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Development of Tactical Laser Weapons

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Abstract: Recent developments of tactical laser weapons are reviewed in detail.

In the past few years, remarkable technological strides have been made in the development of directed energy weapons including tactical laser weapons and microwave weapons, which have gradually become appreciated and accepted for their capability of producing a soft kill to targets like aircraft and tanks. It is estimated that with the advent and application of directed energy weapons, new military tactics are expected to come into being in the near term which can blind human eyes or military-oriented photoelectric equipment and eventually, paralyze weapon systems.

The basic concept of directed energy weapons was incorporated in the U.S. Army 2000 air-ground combined operations theory and in the battle plan. A special institution under the U.S. Army training and regulations command center is currently working on the role that directed energy weapons are likely to play in air-ground combined operations and their possible impact on the 21st century battlefield and combat regulations, as well as army formations in response to such weapons.

It is believed, based on analysis of technological development of directed energy weapons, that tactical laser weapons, the most developed and most mature kind of directed energy weapon, will possibly become the first to be employed in the military forces. So far, tactical laser weapons have already

been developed, and soon will be operational in overseas countries, which target enemy soldiers' eyes and military-oriented photoelectric equipment and have the capability of producing a soft kill. This paper outlines and analyzes the present situation and development trend of overseas tactical laser weapons.

1. A Glance at Present Development of Tactical Laser Weapons

For quite a long time, the United States and Soviet Union have been taking the lead in the area of tactical laser weapons. To date, the United States has developed different kinds of such weapons including portable, vehicle-borne and airborne weapons, while the Soviet Union has develped vehicle-borne and ship-borne weapons. Similarly, Britain and Federal Republic of Germany have also made considerable achievements in this area.

The U.S. Army completed field tests on two types of portable laser weapons, namely dazzler and "Cobra" laser devices, which can blind enemy troops or burn up photoelectric sensors and periscopes mounted in armored vehicles.

The dazzler laser device, developed in the U.S. by United Signal Company with government funds, weighs, with a cadmium-nickel battery inside, about 9 kg and costs less than $50,000 each. Instead of causing permanent damage to the eyes, this device can inflict a flash blindness, i.e. a lingering image, which makes the opponents lose their normal vision for two to three minutes. Duration of flash blindness ranges from 10 to 100 s, depending on laser brightness and surrounding illumination intensity. It can stay long during the night or under weak illumination, while under the action of repetition laser pulses, it can remain even longer. Although the dazzler device cannot strike a large number of targets at the same time, it can blind key personnel like helicopter pilots or weapons guided by

electrooptic sensors. Certainly, at very close distances, it can also damage soldiers' eyes. The U.S. Army Missile Command Center carried out in Brisber [transliterated] a wide range of tests, intended to assess its efficiency over various targets.

The Cobra laser device was developed with the funds provided by McDonnell Douglas Electronic Systems, Inc. In configuration, it is similar to an M16 rifle with batteries and can provide an effective range of 1 km in attacking unprotected vehicle sensors. The Cobra laser device, constructed on the basis of a newly developed solid-state laser device with a higher power capacity, features small size, higher reliability and better efficiency. This device underwent tests by the U.S. Army at Huntsville and Eglin air force bases, which were conducted to examine its efficiency over fixed targets. As the test crew commented, the "Cobra" laser device proved to be an impressive technology. Such portable laser device is estimated to be used in the battlefield in 3 to 5 years, though its working wavelength is still being kept secret.

The "Stingray" laser weapon system, a vehicle-borne laser weapon developed by the U.S. Army, successfully passed a field test from March through May, 1990. Mounted on the "Bradley" fighting vehicle, this system has a transmitting tube placed side by side with a 25 mm artillery gun and is powered by a generator. The Stingray first transmits low-energy laser pulses to scan the battlefield, which will then partly reflect back as soon as it touches upon forward looking infrared equipment like photoelectric equipment, and the reflected pulse detected by its sensor can excite a middle-energy laser pulse to irradiate and blind photoelectric equipment. During the U.S. Army test, a vehicle equipped with a Stingray laser weapon system was applied in a fight against four to five assaulting vehicles. The test showed that it could, within the range of vision of its aiming device, permanently or temporarily blind 3/4 of the enemy

vehicles and their sensors, though no technical details of the test were ever disclosed.

