

Method for controlling a directable weapon of a vehicle during shooting exercises

5 The invention concerns a method of controlling a directable weapon of a vehicle during shooting exercises, wherein the orientation of a shooting sector in which shooting is allowed is determined.

10 The invention can in particular be used with military vehicles. Military vehicles usually comprise a vehicle housing, for example in the form of a hull, and a weapon that can be oriented relative to the vehicle housing in azimuth and elevation. Such weapons can for example be disposed on a turret of the vehicle that is
15 rotatable relative to the vehicle housing.

In order to train crew members of such vehicles, shooting exercises are carried out on training grounds, such as for example military training grounds, during
20 which shots can be fired with live ammunition. In order to reduce and prevent the risk to other people on the training grounds and other vehicles of rounds being fired into a region lying outside the training ground, prior to the actual shooting exercise vehicle-related
25 shooting sectors are specified in which shooting is allowed. By means of a control method, permission to fire can be given if the weapon is directed into the shooting sector and is denied if it is directed outside the shooting sector.

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A control method for a directable weapon of a vehicle is known from FR 2 712 675 A1, with which the weapon is directed at a plurality of boundary points of the shooting sector before the start of the shooting
35 exercise in order to determine the shooting sector. During the shooting exercise, the directed position of the weapon is continuously compared with the shooting sector. The weapon is only enabled if it is being

directed into the shooting sector, and otherwise is blocked.

5 In fact, in this way shooting into the region outside
of the shooting sector can be effectively prevented,
but it has proved disadvantageous with said method that
the directed position of the weapon is determined by
means of rotary encoders and is hence defined in
10 relation to the vehicle housing. The result of this is
that the shooting region would turn with the vehicle
during rotation of the vehicle and would no longer have
the original defined orientation. Therefore, driving
the vehicle during the shooting exercise is not
possible, which limits the options for training the
15 crew members.

Against this background, it is the object of the
invention to enable movement of the vehicle during the
shooting exercise.

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With a method of the aforementioned type, the object is
achieved by maintaining the determined orientation
during movement of the vehicle.

25 During movements of the vehicle, the orientation of the
shooting sector in space is maintained. In this respect
the orientation of the shooting sector is not defined
relative to the vehicle housing, but relative to the
environment. This makes it possible for the vehicle to
30 be moved during the shooting exercise without the
orientation of the shooting region being changed.

According to an advantageous embodiment of the method,
the orientation of the shooting sector is determined
35 wherein the weapon is directed at boundary points of
the shooting sector. This can be carried out before or
at the start of the exercise. The advantage arises that
the shooting sector can be predetermined from the

vehicle. It is not necessary to specify the shooting sector from a unit that is separate from the vehicle, for example a control center. An autonomous method is provided for controlling the weapon during shooting exercises.

The weapon is preferably directed in azimuth and/or elevation for determining the shooting sector before or at the start of the shooting exercise, so that the shooting sector can be determined in azimuth and/or elevation. For this purpose, an azimuth angle and an elevation angle can preferably be defined and stored in a control device. During the shooting exercise, the orientation of the shooting sector is then maintained in azimuth and/or elevation.

It is advantageous if the directed position of the weapon is determined relative to a vehicle-independent spatial coordinate system. This has the advantage that the directed position of the weapon is defined independently of the orientation of the vehicle or the orientation of the vehicle housing. In this respect, the directed position of the weapon is determined relative to the environment of the vehicle.

It is particularly advantageous if the directed position of the weapon is determined independently of a sensor arrangement of the weapon. Besides the sensor arrangement of the weapon that is present anyway, which is used for controlling the directing displacements of the weapon, additional sensors can be disposed on the vehicle, by means of which the directed position of the weapon can be detected for enabling of the weapon for shooting exercises. This enables the determination of the directed position of the weapon without a weapon sensor arrangement. Hence two mutually independent sensor arrangements for the determination of the directed position can be disposed in the vehicle. This

additionally enables the sensors of the weapon to be checked by a second sensor system.

