

MODULAR SUBMACHINE GUN

The construction and the results of the model of 9 mm submachine gun of the modular structure are presented. The new constructional elements of the submachine gun were tested in order to adapt it to the use of the new NATO (5.7x28 or 4.5x30) submachine gun round or the new civilian-police .40S&W (10x21) round. The construction of the weapon was presented with the special focus on the automatic weapon operation with the method of blowback with the pneumatic spring. The paper also shows the results of tests which were carried out in „Łucznik” Weapon Factory and in Military Institute of Armament Technology considering the operation of the pneumatic spring in different exploitation conditions and the obtained values of the rate of fire. The further directions of research aimed at the reduction of the rate of fire and the decrease of the production costs were proposed.

1. Introduction

Submachine guns (SG) achieved popularity thanks to their mass using by almost all fighting armies in the Second World War and in the limited range in the post-war period. Previously the military use of submachine guns set out directions of the development of SG, and at present the increase of the organized crime and the development of the terrorism in last 10÷20 years brought to light new users of the weapons [1], i.e. the police, security services and various task forces, among them anti-terrorist forces. The interest of these services resulted from the following:

- large fire manoeuvrability (as a consequence of the small mass and dimensions) with the large sustained rate of fire predisposes them to indoors fight;
- the use of the same type of ammunition, as in the short weapons – pistols;
- the limited fire range and the penetration ability diminishes the threat for strangers;
- the limited penetration ability makes possible their use on plane boards without the danger of unsealing of the fuselage of air-crafts;
- small ability to ricochet of pistol cartridges makes possible the safe use of them indoors (comparatively to the indirect ammunition);

Nowadays two groups of SG users exist in Poland, i.e. the Polish Army (PA) and all security services dependent on the Ministry of Domestic Affairs and Administration (MDAA) which possess a number of Polish SG of the PM-84P type - „Glauberite” (Fig. 1) and they continue shopping of its modernized version - PM-98. However, exclusive forces inside formations mentioned above, as a rule are equipped with the MP-5 German submachine guns in many versions. In Polish Army the MP-5 (Fig. 2)

submachine gun is a part of equipment of the “GROM” task force, and in MDAA – of some preventive and anti-terrorist forces. The small quantity of such equipment is also the Israeli UZI submachine gun and the Mini UZI.



Fig. 1. PM-98 „Glauberyt” submachine gun



Fig. 2. PM-5 submachine gun

The situation mentioned above results from the rational use of financial resources to purchase of armament. The second reason of that is the necessity of possessing small quantities of specialized types of armament (e.g. the SD version of MP-5) but their research and development in the country would be unjustified economically.

However, there are significant disadvantages of this situation. The price of the German SG is about 4÷5 times higher than the price of the Polish one, what makes impossible the equipment of all task forces with them. Especially in the Police and in the Military Police preventive forces can be equipped with the PM-98 SG, and even older - the PM-84 SG. Additionally in last years unplanned clashes of usual police officials with organized criminal groups grew more intense, which possessed submachine guns, e.g. in Parole town. The question arises as to whether only exclusive forces should be provided with the supporting weapons of the higher class. Besides, newly worked out German UMP submachine gun (Fig. 3), due to wide using of plastics and due to the simplification of its construction, can be twice cheaper than the previous one. In Poland it can lead to the considerable reduction of orders at Polish producer.



Fig. 3. UMP submachine gun

There is a growing demand for this kind of weapon the last few years, especially in the part of The Border Guard and the Police, and designed 20 years ago PM-98 does not meet present technological (limited possibilities of the use of the numeric machining) requirements and the requirements of low manufacturing costs. A new submachine gun, which price is similar to the price of the present PM-98 submachine gun of considerably better combat features, was worked out with the Weapon Factory „RADOM” (2 models were made).

2. Present requirements of submachine gun

In order to limit the costs it was decided that the weapon would operate on the basis of blowback, similarly to newly worked out German UMP submachine gun. The more advanced constructions, i.e. the delayed blowback and the short recoil of the barrel were rejected because of the complicated construction, the costs of weapon and the lack of possibility to assure the unfailing operation of the weapon with ammunition of limited impulse recoil [2]. This group of ammunition includes:

1. incapacitating rounds,
2. several types of rounds (of low mass than the mass of standard rounds) intended for task forces:
 - armour-piercing bullets,
 - rounds of limited range.