The Stingray was first developed in 1984 by Martin Marietta Company as major contractor, and General Electric as subcontractor responsible for providing la rod-type laser device. It is designed to quickly cause optical systems in enemy vehicles to lose their function, so that U.S. troops are able to swiftly retreat or escape. The Stingray cannot blind enemy infrared sensors, but it can temporarily or permanently blind the periscope operator in the vehicle as well as the light amplifying camera which is operating at night. By using the reflected laser beam from the enemy vehicle, this system can also help the crew of a vehicle discover hidden targets. U.S. Army is now preparing an application for developing a full-size "Stingray", which is planned to start in early 1993. The Stingray Program Administration has scheduled purchase of 48 sets of Stingray laser weapon systems to be mounted in M3 "Bradley" armored scout cars under two armored cavalry regiments, with an estimated cost of $500,000 to one million dollars.

Among U.S. developed air-borne laser weapons are: the advanced optical jamming pod, "Crown Prince" and helicopter-based laser weapons. The advanced optical jamming pod, jointly developed by the U.S. Air Force and Navy, is produced to be mounted in various strategic and tactic aircraft as well as aircraft and helicopters for special electronic missions. During the Vietnam war, most of planes the United States lost were hit by ground-air defense weapons equipped with vision aiming or optical aiming apparatus, against which the United States had no effective countermeasures. It was for this reason that the U.S. Air Force and Army teamed up to begin a joint development of the advanced optical jamming pod early in the mid seventies.

The pod contains a gun muzzle flare detector, YAG laser

device and YAG amplifier laser device. When ground air defense weapons fire on an aircraft, the gun muzzle flare detector can capture the shooting flare so as to determine the position of ground defense weapons, after which the YAG laser beam is emitted to complete ranging and finally, a blue-green high-power laser beam is transmitted to injure the ground shooters' eyes. From 1975 till 1984, the United States, with further development of the pod, produced the advanced model prototype and miniature devices, along with conducting of the flight tests. In 1986, this research program entered its engineering development phase and the pod is scheduled to be put into production in 1990. It is estimated that a total of 4000 such pods will be constructed in the nineties with an estimated price of $75,000 for each.

The "Crown Prince" is an air-borne laser weapon developed by the U.S. Air Force on the basis of "Stingray" technology. To make it operate over long distances, a rod-type laser device is selected, which can provide an even higher output power and satisfy various requirements for aiming, target tracking and the environment. The Crown Prince was developed by Westinghouse Electric Company, which designed its first prototype in 1986. This pod-borne laser weapon, installed beneath the aircraft wings, is designed for use against ground-based optical and electrooptical tracking systems, so as to improve the aircraft survival capability in the nineties.

Since helicopters are confronted with more and more complex threats, the U.S. Army started highly confidential research on helicopter-based laser blinding systems in accordance with "Cameo Bluejay" Program, which, however, was later cancelled for some reason.

As the U.S. Army recently disclosed, they will sign a three-year contract with related industrial departments, which, taking advantage of technology and experience accumulated with

implementation of the "Stingray" and "Cameo Bluejay" projects, directs its focus on an advanced model of the helicopter-based laser weapon. This new weapon is designed to be mounted in an AH-64 Apache helicopter or future light-weight helicopter, to confront the Soviet ZSU-23-4 "Shlek" air defense weapon and the SA-13 infrared-guided air defense missile system. The new helicopter-borne laser weapon, though based on "Stingray" technology, can be made even smaller and lighter, suitable to be carried by helicopter. Also, it can be used as a scouting system to determine the accurate position of an enemy target by using the reflected laser beam from the enemy periscope and sensor.

The Soviet Union now possesses 25,000 tank-based laser rangers and 10,000 to 15,000 aircraft-borne and gun-oriented laser rangers. These rangers, despite their original design, can attack personnel and sensors and give temporary or permanent damage to NATO forward looking infrared sensors, commonly installed in tanks or offensive helicopters. The Soviet Union used ship-based laser devices to track U.S. military planes and hurt members of the crew with laser radiation, for which the United States made a protest to the Soviet government. Latest Soviet warships are equipped with a ranging system named "Squeeze Box", which carries a laser ranger that can hurt eyes. Apart from ranging capability, the Squeeze Box seems to possess other functions such as air defense and anti-personnel. Examining a huge number of Soviet references concerning biological effect of laser radiation, the U.S. Army came to a belief that the Soviets are developing a battlefield-oriented laser weapon system which is similar to the "Stingray".

