Cristian BARBU
Titica VASILE
Adrian COMAN
Military Technical Academy
Bucharest, Romania

REGARDING OF ANTIFIRE BALLISTIC SYSTEM

In this paper it is presented the main aspects concerning of utility, designing and realization of antifire ballistic system. This system is designated for extinguishing of fire in closed areas with difficult accessible positions, acting at distances of 10 to 450 m and different elevations. The system is a recoil ballistic system and can be used individually or embarked on auto vehicles and helicopters. In paper is presented ballistic designing of such as system, too. The system was realized and in present is during of testing.

1. Introduction

There are many systems and procedures for extinguishing of fire. It is known that actual systems for extinguishing of fire are realized on the base of principle of extinguishing of fire from exterior to interior affected zone, effecting gradual limiting of this zone, then, diminution and extinguishing of fire.

The main disadvantages of extant systems for extinguishing of fire consist of their using only neighborhood of fire, affecting integrity of intervention personnel as well as only act from exterior to interior affected zone, being to act in zone with difficult accessible positions (high levels or inside of buildings, mountain zone etc.). These disadvantages can be avoided by using new antifire ballistic system.

The system for extinguishing of fire consists of embarked launcher 1 with one or many launch tubes and antifire ballistic system 2 (Fig. 1). The launcher can be portable, having only one guidance tube. The role of launcher is to orientate the antifire ballistic system in direction of affected zone and to ignite propulsion device of ballistic system.

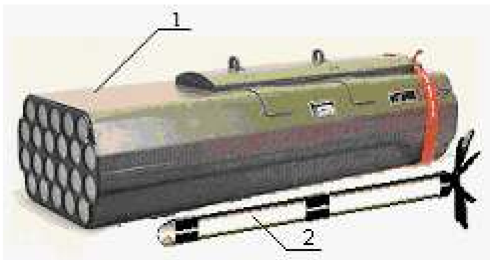

Fig. 1. Embarked fire extinguishing system

The antifire ballistic system (Fig. 2) can have in its structure one stabilizing block 3, two useful compounds 4, two disperses 5 and decreasing device of shock 6.

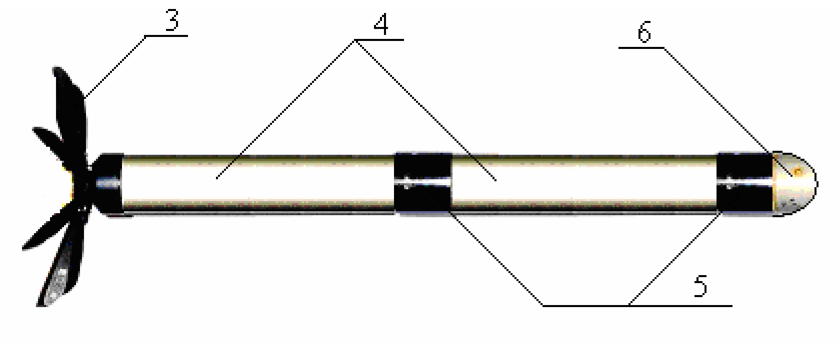

Fig. 2. Antifire ballistic system

The advantages of proposed fire extinguishing system are followings: transports the charge for extinguishing of fire inside of affected zone; can be used for distances of 5-250 m and elevations of 150 m.

2. Organizing and functioning of portable antifire system

The portable fire extinguishing system is presented in Fig. 3 and is consisted of from individual launcher 7 and antifire ballistic system 2. The functioning of antifire ballistic system inside of affected zone is possible due to of two igniting devices 9 which exist in useful compound 8.

