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Laser Challenge of China

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Article Info

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Abstract

The use of lasers in the military sphere has been talked about for more than five decades and now we are able to talk about very effective development of the Chinese first real solid state (S/S) weapon of a fiber type. The main concerns of the new fundamental physical and technical idea and power source as itself for such a weapons are now not a serious scientific and engineering problems for the country. An artificial intelligence as well developed in China is another important option of contemporary laser weapon (LW) development. Using a high-speed game processors that are capable of processing such volumes of incoming data and performing the necessary visualization, it becomes possible to launch the developed algorithms and in the interests of creating truly effective LW complexes. Along with that, rapid development of high-energy LW can also get the benefit from the modern electric vehicle market. Common to LW and electric vehicle technology are the processes of energy storage at high power, the processes of controlling the temperature regime of circuit elements, the important ability to effectively transfer high power to the emitter, and hence the technologies of cables and electrical connections, switching circuits and other technologies for redistributing energy in the engine. That are the tools for the nearest bright future of Chinese LW technology, but now as the majority of the developed countries they still have a lot of much heavy and bulky laser systems for possible military operations.

Keywords: High energy; Laser; Density.

Introduction

Chinese President Xi Jinping, at a meeting with delegates of the People's Liberation Army of China (PLA) during the last session of the National People's Congress (NPC), demanded the introduction of scientific discoveries and innovative technologies in the army. Xi Jinping noted that new technologies are the key to modernizing the Armed Forces. The Chinese leader discussed with the military how to achieve the goals set in the field of national defense and army development and the implementation of the 13th five-year plan for the development of the armed forces. It is safe to say that Laser Weapons (LW) are on the agenda of China [1]. Chinese scientists and technologists have thought and worked on the LW problem for a long time. Since the 1970s, industry and the military have laid the groundwork for seriously figuring out how to achieve practical power levels, how to steer a beam, and how to deliver laser radiation over long distances. The Department of Defense officially recognized lasers as the likely weapon of the future back in that century, initiating official research and development. The PRC, following the United States, Japan, Germany, France and England, plans to equip the country's fighter aircraft with light and compact LW. About this on the official website for the procurement of weapons for the PLA were posted two announcements of tenders for the creation of appropriate equipment and software. Under the terms of the first tender announced by the PLA, applicants for the contract must develop a suspended aviation container for the aircraft. The second tender included requirements for the

