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The basic requirements for modern complexes of guided artillery armament as an element of conducting distribution-fire actions of tactical level

Розглянуті загальні тенденції інтеграції елементів артилерійського озброєння, безпілотних літальних апаратів, автоматизованих систем управління реального часу функціонування в розвідувально-вогневі комплекси.

Рассмотрены общие тенденции интеграции элементов артиллерийского вооружения, беспилотных летательных аппаратов, автоматизированных систем управления реального времени функционирования в разведывательно-огневые комплексы.

Essential military-political changes in the world, taking place for the last time, lead to a revision of concepts of the technical equipping the armed forces in the leading countries. The question of a significant increase in their combat capability is solved by conducting a wide range of measures, including the equipment of new types of weapons and military techniques.

Obviously, the most characteristic feature of modern military conflicts is the transition from «contact» forms of fighting action, in which the main role is assigned to blows by the ground general military forces, to the so-called «contactless» intelligence-fire forms, in which effective fire damage plays an increasingly important role. Exactly to such types of fighting action a system of ground rocket and artillery armament should be prepared. At the same time, considering their relative low cost, special importance is given to the creation and development of high-performance artillery complexes with guided artillery shells (KAC) that are capable of providing high precision to hit the target. Schematically, the fighting use of artillery complexes with controlled shells is given in Figure 1.

At present, as the most modern artillery damage means of this kind can be consider KAC "Krasnopol", "Krasnopol-M1, M2," " Copperhead -2", "Kvitnyk-E" (comparison of the TTC of these artillery shells with the laser semiactive head of self-guidance is given in Table 1).

From table 1 it is easy to make a positive conclusion in favor of the domestic high-tech components in the field of laser technology, which provide the advantage of «Kvitnyk-E» over existing analogues (American «Copperhead-2» and Russian «Krasnopol-M1») regarding the accuracy of the hit in single (including moving) target and its damage due to a larger mass of explosive material of the combat part. It is also necessary to note that the «Kvitnyk-E» in solving the typical task of destroying the platoon support point with a damage level of 60% has efficiency several times higher than conventional ammunition [1].

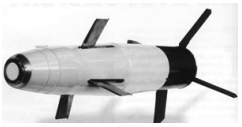
Also note, that as a result of many years of research and development in many countries of the world, including, unfortunately, only partly in Ukraine, the system of land-based artillery intelligence has been formed in the following composition:

- radio-location intelligence stations for land-based moving objects;
- radio-location intelligence complexes of firing (starting) positions of shooting equipment;
- complexes of radio engineering intelligence;
- acoustic-thermal complexes;
- complexes of intelligence-signaling devices with ground-based sensors of various physical nature;
- moving intelligence points;
- laser target point-rangefinder;
- optical-electronic sights;
- optical-electronic devices for intelligence and surveillance.

Armed with the above-mentioned samples, artillery units, to a certain extent, are ready to perform their tasks in promising forms of fighting action.

Fig. 1. Fighting use of guided artillery shells (the operator of a rangefinder-target point has a hidden position for observing and illuminating the target by a laser device in a zone of 30 degrees angle to the left and to the right of the line of the shot and not more than seven kilometers at the dominant height)

Table 1

Basic indicators of the tactical and technical task	«Kvitnyk-E» Ukraine	«Krasnopol» (USSR)	«Krasnopol -M1» (Russia)	«Copperhead -2» (USA)
Appearance				
Maximum firing range, km	at the level of analogues	17	18…20	16
Type of BC	HEF	HEF	HEF	cumulative
Weight ES, kg	more 8	6,3	6,5	6,7
Weight of the projectile, kg	less 48	52	51	62
Probability of defeat (destroy)	better than analogs	0,7…0,8	0,8…0,9	0,6

The tactical and technical characteristics of the samples of RV and A in terms of reliability and maneuverability generally satisfy the requirements that are being made, at the same time, the processes of managing the weapon require automation, and the effectiveness of combat use of certain types of ammunition is an increase. The tactical and technical characteristics of rocket forces and artillery samples, such as reliability and maneuverability, generally satisfied the nominated requirements, at the same time weapons management processes require automation, and the effectiveness of combat use of certain types of armament needs to be improved.