Insufficient combat features of produced at present SG result from the placing of the magazine in the grip and considerable changes of the gravity centre during firing. The location changes of the gravity centre are lineally dependent on the bolt mass and its distance of moving. All of them influence the stability of the weapon during firing. The PM-98 submachine gun, in spite of firing with the round of three times smaller energy than the energy of carbines of the caliber 5.56 mm, during the continuous firing obtained the comparable and even worse concentration of firing than the carbines mentioned above. It was because of greater mass of carbines and with considerably smaller mass of their recoil aggregates. For example, the slide mass of the carbine M16 is 0.27 kg, i.e. it is less than the half of the bolt mass of PM-98. In consequence it is necessary to diminish the bolt mass and the distance of moving of the bolt.

A feature of the weapon with free bolt is the considerable influence of the bolt mass on all parameters of the weapon. The diminution of the bolt mass influences the change of the weapon parameters as the following:

- the probability of tearing of the cartridge case increases during firing [3];
- the rate of fire of the weapon grows above the optimum value, what causes the use of its limiter;
- the life of the receiver diminishes in consequence of greater energy of impact of the bolt [4].

The most simple way of the limitation of the rate of fire and of the increase of the receiver life is the elongation of distance of the bolt moving [5]. However, it is contradictory with postulated earlier necessity of the shortening of the distance of the bolt moving in order to limit the location changes of the gravity centre. This problem cannot be resolved in case of classical construction of the free bolt, where the bolt rebounds from the receiver while recoiling. Thereby, the fluid spring brake was used that makes possible the limitation of distance of the bolt moving with the simultaneous limitation of the rate of fire [6]. Constructions of this type are used successfully in automatic grenade launchers, e.g. 9 mm Buschmaster SG (Fig. 4), worked out the last few years in Great Britain, with the fluid spring.



Fig. 4. Buschmaster submachine gun

3. Construction of submachine gun

The construction of the submachine gun (Fig. 5) is a modular one that makes possible the configuration of the weapon depending on requirements. Its basic variants are:

- SG with the long barrel and the horizontal cradle,
- SG with the short barrel and the perpendicular cradle.

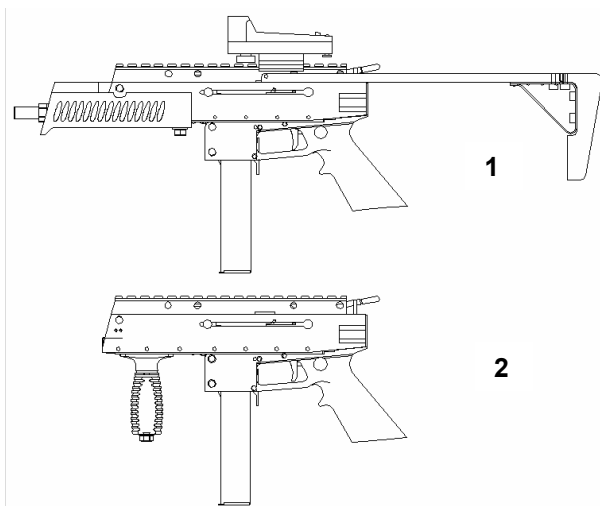


Fig. 5. Basic variants the submachine gun: 1 - with the 220 mm barrel, the batt and with the cradle, 2 - with the 120 mm barrel and with pistol grip

The quickly replaceable barrel is assembled from the entry side that prevents to premature fires. The barrels in length from 115 mm up can be assembled in these pistols. The barrels of 120 mm and 200 mm lengths were planned to assembly in these models. The bolt aggregate contains the striking hammer mechanism and the hydraulic or pneumatic spring (Fig. 6).

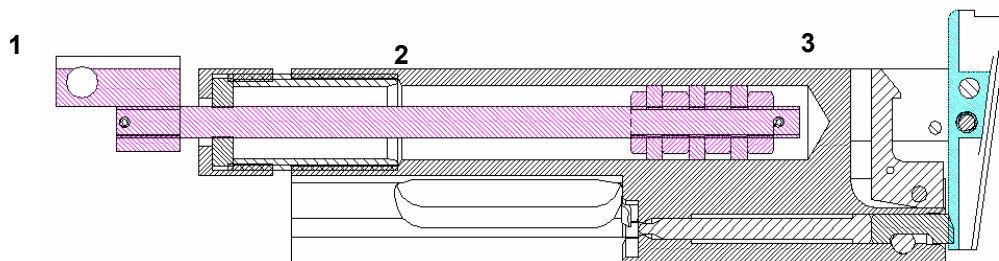


Fig. 6. The bolt aggregate: 1 - the hydraulic or pneumatic spring, 2 - the bolt, 3 - the striking hammer mechanism

The receiver with guide was made from the metal sheet with the forming and riveting methods. On the upper surface there are the rail to fastening of the optical sights and the butt guide. The trigger chamber (Fig. 7) is made of Tarnamid and contains the trigger mechanism and the magazine sear. Due to the moving of the hammer to the bolt aggregate, the point of support of the palm is near the axis of the barrel bore.

