

5 Drone and Method for Attacking a Target

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The invention is concerned with an attack drone. The invention relates in particular to a non-lethal anti-tank drone. The invention aims to render enemy targets incapable of combat with an extremely cost-effective effector that can be integrated into different systems, such as a drone. The "Mission Abroad Kill" necessary for this is produced with a saturation attack, which leads to the fact that in particular the barrel of a main weapon of the enemy target, such as the weapon system of a main battle tank, is damaged or preferably completely destroyed during its own firing.

The level of protection of battle tanks is getting higher and higher. Currently, it is assumed that battle tanks, especially due to the reactive modules such as 'malachit' or 'relict', have armoring equivalents of up to 1m of steel. Furthermore, active protective measures are increasingly being used. Along with a large number of available combat vehicles with this level of protection, successfully attacking such systems is becoming increasingly complicated and difficult.

Currently introduced anti-tank systems, such as 105/120mm tank weapons with conventional KE, HL or HE ammunition or anti-tank missiles with HL warheads, guided and/or unguided, are not always able to reliably ensure effective elimination of the enemy. In addition, these systems are large, heavy and expensive. Systems such as anti-tank guided missiles or rocket-propelled

grenades have at least one warhead as an effector, which requires explosives to produce its effect. Due to the use of explosives, safety systems are necessary to ensure or guarantee handling safety during storage,
5 transport and in use.

From US 9,939,239 B1 a grenade is known, which contains multiple stack projectiles that use tricopter or quadcopter guide vanes to steer themselves towards a
10 target. Such projectiles may have algorithms programmed in their autopilots or control systems for collaborating as a leader-follower, or real-time camera systems that send back images to a user, wherein each projectile has its own steering, navigation and control
15 components, autopilots, cameras, transmitters, receivers, antennas, power sources, sensors, detonators and/or flexible circuits. The projectiles can be pre-programmed to attack a single target or multiple targets. The projectiles may contain payloads, such as
20 flares, smoke devices, fragments, air blast devices, warheads, hovering surveillance/reconnaissance equipment, illumination means, detonating devices, and shaped charge payloads.

25 The unpublished WO 2019/046911 A1 discloses an unmanned vehicle which is fired and can accommodate a payload. The payload may contain at least one explosive, one incendiary agent, one smoke charge, one means with no active capability and one composite means of
30 illumination. In addition, lethal and non-lethal payloads can be supported. Two or more unmanned vehicles may be configured with a swarm feature so that two or more unmanned vehicles are brought to the target together autonomously or by the manual input of an
35 operator via the ground station, i.e. the operator can steer the unmanned vehicle to the destination or target area autonomously or by manual input through the ground station. A swarm can be seen as a self-organizing

network of unmanned vehicles, in which each unmanned vehicle is aware of the movement of the others, so that they cluster together or move en masse towards the target. The swarm can encounter different targets, with
5 the swarm splitting into numerous smaller groups of unmanned vehicles for certain attacks. The groups can regroup to further engage with other targets or loiter in the battlefield where they can be reactivated.

10 The invention sets itself the task of revealing a cost-effective, as explosive-free as possible but effective attack system which renders an enemy target at least incapable of combat.

15 The object is achieved by the features of claim 1 concerning the attack system. Advantageous embodiments are mentioned in the subordinate claims. In addition, claims 10 and 11 reveal a method for attacking enemy targets.

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The invention is based on the idea of offering an attack system which renders an enemy target incapable of combat by not making the armor of the target the attack surface as is usual, but rather a weapon system
25 of the target with at least one barrel, which is preferably designed as the main armament.

In the implementation of this idea, it is planned to use at least one drone, which can accommodate at least
30 one effector to render the weapon system of the enemy target, for example of a main battle tank, unusable. A drone is understood to mean any unmanned flying object which can move from one place to another under remote control and/or autonomously. In particular,
35 quadcopters or octocopters or the like are considered drones.

