GENERAL CHARACTERISTICS OF AUTOMATICS IN THE SPATIAL MOVEMENT OF A SHOT

Penkov P. PhD, Bakalov K. PhD, Nedev. N PhD
Vasil Levski National Military University – Veliko Tarnovo, Bulgaria

e-mail: pet_penkov@abv.bg

Abstract: *In the present paper the general characteristic movement of automatics of a shot is discussed, and an analysis is given concerning the laws of the movement of the weapon mechanisms..*

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1. Introduction

The characteristics of automatics in the spatial movement of a shot are important component for increasing the efficiency of shooting. The forces that arise from the movement of the automatics change the targeting, rise the diffusion which decrease the efficiency of the shooting and creates the requirement for searching of new constructive solutions applied in the weapons.

2. Results and discussion

Providing the necessary strength, rigidity and reliability of the kinematic couple units in the automatic weapon mechanisms is solved by analyzing the power load of these mechanisms. The stability of the functioning of the weapon's automation mechanisms, their position in the space during the firing, significantly determine the effectiveness for the destruction of the objectives and the action of the forces applied to the weapon's body. Therefore, the study and analysis of the entire system of forces operating both its mechanisms and the weapon as a whole constitute the first major task of weapon dynamics in a shot.

When considering the task of the kinematics of the weapon mechanisms, it is assumed that the law governing the movement of the leading unit, is known. The kinematic parameters are a function of the external forces acting and the mass of the weapon's automation units. Therefore, studying and analyzing the laws of motion of the mechanisms and the weapon under the system of applied forces, constitutes the second major task of weapon dynamics in the shot [1].

For the general characteristics and the calculation of the forces acting on the automatic weapon, the most important are the forces F^{gun} of their physical nature. This division of the acting forces allows to find the co-ordinates for their modification and to develop the general methods for calculating these forces in the study of the movements of the units and the mechanisms under their action.

These forces act not simultaneously. They perform different tasks, and attach themselves to different mechanisms or elements of the weapon's construction. In some momentary cycles or in relation to some units of automation they can be moving forces, external, adaptable and acting constantly F_{ext}^{gun}, whereas with respect to other units they can be- respectively forces of resistance, internal forces of reaction and acting periodically F_{int}^{gun}.

Efficiency forces and forces with harmful or passive resistance should be distinguished. In the operation of the weapon, sometimes the same force in some conditions can be a force with a useful resistance, and in other conditions a force with no-load resistance. This division of the forces into external and internal forces is of a relative nature, but it has a fundamental practical meaning [1]. The external forces are attached to the units or the weapon and work with respect to their displacement. Internal forces are mutually equated and most often are excluded in a number of calculations. Or the forces which impact on the system can be described by the equation:

$$F^{gun} = F_{ext}^{gun} + F_{int}^{gun} \quad (1)$$

The division of the forces of two types; those assigned, and those reacting in the supports and connections, is more definite, because they never change their role. Assigned forces depend only on the kinematic parameters of the mechanisms and the law of their modification is usually known until the beginning of the analysis of mechanics or weapon dynamics. Reactions in the supports and connections in the kinematic pair arise as a consequence of the assigned forces attached to them, and therefore can be determined only as a result of the study of the dynamics of the mechanisms.

In general, the equations for the movement of the automatic firearms in a shot should be added to the equations defining all the forces involved in the operation of the automation. The forces under which the elements of the weapon's mechanisms F_{muv}^{gun} are moved can depend on each other or on the movements of the units, or they may not depend on it. In the first case, the automated motion equation system and the equations characterizing force change laws must be solved together. If such interdependence does not exist or is insignificant, then the equation systems for automation and forces can be solved independently

As criteria for evaluation, the dynamic characteristics of individual weapons K_{din}^{gun} mechanisms are used: the magnitude/value/ of the efficiency of the mechanisms $K_{mech}^{\kappa n\partial}$ - it testifies to the degree of perfection of the mechanisms; the coefficient of loss in kinematic pairs and weapon mechanisms K_{mech}^{loss}, closely related to the notion of durability and wear-resistance of the units; the growth coefficient of the output of the leading (unit) K_{ener}^{freq} - gives an idea of the degree of dynamics of the work units and automation mechanisms; various coefficients characterizing force change, force moments, reactions, powers, friction, relative pressure, etc., applied for solving private tasks in the overall assessment of the dynamics of individual weapon mechanisms K_{other}^{gun}.