In principle, it is possible to design the additional
5 sensors identically to the sensors that are necessary
for controlling the positioning motors for directing
the weapon. However, a preferred embodiment of the
invention provides that the directed position of the
weapon is determined by inertial sensors. Such inertial
10 sensors are characterized by particularly high
availability. The inertial sensors can be in the form
of rate of turn sensors, acceleration sensors and/or
magnetic field sensors. The inertial sensors can be
configured as microelectromechanical systems (MEMS).
15 The directed position can particularly preferably be
determined by an inertial measurement unit, which
comprises a plurality of, in particular orthogonally
disposed, rate of turn sensors and/or a plurality of,
in particular orthogonally disposed, acceleration
20 sensors and/or a plurality of, in particular
orthogonally disposed, magnetic field sensors. In order
to increase the measurement accuracy, a plurality of
inertial measurement units is used for determining the
directed position, the measurement values of which are
25 combined with each other. Owing to the use of an
inertial measurement unit, the directed positioning can
be carried out independently of the shooting path and
independently of possible targets.

30 It is advantageous if the inertial sensors are directed
together with the weapon, so that the orientation of
the inertial sensors coincides with the directed
position of the weapon. The directed position of the
weapon can be directly detected by the inertial
35 sensors. It can be constructively provided that the
inertial sensors are disposed on a weapon cradle or on
a turret of the vehicle.

It has also proved to be advantageous if the inertial sensors are disposed within a directable turret of the vehicle. This enables an arrangement of the inertial sensors that is protected against hostile threats and weather. It can also be achieved in this way that the sensors are disposed in an interference protected manner. It is not possible for an enemy to detect the inertial sensors externally and to interfere with or influence said inertial sensors. The interference immunity can be increased further as a result.

Alternatively or additionally, a satellite navigation receiver can be used for determination of the directed position of the weapon. Such a satellite navigation receiver generally comprises a lower availability than an inertial sensor. The satellite navigation receiver is preferably additionally used for determination of the directed position, as inertial sensors often exhibit drift phenomena, which reduce the accuracy of the determination of the directed position of the weapon. The drift of the inertial sensors can be compensated by the satellite navigation receiver. The satellite navigation receiver can likewise be used to determine the position of the vehicle.

It is advantageous if the directed position of the weapon during the shooting exercise is compared with the shooting sector for the release of the weapon. Enabling of the weapon can then take place depending on whether the weapon is directed into the shooting sector or not.

The weapon is preferably enabled if the directed position of the weapon is located within the shooting sector. Alternatively, the weapon can be blocked if the directed position of the weapon is located outside of the shooting sector.

It is advantageous if the determination of the orientation of the shooting region and the enabling of the weapon are carried out by a device that is fixed to the vehicle, so that autonomous operation of the controller is ensured.

According to an advantageous embodiment of the method, the size of the shooting sector is adapted to the directed position of the weapon and/or the directed speed of the weapon. This enables delays that are caused by the inertial sensors and/or the data processing logic downstream of the inertial sensors to be taken into account. The shooting sector can be reduced if the directed position of the weapon is located within the shooting sector and/or if the directed speed is less than a threshold value that is greater than or equal to zero, so that the enabling of the weapon in the event of a directing movement out of the shooting sector is not withdrawn too late. The shooting sector can thus be smaller if the weapon is being directed within the shooting sector than if the weapon is being directed outside of the shooting sector.

A further advantageous embodiment provides that a shooting path is divided into sub regions and the orientation of the shooting sector in each sub region is determined and maintained. Owing to the shape of the shooting path, it can be necessary to re-determine the orientation of the shooting sector during the movement of the vehicle along a shooting path, so that it can be ensured that enabling the weapon is only carried out if the orientation of the shooting sector corresponds to the orientation of the shooting path. The adjustment of the orientation of the shooting sector can preferably be carried out automatically for this. It can thus be ensured for example, even on long shooting paths, that the weapon is only enabled if the same is located

within the predetermined shooting sector. Thus directional changes of the shooting path can be incorporated into the shooting authorization.