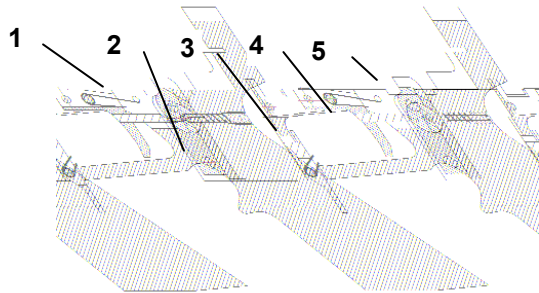


Fig. 7. The trigger chamber aggregate: 1 - slide, 2 - the magazine sear, 3 - the pour, 4 - the safety, 5 - the trigger- chamber

The magazine was worked out on the basis of the PM-98 magazine considering of the use of half-jacket rounds. In order to do it the following changes were introduced:

- the magazine was removed to back of the barrel flat - too close location of the magazine in PM-98 was the reason of the use of such rounded cartridge chamber and the magazine removal was impossible because of general construction of the weapon (originally it was designed to the Soviet rounds - 9x18 Makarow which are about 5 mm shorter than the rounds used at present);
- the magazine location was raised about 1.5 mm nearer the rammer line;
- the shape of the jaws of the magazine was changed fundamentally;
- the channel of the bolt was widened from 10 mm to 12 mm;
- the length of the round guide in the jaws was shortened.

The weapon operates with the method of blowback which is braked by the fluid or pneumatic spring. The location of the main parts of SG during the work is presented in Fig. 8 and 9.

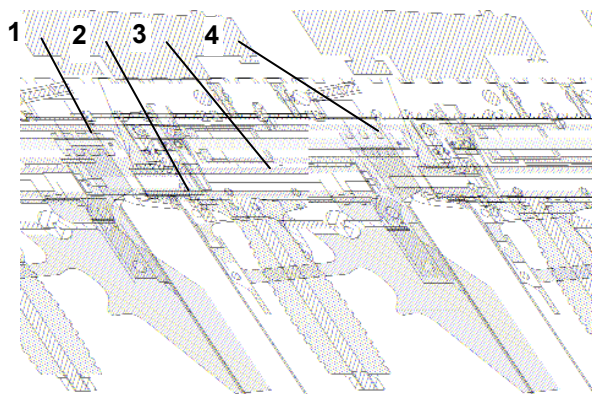


Fig. 8. Location of the parts at the moment of shot. 1 - pneumatic spring, 2 - the barrel, 3 - the bolt, 4 - the hammer

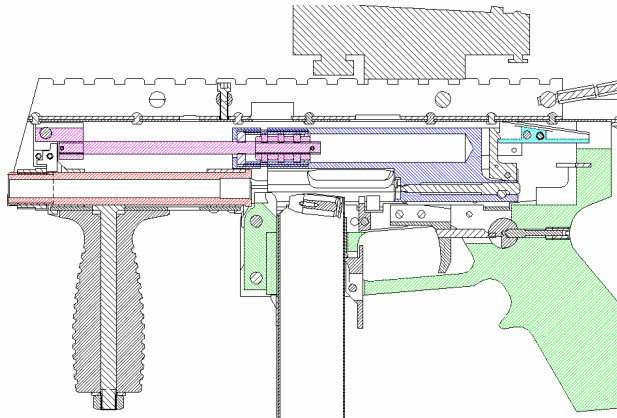


Fig. 9. The location of the parts after shot

4. Tests of weapon

The tests of SG models were carried out both at the producer's place in the Weapon Factory „ŁUCZNIK” and in Military Institute of Armament Technology. The tests at the producer's place were the first ones for newly worked out design of the small arms and were oriented mostly on the operation safety. On that account the tests were carried out by stages, including to the tests stronger and stronger kinds of ammunition. The firing was carried out with the use of the maximum quantity of the ammunition as the following:

- blank rounds;
- anti-ricochet rounds of smaller mass;
- rounds of the energy similar to the energy of the ammunition used in Polish Army and (MDAA);
- LAPUA 400 rounds - the strongest ammunition available commercially.