Britain was the first country to apply laser weapons to actual combat. During the Falklands war early in 1982, the British Royal Navy Force deployed and applied a ship-based laser weapon called "laser dazzling aiming device". This device, borne

of an industry-oriented laser device, was jointly developed by Royal Signal and Radar Research Institute under the Department of Defense and Navy Department Research Institute. With a configuration similar to a cannon with a rectangular barrel, it is mounted on a simple support like a tripod and under visual aiming, operates in pulse form by emitting a blue laser beam with an effective shooting range of approximately 5 km. It is primarily designed to severely damage or even blind eyes so that hostile pilots have to give up their attack mission.

In 1981, this laser dazzling aiming device was mounted in "Julialers" escort warships for an initial test conducted in the Irish Sea. In 1982, the device was carried by warships including "Sports Deity", "Permanent Victory", "Magnificent", "Sword" and "Yalgo Sailor" and applied in the Falklands war. As a result, one Argentine A-4B plane crashed into the sea, one A-4 flew off course and was hit by Allied air defense weapons, as well as one MB339A plane which gave up its planned engagement of attacking "Yalgo Sailor". Currently, British Royal Navy warships located in potentially dangerous areas are all equipped with laser dazzling aiming devices, and 22 model and "Leander" class escort vessels routinely carries two such devices.

A vehicle-borne laser weapon developed by MBB Inc. and the Deere Company, Federal Republic of Germany under support of the Department of Defense, unlike those constructed in the United States, Soviet Union and Britain, is designed to produce a hard kill. According to the design proposed by the foregoing two firms, this laser weapon-oriented system is an air-driven laser device with an output power 1 MW, which, 20 t in weight, is mounted on a Puma II tank chassis. It carries an adjustable elevator arm to make its total height up to 20 m and emits laser beam 10 cm in diameter, which can burn through casings on an aircraft, helicopter or missile at distances of 10 km and blind hostile infrared detectors 20 km away. Nevertheless, this German

vehicle-based laser weapon still remains in its initial phase and will not be made operational until the next century.

2. Tentative Analysis of Development Trends of Tactical Laser Weapons

Based on a review of development and the present situation of overseas tactic laser weapons, we come up with some conclusions with regards to their development trend as follows:

1) Rapidly developing laser technology is being materialized into practical weapons

Different kinds of tactical laser weapons with a soft kill capability have overcome a number of technical difficulties and will be employed by military troops in succession in the nineties. While those strategic and tactical laser weapons which can produce a hard kill, challenged with various knotty technical problems, are expected to appear on the horizon in the next century.

The United States has been leading other countries in the area of military-oriented laser development, yet it has gone down a tortuous path in the research on tactical laser weapons. Their experiences as well as lessons they have learned deserve our attention. In the sixties and seventies, the major concern of the United States was to achieve the goal of developing hard kill laser weapons. Correspondingly, they invested large amounts of personnel and funds in the development of high-powered laser weapons and research on high-powered laser damage mechanisms and high-powered laser beam atmosphere propagation effect, making remarkable achievements. However, as the research went on, they gradually realized how difficult it was to achieve this goal. From 1979 through 1980, U.S. Army carried out an "Army laser weapon technical assessment", which resulted in new thinking about the research direction of laser weapon development. The new goal determined was to develop laser weapons available for

near term benefits. Consequently, they gradually shifted their focus to the development of soft kill laser weapons during the eighties. The first project Army undertook was "the Chicken" [literal translation from Chinese] laser weapon-oriented system but, when discovered that the weight and cost of this system greatly exceeded what had been planned, they resolutely stopped the project and turned to development of the "Stingray" system. Practice showed that this change of research direction was correct.

As described above, the United States, Britain and Soviet Union all made impressive breakthroughs with soft kill laser weapons. Various kinds of tactical laser weapons are likely to be engaged by military troops in the nineties. With soft kill laser weapons, troops can not only effectively defend against different photoelectric sensors and optical equipment, but also paralyze opponent expensive weapon-oriented systems with the new tactics of using soft, to strike hard. In addition, they can force the hostile side to develop, with large expenditures, technologies and equipment which are capable of protecting their soldiers' eyes and photoelectric sensors.