Drones are diverse and well-known in practice. They are subjected to special tasks. These special tasks in turn require a special design of the individual drone. From DE 10 2015 008 256 B4 a defensive drone for defense against a small drone is known, which includes a jammer for sending out a GNSS interference signal. Another defensive drone is described in DE 10 2015 008 296 84. This drone is capable of automatically controlling a small drone after the small drone has been detected as such. DE 10 2015 008 255 84 discloses a defensive drone, with at least one motor for driving at least one propeller and a fuselage connected to the motor. An effector is provided on the fuselage, as well as an apparatus for ejecting the effector. For its part the effector includes threads which are intended to hinder another small drone from carrying out onward flight. The effector consists of a shell encompassing the threads as well as an ejection agent accommodated in the shell and an activation means. A defensive device for attacking an unmanned aircraft is described in DE 10 2014 014 117 A1.

The drone according to the invention is intended to act as an attack drone. As an effector, it comprises at least one payload which causes at least damage in or on the barrel of the weapon system, at the latest when a shot is fired. A projectile to be fired can no longer be guided through the barrel without problems.

Steel nails, glass fragments, sand, cutting charges, etc. can be seen as payloads. Hollow charges can also be used as payloads. The effector has a shell enclosing the payload.

The use of pyrotechnic charges is also not excluded. This pyrotechnic charge should be able to burn through or melt a barrel, i.e. a steel tube possibly with a

protective cover. The pyrotechnic charge may preferably be a thermite charge. This produces liquid steel.

5 In combination with steel nails, for example, the pyrotechnic charge can weld a pile of steel into the barrel. In addition, magnetic Teflon-based charges can be used. These, for example, 2-stage charges first melt the barrel. Then the thermite charge burns down, wherein liquid metal enters the barrel.

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The drone is designed to bring the effector into/onto the enemy target and to place it there. The drone works autonomously. In the case of autonomous working, the drone can move itself precisely to the target, for
15 example to the barrel of a weapon system of an enemy target. It goes without saying that remote operation of the drones can also be possible. However, autonomous working is preferred.

20 The drone usually has at least one propeller. Preferably, the drone has at least four propellers. However, alternative designs of the drone are possible and known. One motor is used to drive at least one propeller. A power supply source, for example A
25 battery, can provide the energy necessary for the functioning of the drone.

The drone used is designed in such a way that it is immune to jamming, spoofing, high-power microwave,
30 etc., so that such enemy measures are harmless to the drone. A protective measure of this kind is revealed, for example, by DE 20 2014 003 131 U1. The protective device is designed to protect a missile against radiation weapons.

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In addition to a memory, each drone has at least one sensor system, consisting at least of a day and/or night vision camera and preferably programmable

friend/foe image recognition. In addition, each drone should include an inertial system and/or a GPS tracker in order to be able to fly over a given route autonomously (independently). EP 2 071 353 A2 discloses
5 such a system and method for the autonomous tracking of a flying object. The drone itself can be controlled by means of satellite-based navigation systems or waypoint navigation. Such navigation is known, for example, from US 2004/0193334 A1 and can be used here.

10 In a first variant of the attack system, the drone searches, among other things, for the muzzle of the barrel of a target (coarse tracking). The search is supported by appropriate sensors, such as a day vision
15 camera, on the respective drone. If the muzzle of the barrel is detected, the drone flies to the muzzle of the barrel to transfer the effector into the barrel. The drone then flies to the target preferably in fine tracking.

20 The individual drone has means which allow it to be deposited in the barrel or the muzzle of the barrel. In a preferred embodiment, these means are hinges which can be swiveled in such a way that an effector located
25 between these hinges is deposited in the muzzle of the barrel. The hinges can be swiveled mechanically or electrically.

30 In the muzzle of the barrel there is now a payload, such as steel nails, glass fragments, sand etc. If the effector includes a pyrotechnic charge, for example, placement in the muzzle of the barrel itself can be used to trigger the effector, i.e. to ignite the pyrotechnic charge.

35 Alternatively, a device can be provided for ejection or application of the effector. This device itself can be of a mechanical form. A pyrotechnic charge of the

device can alternatively drive the effector into the muzzle of the barrel.