5 In this context it is advantageous if the orientation of the shooting sector is determined when the vehicle is crossing a position line disposed in a sub region. For re-determination of the orientation of the shooting sector on the shooting path, the position of the
10 vehicle that is determined by means of the satellite navigation receiver can be compared with georeferenced boundary points stored in the control device as well as position lines. It can thus be determined whether the vehicle is located in a new sub region and therefore a
15 re-determination of the orientation of the shooting sector is necessary. For this purpose, boundary points are disposed along the course of the shooting path that define the respective sub regions of the shooting path. At a distance from the boundary points, position lines
20 can be determined that preferably lie before the boundary points at which the re-determination of the orientation is to be carried out. It can thus be ensured that a re-determination is carried out at the right time, whereby the safety of shooting can be
25 further increased. Owing to the continuous re-determination of the shooting sector in the different sub regions of the shooting path, it can be achieved that the shooting sector has an orientation that corresponds to the orientation of the shooting path.

30 It is also advantageous if the shooting sector encloses an azimuth angle that is maintained during movement of the vehicle. The azimuth angle can be enclosed by the boundary lines that span the shooting sector. A center
35 line running through the azimuth angle can determine the orientation of the shooting sector here. Said orientation is also maintained during the movement of the vehicle in a sub region.

Alternatively, the shooting sector can enclose an azimuth angle that is changed during movement of the vehicle, but wherein the orientation is also maintained. The orientation of the shooting sector can
5 be determined by the boundary points here. This is maintained during the movement of the vehicle in a sub region. As the boundary points are used as orientation points, it is necessary for maintaining the orientation that the azimuth angle of the shooting sector changes
10 during the movement of the vehicle. The determination of the orientation can be determined when entering a new sub region and can be maintained in the same. It can thus be ensured in a simple manner that enabling the weapon is only carried out if the orientation of
15 the shooting sector corresponds to the orientation of the shooting path.

In this context it is preferable if the shooting sector is determined by means of boundary points and the
20 boundary points are maintained during movement of the vehicle. The orientation of the shooting sector is further maintained during this, as said orientation is also determined by means of the boundary points. In this respect, only the azimuth angle of the shooting
25 sector is changed. In this way it can be ensured that the shooting sector covers the entire shooting path between the boundary points. The boundary points can preferably be in the form of shooting path boundary points for this.

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Further details and advantages of the invention will be described below using the exemplary embodiment represented in the figures. In the figures:

35 Fig. 1 shows a training ground in a schematic top view,

- Fig. 2 shows a vehicle and a shooting sector in a first position of the vehicle (a), while the vehicle (b) is turning and during movement of the vehicle (c) in a schematic top view,
- Fig. 3 shows a schematic side view of the vehicle and of the shooting sector with different directed positions of the weapon and inclinations of the vehicle,
- Fig. 4 shows a schematic side view of the vehicle and the shooting sector to illustrate necessary safety areas,
- Fig. 5 shows a control device for determination of the shooting sector,
- Fig. 6 shows a lateral sectional representation of a turret of the vehicle,
- Fig. 7 shows a top view of the turret according to Fig. 6,
- Fig. 8 shows a schematic top view of a first embodiment version of the determination of the orientation of the shooting sector in a training ground, and
- Fig. 9 shows a schematic top view of a second embodiment version of the determination of the orientation of the shooting sector in a training ground.
- In Fig. 1 a training ground 15 for performing shooting exercises is represented. The training ground 15 is configured as a type of military training area and comprises a control center 18, with which vehicles 1

located on the training ground 15 are in radio contact. A shooting path 16 on which shots can be fired is arranged on the training ground 15. For training purposes, a plurality of target objects 17 are disposed
5 on the shooting path 16, which form training targets for shooting exercises. In order to train over different shooting distances, the vehicle should be able to drive on the shooting path.