At present the perspectives for the development of artillery armament are related to the implementation of the modern concept of enemy fire damage (EFD). A key element of this concept is the implementation of the EFD by method of intelligence-fire action [2, 3]. The possibilities of using artillery armament in the mode of intelligence-fire actions with the implementation of modern methods of zonal-object and structural damage to the enemy's objectives are currently limited. The reason for this – the shortcomings found in recent years in existing artillery armament:

- insufficient existing capabilities of land-based artillery intelligence;

- insufficient possibilities of the system of guiding the projectiles to the target;

- insufficient possibilities of artillery armament (with controlled ammunition) from firing range (up to 2 times) in comparison with other samples;

- insufficient degree of automation process of applying the artillery complex;

- significant tactical complexity of applying the elements of the complex (the necessity to place a reconnaissance receiver with a laser backlighting directly in relation to the target and the dominant heights).

Elimination of these inconsistencies to modern requirements to the level of development of artillery armament is possible only with the implementation of an integrated approach to the creation of a balanced perspective artillery system from the part of the intelligence-fire complex of tactical level. This implies the correlation between the improvement of the means of damage and intelligence, automated control and security. This approach allows you to create not separate samples, but artillery complexes of armament with a structure of open type. Due to this approach, the increase of the adaptability of artillery armament (AA) to various organizational-staff structures, military formations and combat missions, the maximum realization of the potential of the means of destruction.

At present, as the priority directions of development of artillery systems, as elements of conducting intelligence

-fire actions of tactical level, it is necessary to determine the following:

- increasing the capabilities of the subsystem means of intelligence to detect enemy objects using UAV;

- increasing in the level of automation management of combat work of fire equipment, processes of preparation and conduct of fire and tactical autonomy (including - automation of topo-geodetic, meteorological, ballistic support, automatic support of the target system of illumination);

- the creation of an automated control system that provides control of the enemy's fire damage in real time (automation not only the process of the KAC shot, but also the management of an unmanned intelligence device and objective illumination);

- the implementation of a new generation of high-precision armament with increased range of shooting and an integrated target pointing system (active-reactive shells or the use of bottom generators and complex correction of shells through receivers of satellite navigation and self-guidance systems);

All this can be characterized as the integration of intelligence, guidance and damage on the basis of automated real-time control systems for the purpose of creating intelligence and fire artillery systems.

How can this be realized?

First, modern advances in the fields of microelectronics, computing, communications, navigation, and other fields of science and technology allow the creation of diverse or multi-purpose UAVs [4, 5, 6]. In our case, the main functions should be the following three: monitoring of territories (in this case, the equipment in automatic mode determines coordinates of the location using the ability to receive signals through the terminal of satellite navigation systems GLONASS and GPS, as well as other navigational parameters such as speed, direction and condition of the connected sensors, as well as the technical condition of the unmanned vehicle as a whole); targeting for artillery armament systems; illumination and automatic tracking of laser beam targets for the management of artillery shells with laser guidance system [7]. For this purpose unmanned vehicles are composed of laser radar and the camera. Underline that this function UAV can perform both for artillery shells and for the means of damage, which are located on the autonomous aircraft (fig. 2).

Fig. 2. Intelligence, automatic tracking of the target and guidance the means of defeat from the UAV

At the same time, there are a number of technical problems that abstain the development of the UAV. The most important task is to ensure the transfer of information through the communication channels between the "unmanned aerial vehicle" and the ground control point in the required quantity, with a given speed and without distortion. This task is solved by increasing the bypass capabilities and noise immunity of the channels of information transmission, as well as the concentration of aboard the UAV maximum of facilities that operate in the autonomous (software) mode without the need for constant exchange of information with the control point. To perform tasks solved the issue of communication with the UAV via satellite channels as the most stable and reliable.

Another problem is the vulnerability of data transmission channels between the UAVs and their control point. This problem is solved by the closure of communication lines, the use of autonomous UAVs, the use of satellite repeaters, etc. Unfortunately, at present, such technologies of equipment of unmanned vehicles are still practically not used in Ukraine.

The second direction is the improvement of automated control systems as an element of the IFC.

As stated in the opening part of the article, during conducting modern combat operations, network centricity became a reality. This led to new forms and methods of managing the armed forces, requiring the automation of the process of making fighting decisions and planning the battle and leading to new ways of conducting fighting action [2].

At the same time, the existing artillery units in the armed forces of Ukraine do not meet the requirements of the present: low level of information exchange and automation of calculations, the absence of automated navigation and top-up navigation systems, the lack of automated reception of information and analytical information (for example, geodetic and weather data), the absence of automated combat operations, which is the basis of modern automated control systems (ACS) of tactical link and thus not the invariance of samples into a single IFC [2, 8, 9]. In order to eliminate these inconsistencies of the existing ACS with modern requirements in Ukraine, the development of the "Obolon-A" model is completed (Fig. 3) [8, 9].