Another variant of the attack system consists of placing the effector on the barrel. However, preference is given to the possibility that the drone can clamp onto the barrel together with the effector. As soon as the drone has attached itself with the effector to the enemy target, to or on the barrel, the effector is triggered. Among other ways, the triggering can be initiated mechanically, for example by contact with the barrel. But pre-programming is also conceivable. At least one pyrotechnic charge is provided as an effector. This manages to burn through or melt the barrel, i.e. the tubular steel, possibly with a protective cover. After ignition of this pyrotechnic charge, the barrel is thus at least welded from the outside. As a result, the internal geometry of the barrel is changed.

The effector in the muzzle of the barrel or on the barrel causes the passage of the projectile to be impaired at the latest when a shot is fired. The projectile can no longer be guided through the barrel without problems. As a result, the barrel at least rips open, preferably even rips off. The target thus becomes unusable on the battlefield. The mission must be aborted.

For an attack on at least one target, multiple drones are preferably used. The drones therefore have at least one transmitting and receiving device, which also serves for communication with each other.

In a special version the drone or the drones is/are preferably moved by means of a container etc., preferably close to the battlefield (target area). The container may include a power unit, but it may also be

carried separately. In addition, the container should be provided with a programming unit. The drones carried in the container are programmable by means of the programming unit.

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Preferably, the drone or the drones has/have no landing devices. This has the advantage that the drone or the drones themselves can preferably be accommodated in racks within the container. These can be transported close to a target area.

In addition, the absence of a landing device on the drone creates space for the means for placing the effector in the barrel or for clamping the drone or the effector on the barrel.

At the latest in the target area, the drones are programmed by means of the programming interface on/in the container. This can be carried out by inputting data for image recognition/signature etc. of the respective combat vehicles to be attacked. A possibility of friend/foe identification is also taken into account. In addition, the search area in which the enemy (targets) is expected is programmed in. The individual drone converts this information in such a way that it can fly into the target area independently or autonomously (coarse tracking).

In a preferred version, it is provided that a number "n" of drones with effectors are deployed, which is based on the number of enemy vehicles with a weapon barrel. Depending on the preliminary reconnaissance, the ratio of the number of drones to the enemy vehicles can be at least 3:1 to 5:1. However, other combinations are also possible.

Flying in as a swarm, the drones search for their target independently according to the programmed

signature of the enemy vehicles. This can be carried out, for example, over a distance of at least 3 to 6 km. The drone which has first detected a target reports this information with the data to the other drones in its vicinity, for example in the form of GPS information.

In a particularly effective embodiment of the method, at least one more drone switches onto this target. The first drone becomes the master, the at least one further drone becomes the slave. The two or more drones form a group that then flies to the common target. For the other drones, this target area is hidden. The drones outside the group in turn search for other targets in the target area. Once a drone has detected another target, the drone reports this data to other drones in its vicinity. The first detecting drone again becomes the master, which one or more drones join as slaves. In this way, new groups are constantly forming for further targets. For their part, the drones which have not been designated as masters or slaves can fly back to the container.

A method for communication between drones can be obtained from DE 10 2015 006 233 A1, for example. DE 10 2014 014 117 A1 also reveals a communication option within a defensive device.

The individual drones can be identical in design and can be equipped with the same effectors. In this case, the means are designed for placing the effector in the barrel or clamping the drone to the barrel.

However, there is a possibility that the drones can be equipped with different effectors. In the case of the different payloads, this can be taken into account when forming groups. In this case, drones with an effector which is to be deposited in the muzzle of the barrel

join forces with drones which together with the effector clamp around the barrel from the outside. The information about the design of the respective effector can be communicated between the drones. This variant
5 allows the use of simpler means for deploying the effector or for clamping the drone to the barrel.

A drone is proposed with at least one motor with at least one power supply, at least one propeller and at
10 least one effector. This drone is characterized in that the at least one effector includes steel nails, glass fragments and/or sand, and/or at least a cutting charge and/or at least a pyrotechnic charge. The drone also has a computer or a processor. By means of this
15 computer or processor, the drone is able to make decisions to fly over a given space autonomously. In addition, the drone can communicate with other drones, for which the drone has at least one transmitting and receiving device.

