicates with the bi-directional data transmission telemetry unit 6 located in the mobile portion 3.

The task of the second on-board computer 13 resides in calculating and displaying the simulated target, taking into account the visibility, the size, the direction and the possible target results in the case of direct hits. At the output side of the second on-board computer 13, a VGA signal is obtained, which passes to a monitor 14, which superimposes a target image in the beam path of an optical system (commander's periscope) present in the mobile portion. In addition, a so-called firing button

15 is provided, by means of which it is possible to simulate weapon firing by the mobile portion 3. The firing information passes via the second on-board computer 3 and the bi-directional data transmission telemetry unit 6 back to the simulator 1.

According to a further, second embodiment according to Figure 2, in addition to the components already explained in Figure 1, and which have the same reference numbers, a computer-operated data channel "PDU for DIS" 20 and 21, which communicates via a wave guide cable. (PDU for DIS = Protocol Data Unit for Distributed Interactive Simulation). Via the PDU for DIS channel, further simulators 1 or further mobile real weapon systems can be connected in order to execute comprehensive exercises.

An operational data detection system 22 is connected to the calculator 7, which is located in the vehicle base 2, and in turn receives via a radio channel 23,24 data for producing the azimuth angle of a vehicle navigation system 25. The components 26 and 27 belong to the standard equipment of an experimental battle exercise system and serve for position detection independently of the GPS receivers 11.

The inclinometer 28, already mentioned in explanation of the embodiment in Figure 1, serves to determine the

elevation angle of the weapon or in the operational mode "commander operates main weapon", also to determine the aiming line of a viewing or targeting appliance not shown.

As can be seen from the description of the embodiment in Figure 2, components already present in the operating weapon system for converting the simulation process can be used to increase the precision of the determination of position and direction. In addition, particularly by means of using the output signals of the vehicle navigation system 25, it is possible if the GPS receivers 11 fail, to carry out a meaningful interpretation, so that the operational capacity of the system as a whole is maintained.

The theoretical structure for high-precision determination of position and angle in real time will now be explained with reference to Figure 3.

On the vehicle side, i.e. in the operating weapon system, there is provided a vehicle navigation system 30 (corresponds to 25 in Figure 2), which co-operates via a standardised interface with the on-board computer 34 already mentioned.

The GPS antennas 31,32, located preferably at a maximum spacing along the axis of the bore of the weapon system, provide output signals which, in conjunction with reference signals from the stationary GPS receiver 33, make it possible for the on-board computer 34 to determine the position, the height, the azimuth and also the elevation of the weapon system. The transmission channel 35 shown in Figure 3 corresponds to the communication link explained with reference to Figures 1 and 2 between the basic GPS 9 and the receiver 10 located in the mobile portion 3.

The positional and angular data are then passed to a second on-board computer 36, which corresponds to the on-board computer 13 according to Figures 1 and 2. This second on-board computer 36 in turn prepares a video signal for superimposition of the target.

Thus there are mounted on the real vehicle, on the mobile weapon system, two GPS receivers 31 and 32, which obtain correctional data from the base GPS 33 via a telemetry channel. The site of the base GPS 33 is exactly measured and known. The GPS receivers 31 and 32 pass their data via the aforementioned preferably V24 interface to the first on-board computer 34 located in the vehicle. In addition, the vehicle navigation system 30 is in addition connected to this first on-board computer 34 for example

via a V24 interface. The vehicle navigation system 30 determines in a land-based manner the position in UTM (Universal Transversal Mercator Projection) and the angle, relative to grid north.

It will be explained with the aid of Figures 4a and 4b how by means of the mutual exchange of data between weapon system and simulator (system blue and system red) a two-sided reconnaissance and combat in the framework of a battle exercise is possible, and how the corresponding events are shown.

According to Figure 4, after target reconnaissance, the real weapon system operating in the terrain initiates a firing event by means of firing button 15 (Figures 1 and 2), said event being indicated by pyrotechnics mounted on the vehicle.

In the case of a direct hit, in the simulator, the vehicle which is characterised by a tactical signal, is removed or provided with a corresponding X symbol. In the simulator, the firing event initiated by the real weapon system is illuminated by flashing of the tactical system and by an illustration of a firing line.

By means of data re-transmission to the real weapon system "blue", in the case of a direct hit on the

simulated vehicle, the view, i.e. the superimposition of the monitor image in the optical system internal to the weapon system, can be changed.