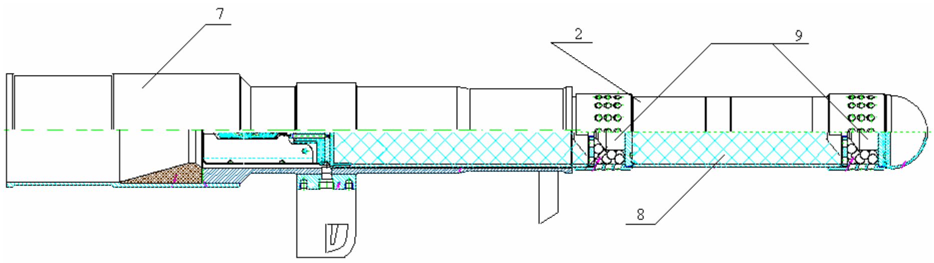

Fig. 3. Portable fire extinguishing system

Individual launcher has got in its compound one evacuation tube of gases 10, one reactive nozzle 11, one handle 12, one barrel for guiding of grenade 13, and one firing device14 (Fig.4).

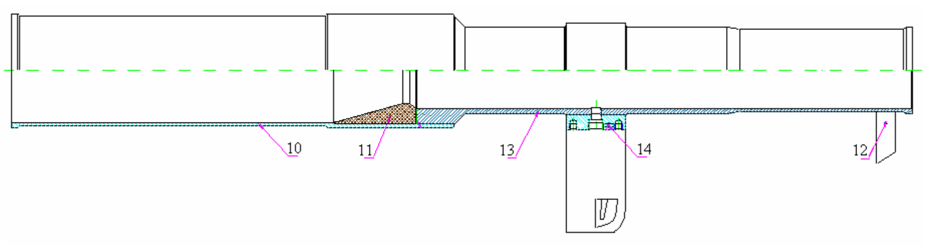

Fig. 4. Individual launcher

The antifire ballistic system is shown in Fig. 5 and is consisted of from one stabilizing block 3 (Fig.2) with four portant surfaces 15, a propulsion charge 16, one contact block 17, two containers 8 (Fig. 3) for useful compound 4 (Fig. 2), anifire charge 18 which is protected by cover 19.

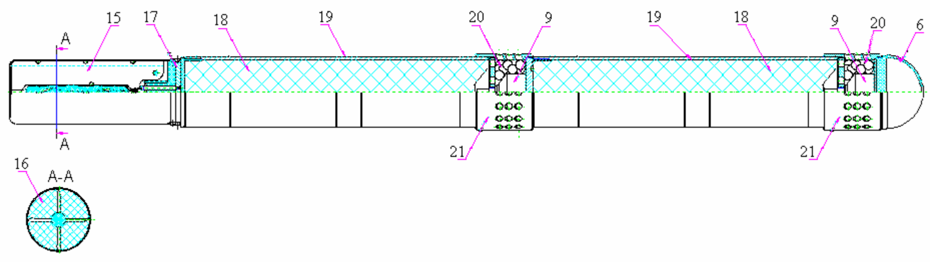

Fig. 5. Antifire ballistic system

The gases resulted by combustion of useful charge are cooled with the aid of device 20 and are evacuated through orifices of disperses 21.