20 A proposed method for attacking at least one target with at least one drone includes the steps of programming the drone with data for image recognition and inputting the search area in which the target is
25 expected. Another step is the programming of the detection of a target and flying to the target by the drone, preferably directly. The drone flies to the muzzle of at least one barrel of the target, wherein the orientation of the barrel is detected, so that
30 placing the at least one effector in the barrel can be carried out.

Alternatively, a further method for attacking at least one target with at least one drone is proposed, which
35 also includes the steps of programming the drone with data for image recognition. A further step here is also inputting the search area in which the target is expected. In addition, the drone is programmed to

detect a target and fly to the target, preferably directly. The drone flies to a barrel of the target and clamps around the barrel in such a way that it can at least hold itself on the barrel. The at least one
5 effector then causes an internal geometry of the barrel to be changed, so that the barrel itself becomes unusable and tears apart when firing a projectile, for example.

10 A defensive system or a combat system against a target is proposed which has a low weight with the smallest possible installation space, but in which defense or attack is highly effective.

15 The invention will be explained in more detail on the basis of an exemplary embodiment with a drawing. In the figures:

- Fig. 1 shows a container for holding multiple
20 effectors, closed
Fig. 2 shows the container from fig. 1 in an open view,
Fig. 3 shows a sketch representation of a target area with combat vehicles,
25 Fig. 4 shows a schematic representation of the target area from the point of view of one of the effectors,
Figs. 5, 6 show a schematic representation of an effector in action,
30 Fig. 7 shows a schematic representation of the result.

Fig. 1 shows a container 1. The container 1 is used to accommodate at least one, but preferably multiple
35 drones 5. Such drones 5 are small-scale and unmanned. They can be controlled remotely but can also fly autonomously. Preference is given here to the autonomous or self-sufficient function of the drone 5.

Up to 800 drones 5 (small drones) can be carried in a standard container.

5 The container 1 has at least one programming unit 2, which can be attached to a container wall 6 or to a door 3 etc. However, it is also possible to provide an interface and to arrange the programming unit 2 within the container 1. A power unit 4 may be carried inside container 1, for example as a separate module, and/or
10 may be provided outside. The separate carrying of the power unit 4 has the advantage that more space is available for the drones 5.

Each drone 5 has at least one motor (not shown in more
15 detail) and at least one propeller 5.1, which are arranged on or in the fuselage of the drone 5. Preferably, four propellers 5.1 are attached to the drone 5. The motor is used in particular to drive at least one propeller 5.1.

20 Each of the drones 5 also includes an effector 5.2. Steel nails, glass fragments, sand, etc. can be used as a payload for the effector 5.2. The use of a pyrotechnic charge, such as a thermite charge, can be
25 provided. In combination with steel nails, glass fragments, sand, etc., the effect on the target 8 can be increased. The effector 5.2 preferably comprises a shell to accommodate the payload.

30 Each drone 5 has its own intelligence, such as a computer or a processor etc. (not shown in more detail), which allows the drone 5 to make decisions, for example based on stored comparative data and/or queries, to communicate with other drones 5 and to fly
35 over a given space autonomously. Preferably, each drone 5 also has a day and/or night vision camera and preferably programmable friend/foe image recognition (not shown in more detail). These sensors are connected

to the computer. Each drone 5 also has an inertial system and/or a GPS tracker (not shown in more detail). The control of the respective drone 5 can be carried out by means of satellite-based navigation systems or
5 waypoint navigation. As a result, each drone 5 can work and communicate alone independently, but also with other drones 5. For this purpose, the drone 5 has at least one transmitting and receiving device. For the function of the drone 5, there is at least one power
10 source in the drone 5 (not shown in more detail).

Each drone 5 also has means 5.3. These means 5.3 may be hinges, which on the one hand can be swiveled by about 90°, on the other hand can clamp onto a target 8, for
15 example to a barrel 10, or may encircle it (Fig. 5). Swiveling the means 5.3 in the direction of flight allows the effector 5.2 to be placed in a muzzle 10.1 of the barrel 10. Alternatively, a device can also be used which ejects the effector 5.2, so that the
20 effector 5.2 comes to rest in the muzzle of the barrel 10.1. Clutching with the help of the means 5.3 creates the possibility of attaching the effector 5.2 including the drone 5 to the barrel 10.