A. Tests at the producer's place

As result of tests which were carried out it was stated that:

2. The efficiency of the pneumatic spring is large as the result of the small theoretical rate of fire of the weapons – 500÷600 shots/minute, i.e. 100÷200 shots/minute smaller than the PM-98 rate of fire produced at present. In consideration of the smaller recoil distance and the smaller mass of the bolt the rate of fire would be considerably larger. Analyzing other kinds of SG, it would be about 900 shots/minute. However, difficulties in selection of suitable fit of piston and its sensitivity to postaxial tightening during the assembly occur. It was also stated the large influence of the carbon deposit settling on the piston rod and the influence of piston on the efficiency of braking. During firing the efficiency of dumping grew.
3. Small weapon recoil and little sensible by the rifleman weapon recoil as a result of:
 - dissipation of recoil energy in the pneumatic spring,
 - the use of the plastic grip which diminish the recoil energy,
 - good forming of the grip which assures the large contact surface with the palm.

B. Tests in Military Institute of Armament Technology

Tests of submachine gun concerned:

1. Operation of the pneumatic spring of recoil:
 - the efficiency of SG was considerably dependent on the assembly and cleanness of pistons,
 - surprisingly high efficiency of SG and permanent operational reliability of SG was obtained in case of optimum of pistons fit and their dry surface,
 - the rate of fire was 180÷300 shots/minute that does not occur in case of small arms,
 - efficiency of dumping violently decreased and it was 700÷900 shots/minute after slackening and oiling of pistons fit.
2. Operation of the bolt and the striking mechanism:
 - there was not any jamming caused by the striking mechanism,
 - the tearing of pull springs occurred quite frequently,
 - the cooperation of the SG parts makes impossible the premature shot.
3. Operation of the trigger chamber was examined in two aspects:
 - operation of the trigger striking mechanism;
 - mechanical durability;and carried out tests proved:
 - the springs power and distance of the trigger were proper, so operation of this mechanism was light and smooth,
 - the proper ergonomics of the grip (obtained from the shooting opinions),
 - lack of any signs of too small durability of the trigger chamber.

5. Conclusions

On the base of carried out research it can be stated the following:

1. The use of the pneumatic delay of the bolt movement reduces the rate of fire considerably more efficiently than the pneumatic delays used at present. Under optimum conditions it makes possible the diminution of the theoretical rate of fire of weapon from 900 shots/minute to 300 shots/minute. For comparison, the mechanical limiter of the rate of fire of PM-98 reduces the rate of fire from 800 shots/minute to 600 shots/minute only.
2. The use of this delay additionally reduces the recoil energy of SG, what does not appear in the case of mechanical delays.
3. A defect of this construction is the dependence of the proper operation of this delay on the precision of fit and the cleanness of co-operative surfaces. One observed. The lack of the repeatability of the operation of the delay was observed. It seems very difficult to work out of the construction of properly operation in all exploiting conditions.
4. The works concerning the hydraulic damper, which preliminary tests show the greater independence operation on the fit precision and on the cleanness of the surface, should be continued.
5. The rear kind of fastening of the barrel makes impossible the change of its location even during shooting without installing of the clamp nut.
6. The use of the short trigger chamber, devoid of the hammer mechanism, diminished the arm of operation of the recoil force and the jump of the SG is hardly sensible.

7. The use of the magazine of the widened jaws and its removal from the barrel improved conditions of round feed and such jaws can be used in SG produced at present.
8. It is impossible (and inadmissible) to load the twenty-sixth round to the magazine of the nominal capacity of 25 rounds.
9. Fifteen-round magazines and the system of their parallel joining should be worked out.
10. Quite large mass of SG - about 2.5 kg, which was obtained, can be diminished in the stage of the prototype construction as a result of making:
 - the plastic bolt chamber,
 - the plastic butt,
 - the aluminium base of the sight.
11. The new stretching handle which does not enlarge the width of SG should be designed.
12. Submachine gun for the right-handed and left-handed people should be designed.
13. In case of obtaining of the permanent rate of fire above 500 shots/minute the trigger mechanism to fire the single shot should be adapted.

6. Bibliography

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Pistolet maszynowy modułowy

Streszczenie

Przedstawiono konstrukcję oraz wyniki badań modelu 9 mm pistoletu maszynowego o budowie modułowej. Sprawdzone nowe elementy konstrukcyjne pistoletu w celu przystosowania go do użycia nowego naboju pistoletowego NATO (5,7x28 lub 4,5x30) lub nowego naboju cywilno-policyjnego .40S&W (10x21). Przedstawiono budowę broni, ze szczególnym uwzględnieniem automatyki broni działającej na zasadzie odrzutu zamka swobodnego z pneumatycznym amortyzatorem odrzutu. Zaprezentowano wyniki badań przeprowadzonych w Fabryce Broni „Łucznik” oraz w WITU pod kątem funkcjonowania tego amortyzatora w różnych warunkach eksploatacji oraz uzyskanych wartości szybkostrzelności. Zaproponowano dalsze kierunki prac zmierzające do redukcji szybkostrzelności oraz obniżenia kosztów produkcji.