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GROUND COMPLEX DETERMINATION OF THE FLIGHT TRAJECTORY OF A LOW-LYING OBJECT

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Abstract—Designing a system of protection of the state border on the basis of a capacitive converter. The analysis of the main stages of the system's operation is carried out, its principle of operation. The mathematical model of the system model and algorithm of work is developed. Other systems of territory protection with the further conclusion are considered and investigated. The scheme of the system of protection of the territory of special purpose on the basis of a capacitive converter is considered. It has been established that the designed system of protection of the state border on the basis of a capacitive converter has advantages over existing security systems, which gives it an urgency and impetus for the prospects for further development.

Index Terms—Leading lines; electrode; electromagnetic field; power generator; measuring circuit.

I. INTRODUCTION

Territory protection is a particularly important element of a complex of security measures, both for the objects of the nuclear weapons complex, including nuclear power plants, and for oil refineries enterprises and oil terminals, gas compressor stations and enterprises of chemical production, thermal power and hydro power stations, airports, military arsenals, objects of the military-industrial complex and etc. The State Border Protection System allows us to obtain the earliest information on the penetration of unmanned aerial vehicle (UAV) into the protected area, on the basis of which preventive and operational measures are taken to timely neutralize possible illegal actions in the protected site. [1] Therefore, the warning system – the main component of all complexes of technical means of protection (Fig. 1), which is the basis of any system of physical protection of the object. The system of protection of the state border should promptly (Fig. 2) and accurately identify the place of penetration of the object. This is important for effective unit response (Fig 3). The system of protection of the state border – the main and determinant factor in termination of possible interaction between the UAV and the main vital centers of a particularly important object at the initial stage of the attack. Means of detection occupy a special place in the system of technical means of protection and for a number of other reasons. First and foremost, the conditions of their exploitation vary great variety and a wide range of influence of climatic and geological and geographical factors; in many objects there are numerous interferences of

anthropogenic nature: acoustic and vibrational – the work of transport or equipment. And also from the choice of the tactics of the object's protection, availability of the city telephone line, the opportunity to lay out the leading lines (signal lines) and other factors. Thus, a "useful" signal from the object arises in the conditions of a huge number of external destabilizing factors. And the range of basic characteristics of useful signals and interferences, as a rule, overlap, which causes the need to use complex and sophisticated algorithms for their processing. Therefore, precisely, efficient and not complex structure of protection means today determine the scientific and technical potential of developers in the market of security technologies. On the modern market of security services there is a wide range of safety systems of domestic and imported equipment, with the help of which it is possible to build a security system of any object.

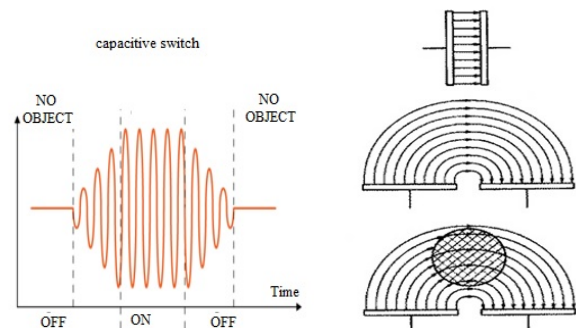


Fig. 1. Scheme of part of the system of protection of the state border

Probably everything from a simple, with a minimum saturation of means to a fire and security

system, to a complex, integrated security system, which combines video surveillance systems, access control, time recording, as well as OPS and alarm signaling, emergency alert system and etc. But due to the multifactority, complexity and unreliability of systems. It is such a system that is a technical solution that can solve such problems. Simplicity,

absence of significant influence of climatic conditions on the work of the system, the ability to contact lastly identify low-flying objects and the location of the violation of the boundary of the territory, the speed of installation and programming will be able to equip any territory with any relief.

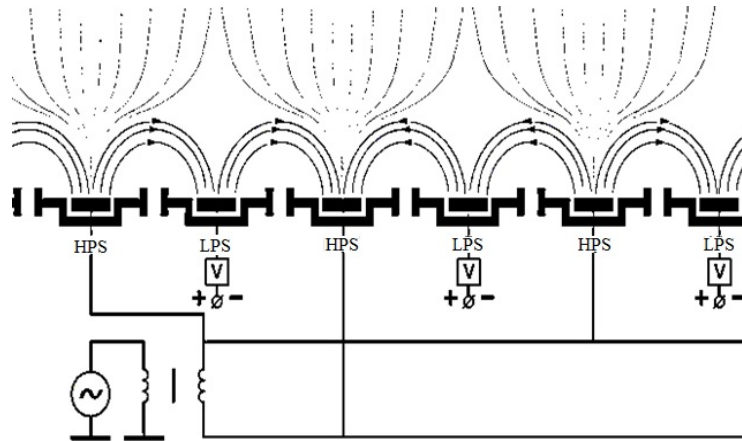


Fig. 2. Scheme of ground complex determination of the flight trajectory of a low-lying object. HPS(high potential sensor)LPS(low potential sensor)