creation of software for the management of this LW. The combat laser must not only protect the PLA Air Force planes from enemy missiles, but also hit various targets, including aircraft, ground and surface targets. The Chinese military are planning to receive a universal laser module, which in the future will be able to become a tactical aircraft of sea, land and aircraft based. Airborne LW will be able to intercept approaching missiles and shoot down enemy aircraft in aerial battles. The significant advantage of LW over missiles and firearms makes it an indispensable tool for air combat. Aviation LW will be able to provide not only protection against missile attacks from the ground and from the air, but also the superiority of Chinese aviation in air battles. Over the past few years, the PRC has been very actively involved in the development of LW. At the Air show China 2018 exhibition in Zhuhai, the China Aerospace Science and Technology Corporation (CASIC) demonstrated the LW-30 self-propelled laser warhead designed to protect objects from unmanned aerial vehicles, light aircraft and helicopters. The 30 kW laser installed on the LW-30 is capable of hitting targets in the functional mode at a distance of up to 25 kilometers. The installation has already been adopted by the PLA. At the same time, the central television of China showed a new development-a mobile LW installation. Details about the purpose and technical parameters of the new development were not disclosed, although, from a link to a local source, it becomes clear that the system is designed to instantly destroy targets near the coastline, and its main targets will be small boats and unmanned aerial vehicles. When installed on aircraft, this LW can potentially protect against possible missile attacks and dominate in close combat, says the Global Times. The Chinese media noted that the created LW module is tactical. If it were a laser designator for targeting smart bombs, then it would be called that - a laser targeting module. Recently, the Chinese television program also claimed that China has already developed a prototype of a 100-kW aircraft LW. It referred to a document entitled "Investigation of Energy Storage and Power Source for Airborne LW", prepared by the State Institute of Manufacturing Technologies AVIC and the Military Representation of Special Equipment of the PLA Missile Forces. It is important to note here that many other countries are working on the problem of creating LW. For example, Russia recently announced that the next generation fighter could be armed with an LW complex, and the US-announced project called "Self-protection High Energy Laser Demonstrator" will consist of a laser, a power and cooling unit and a beam control system to focus the LW complex on a target. In February at the International Defense Exhibition and Conference in the United Arab Emirates China showed off its Silent Hunter laser complex, which is capable of knocking out machine engines at a distance of one mile and has a power of up to 70 kW. This information raises a reasonable question, what is in the arsenal of China in the field of LW, if they openly show such complexes at international exhibitions. For comparison: the operating LW complex on the American ship "Ponce" has a capacity of 33 kW. Earlier, China presented at an exhibition in South Africa one more ground-based mobile complex "Low Altitude Guard II" based on a conventional military truck and with a laser installation with a power of 30 kW to destroy drones and helicopters. Recently, foreign and Russian media again began to cite material from the Chinese Optics magazine, where leading Chinese scientists in the field of military lasers proposed to place a five-ton chemical laser into orbit by 2023, which would disable US satellites. The same scientists said that back in 2005, China conducted successful tests to disable orbiting satellites of its own production using a ground laser with a power of up to 100 kW. For the Chinese army, airborne lasers are more than potentially useful weapons for destroying enemy aircraft or defending their aircraft against anti-aircraft missiles. LW can also be a key component of ballistic missile defense. The Chinese media admit the difficulty of creating airborne complexes of the LW. "This type of weapon has not yet become widespread due to remaining technical difficulties, including problems with power supplies and insufficient output power of the lasers themselves due to their large weight and size." A prime example of how not to develop an airborne laser for China is the US Missile Defense Agency's YAL airborne laser test bed. This ambitious attempt to turn the Boeing 747 into a flying aircraft ended in failure. Armed with a giant chemical laser powered by an environmentally hazardous propellant, the YAL was designed to destroy ballistic missiles. However, it turned out to be so expensive and tactical ranges so short that then Defense Secretary Robert Gates scrapped the project in 2009. However, the YAL concept dates back to the 1980s and grandiose ideas such as Ronald Reagan's Star Wars missile defense project. The current focus of the Chinese military is on a more compact and more practical aircraft that can be mounted on land or sea vehicles, as well as on airplane-carried harnesses. Airborne tactical aircraft based on modern solid-state (s/s) technology, according to the Chinese military, is approaching its final intelligent form. Today, the leaders of the PLA Armed Forces are beginning to actively figure out how to integrate laser systems into existing weapons systems. Despite the fact that lasers have been around for almost as long as rocketry itself, modern military forces take a fair amount of time to effectively deploy the LW. The problem in previous years was that these laser systems were too bulky and heavy. They were physically too large to be effectively used for tactical purposes, either on a truck, or on an airplane, and even on a ship, without taking up large spaces of the carrier. Naturally, there are some limitations as to which system can run on which delivery vehicle. Not all carriers can support 100-150 kW class systems. Since s/s lasers are powered by electricity, they can last long enough until that energy runs out, s/s lasers ideally can counter fast moving targets with high accuracy and offer the necessary variability that can be used for different types of impacts, from simply observing targets to causing serious or unacceptable damage to them [2].

From "laser monsters" to compactness

Modern new threats make high-energy LW complexes more practical than they were earlier during the creation of

laser monsters on gas-dynamic, electric-discharge, chemical and alkaline vapor bases. Today, the Chinese Ministry of Defense, like the military of other advanced countries, is ordering high-energy LW systems for field tests in order to determine the most effective designs of complexes and methods of protection against high-tech Enemy Military Equipment (EME). Modern s/s LW systems must be able to track the target, hit it and have a lethal effect on it in order to completely neutralize it. The systems themselves lack tactically significant size, weight, and power. Previously, these systems could not be effectively integrated with existing weapons. But three important components of the LW complexes have changed. First, the development of fiber and disk laser technology has allowed the systems to be "most efficient at converting electricity into a powerful beam, which means that the weight and size of the power supply and heat exchange systems are minimized as efficiency is high. Secondly, the beam has become more qualitative from the point of view of homogeneity over the beam cross section and its divergence. Third, the commercial industrial base is now becoming much cheaper and is able to quickly provide many of the basic components of the LW complexes. China, like most countries with laser technology, is developing the ideology of combining the output power of a large number of individual lasers, rather than trying to create in the very beginning a single, much larger beam. However, this approach is suitable for the creation of modern tactical aircraft systems with an output power within 500 kW, which is determined by the physical and technical limitations of the technology used.