10 In Fig. 2 through Fig. 4, a military vehicle 1 in the form of a battle tank is represented, which comprises a chassis in the form of an armored hull 2 with a chain drive unit 5 as well as a turret 3 that is mounted rotatably relative to the chassis 2. A weapon 4 is
15 disposed on the turret 3 that can be directed by rotating the turret 3 in azimuth. The weapon 4 is also designed to be oriented in elevation relative to the turret 3, so that the weapon 4 can also be directed in elevation.

20 The operation of the weapon 4 is carried out by means of a fire control system, which comprises a sensor arrangement for determining the directed position of the weapon 4. Said sensor arrangement determines the
25 directed position R of the weapon in azimuth and elevation. The measurement values determined by the weapon sensors form the basis for controlling positioning motors for directing the weapon 4 in azimuth and elevation.

30 In addition, a control device that is independent of the fire control system is provided on the vehicle 1, with which the method according to the invention for controlling the directable weapon 4 of the vehicle 1 is
35 performed. The control device is used during shooting exercises in order to train crew members to handle the vehicle 1 and/or the weapon 4.

In order to prevent shooting from being able to occur into the region outside the shooting path 16 shown in Fig. 1 during training, such as for example at objects 19 placed outside of the training ground 15, a shooting sector S in which shooting is allowed is determined before the start of the shooting exercise. The orientation of the shooting sector S is determined in doing so, so that it coincides with the orientation of a shooting path 16. The shooting sector S is essentially in the form of a type of acute pyramid. As can be seen from the representation in Fig. 2a, the shooting sector S is bounded in azimuth by two boundary lines, each of which starts from a boundary point D that is fixed with respect to the vehicle and intersects predetermined boundary points A and B. The boundary point D that is fixed with respect to the vehicle forms the apex for this and the boundary lines form the legs of an azimuth angle σ . In elevation, the shooting sector S is bounded on the one hand by a horizontal line that passes through the boundary point D that is fixed with respect to the vehicle, and on the other hand by a straight line starting from the boundary point D that is fixed with respect to the vehicle, which intersects a third predetermined boundary point C. The horizontal line and the boundary lines through the boundary point C enclose an elevation angle α here.

With the method according to the invention, it is also provided that the determined orientation of the shooting sector S is maintained during movement of the vehicle 1. In this respect the shooting sector S is moved with the vehicle 1 during movement of the vehicle 1 such that the orientation of the shooting sector S in relation to the shooting path 16 is maintained. In this way it is possible to turn the vehicle 1 relative to the original position during the shooting exercise, as shown in Fig. 2b, without having to re-determine the

shooting sector S on the shooting path 16. The determined orientation of the shooting sector S is maintained during a rotation of the vehicle 1. The vehicle 1 can also be moved, as shown in Fig. 2c, wherein the orientation of the shooting sector S remains unchanged. Therefore a re-determination of the shooting sector S is also unnecessary when moving the vehicle 1. The vehicle 1 can thus also move closer to the target 17 on a curved path in order to change the distance to the target 17 for training purposes.

Fig. 2b and Fig. 2c show different examples of movements of the vehicle 1, during which the orientation of the vehicle 1 in azimuth is changed, wherein the orientation of the shooting sector S in azimuth and elevation is not changed. The orientation of the shooting sector S is however also maintained in elevation during changes of the orientation of the vehicle 1, as can be seen from the representations in Fig. 3. Such changes in orientation of the vehicle 1 can arise for example when travelling on uneven terrain, and can result in tilting of the vehicle relative to the horizontal. Also during movements of the vehicle 1 in elevation, the shooting sector S is moved with it such that the determined orientation of the shooting sector S is maintained in azimuth and elevation.

Enabling the weapon 4 is always carried out if the directed position R of the weapon 4 is within the shooting sector S. For this purpose, the directed position R of the weapon 4 during the shooting exercise is compared with the shooting sector S either continuously or before shooting. For example, enabling of the weapon 4 is carried out for a directed position R as shown in Fig. 2a, Fig. 3a or Fig. 4. Enabling the weapon 4 is not carried out if the directed position R

of the weapon lies outside of the shooting sector S, as shown for example in Fig. 2b, Fig. 3b or Fig. 3c.