25 The method of operation of the drone 5 or multiple drones 5 as an attack drone or attack drones is as follows:

For example, the drones 5 are transported to a target
30 area 7 or near a target area 7 by means of the container 1 (fig. 3). In advance, accumulators of the drones 5 are charged (not shown in more detail). Charging can also take place within the container 1. The drones 5 are preferably accommodated in racks
35 within the container 1 and electrically connected to the power unit 4 via the racks.

In the target area 7, the data for image recognition, such as a signature of the respective targets 8 to be attacked, are input, i.e. programmed, into the drones 5. This can be carried out via the programming interface on/in the container 1. A specific signature of an enemy combat vehicle can be used. The sole criterion may for example be a friend/foe identification. In addition, the search area in which the enemy target 8 is expected is input. This programming can also be carried out via the programming interface on/in the container 1. The programmed search area may be larger than the target area 7. The drone or drones 5 themselves can fly this stored route autonomously with the help of their inertial system or GPS system (rough tracking).

Fig. 2 shows the container 1 from fig. 1 in the target area 7 in an open state or position. Preferably, the side walls 6 of the container 1 can be swiveled away laterally by means of articulated connections 1.1. This allows the drones 5 to be able to leave the container 1 independently in a simple way.

Fig. 3 shows the target area 7 with enemy targets 8 in more detail. The targets 8 themselves have at least one weapon system 9 with at least one barrel 10. The at least one swarmed drone 5 detects the target 8 within a radius of multiple kilometers with the help of the camera(s) based on the programmed signature. After a friend/foe identification (12 = view of the drone 5), the drone 5 preferably flies directly to this target 8 (fig.4). This direct approach is then preferably carried out in fine tracking.

In a first version, a muzzle 10.1 of the barrel 10 can be approached. For this purpose, the orientation of the barrel 10 is detected via the day and/or night vision camera and the muzzle of the barrel 10.1 is targeted.

By means of the means 5.3, the effector 5.2 is placed in the barrel 10. A thermite charge as the effector 5.2 would weld an accumulation of steel into the barrel 10.

5 In another version, the drone 5 flies towards the barrel 10. The means 5.3 of the drone 5 are used in this version so that the drone 5 can clutch the barrel 10, for example, but at least can hold onto or on the barrel 10 (fig. 5). The drone 5, recognizing the
10 alignment of its means 5.3 to the barrel 10, flies towards the barrel 10 and clamps itself with the means 5.3. Grippers or hinges can be used here as the means 5.3. After clamping, the effector 5.2, for example a thermite charge, is ignited (fig. 6), which welds the
15 barrel 10 from the outside. As a result, the internal geometry of the barrel 10 is changed. When a shot is fired, the passage of a projectile (not shown in more detail) is impaired in such a way that the barrel 10
rips off, for example (fig. 7).

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The triggering of the effector 5.2 should preferably be carried out by the drone 5 itself. This can be carried out by programming or by using a contact on the drone 5 which is not shown in detail and which is operated on
25 contact with the barrel 10.

In a preferred version, multiple drones 5 fly into the target area 7. Flying in as a swarm, the drones 5 search the target area 7/search area independently on
30 the basis of a programmed-in signature of the enemy targets 8. This can be carried out over a distance of at least 3 to 6 km within a circle. The drone 5 which is the first to detect a target 8 passes this information on to other drones 5. This drone 5 becomes
35 the master drone. At least 1, preferably at least 2 to n further drones 5 then follow the defined first master drone to the detected target 8. For the other drones 5

in the swarm, this target 8 is hidden and the swarm searches for more targets 8 in target area 7.

5 The next drone 5 which recognizes or detects a new target 8, for example, becomes the second master drone. It is also followed by at least 1, preferably 2 to n more drones 5. This target 8 is hidden for the remaining drones 5.

10 The next drone 5 which then detects another target 8 becomes the nth master drone, etc. until all drones 5 have received a (their) target 8.

15 At the target 8, the barrel 10 is approached by the drones 5 in fine tracking, making it unusable, as already described.