Scheme of igniting devices is presented in Fig. 6

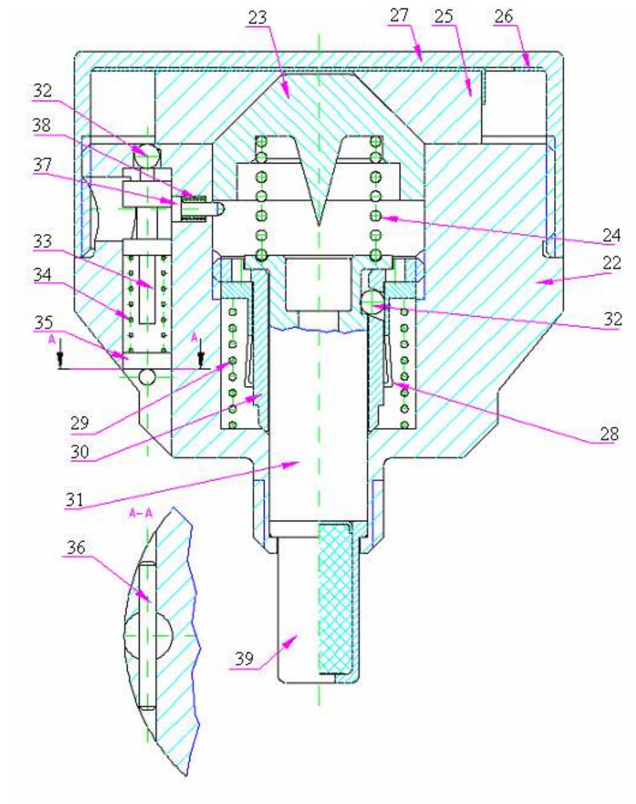

Fig. 6. Scheme of igniting devices

3. Establishing of main designing parameters

The establishing of main designing parameters was realised by numerical simulation [1]-[4]. For that was used an interior ballistics software of a recoilless ballistic system [5]-[7]. On the base of this software were determined the values of chosen designing parameters for that the main ballistic characteristics have got

suitable values, in the case of an antifire recoilless ballistic system of 60 mm calibre with the mass of. grenade 5.5 kg, the muzzle velocity 90 m/s and nozzle throat section 0.214
dm^2.

For this antifire recoilless ballistic systems with obtained ballistic characteristics was solved the fundamental problem of interior ballistics that consists of the variation of gases pressure and grenade velocity versus time and displacement of the grenade inside of the launcher system.

During of numerical simulation were modified in the possible limits the following designing parameters: the mass of powder ω; the volume of charging chamber W_0; the force of powder f; the threshold pressure p_0.

The interior ballistics software allows to study the influence of the variation of these designing parameters over the following ballistic characteristics: the grenade initial velocity v_g; the kinetic energy E_g; the maximum pressure of powder gases $p_{\max}$; the ballistic efficiency[1] r_g; the piezometric efficiency[2] η_g; the characteristic of powder utilization η_ω; the pressure at the ending of powder burning p_k; the displacement of grenade at the ending of powder burning ℓ_k; the maximum acceleration of the grenade a and so on.

With the aid of this interior ballistics software was obtained the curves of variation of these ballistic characteristics versus named designing parameters. From these curves can be find these values of chosen designing parameters for which the ballistic characteristics have got suitable values, without the exceeding of the imposed designing parameters values.

A part of the results of this study was presented in Figure 7-10. In this paper were presented only Figure 7 and Figure10.

3.1. The variation of the powder charge mass

In Figure 7 it can see that the muzzle velocity of the grenade, the kinetic energy the maximum pressure, the ballistic and powder efficiency, the burning pressure increase with the increasing of powder charge mass. From the graphic $v = f(\omega)$, it is observed that a velocity of the grenade of 90 m/s, suitable value for proposed goal, it is obtained for a mass of powder charge of 0,240 kg. For this powder charge corresponds a maximum pressure of approximate 510 daN/cm^2. In function of this value of powder charge result from graphics the values of another ballistic characteristics.

3.2. The variation of the powder force

In the graphic $v = f(f)$ from Figure 8 result that the value of 90 m/s of the muzzle grenade velocity corresponds the value of 1100000 daNdm/kg for powder force. For the value of 90 m/s for the muzzle grenade velocity, the kinetic energy of the grenade is 22700 daNm and the ballistic efficiency is 22 %.

---

[1] Defined as the ratio between the shot out kinetic energy of the grenade and the total energy of the powder;

2 Defined as the ratio between the mean pressure that acts on the grenade in the launcher and the maximum pressure.

3.3. The variation of the threshold pressure

If the value of 510 daN/cm^2 of the maximum pressure is considered suitable, than for this value, from the graphic $p_{\max} = f(p_0)$ from the Figure 9, results the value of 80 daN/cm^2 for the threshold pressure. For this value of the threshold pressure correspond the values of 94550 daNm/kg and 70 % for powder and piezometric efficiency.

3.4. The variation of the charging chamber volume

From Figure 10, graphic $p_{\max} = f(W_0)$, it is observed that a charging chamber volume of 0,4 dm^3 realizes the value of 510 daN/cm^2 of the maximum pressure. For this value of the charging chamber volume result the values of 400 daN/cm^2, 1,5 dm and 25650 m/s^2 for the burning end pressure and displacement, acceleration respectively.