Alternatively, the weapon 4 is disabled if the weapon 4
5 is directed outside of the shooting sector S and the disabling can be lifted if the weapon 4 is directed within the shooting sector S.

Before details of the movement of the shooting sector S
10 together with the vehicle 1 are discussed, it will first be described how the shooting sector S is determined.

The determination of the shooting sector S, and in
15 particular the orientation thereof, is carried out exclusively by devices 6, 7, 8 that are fixed to the vehicle. Control by the control center 18 that is separate from the vehicle 1 is not necessary.

In this respect, it is an autonomous control method for
20 shooting exercises. Before the actual shooting exercise, the weapon 4 is directed at different boundary points A, B, C of the shooting sector S in order to define the boundaries and hence also the angles σ , α of the shooting sector S. An operator's
25 control device 8 of the control device that is represented in Fig. 5 is used for this.

The operator's control device 8 comprises a plurality of operating elements 9, 10, 11, 12 in the form of
30 buttons, by means of which boundary points A, B, C of the shooting sector S can be defined. The weapon 4 is first directed by means of the fire control system of the vehicle 1 at a boundary point A on the left boundary region of the shooting path 16. The directed
35 position R of the weapon 4 is checked by means of an optical sight. Thereafter the operating element 10 is operated, whereby the current directed position R of the weapon 4 is temporarily stored as the left boundary

of the shooting sector S. In a next step the weapon 4 is directed by means of the fire control system at a boundary point B in the right boundary region of the shooting path 16. The operating element 11 is now
5 operated, whereby the current directed position R of the weapon 4 is temporarily stored as the right boundary of the shooting sector S. In a further step, the weapon 4 is directed at a maximum permitted elevation α for the respective shooting path 16. In
10 said position the weapon 4 is directed at an elevation boundary point C. At the maximum elevation position of the weapon 4, the operating element 9 is operated, whereby the current directed position R of the weapon 4 is temporarily stored as the upper boundary of the
15 shooting sector S. The determination of the shooting sector S is terminated by operation of the button 12. In this way the temporarily stored values for the right, left and upper boundaries of the shooting sector S are adopted as new boundaries of the shooting sector
20 S. The azimuth angle σ as well as the elevation angle α are also stored in the control device.

The directed position R of the weapon 4 is defined relative to a vehicle-independent spatial coordinate
25 system with the spatial directions x, y, and z both for determination of the shooting sector S and also for comparison with the determined shooting sector S during the shooting exercise, cf. Fig. 2a and Fig. 4. The directed position R of the weapon 4 is thus always
30 known relative to the environment of the vehicle 1, which has the advantage that the shooting sector S is determined relative to a vehicle-independent spatial coordinate system x, y, z. In this respect the shooting sector S is defined independently of the orientation of
35 the vehicle 1.

The detection of the directed position R for the determination of the shooting sector S and the

subsequent comparison with the shooting sector S is carried out independently of the sensor arrangement of the fire control system. The vehicle 1 is provided with inertial measurement units 6 for determining the
5 directed position R that are independent of the fire control system. The inertial measurement units 6 each comprise a plurality of inertial sensors 13, which are in the form of rate of turn sensors, acceleration sensors and magnetic field sensors. The inertial
10 sensors 13 are part of an inertial navigation system (INS), by means of which the directed position R is determined in a vehicle-independent coordinate system. The directed position R is determined by three orthogonally disposed rate of turn sensors as well as
15 three orthogonally disposed acceleration sensors and three orthogonally disposed magnetic field sensors. The inertial sensors 13 are disposed in the interior of the turret 3 on the weapon cradle, so that the same are directed in azimuth and elevation together with the
20 weapon 4, cf. Fig. 6 and Fig. 7. In this way it can be ensured that the orientation of the inertial sensors 13 coincides with the directed position R of the weapon 4. The inertial sensors 13 are protected against external effects and in particular against interference effects
25 owing to the arrangement in the interior of the turret 3. The position at which the inertial sensors 13 are disposed is not directly visible to an attacker, so that interference or influencing can be prevented. In addition, owing to the use of inertial sensors 13 it is
30 possible to minimize error sources, such as can occur for example owing to masking, deflections or similar.