Market influence on the development of LW technologies in china

Commercial laser technology has significantly influenced the development and powerful acceleration of military LW technology. Fiber optics have become widely used for communication purposes, and a wide range of fiber laser machines have made industrial cutting, welding and drilling much more efficient. Smart phones and other small electronic devices required very high-quality fiber "scalpels" to focus the laser beam very accurately and in an extremely small size. The development of fiber lasers for defense purposes has in turn led to the development of the idea of combining the radiation of individual fiber lasers with each other using highly efficient spectral elements. Along with the ability to focus the beam on the target, the LW must also ensure the propagation of radiation over long distances. Therefore, the creation of optical telescopes based on silicon carbide not only for laser physics should be considered one more positive output of the LW technology. The development of technology for obtaining high-quality fiber for communication purposes was important for a wide range of technologies. Manufacturing of a large range of fibers, material purity, fiber doping techniques with rare earth elements, creation of waveguides and the ability to draw large-sized and high-quality fibers-all this was successfully developed by the industry of developed countries, and hence China, which appeared to the world in the form of a huge technological platform with cheap labor. The technology for the production of semiconductor arrays and laser diode arrays for pumping lasers is also the essence of military lasers. When it comes to industrial laser cutting and welding, these laser applications use highly efficient electrical circuits, power switching circuits, and the fiber itself, which is capable of withstanding high-power density. As for target tracking with the help of LW, it requires fast and simultaneous processing of video information from several high-speed cameras. The technology behind this fast processing of information is based on developments widely used in the video game industry. Using all these high-speed game processors that are capable of processing such volumes of incoming data and performing the necessary visualization, it becomes possible to launch the developed algorithms and in the interests of creating truly effective LW complexes. Along with this, there is also a strong opposite effect on the LW industry. Game development of Artificial Intelligence (AI) and machine learning technologies, which already today help in the development of target search algorithms, help to significantly improve the aiming procedure itself. Simultaneously with this, rapid development high-energy LW can also benefit the modern electric vehicle market. Common to LW and electric vehicle technology are the processes of energy storage at high power, the processes of controlling the temperature regime of circuit elements, the important ability to effectively transfer high power to the emitter, and hence the technologies of cables and electrical connections, switching circuits and other technologies for redistributing energy in the engine. On the other hand, lasers are widely used in many industries, with markets spanning the defense, industrial and medical sectors. Gas lasers, classic s/s lasers, electric discharge lasers and excimer lasers are used in major industries such as materials processing and automotive. Today, significantly lower power lasers are playing an increasingly important role in the development of many new technologies, including targeting, communications, surgical and diagnostic applications. Thus, this rapidly expanding market for China seems to be a very important foundation not only for economic prosperity, but also a factor in the rapid growth of defense technologies and, in particular, the improvement of LW.

What does china and the world expect tomorrow?

Recently, there has been a lot of talk in the world about the need to further increase the output power of the s/s LW complexes. The world power level of compact and lightweight s/s fiber laser systems does not exceed 300 kW. The principal competitor to the "fiber" is a disk laser, a single module of which has already reached the output power level of 50- 75 kW. In China, both of these laser designs are actively developing, and their element base is also developing. China has long been a supplier of a wide range of s/s components to the world market. Laser systems and more. Chinese scientists and technologists are well aware that the future belongs to compact, lightweight and reliable s/s systems for the development of a new class of technologies and the creation of the entire line of tactical and strategic LW systems.