Using the interior ballistics software, were established the values of studied designing parameters for which the main ballistic characteristics get suitable values, without the exceeding of the imposed designing magnitudes.

The obtained values of these parameters with the aid of numerical simulation are following: the powder charge mass ω=0.24 kg; the powder force f=1100000 daNdm/kg; the threshold pressure p_0=80 daN/cm^2; the charging chamber volume W_0=0.4 dm^3.

In the case of the recoilless ballistic system of 60 mm calibre which has got these designing parameters, the main ballistic characteristics are following: the maximum pressure of powder gases $p_{\max}$=510 daN/cm^2; the muzzle grenade velocity v_g=90 m/s; the piezometric efficiency η_g=70%; the ballistic efficiency r_g=22%; the kinetic energy of the grenade E_g=22700 daNm^2/s^2; the characteristic of powder utilization η_ω=94550 daNm^2/s^{2}kg; the gases pressure at the ending of powder burning p_k=400 daN/cm^2; the displacement of grenade at the ending of powder burning ℓ_k=1.5 dm; the maximum acceleration of the grenade a=25650 m/s^2.

For the recoilless ballistic system of 60 mm calibre with these main ballistic characteristics, was solved the fundamental problem of interior ballistics, i.e. the variation of the gases pressure and grenade velocity versus time and versus displacement.