In order to reduce the risk of failure of the control system, two identical inertial measurement units 6 are
35 disposed on the vehicle 1, so that in the event of a failure, one of the two units 6 can perform the determination of the directed position R rather than the respective other unit 6. If both inertial

measurement units 6 are operational, the measurement values of both units 6 can be interpolated in order to increase the accuracy of the measurement.

5 A satellite navigation receiver 7, which can be in the form of a GPS receiver for example or a different satellite navigation system, is additionally disposed on the turret 3. By means of the satellite navigation receiver 7, additional position data of the weapon 4
10 can be determined, which are used for compensation of drift phenomena of the inertial sensors.

The inertial sensors 13 and also the data processing logic connected downstream of the inertial sensors 13
15 each comprise signal delays that are to be taken into account in the control method. In order to compensate said delays during directing displacements of the weapon, the size of the shooting sector S is adapted to the directed position R of the weapon 4 and/or to the
20 current directing displacement of the weapon 4, which will be described using the representations in Fig. 2a and Fig. 4.

If the directed position R lies within the shooting sector S and/or if the weapon 4 is directed, the shooting sector S is reduced, which is represented in Fig. 2a and Fig. 4 by the boundary points A", B" and C". In this way the risk is countered that without adjustment the firing authorization for the weapon 4 in
30 the case of a rapid directional movement out of the shooting sector S would only be blocked at the points A', B' and C' and hence belatedly. Said circumstance is already to be taken into account in advance during the safety planning of the shooting sector S.

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In the inverse case, i.e. if the directed position R of the weapon 4 lies outside of the shooting sector S, the enabling of the weapon 4 when swiveling the weapon 4

into the shooting region is carried out belatedly owing to the aforementioned delays, so that the shooting sector does not have to be reduced. Said circumstance is already to be taken into account in advance during
5 the safety planning of the shooting sector S.

In order to further increase the safety of the system, in particular for large shooting paths 16, it is advantageous if the orientation of the shooting sector
10 S that is authorized by the system is re-determined at defined points during the movement of the vehicle 1 along the shooting path 16. Said method will be described in detail below using the representations in Fig. 8 and 9.

15 Large shooting paths 16 are frequently divided into a plurality of regions, in which a vehicle 1 can be disposed during a shooting exercise. Said regions are defined by different boundary points A_1 , B_1 , A_2 , B_2 , A_3 ,
20 B_3 that are disposed staggered in depth. Thus, for example, the representation in Fig. 8 shows a first region, which extends from the start of the shooting path 16 to the first boundary points A_1 , B_1 . A second region lies between the first boundary points A_1 , B_1 and
25 the second boundary points A_2 , B_2 . Further regions can also be defined in a similar way.

With such large shooting paths 16, it can occur that when maintaining the orientation of the shooting sector
30 S that is determined once at the start of the shooting exercise, the weapon 4 can exit the safety region and hence there is a risk. In order to prevent this, it is necessary to continuously adapt the orientation of the shooting sector S, S', S'' to the respective region of
35 the shooting path 16. This can for example be achieved with an automatic shooting sector adaptation.

In order to be able to determine in which region the vehicle 1 is currently located, position lines 20, 20', 20'' on which a determination of the orientation of the shooting sector S, S', S'' is to be carried out can be defined in the individual sub regions of the shooting path 16. If such a position line 20, 20', 20'' is crossed by the vehicle 1, the shooting sector S, S', S'' is re-determined and initialized, so that the orientation is then adapted to the respective sub region of the shooting path 16. The orientation is then maintained during the movement of the vehicle 1 in a sub region.