Fig. 3. Option of the layout of the technical equipment on the crawler platform

It should be noted that when designing the equipment of the complex for machines and machines themselves, there

were contradictions between the depth of automation of real-time control processes of machine systems and the simultaneous necessity of the availability of advanced technical means that expanded the ability of the crew to receive and process information and, first of all, in the field of computing, navigational tasks and inter-machine interaction.

The optimal performance of this function was achieved through the creation of automation of control processes as a separate machine and control complex as a whole, that is, the possibilities of the continuous process of receiving, processing and transmitting data within the framework of the integrated control system of the tactical link were realized.

The main attention during the creation of the complex was aimed at the construction of modern hardware and software data processing, equipment for internal communication and data transmission, external communication equipment, the introduction of automatic navigation systems and top-linking. Accordingly, there were newly created systems of energy and life support of machines that took into account all requirements of the use of new hardware and software of the modern stage [9].

The main functions of the proposed variant of the technical equipment for command-staff cars (CSC) of the artillery division (battery) are: automated implementation of a complete set of fire tasks, the formation, transmission and reception of telecode messages in digital form, automated top-linking, the ability to deploy equipment system on any kind of vehicle or combat armored vehicle, deep automated testing of systems in the event of failure. The automated data processing system consists of a combined information database of crew jobs (the number depends on the organizational and staff structure of the unit), which is located on a tracked or wheeled platform [8, 9].

In addition, for each control machine, regardless of the type and type of mobile platform, remote equipment kits have been developed, which allowed autonomously without a car to solve a certain range of tasks for controlling fire batteries (batteries) while maintaining sufficient digital information and voice communication with the entire system of the complex (Fig. 4) [8, 9].

Fig. 4. Remote control complete set

At the same time, it is necessary to find out how the specified level of development corresponds to the prospects for the development and integration of elements of artillery armament, unmanned aerial vehicles, real-time automated control systems in intelligence and fire systems.

One of the important ways to increase the effectiveness of the use of army and weapons in a single information space is to achieve information and operational superiority over the enemy. This should ensure a qualitatively new level of information compatibility systems of the intelligence, control and damage systems within the framework of the only one information and management infrastructure (including integration of UAV ground control points in the artillery complex system) and the closure of the intelligence and fire control system – fire complex (Figure 5).

Fig. 5. Option for building the IFC control point

The main direction of creating a single information space is the complete automation of the main processes of forces control on all chains and the creation of means that allow forming a single picture of the combat situation on the basis of data obtained from various sources. The uniform picture of the combat situation should be reproduced and brought to the commanders of all levels in a manner that is convenient for perception and sufficient to fulfill the task, to provide comprehensive planning of the combat application of various forces and weapon systems in accordance with the current situation at a near real time.

In other words, an important direction in further improving the efficiency of the command-and-staff car (CSC) of artillery division (battery) type «Obolon-A» (except the integration the UAV's ground control points into the ACS of the artillery complex) can be considered the unification of the sample on the basis of a modern high-speed communication system and data exchange for the needs of rocket forces and artillery, tactical units of the typical general military formations, and, in the future, integration into a single ACS of the Ground Forces on single technical, informational and software solutions (without locking which provides effective fire damage to the enemy in the intelligence-fire circuits, including the use of high-precision weapons.

First and foremost, thirdly, the improvement of precision munitions due to increasing the range of firing and building a comprehensive system of guiding the projectile to the target.

The range of shooting depends not only on the length of the tube. In fact, the parameters of the trunk affect the range only indirectly, because only helping throwing charge to disperse the projectile for a little longer time. In recent

years, many new varieties of artillery gunpowder, which are used in modern throwing charges, appeared.

Some new original solutions have been applied to create new cartridges with charge in the leading countries. For example, there is gunpowder with inclusions of explosives substances or with a special form of grain of gunpowder. Such measures help to significantly increase the rate of combustion of gunpowder and, as a result, the release of energy. In addition to the use of conventional gunpowder, although made on the basis of new technologies, at present, other versions of the throwing charge are also investigated. Abroad are conducting research on the use of liquid fuels or even powder of some metals. In theory, such techniques can significantly increase the energy transferred to the projectile, however, while combatant artillery has to deal with traditional composite based on gunpowder. It is noteworthy that in pursuit of an increase in the range of firing "involved" not only trunks and throwing charges. For a long time, there are two ways to increase this parameter by upgrading the projectile. For the most effective dispersal in the channel of the tube, the projectile must have straight or close to the surface of the bottom part. However, in flight, such a "chopped" back part of the projectile is formed vortices that inhibit it. In order to avoid the formation of these vortices, shells with gas generators were created. A special pyrotechnic checker, which is located at the bottom of the projectile, burns and throws gases through the nozzles. Those, in there turn, fill the space behind the projectile and interfere the formation of excess turbulence, and to some extent disperse the projectile. As a result of the application of the gas generator, the range of the projectile's flight increases by a significant amount. For example, the charge ZVOF91 SPAM "Msta-C", equipped with a bottom gas generator, has the same weight parameters and characteristics of the throwing charge, as well as the conventional fragmentation-high-explosive projectile ZVOF72. In this case, the projectile with a gas generator can fly at a range of about 29 kilometers, which is almost 20% more than the similar parameter projectile ZVOF72.