Thus a so-called scrap signal can appear or it is possible to have the silhouette of the opponent disappear after a view of an explosion.

In the reverse case, i.e. when a firing event is initiated by the simulator, the tactical system in the latter flashes on and a corresponding firing line is shown in the direction of the target.

Upon a direct hit, the tactical symbol of the real vehicle is altered in the simulator, i.e. is provided with an X or shown as destroyed in some other way. Initiation of a shot can be shown in the real weapon system by illumination or flashing of the simulated target image in the monitor, i.e. in the optical system internal to the weapon system.

For the battlefield observer, a direct hit initiated by the simulated object is indicated by a flashing beacon, located on the real weapon system, and by a signal tone. In addition, direct hits and miss events can be detected via the computer 7 (Figure 2) and considered for later evaluation.

With the aid of Figure 5, it will be shown in accordance with an embodiment, how the image in the eye-piece of an optical system internal to the weapon system is shown at about 8 X enlargement.

The superimposed, simulated target image simulates a leopard battle tank, and is located at about 500 m distance in abeam position.

The contrast with the target superimposition on the terrain is dependent on the brightness of the terrain and thus from the time of day and the level of the sun and can be adapted and optimised by fitting filters in front of the lens of the optical system internal to the weapon system, or by electronic means.

The representation of the target is adapted to the given opening angle, in the shown example 8°. A target is only superimposed when a sight line calculation has shown that sight is available to the target. The azimuth position of the target in the image can be determined and shown at intervals of seconds. Likewise, target position in elevation can be effected at intervals of seconds. The step size for the type of the target above NN lies at about 0.2 m. Only the resolution of the monitor showing

the target is determined for the step size which is predetermined by GPS angle.

A representation of the target size altered by a corresponding factor is provided by determination of the distance.

As explained with reference to Figures 4a and 4b, the target condition is firstly shown in the form of an intact target or in the form of a destroyed target, by a symbol without turret, and a firing target flashes at the front. It is within the meaning of the present embodiment that many variations of the representation of target, e.g. for the simulation of battles on land, on sea and in the air are possible.

In addition it is possible to supplement the real optical image of the background in addition to the simulated representation of the target by a tracer shell track or similar in the firing condition of the real weapon system, so that the realism of the simulation is further increased. As already explained, the simulated target image is superimposed into the optical system internal to the weapon system. This is possible for example by means of a special adapter which has a colour monitor, which obtains the corresponding video signal directly or via a video interface from the on-board computer. In order as

far as possible to avoid interventions in the weapon's optical system, the colour monitor including an imaging optical system, which if necessary has a deflecting mirror, is located externally and is merely linked through an opening provided in the works into the beam path of the weapon's optical system in such a way that for example a semi-transparent mirror is made use of.

The colour monitor can be a cathode ray or an LCD display, and in the latter case the LCD display can also be located directly in the beam path or in front of the eye-piece of the weapon's optical system. When the weapon's optical system has optronic sub-assemblies, e.g. based on a camera system in the visible and/or infra-red range, it is then possible electronically to superimpose the target image on the sections of terrain detected by the optronic arrangement.

PATENT CLAIMS

1. Method for battle simulation with at least one mobile weapon system operating in real terms in an environment or terrain, and a virtually stationary simulator, comprising the following steps:

continuous high-precision determination of position and direction of the freely operating weapon system and determination of the weapon angle or of an aiming line of a sighting or target appliance in space;

continuous telemetric transmission and updating of position, firing result and miss signal from the simulator to the operating weapon system and transmission of the position and direction of the operating weapon system including the determined weapon angle or the aiming line of the sight or target appliance, of a firing result or of a miss signal to the simulator;

processing of the data transmitted by the simulator and received by the weapon system by an on-board computer, utilising position and direction of the weapon system and the weapon angle or the aiming line of a sight or target appliance in space;

generation of a simulated target image on the basis of the data transmitted by the simulator and superimposition of the same in an existing optical system internal to the weapon system in front of a real background after determination of a calculated optical sighting instruction between the simulated and the real object, wherein the optical sighting instruction is effected by determination of sight lines by means of an external computer having a terrain profile data bank, or by means of the on-board computer of the weapon system, using a terrain profile.

2. Method according to claim 1,

characterised in that

for high-precision determination of position and direction of the freely operating weapon system and detection of the weapon angle or the aiming line of a sighting or target appliance in space, a cross-correlated differential GPS method is used, and in order to increase the precision of detection of the elevation angle, use is made of data from an angle-measuring gyro arrangement of the weapon system.