The position and travelling motion of the vehicle 1 can be continuously determined by means of the satellite navigation receiver 7 and can be stored in the control device. In order to be able to determine at which point or in which sub region of the shooting path 16 the vehicle 1 is located and whether a re-determination of the orientation of the shooting sector S, S', S'' is necessary, the position data of the vehicle 1 that is determined by the satellite navigation receiver 7 can be compared with georeferenced boundary points A₁, B₁, A₂, B₂, A₃, B₃ stored in the control device as well as the position lines 20, 20', 20''. If it is determined by the comparison that the vehicle 1 leaves a sub region and enters a new sub region, it is necessary to re-determine the orientation of the shooting sector S, S', S'', which is then in turn maintained in said sub region. The orientation can be determined in different ways for this.

A first option is represented in Fig. 8 and was also illustrated in the above figures. A first shooting sector S is determined in terms of the orientation thereof when traveling over the first position line 20. This means that the azimuth angle σ remains the same over the entire sub region and the shooting sector S

along the center line between the two boundary lines enclosing the angle σ determines the orientation. If the vehicle 1 now moves along an arbitrary turn, then said orientation of the shooting sector S is maintained
5 until the vehicle 1 crosses the next position line $20'$ and it is thus indicated that the vehicle 1 is located in a new sub region of the shooting path 16.

The position lines 20 , $20'$, $20''$ are each disposed at a
10 sufficient distance in front of the associated boundary points A_1 , B_1 , A_2 , B_2 , A_3 , B_3 such that it can be ensured that a re-determination of the orientation of the shooting sector S , S' , S'' is carried out at the right time and shooting outside the shooting path 16 is not
15 possible.

By crossing the position line $20'$, by the comparison of the position of the vehicle determined by the satellite navigation receiver 7 and the stored georeferenced
20 boundary points A_1 , B_1 , A_2 , B_2 , A_3 , B_3 as well as the position lines 20 , $20'$, $20''$ it can be determined in the control device that the vehicle 1 is now located in a new sub region of the shooting path 16, and therefore a re-determination of the shooting sector S is necessary.
25 Accordingly, the orientation of the shooting sector S is re-calculated, so that the orientation then corresponds to the shooting sector S' . Consequently, the shooting sector S' is also adapted when crossing further position lines $20''$, so that it can be ensured
30 that enabling the weapon 4 is only carried out if there is no risk.

A second, alternative option for the determination of the orientation of the shooting sector S , S' , S'' is
35 represented in Fig. 9. The orientation of the shooting sector S , S' , S'' is not defined by means of a center line between the boundary lines there, but rather by means of the boundary points A_1 , B_1 , A_2 , B_2 , A_3 , B_3

themselves. At the start of the exercise, the orientation of a first shooting sector S is determined in a known way, while the vehicle 1 is on the position line 20. If the vehicle 1 now moves along a turn on the shooting path 16, the angle σ of the shooting sector S changes, but the orientation, which is determined by means of the boundary points A_1, B_1 is maintained.

If the vehicle 1 now crosses a second position line 20', similarly as already described for Fig. 8 the orientation of the shooting sector S is re-determined and then maintained during movement of the vehicle 1 in the new sub region. The shooting sector S' thus produced uses the boundary points A_2, B_2 as orientation reference points, so that the orientation of the shooting sector S' is determined by means of the same. The shooting sector S, S', S'' is determined for this by means of the boundary points $A_1, B_1, A_2, B_2, A_3, B_3$, wherein the boundary points $A_1, B_1, A_2, B_2, A_3, B_3$ are maintained during movement of the vehicle 1 as determining points. As a result, the orientation of the shooting sector S, S', S'' is maintained, but the azimuth angle σ changes. In this way, the orientation of the shooting vector S, S', S'' is maintained, but the azimuth angle σ of the shooting sector S, S', S'' is dynamically adapted within each sub region, so that here too a safe firing authorization can be achieved.

With the method described above for controlling a directable weapon 4 of a vehicle 1 during shooting exercises, with which the orientation of a shooting sector S in which shooting is allowed is determined, the determined orientation is maintained during movement of the vehicle 1. In this way it is possible that the vehicle 1 can be moved during the shooting exercise without the orientation of the shooting region S being changed.