2) Technological approach to developing tactical laser weapons is finalized

Photoelectric sensors and human eyes, able to sense visible light and/or infrared radiation, are inherently vulnerable to damage by laser radiation. Tests done in the United States shows that 151 mJ/cm^2 of laser energy density is enough to burn the retina and damage vision. Laser damage thresholds of HgCdTe, PbS and InSb infrared detectors are 10^2-$3x10^4$ W/cm^2 at 0.1 s radiation time or $5x10^2$-$3x10^4 W/cm^2$ at 0.01 s. When glass is irradiated by a 300 W/cm2 laser for 0.1 s, its surface begins to melt. Solid-state laser devices, technically more mature, can satisfy the required laser output power and emit enough energy to target

regardless of size, weight and the like. Therefore, solid-state laser devices have been applied to almost all tactical laser weapons, either those already developed or those under development.

According to recent source, YAG laser device is selected for the U.S. advanced optical jamming pod, "Crown Prince" and helicopter-based laser weapons. The British laser dazzling aiming device, though there is no report explaining which laser device it is, is presumably an amplifier Nd:YAG laser device, judging from information available such as time of its appearance, blue laser beam emitted, having an industry-oriented laser device as its basis, similar to >1m long rectangular tube in configuration. The U.S. dazzler device is developed from a flash tube pumped gold emerald laser device for the reason that compared with other solid-state laser devices, the gold emerald laser can bear higher working temperature, but other details still remain unknown. The semiconductor laser device pumped YAG laser device can generate a high-powered laser for its compact structure and, with an increase of its output power, is likely to be selected for use in future tactical laser weapon development. Judging from the current development of solid-state laser technology, the rod-type laser device will undoubtedly become the first option for tactical laser weapons, as it can effectively compensate, based on its rod-type structure, distortion produced by the thermal gradient inside the laser rod and therefore, greatly increase beam quality and output of the high quality high-powered laser beam. The rod-type laser device has already been applied to "Stingray", "Crown Prince" and helicopter-borne laser weapons.

3) Enhancing wavelength flexibility is a key direction in future development of tactical laser weapons

Development of tactical laser weapons has excited advancement of confrontation technology. To develop laser

weapons with adjustable wavelength to increase flexibility is a new direction because the optical filter and goggles can defend against tactical laser weapons with a single wavelength. Another reason the United States adopts the gold emerald laser device as dazzler device is that the gold emerald laser is adjustable in the near infrared zone.

4) Cat-eye effect has been applied to laser weapon aiming systems

Cat eyes shine in dark night, which does not signify that they really shine, but because cat eyes exhibit higher reflectivity compared with surroundings. Researchers from the United States, Soviet Union and France believe that, with this principle, tactical laser weapons can search for enemy optical equipment and photoelectric sensors as attack targets, locate their position and then deliver a punch. The cat-eye effect has been applied to some of the tactical laser weapons. U.S. "Stingray" laser weapon systems and the Soviet vehicle-delivered laser devices first emit a low-powered laser pulse to scan and then can easily pick out and hit military optical equipment and photoelectric sensors with high reflectivity by using the high energy laser beam reflected from them. With cat-eye effect, tactical laser weapons can also discover hidden targets in reconnaissance engagements.

5) Next goal of tactical laser weapon development will be the development of laser weapons capable of producing a hard kill

Laser weapons with hard damage capability are difficult to develop successfully in the near term, due to some technical obstacles, yet some developed countries have not given up this goal. For instance, MBB Inc. in Federal Republic of Germany, has been engaged in this research with great perseverance. NATO Industry Consultation Group which involves 10 countries is currently planning a research program on a very short-range air defense system of future NATO warships, which, considered as a

hard kill system, will be designed to protect their ships from being stricken by anti-ship missiles and aircraft in the 21st century. During 14 months of research, several options are to be under careful examination, including laser weapons. Similarly, the United States and Soviet Union have also been sticking to research on the high-powered laser device with capability of producing hard damage to the target.

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References

[1] Jane's Defence Weekly, 1990 Jan 13: 48
[2] Defense New, 1990 Mar 15
[3] Military Technology, 1990; (3): 58
[4] Defense New, 1990 Mar 26
[5] Flight International, 1990 Jan 17/23: 23
[9] Defense New, 1990 May 28

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