As the output power of such equipment grows in the world, trading in LW complexes of lower power, by analogy with laser metalworking machines, will become more and more possible and cost-effective. Therefore, one should expect a further increase in the output power of technological laser equipment and LW complexes produced in China, saturated with state-of-the-art AI systems that control them [3].

High-Energy laser market

According to SIPRI, the global high-energy laser market will reach $ 14.74 billion by 2026, which will average 12.4% growth from 2021 to 2026. This industry is one of the hardest hit by the Covid-19 pandemic. Today, the market began to recover again after a corresponding increase in demand for laser systems and laser technological equipment: High energy lasers have played a critical role in today's society with an increasing number of applications in manufacturing, communications and defense. Thanks to a growing defense budget and research grants, the military, including China, is introducing high-energy laser equipment and investing heavily in research and development. For example, in May 2021, the US Army began testing a prototype of s/s LW for short-range air defense; this sample is a 50 kW LW connected to a Stryker A1 vehicle that can detect, capture, track and destroy airborne threats. Countries with high military spending are interested in the development and implementation of laser technologies within their capabilities. According to the Stockholm International Peace Research Institute ("SIPRI" since 1966 provides data, analysis and recommendations for armed conflict, military expenditure and arms trade as well as disarmament and arms control), global defense spending hit a record $ 1.98 trillion. US in 2020, an increase of 2.6% over the previous year. Defense developments, including laser technology, are expected to pave the way for new technology and modernization. The defense industry in China, like the industry in other countries, provides a significant share of R & D and applications of laser technology. With the proliferation of drones in the defense sector, the demand for solutions that can track and destroy them has increased. For example, in March 2021, the European missile manufacturer MBDA (UK) and the French company CILAS (France) agreed to cooperate with an electronic warfare and reconnaissance specialist to study the possibilities of joint development of high-energy LW systems for the destruction of unmanned aerial vehicles. It is expected that in the coming years the number of such associations in the military sphere will increase. It is expected that the use of high-energy s/s lasers in missile defense systems will expand, including in China, as the world's major defense giants increasingly adopt these solutions and show interest in developing such solutions. For example, in March 2021, Israel's MoD showed interest by soliciting funding and expertise from the United States for its air and missile defense lasers. Israel's current prototypes have achieved an output radiation of almost 100 kW, while the United States already has prototypes of s/s 300 kW aircraft capable of destroying cruise missiles. Demand for aircraft s/s systems in naval forces around the world is growing rapidly to combat airborne threats such as missiles and unmanned aerial vehicles. LW has proven effective against missiles and is used as the first line of the EME security network. For example, a high-energy aircraft complex with a built-in blinding system and a HELIOS "Lockheed Martin" surveillance system is planned to be placed on board the DDG destroyer of flight IIA "Arleigh Burke" in 2021. The US Navy has officially adopted the LW complex into the Aegis combat system. In addition, LW is being tested for the ability to disable unmanned aerial vehicles by integrating such weapons on board naval vessels. For example, in May 2020, USS Portland successfully disabled an unguided aircraft while testing a new high-energy LW system. Northrop Grumman developed the system and the test was carried out after an incident with a Chinese destroyer, where a US Navy patrol plane "P-8A Poseidon" fired a weapon-grade laser. In addition, it should be said that many countries are also seeking to expand their naval defense capabilities to contain and neutralize the threats of a potential adversary. China is among the countries that intend to fight for their security, and therefore for parity in the creation of a modern LW. The PLA Navy has tested its s/s fiber tactical laser system, which, according to foreign experts, bears a striking resemblance to the US Navy LW, which today is close to achieving absolute target hitting accuracy at the already achieved power level.

Conclusion

Over the past decades, China has done and is doing a lot for the well-being of the Western world. China had to develop dirty and environmentally hazardous industries, put up with low wages for hard work of performers and much more. Why not, then, to take an advantage of China`s position as a world workshop and to do something for own defense! Moreover, the situation around China has become much more complicated lately. A talented and hardworking scientific and technical contingent of China is able to solve complex problems and effectively introduce new modern technologies into the country's industry, which, as President of the People's Republic of China Xi Jinping said, is the key to modernizing the Chinese Armed Forces [1].

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