3. Method according to claim 1 or 2,

characterised in that

the weapon angle is the direction of the weapon in terms of height and side.

4. Method according to one of the preceding claims,

characterised in that

the superimposition of the simulated object or objects is effected correct for position, size and position and after execution of the visibility calculation or partial visibility calculation in front of the real background of the weapon system operating in the terrain or the like, the view of the background terrain being maintained via the optical system internal to the weapon system or an optronic sighting device.

5. Method according to one of the preceding claims,

characterised in that

the telemetric data exchange between one or a plurality of weapon systems operating in the terrain and the at least one simulator is effected by using a standardised transmission protocol.

6. Method according to one of the preceding claims,

characterised in that

a two-sided reconnaissance and duel combat is effected within the framework of a battle exercise on the basis of the mutual data exchange between weapon system and simulator.

7. Device for carrying out the method according to one of claims 1 to 6,

characterised by

a computer-supported object simulator;

a first bi-directional data transmission telemetry unit connected with the object simulator;

an on-board computer located in the freely operating weapon system, and which co-operates with a second bi-directional data transmission telemetry unit, integral with the vehicle, for transmitting and receiving positions, firing results, miss signals and viewing instructions;

an arrangement, provided on or at the weapon of the weapon system, of two spaced-apart GPS receiver systems both for determining the direction of the weapon and the position of the weapon system, the received GPS data, if necessary supported by positional data from a vehicle navigation system, passed to the on-board computer;

a monitor, linked to the optical system internal to the weapon system or the optronic viewing device, for video representation and superimposition of the simulated target object in front of a real background on the basis of the data processed by the on-board computer.

8. Device according to claim 7,

characterised in that

an angle-measuring gyro arrangement is provided in order to derive angular data, particularly elevation data of the weapon or of the aiming line of the sighting or target appliance of the freely operating weapon system.

9. Device according to claim 7 or 8,

characterised by

a unit is provided for calculating sight lines between simulated object and mobile weapon system on the basis of digitised terrain data.

10. Device according to claim 7,

characterised in that

the GPS aerials are located at maximum spacing apart along the axis of the bore of the weapon of the weapon system.

11. Device according to claim 10,

characterised in that

the first of the GPS aerials is located at the barrel mouth and the second of the GPS aerials, in extension of the axis of the bore, is located on the turret or on the weapon shield of the respective weapon of the weapon system.

12. Device according to claim 7,

characterised by

an adapter for direct superimposition of the simulated target object video image in the beam path of an optical system internal to the weapon system, the adapter having a cathode ray or LCD colour monitor.

13. Device according to claim 12,

characterised in that

the adapter further has an imaging optical system and a semi-transparent mirror, which extends into the optical beam path of the optical system internal to the weapon system.