Or the summary evaluation of the weapon's dynamic characteristics, i.e. the criterion for evaluation on these characteristics may be expressed by the dependency relation:

$$K_{din}^{gun} = K_{mech}^{\kappa n\partial} + K_{mech}^{loss} + K_{ener}^{freq} + K_{other}^{gun} \quad (2)$$

With the usage of (2) the main objective of the analysis of the dynamics of automatic weapons automation mechanisms is the clarification of the nature and degree of the mutual influence of the movement of the automation mechanisms on the spatial movement of the weapon and vice versa.

Practically, each sample weapon resulting from the shot performs various character movements in space, characterized primarily by its geometry, non-established regime and insufficiently stable alteration of its characteristics. Under these conditions, the absolute movement of its automatics can be regarded as complex, representing the totality of the relative movement of the mechanisms in the corpus, and thgrough transmission - together with the corpus. Presenting the spatial movement of the weapon by introducing corrections or adjusting the initial conditions of the shot to the characteristics of the relative movement of its mechanisms is inaccurate and, in a number of cases, incorrect and wrong, given the complexity of the phenomena.

Each consecutive cycle of automation in consecutive line shots practically starts in the conditions of in determined spatial weapon movement caused by the cumulative influence of factors as a result of the previous shot.

The spatial movement of the weapon during firing affects a number of its properties and especially the flawless functioning of the weapon's mechanisms and the effectiveness of firing it. The impact of the weapon's flawlessness is manifested by changing the conditions and characteristics of movement of the individual parts resulting from the spatial movement of the weapon. This situation alters the energy balance of the main parts and their relative movement, which is a reason for malfunctions and glitches in the operation of the automation mechanisms.

Shooting efficiency Eff_{shut}^{gun} is a parameter that depends on many factors but is largely determined by the dynamic resistance of the weapon, of its ability to maintain the persistence of its movement characteristics or to maintain the position of the barrel channel axis at the point of discharge in space before each shot. Therefore, the quantity of the angles and the angular rate of rotation of the weapon or its alignment over the cycle of the operating automaton can be taken as criteria for dynamic stability of the automatic weapon. Of course, this is not a simple phenomenon, as a number of factors have accumulated on the movement of the weapon, which in the analysis of the compilation of differential equations for the movement of the automation and the weapon must be accounted for.

The system "firing gun"- "shooter" as a biomechanical system is characterized by the greatest complexity due to the uncertainty of the psychic and physical reaction of the subject at each shot. In the shot, the weapon initially moves by experiencing the increasing muscle drag on the part of the shooter. Studies have shown that the perceived force response can not be expected earlier than 0.2-0.25 seconds. after the shot. This gives us the right not to consider the shooter's reaction in short rows (3-4 shots) and to consider the "firing gun-shooter " system as an open system [2].

Cyclicality in the action of forces and impulses makes it possible to present the system as an non-closed oscillating system with fully defined characteristics that can be fully correlated with the experimental data.

Drawing from the peculiarities of the system under consideration, the reduction of the effects of the spatial movement of the weapon can be achieved by reducing its impact on the shooter and selecting the most suitable shooting position. The "weapon-mount -shooter" system is not complicated, has a small span and a defined measurement of the spatial movement of the gun when shooting. In this system, on the part of the mount, the arms of the weapon are mainly loaded - mainly its longitudinal, reciprocating movement in the guiding of the mount [2]. Attachment of the guiding mechanisms limits the turning of the weapon within the tolerance of the technical gap in the links of the mount. The force effect of the shooter on the spatial movement of the weapon on mount, is not decisive because of the mechanical link. The nature of the movement of the weapon is influenced by: the structure of the mount, the design and characteristics of the dampers and other mechanisms of the mount; the rigidity of the whole system; the means of gripping the mount in the soil or in the platform, as well as the soil properties.

The "weapon - fighting machine" system is characteristic of tank, zenith and aviation weaponry. The latter are fastened to swing and swiveling parts of the set and control power lines, which practically exclude the direct impact of the shooter on the functioning weapon. The movement of such a weapon in space is mainly determined by the nature of the connection of the weapon with the combat machine and the oscillation of the machine itself.

When the system of forces acting on the weapon is known, the general task of analyzing the dynamics of the system's mechanisms in space movement is determined by the degree of mutual influence of the characteristics of the weapon's constants, its automation and its means of attachment.