II. PROBLEM STATEMENT

The main problem is the protection of state border. Creating technical means for detection of low-flying object which the unauthorized goes over border. If this flying on a hundred meters, can we detect this object or fly further? Yes our border guard can detect object but they have not our technique which received from western neighbors.

III. PROBLEM SOLUTION

In our opinion, the most suitable method for finding potential violators is the electroneutric method, which, unlike the ones described above, provides accurate information regardless of the weather conditions and the way to overcome the system barrier. If there is any violator in the monitoring area, this will change the configuration of the electromagnetic field of the capacitive converter and will allow you to receive warning information about the change of the situation at the state border. The study of the properties of a capacitive transducer with a nonuniform field, carried out by mathematical modeling, showed the following. The converter with systemically located electrodes forms the electromagnetic field of a certain configuration.

The electromagnetic energy stream emits an electrode and divides it into three streams: the flow to the adjacent low potential electrode (NPE) or the high potential electrode (VPE) of the opposite sign

and to the flow that fills the other space and goes to infinity. Due to the symmetry of the location of the emitting electrodes, the picture of the distribution of the electrodes will also be symmetric.

IV. PRESENTATION OF MAIN MATERIAL

The creation of such a system based on the capacitive method was restrained by the lack of well-designed devices for measuring excess capacities on the one hand, the uncertainty of the nature of the change of inter-electrode capacitances of the converter from the distance, the nature of the obstacle, the electrical properties of the environment, on the other [2]. For measurements of small quantities of capacities many works devoted to the Institute of Electrodynamics of the National Academy of Sciences of Ukraine (Kyiv), Institute of Automation and Electrometry of the Academy of Sciences of the USSR (Novosibirsk), VNIIM (Leningrad), KIIGA (Kyiv), as well as some branch institutes (Kyiv, Lviv, Ivano-Frankivsk, Baku, Tomsk, etc.). However, work on methods and devices for measuring capacities of the order of $10^{-4} \dots 10^{-6}$ mf is very limited. In this case capacitive transducers with a homogeneous ("closed") field were investigated, designs and measurement circuits were developed that eliminated the effect of the "edge" effect. Research of the same nature of the changes of interelectrode capacities of converters with substantially inhomogeneous ("open") field in the literature is practically absent. At the same time, device-signaling devices, based on this principle

were developed quite a long time ago and widespread. To find out the physical properties of converters with substantially heterogeneous field, designing the best configuration, composition, geometry and size of the system of electrodes, as well as forming the desired configuration of the electromagnetic field, it is necessary to conduct a theoretical and experimental study.

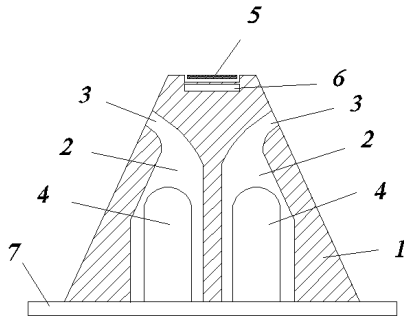


Fig. 3. Protective device

Due to placement under such a scheme it becomes possible to calculate the direction and velocity of the object, which makes it possible to know exactly where it is located, and to neutralize the unauthorized crossing of the border [3]. The advantage of this system, unlike the previous one, is that it is possible to determine the velocity and direction of the observed object, thanks to the sensors propagated in three directions in the line, called "Trident", with the increase of the possible lines, for more accurate determination of the indicators that are calculated by the sensors. If you are missing out on three, you can use the "Quadro" system to help you observe the object, this system adds one line to the "Trident" system. A part of the flow going to infinity is closed by the earth's environment and passed to the receiving electrode. Naturally, the values of the capacities C_{13} , C_{43} change, giving information about the approach to the terrestrial environment. The described effect can be the basis of the principle of the device's operation to create a protection zone. Thus, there is a need to develop technical means that form a protection zone, when a moving object appears in which a control signal is issued. Function the protective device should be the impact on the trajectory of the projectile. To find a solution to the problem considered, a review was conducted and analysis of existing methods and devices. Considered location methods - radio, ultrasound, laser, methods based on measuring the parameters of the electromagnetic field. Analyzed devices that implement these methods. In our opinion, a capacitive transducer with a non-uniform field can be used to create a detection zone for a moving object. Studies of the properties of a capacitive transducer with an

inhomogeneous field, carried out by mathematical modeling, showed the following. A transducer with planar electrodes forms an electromagnetic field of a specific configuration.