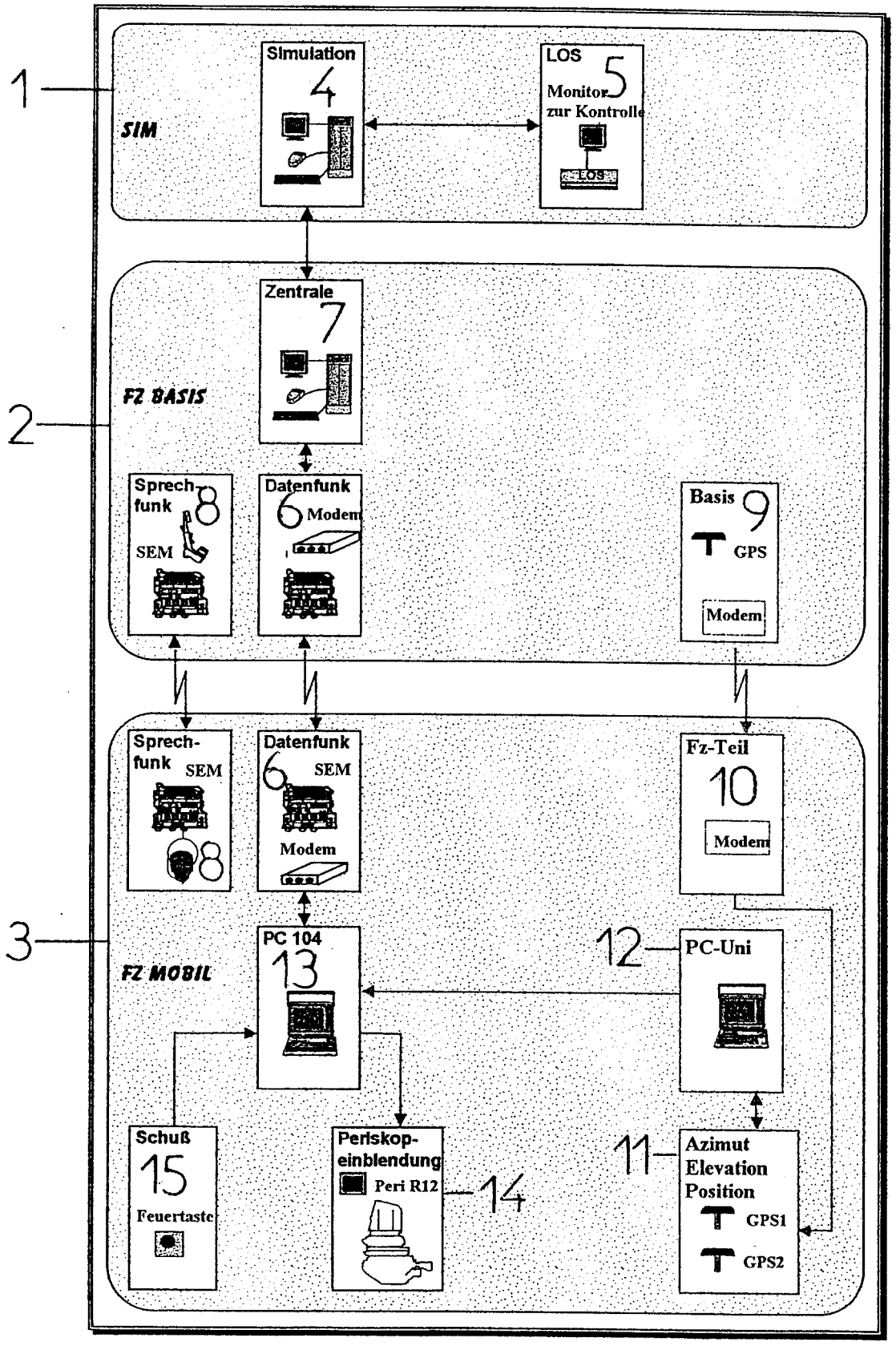
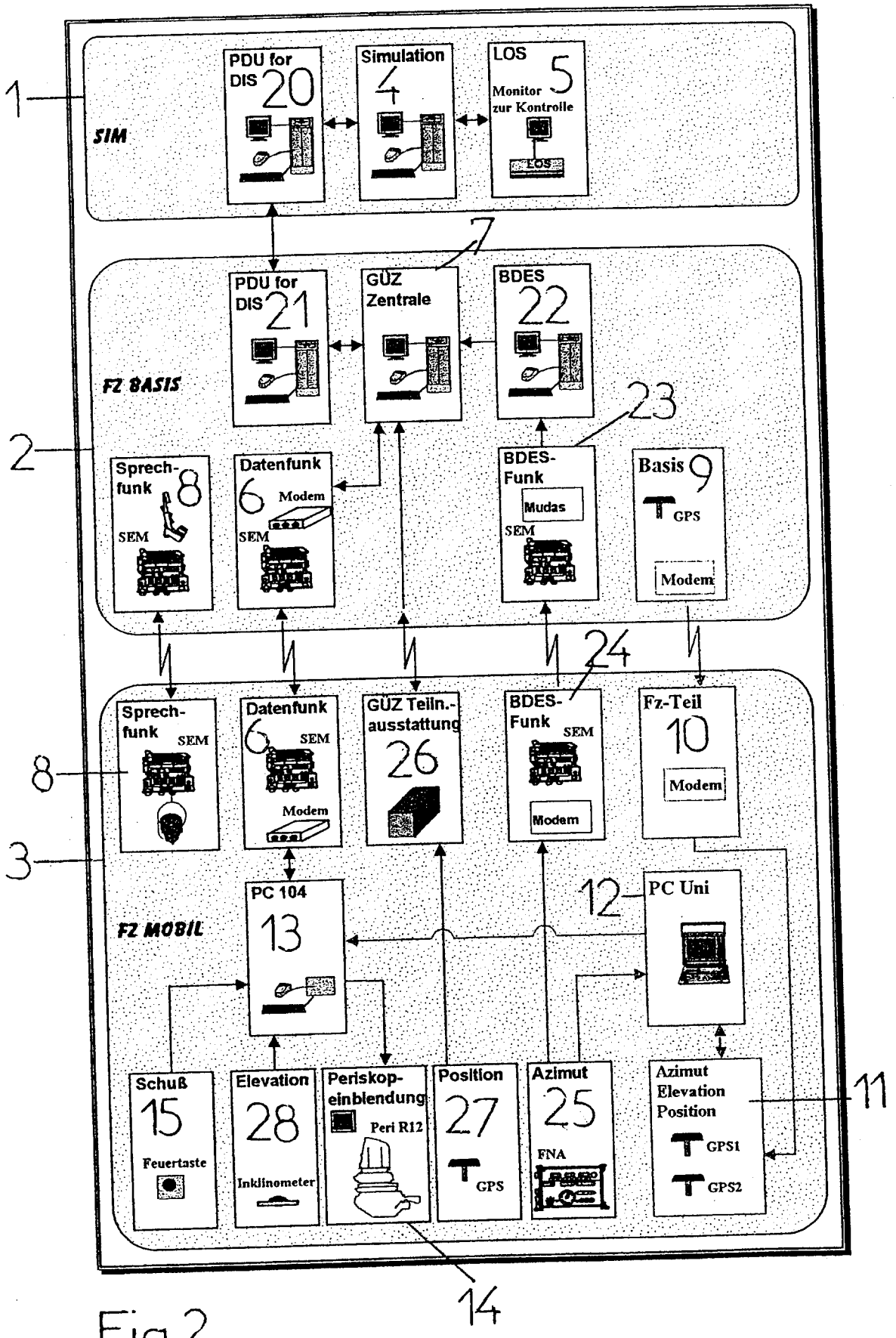