An effective, but more complex alternative to a projectile with a gas generator is an active- reactive projectile. It is thrown out of the gun barrel by means of a powder charge, and then it includes its own solid-fuel engine. Thanks to such a system, it is possible to significantly increase the range of shooting. The record holder for this parameter is currently considered a Denel V-LAP projectile. During the tests of this projectile, the self-propelled artillery installation of the German production PzH 2000 sent it to 56 kilometers. Claimed by the manufacturer, the maximum range of firing with this projectile even more - 60 km. For comparison, the range of firefighting aircraft SPAM PzH 2000 by an ordinary projectile of the same mass with the same throwing charge does not exceed 28 ... 30 kilometers. It is noteworthy that the premise for the result of the V-LAP projectile was not only the presence of the charge of rocket fuel, but also its improved aerodynamics. Now various attempts are being made to increase the range of artillery shells. The most perspective now is the creation of new active- reactive shells with increased thrust of a solid-propellant engine. At the same time, infinite increase in range only due to new fuel composition is impossible, since its quantity is limited by the dimensions of the projectile. For this reason, there are new solutions, such as artillery shells equipped with folding wings with which he will be able to fly for greater distance.

A significant increase in the firing range UAV provoke the need to find additional or other methods for its correction on the trajectory (for a long time flight of the projectile, the negative impact of the environment greatly increases the total shooting error, which should be worked out by the system of self-guidance on the final site of firing).

A M982 Excalibur projectile was developed as a solution to the problem in the United States. This projectile does not use target illumination, since it has a combined inertial-satellite guidance system. Before firing, the artillery unite receives the coordinates of the target from the intelligence and introduces them into the electronic "stuffing" of the projectile. Further, the 155-millimeter projectile is fired and, correcting its trajectory according to the data of the inertial navigation system and GPS satellites, strikes the target, or falls in close proximity to it. The declared range of shooting up to 60 kilometers is provided with the use of an additional solid-propellant engine. Moreover, a high range is provided by a folding wing on which the projectile plans from the upper point of the trajectory. The declared circular probable deviation (DCD) of the shell M982 does not exceed 10 ... 12 meters [10]. Shell M982 allows not expose lethal risk agents and proofreaders because the coordinates of targets may be obtained by any available means, including using unmanned vehicles. This Excalibur (Fig. 6) criticized the fact that the pointing coordinates does not guarantee destruction of moving targets.

Fig. 6. The look of the M982 Excalibur projectile

While the data on the target coordinates will reach the artillery and while they will conduct the training of the projectile and a shot, the technique of the enemy may have time to leave the given area. Therefore, it is expedient to save the self-guiding contour on the final flight.

Considering that, in accordance with the adopted definition, modern intelligence and fire complex is a system that combines intelligence, guidance, control, fire damage and is intended to identify and destroy the most important single and group moving objects of the enemy in the depths of the location of its forces, regardless of meteorological conditions and time of day, we will conclude a conclusion on the trends in the development of integrated elements of the artillery complex.

Thus, such tendencies are:

- Requirements for increasing the firing range (due to the use of a sub-engine or a bottom generator) require the creation of a guided projectile with a combined guidance (the initial phase - for signals GPS (GLONASS) [11, 12], the final - laser self-guided);

- Requirements of a tactical nature require application both for intelligence and high-quality guidance of the KAC (guided artillery shell) to the target with the UAV (herewith the target illumination can be included in the contour of automatic escort of the target);

- Requirements for a unified information policy, the integration of elements of artillery weapons, intelligence, and management in a single RMC need to be equipped with a UAV control point and ACS (automated control system) an artillery complex.

The technology developed in Ukraine, in the main, will allow the creation of more promising specimens of high-precision armament and CAS for other types of artillery armament, and other elements of the RMC.

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