Reference characters:

1	vehicle
2	hull
3	turret
4	weapon
5	chain drive unit
6	measurement unit
7	satellite navigation receiver
8	operator's control device
9, 10, 11, 12	button
13	inertial sensor
14	enabling or authorization device
15	training grounds
16	shooting path
17	target
18	control center
19	object
20, 20', 20"	position line
A, B, C	boundary points
A ₁ , A ₂ , A ₃	left boundary points
B ₁ , B ₂ , B ₃	right boundary points
D	point fixed with respect to the vehicle
R	directed position of the weapon
S, S', S''	shooting sector
x, y, z	spatial directions
α	maximum elevation
σ	azimuth angle

Claims:

1. A method for controlling a directable weapon (4)
of a vehicle (1) during shooting exercises,
5 wherein the orientation of a shooting sector (S,
S', S'') in which shooting is allowed is
determined,
characterized in that
the determined orientation is maintained during
10 movement of the vehicle (1).
2. The method as claimed in claim 1, characterized
in that the orientation of the shooting sector
(S, S', S'') is determined by directing the
15 weapon (4) at boundary points (A, B, C) of the
shooting sector (S, S', S'').
3. The method as claimed in any one of the preceding
claims, characterized in that the directed
20 position (R) of the weapon (4) is determined
relative to a vehicle-independent spatial
coordinate system.
4. The method as claimed in any one of the preceding
25 claims, characterized in that the directed
position (R) of the weapon (4) is determined
independently of a sensor arrangement of the
weapon (4).
- 30 5. The method as claimed in any one of the preceding
claims, characterized in that the directed
position (R) of the weapon (4) is determined by
inertial sensors (13).
- 35 6. The method as claimed in claim 5, characterized
in that the inertial sensors (13) are directed
together with the weapon (4).

7. The method as claimed in any one of claims 5 or 6, characterized in that the inertial sensors (13) are disposed on a directable turret (3) of the vehicle (1).
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8. The method as claimed in any one of the preceding claims, characterized in that a satellite navigation receiver (7) is used for determination of the directed position (R), in particular additionally.
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9. The method as claimed in any one of the preceding claims, characterized in that the directed position (R) of the weapon (4) is compared with the shooting sector (S, S', S'') for the release of the weapon during the shooting exercise.
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10. The method as claimed in any one of the preceding claims, characterized in that the weapon (4) is enabled if the directed position (R) of the weapon (4) is located within the shooting sector (S, S', S'').
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11. The method as claimed in claim 10, characterized in that the size of the shooting sector (S, S', S'') is adapted to the directed position (R) of the weapon (4) and/or the directed speed of the weapon (4).
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12. The method as claimed in any one of the preceding claims, characterized in that the determination of the orientation and the enabling of the weapon (4) are carried out by a device that is fixed to the vehicle (14).
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13. The method as claimed in any one of the preceding claims, characterized in that a shooting path (16) is divided into sub regions and the orientation of
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the shooting sector (S, S', S'') is determined and is maintained in each sub region.

- 5 14. The method as claimed in claim 13, characterized in that the orientation of the shooting sector (S, S', S'') is determined when the vehicle (1) crosses a position line ($20, 20', 20''$) that is disposed in a sub region.
- 10 15. The method as claimed in any one of the preceding claims, characterized in that the shooting sector (S, S', S'') encloses an azimuth angle (σ) that is maintained during movement of the vehicle (1).
- 15 16. The method as claimed in any one of the preceding claims, characterized in that the shooting sector (S, S', S'') encloses an azimuth angle (σ) that is changed during movement of the vehicle (1).
- 20 17. The method as claimed in claim 16, characterized in that the shooting sector (S, S', S'') is determined by means of boundary points ($A_1, B_1, A_2, B_2, A_3, B_3$) and the boundary points ($A_1, B_1, A_2, B_2, A_3, B_3$) are maintained during movement of the
- 25 vehicle (1).