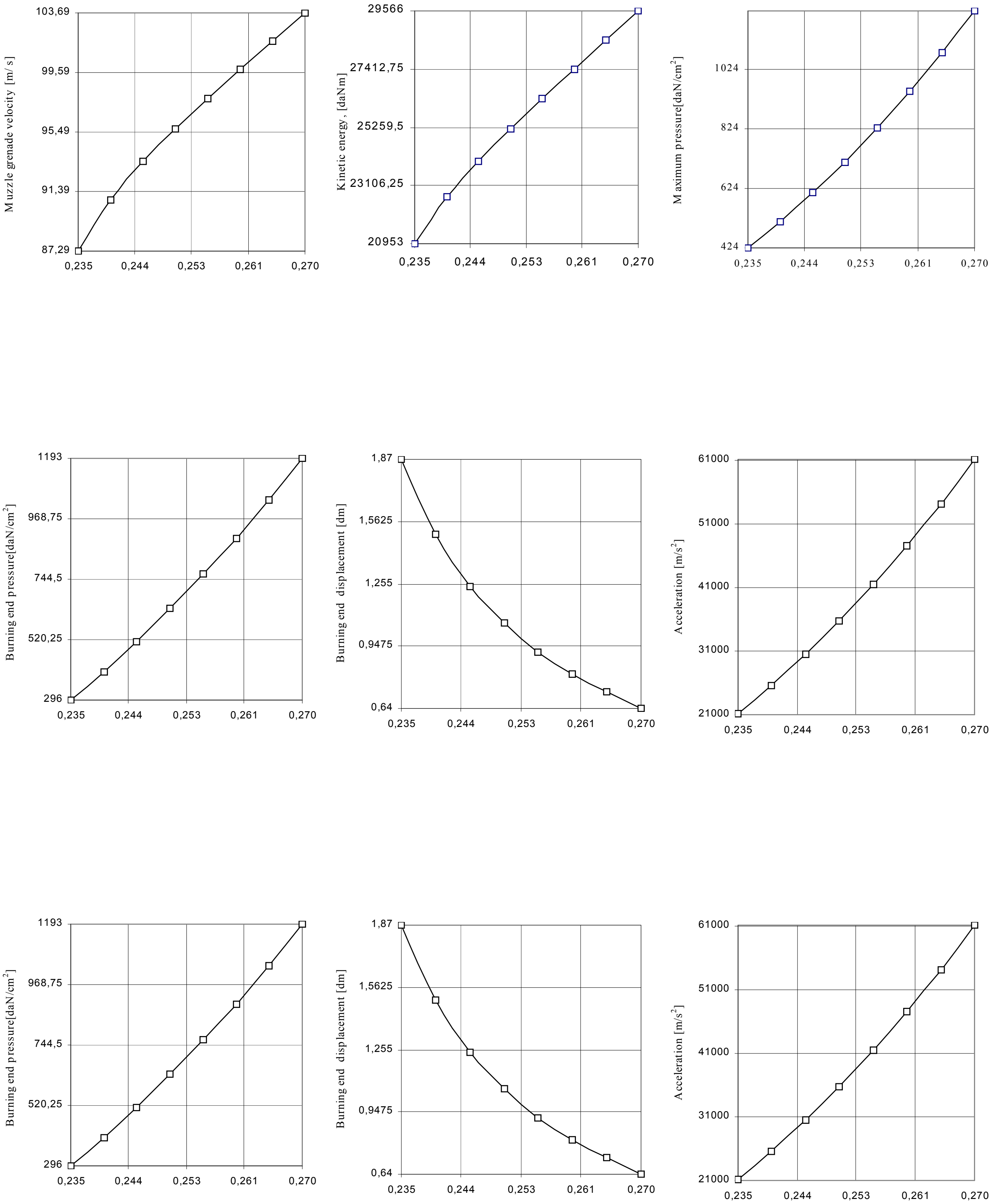

Fig. 7. The variation of the main ballistic characteristics with the variation of the powder charge mass