CLAIMS

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1. A drone (5) with at least one motor with at least one power supply, at least one propeller (5.1) and at least one effector (5.2), **characterized in that**
10 the at least one effector (5.2) comprises steel nails, glass fragments and/or sand.

2. A drone (5) with at least one motor with at least one power supply, at least one propeller (5.1) and
15 at least one effector (5.2), **characterized in that** the at least one effector (5.2) comprises at least one cutting charge and/or at least one pyrotechnic charge.

20 3. A drone (5) with at least one motor with at least one power supply, at least one propeller (5.1) and at least one effector (5.2), which comprises steel nails, glass fragments, sand, at least one cutting charge and/or at least one pyrotechnic charge.

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4. The drone (5) as claimed in claim 2 or 3, **characterized in that** the at least one pyrotechnic charge is a thermite charge.

30 5. The drone (5) as claimed in any one of claims 1 to 4, **characterized in that** the drone (5) has a computer or processor for making decisions to independently fly over a predetermined space and to communicate, for which purpose the drone (5) has at
35 least one transmitting and receiving device.

6. The drone (5) as claimed in any one of claims 1 to 5, **characterized in that** the drone (5) comprises at least one day and/or night vision camera.
- 5 7. The drone (5) as claimed in claim 6, **characterized in that** the drone (5) has programmable friend/foe image recognition.
8. The drone (5) as claimed in any one of claims 1 to 10 7, **characterized in that** the drone (5) has at least one inertial system and/or at least one GPS tracker.
9. The drone (5) as claimed in any one of claims 1 to 8, **characterized in that** the drone (5) has means (5.3) for 15 depositing the effector (5.2), alternatively an apparatus for ejecting the effector (5.2).
10. A method for attacking at least one target (8) with at least one drone (5) as claimed in any one 20 of claims 1 to 9, **characterized by** the following steps:
- Programming the drone (5) with data for image recognition and
 - 25 • Inputting the search area in which the target (8) is expected,
 - Detecting a target (8) and flying to the target (8), preferably directly, wherein
 - a muzzle (10.1) of a barrel (10) of the target (8) is approached,
 - 30 • Detecting the alignment of the barrel (10) and
 - Placing the at least one effector (5.2) in the barrel (10).
- 35 11. A method for attacking at least one target (8) with at least one drone (5) as claimed in any one

of claims 1 to 9, **characterized by** the following steps:

- Programming the drone (5) with data for image recognition and
- 5 • Inputting the search area in which the target (8) is expected,
- Detecting a target (8) and flying to the target (8), preferably directly, wherein
- 10 • the drone (5) flies to a barrel (10) of the target (8) and
- the drone (5) clutches the barrel (10), wherein it can at least hold onto or on the barrel (10), and
- 15 • the at least one effector (5.2) changes an internal geometry of the barrel (10).

12. The method as claimed in claim 10 or 11, **characterized in that** multiple drones (5) fly into a target area (7) as a swarm, wherein the drones
20 (5) communicate with each other in such a way that a drone (5) which is the first to detect a target (8) passes this information on to others of the multiple drones (5), whereby this first detecting drone (5) becomes the master drone and at least one
25 to n others of the multiple drones (5) follow this master drone as slaves, wherein this target (8) is hidden for drones (5) which are not following this master drone.

30 13. The method as claimed in claim 12, **characterized in that** on detecting a new target (8), the detecting drone (5) becomes the second master drone and passes this information on to others of the multiple drones (5), whereby at least one to n others of the multiple

drones (5) follow this second master drone as slaves, wherein this target (8) is hidden for the drones (5) which are not following the master drone.

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14. The method as claimed in claim 12 or 13, **characterized in that** on detecting further targets (8), respective nth master drones are formed and slaves are assigned to these until the multiple
10 drones (5) have received a target (8) or those of the multiple drones (5) which were designated neither as the master drone nor as the slave fly back.

15 15. The method as claimed in any one of claims 10 to 14, **characterized in that** the at least one drone (5) or the multiple drones (5) may be transferred to a target area (7) or to a vicinity of a target area by means of a container (1), wherein the
20 container may have a programming interface and/or a power unit.