1
SIM
Simulation
4
LOS
5
Monitor zur Kontrolle
LOS
2
FZ BASIS
Zentrale
7
Sprech-funk
8
SEM
Datenfunk
6
Modem
Basis
9
GPS
Modem
3
FZ MOBIL
Sprech-funk
SEM
8
Datenfunk
6
SEM
Modem
Fz-Teil
10
Modem
PC 104
13
12
PC-Uni
Schuß
15
Feuertaste
Periskop-einblendung
Peri R12
14
11
Azimut
Elevation
Position
GPS1
GPS2

Fig.1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Simulation 4
LOS 5
Monitor zur Kontrolle
LOS
7
PDU for DIS 21
GÜZ Zentrale
BDES 22
FZ BASIS
2
23
Sprech-funk 8
SEM
Datenfunk 6
Modem
SEM
BDES-Funk
Mudas
SEM
Basis 9
GPS
Modem
24
Sprech-funk
SEM
8
Datenfunk 6
SEM
Modem
GÜZ Teiln.-ausstattung 26
BDES-Funk
SEM
Modem
Fz-Teil 10
Modem
3
PC 104 13
12
PC Uni
FZ MOBIL
Schuß 15
Feuertaste
Elevation 28
Inklinometer
Periskop-einblendung
Peri R12
Position 27
GPS
Azimut 25
FNA
Azimut
Elevation
Position
GPS1
GPS2
11
14