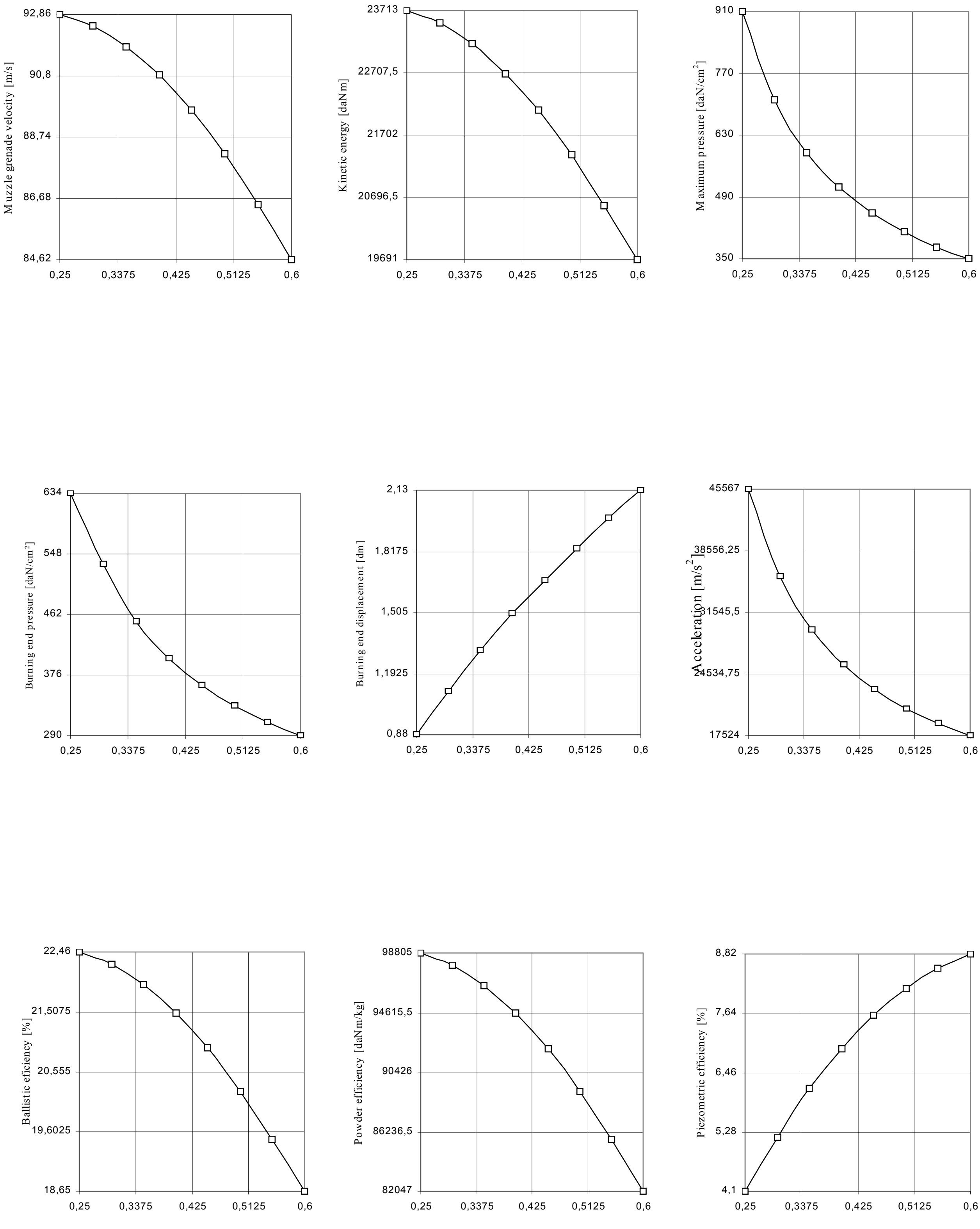

Fig. 10. The variation of the main ballistic characteristics with the variation of the charging chamber volume

4. Results and conclusions

Using the elaborated interior ballistics software, was established the values of studied designing parameters for which the main ballistic characteristics get suitable values, without the exceeding of the imposed designing magnitudes.

The obtained values of these parameters with the aid of numerical simulation are following: the powder charge mass ω=0.24 kg; the powder force f=1100000 daNdm/kg; the threshold pressure p_0=80 daN/cm^2; the charging chamber volume W_0=0.4 dm^3.

In the case of the recoilless ballistic system of 60 mm calibre which has got these designing parameters, the main ballistic characteristics are following: the maximum pressure of powder gases $p_{\max}$=510 daN/cm^2; the muzzle grenade velocity v_g=90 m/s; the piezometric efficiency η_g=70 %; the ballistic efficiency r_g=22 %; the kinetic energy of the grenade E_g=22700 daNm^2/s^2; the characteristic of powder utilization η_ω=94550 daNm^2/s^{2}kg; the gases pressure at the ending of powder burning p_k=400 daN/cm^2; the displacement of grenade at the ending of powder burning ℓ_k=1.5 dm; the maximum acceleration of the grenade a=25650 m/s^2.

The study may be used to the designing of another recoilless ballistic systems in order to find those values of the parameters for which the ballistic performances have suitable values, taking into account the restrictions imposed by initial designing requirements.

REFERENCES

1. CIURBANOV, E.V. - Vnutrenniaia ballistika, Izdatelstvo VAOLKA, Leningrad, 1975.

2. SEREBRIAKOV, M.E. - Interior ballistics of the systems with barrel and the rockets with powder, Publishing house of Military Academy, Bucharest, 1970.

3. VASILE, T. - Interior ballistics of guns, vol. I, Publishing house of Military Technical Academy, Bucharest, 1993.

4. VASILE, T. - Interior ballistics of guns, vol. II, Publishing house of Military Technical Academy, Bucharest, 1996.

5. VASILE, T., SAFTA, D. and GHEORGHIAN, S. - The Maximizing of Designing Parameters of Liquid Propellant Guns by Numerical Simulation, PROCEEDINGS of VI-th Conference on Weapon Systems, April 28-30 2003, Brno, pg.165-174;

6. VASILE, T., BARBU, C and SAFTA, D. – The Establishing of Main Designing Parameters for Anti-Fire Ballistic System, by Numerical Simulation, PROCEEDINGS of the 30th Internationally Attended Scientific Conference of the Military Technical Academy “Modern Technologies in the 21st Century”, Bucharest, 6-7 November, 2003, ISBN 973-640-012-3, pg. 81-89.

7. BARBU, C. – Computational Aerodynamics, Publishing house of Military Technical Academy, Bucharest, 2004, ISBN 973-640-060-3.