The measuring circuit of the device is based on a transformer bridge. Picture of the force field Picture of the force field of a capacitive transducer when interacting with the terrestrial environment. Some part of the flow going to infinity is closed by the terrestrial environment and passes to the receiving electrode. Naturally, the values of capacitances C_{13} , C_{43} change, giving information about the approach to the terrestrial environment. The described effect can be the basis of the principle of operation of the device for creating a protection zone. The appearance in the protection zone of a moving object an information signal arises. It is proposed to develop a complex of capacitive converters with the placement of elements on the plates of the additional design of armor. An information signal appears in the protection zone of a moving object. It is proposed to develop a complex of capacitive transducers. The flux of the electromagnetic energy of the emitting electrode 1 is divided into three streams: the front and rear receiving electrodes 2 and the flow going to infinity. A similar pattern is formed in the next forward emitting electrode 1. When a moving object appears in any part of the protection zone, the configuration of the electromagnetic field changes, and the value of the capacitance changes. This creates a control signal for the security device. The protective device is a truncated cone body 1. In the upper plane, there is a radiating electrode 5, in the cavity below it is placed the electronic unit 6 (power generator of the measuring circuit). The lower part of the housing is divided into two cavities 2 (chambers), each of which is inserted an active charge 4 with controlled undermining. Each cavity in the upper part has a hole in the form of a nozzle 3. The dimensions and arrangement of the nozzle are designed to form a jet of exhaust gas with predetermined pressure, velocity and direction of the jet of the exhaust gas. When the control signal is fed into the corresponding chamber, the charge 4 is undermined, and the jet of the exhaust gas acts on the moving object, changing its trajectory. The protective device is fixed on one of the plates of the 7 additional armor protection structure and has links with the power supply and the electronic control unit. The receiver electrode 2 is connected to the amplifier input whose output signal is converted and processed in the electronic control unit 6. The electronic control unit generates a burst signal that is fed to the corresponding camera of the security device from which the signal of the

appearance of the moving object has been received. The parameters of the control signal (feed time, signal interval, etc.) can be corrected by the operator and / or software.

V. CONCLUSION

In the work, exact and approximate analytical expressions were obtained, allowing to calculate the parameters for determining the position of the UAV or other flying apparatus. The calculation of these parameters is necessary to determine the size and choice of the location of the UAV in space. Both the length and the vertical dimensions of the device depend on the dimensions of the UAV and its

capacity (for example, from which it is made of metal).

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А. Е. Козюк, А. П. Козлов. Наземне комплексне визначення траєкторії польоту низинного об'єкту

Розроблено систему захисту державного кордону на основі ємнісного перетворювача. Проведено аналіз основних етапів роботи системи, її принципу дії. Розроблено математичну модель моделі системи і алгоритм роботи. Розглянуті і досліджені інші системи охорони території з подальшим укладенням. Розглянута схема системи охорони території спеціального призначення на основі ємнісного перетворювача. Встановлено, що розроблена система захисту державного кордону на основі ємнісного перетворювача має переваги перед існуючими системами безпеки, що надає їй актуальність і дає імпульс для перспектив подальшого розвитку.

Ключові слова: лідируючі лінії; електрод; електромагнітне поле; енергетичний генератор; вимірювальний.

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Публікації: більше 50 робіт.

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А. Е. Козюк, А. П. Козлов. Наземное комплексное определение траектории полета низменного объекта

Разработана система защиты государственной границы на основе емкостного преобразователя. Проведен анализ основных этапов работы системы, ее принцип действия. Разработана математическая модель модели системы и алгоритм работы. Рассмотрены и исследованы другие системы охраны территории с дальнейшим заключением. Рассмотрена схема системы охраны территории специального назначения на основе емкостного преобразователя. Установлено, что разработанная система защиты государственной границы на основе емкостного преобразователя имеет преимущества перед существующими системами безопасности, что придает ей актуальность и дает импульс для перспектив дальнейшего развития.

Ключові слова: лидирующие линии; электрод; электромагнитное поле; энергетический генератор; измерительный кругооборот.

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