An analysis of the impact of weapon characteristics, the mechanisms of its automation, and their relative movements on spatial motion are made to provide the required effectiveness of the firing of a projected weapon.

In theoretical studies to determine the characteristics of the joint-movement mechanisms of automation and weapons in space is usually assumed that: the system "weapon - unit" is presented as an idealized scheme to the elements to which forces and impulses emerging at shots and impulses have been applied; it is assumed that the forces and impulses of the forces act on a plane where the center of the mass of the retracted parts is, and the point around which the weapon is rotated; the movement of a weapon in a plane does not depend on its movement in other planes; the conscious reaction of the shooter for the time of the short lines at the normal firing rate does not change; the actual force impact of the shooter on the weapon is offset by the action of the springs and the aerodynamic damping moments and has a fully defined and permanent character corresponding to the average test data [3].

It is necessary when making these assumptions in our own calculations of weapon dynamics, first to analyze the measures of the errors that will occur in our work and, if that suits us, then to accept these assumptions.

The task of analyzing the joint movement of the automation and weapon mechanisms in space is solved by various methods, most often used: the method of mathematical modeling, i. e. analytical solution of differential equations for movement of weapon mechanisms; numerical integration; graphical and graphic-analytical solution; computer solution of differential equations.

The idealized dynamic model should reflect the influence of the elements of the weapon construction, the joint movement of the mechanisms and the weapon in the space of the adopted system. The model is a set of moving mass points dynamically equivalent to the mass of the actual recoil parts of the original, to which the active system of firing and the actions of the stays are applied directly or by means of elastic elements. The movement of the model is considered as a point considered to be immobile for the time of the "motionless" shooter. The model should take into account the features of the adopted system and assumptions.

In many studies of the dynamics of fire systems, the simplified analytical method for determining the characteristics of the spatial movement of the gun during firing has been adopted, to some extent. The basis of this method is the presentation of the accepted system as a rigid system with mean values of the parameters defining its motion during shooting, with respect to the selected point of the support.

In the practical use of this method, we must determine in advance the mean numbers of spring elastic forces, stay response, force impulses, weight and geometric data of the system according to the calculation scheme, as well as the characteristics of the relative movement of the automotive shutter parts.

In the equations for the rotational movement of the weapon in the plane of the shooting, in this case, the following parameters are accepted: the angular velocity for the rotation by the action of the external forces; the variable moment of inertia of the weapon related to its point of rotation; the variable magnitude of rotation of the summed moment by the external forces acting on the shooter's shoulder related to a point; the initial value of the angular velocity from the rotation of the weapon before the shot; the value from the moment of the momentum of rotation of the weapon before the shot; the value of the moment of inertia of the weapon related to the point of rotation, defined as the medium of the end positions of the weapon recoil parts.

The most complete theoretical study of the dynamics of both existing and design weapon models is achieved with mathematical methods based on solutions of differential equations characterizing the functioning of the units and the mechanisms of the weapon. In the majority of cases, the basic equations for dynamics are used, the solution of which is carried out with exact or approximate methods adopted according to the output data. The exact purpose of the research and the accuracy of the results of the study influence the final precision.

The interaction of striking parts and mechanisms of the weapon is one of the features of a functioning automatic weapon, based on the classic scheme of automation with movement of the movable parts after the shot. The impact of automatic weapons is characterized by a wide variety and a high rate of repeatability. Two or more units may be in the process of impact. The most common are strikes between two units immediately or through an intermediate link - both directly and indirectly.

The deformation of the impact units is the reason for the spreading of deformation waves and pressure along the contact points. The end parts of the units of different shapes create a complex structure at the plane of tension, changing their parameters not only to a point, but also to the whole unit. The properties of such a plane determine the distribution of kinetic energy between co-striking units and hence, the change in the velocity of motion of the units after the strike [4].

The strikes transmitted to the barrel box are one of the reasons for the space movement of the weapon. They complicate the operating conditions of the mechanisms and significantly affect the effectiveness of the firing. In the theoretical investigations, the various impacts on the weapon are carried out with a number of simplifying assumptions. Real mechanisms can be represented with simplified idealized schemes or models, and real units - with dynamically equivalent substitution masses, taking into account the specificities of the mechanism and the case under consideration.

3. Conclusion

The study of the characteristics of the automatics on pointing the weapon has important practical meaning. Decreasing the forces that affect the special movement of the weapons leads to decreasing the diffusion and increasing the efficiency of shooting.

4. Literature

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