Fig. 2

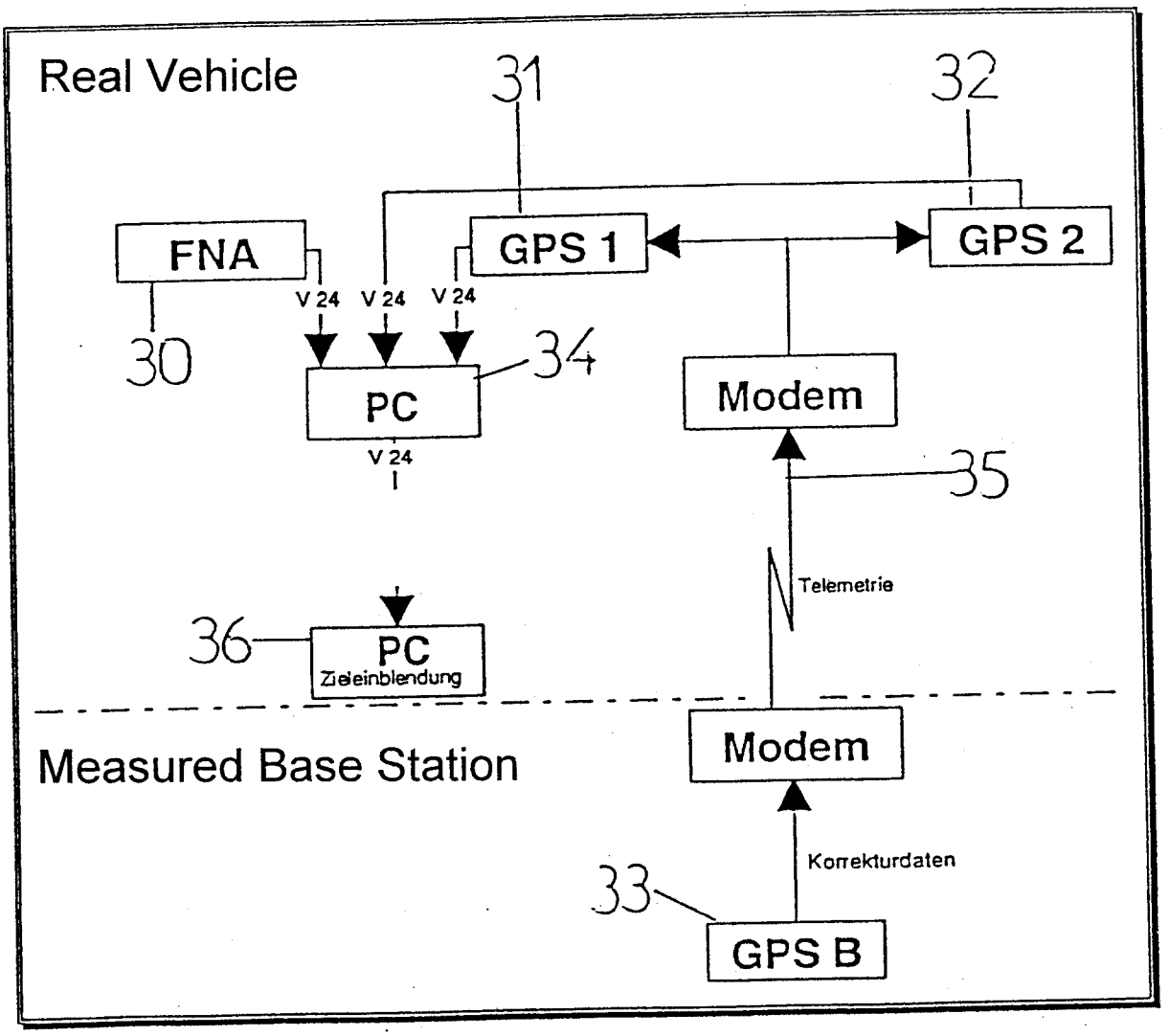
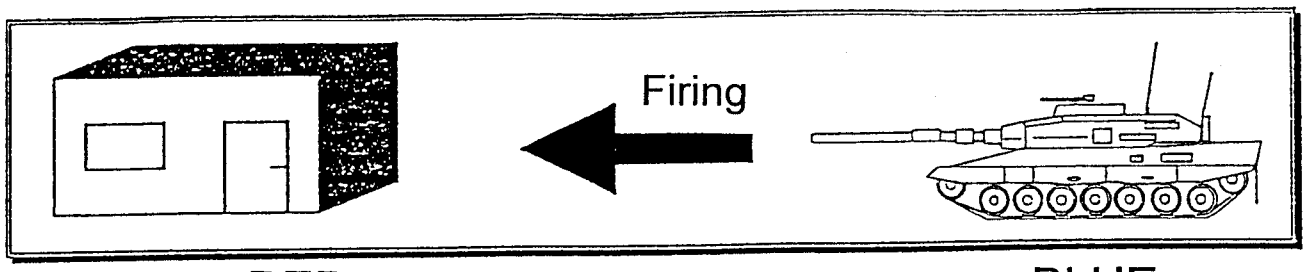

Real Vehicle
31
32
FNA
GPS 1
GPS 2
V 24
V 24
V 24
30
34
PC
Modem
V 24
35
Telemetrie
36
PC
Zieleinblendung
Measured Base Station
Modem
Korrekturdaten
33
GPS B

Fig. 3

416



Simulated Veh.:

Tactical symbol with X

Real Veh.:

Pyrotechnics

Real Veh.:

Tactical symbol flashes
Firing line (long, short)

Simulated Veh.:

„scrap symbol“

Fig. 4a

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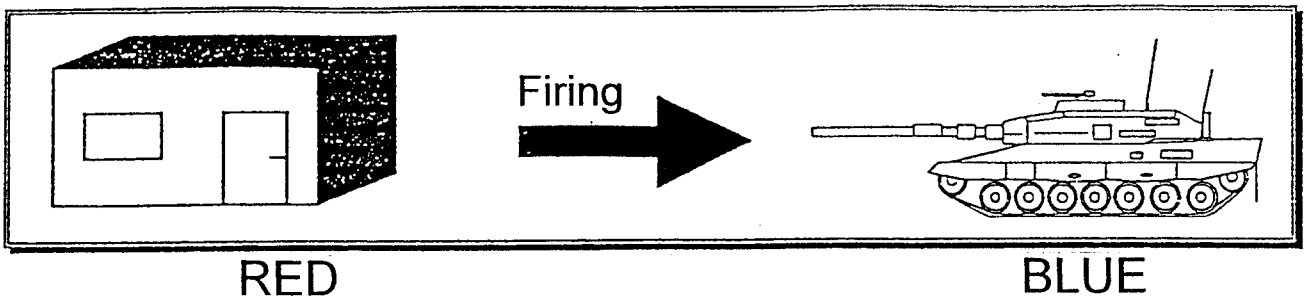


Simulated Veh.:

Tactical symbol flashes
Firing line (long, short)

Real Veh.:

Flashing beacon, tone

Real Veh.:

Tactical symbol with X

Simulated Veh.:

Symbol flashes briefly

Fig. 4b

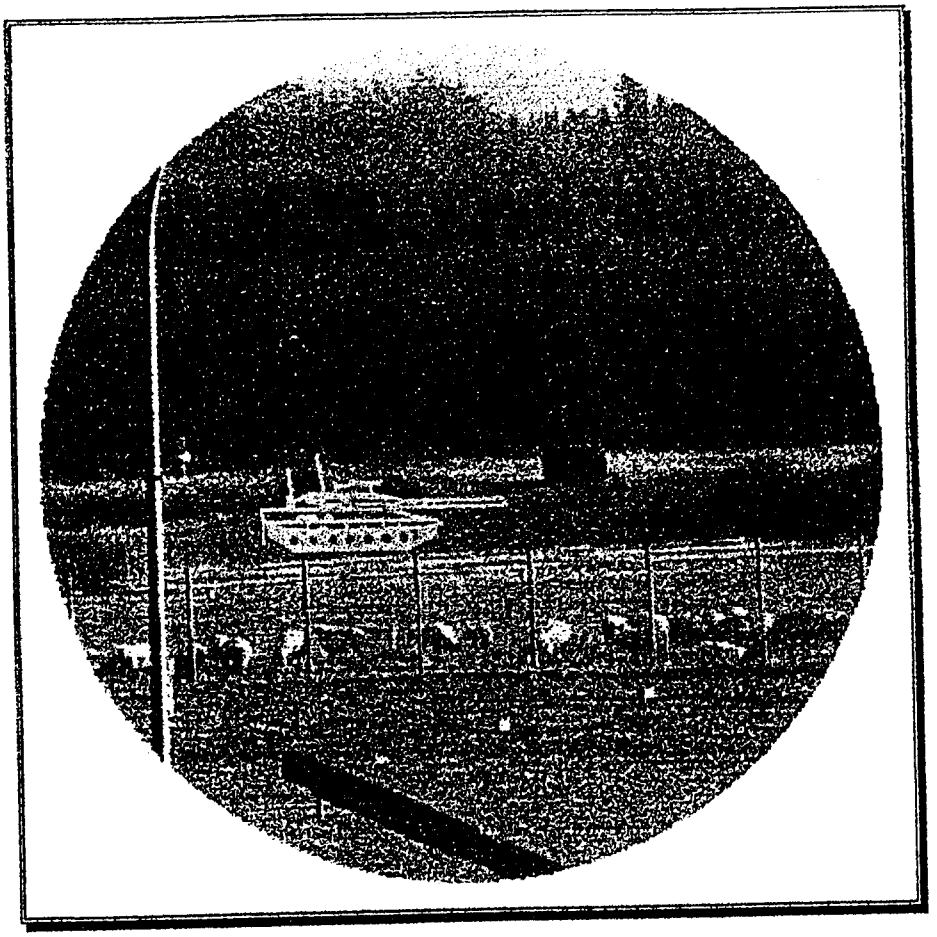
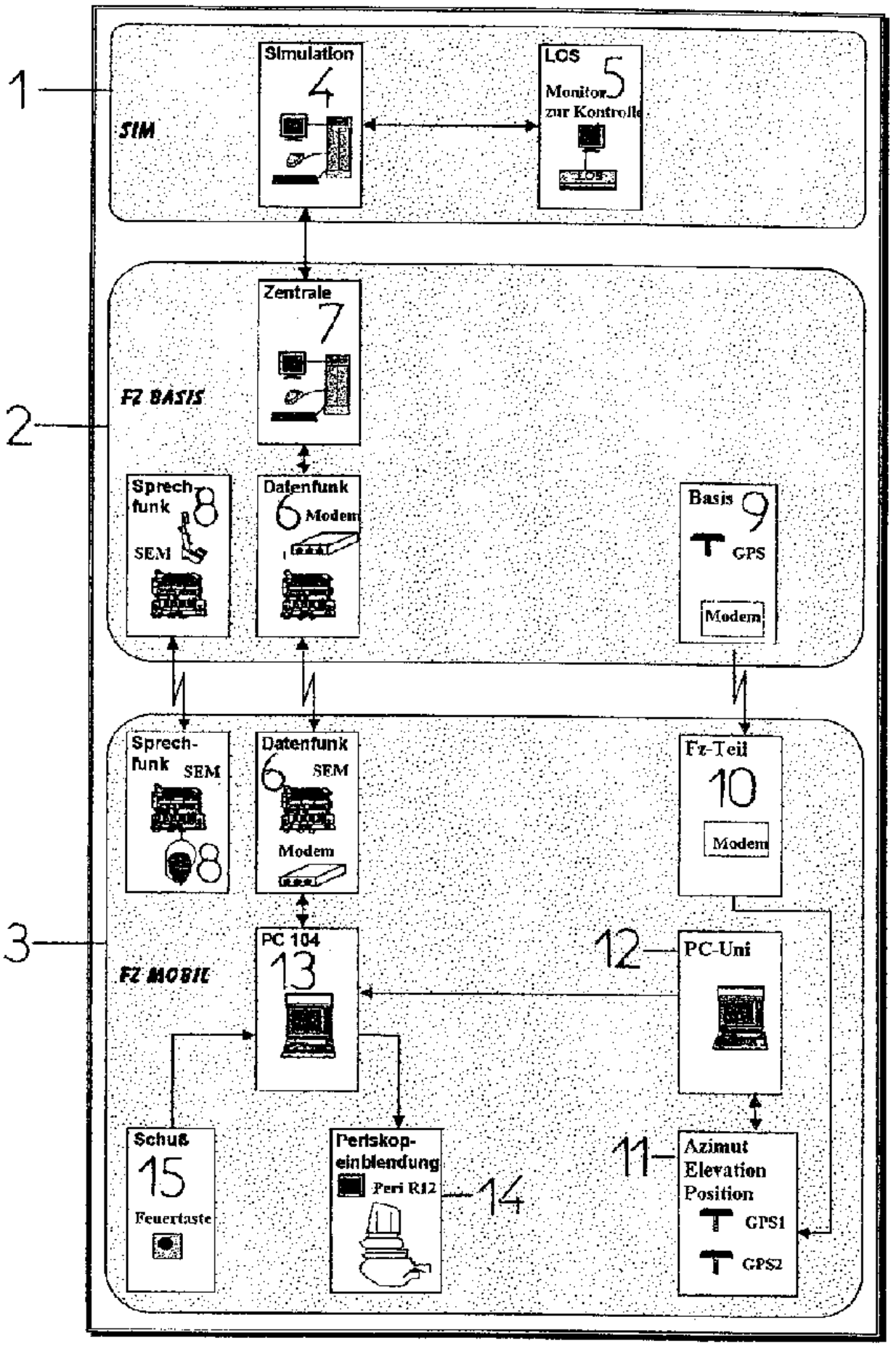


Fig. 5


1
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Datenfunk
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Modem
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GPS
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Datenfunk
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SEM
Modem
Fz-Teil
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Feuertaste
Periskop-
einblendung
Peri R12
14
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Azimut
Elevation
Position
GPS1
GPS2