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# PROPOSITIONS OF CONSTRUCTIONAL DESIGNS OF PERSONAL DEFFENCE WEAPON OF THE PDW CLASS

*The course of previous works, carried out within the framework of the NATO programme, concerning the development of the ammunition and personal defence weapon, were presented. Two competing rounds (Belgian* 5.7x28 *mm and of German* 4.6x30 *mm) and two kinds of pistols adapted for them, were described. The constructions of Polish submachine gun were proposed depending on the chosen rounds.*

## 1. The introduction

At the beginning of the eighties in the United States of America the start of the new research programme - Joint Service Small Arms - began. Within the framework of this programme the new idea of the future small arms family should be worked out and the constructions which answer the needs of the army best should be chosen. It was expected to work out the weapon for these soldiers who use small arms as the secondary self-defence weapon. It refers to the crews of fighting vehicles, heavy weapon as well as signallers, drivers, etc. Nowadays this kind of soldiers accounts for over 60% manpower of modern armies. As a consequence it was supposed that this weapon could have the round range limited to 200 m.

The most important feature of Personal Defence Weapon (PDW*)* had to be the penetration ability of ballistic shields of new generations. Such standardized shield is the shield definite in the programme of Cooperative Research Into Small Arms Technology *(*CRISAT*).*This shield consists of the 6A14V titanic metal sheet with the thickness of 1.6 mm and 20 aramid layers and it is made after the example of Russian heavy bullet-proof vests. The weapon of the PDW class should penetrate this shield from the distance of 100 m, similarly as standard steel and Kevlar helmets.

The use of the existing ammunition was impossible in view of requirements because the 5.56x45 mm round caused the excessive increase of the length and the mass of the weapon, and the 9x19 mm round did not assure the required shield reference piercing.

## 2. Propositions of new ammunition

### A. The 5.7x28 mm round of the FN (Fabrique Nationale) firm

The construction of the 5.7x28 mm round of the FN firm (Fig. 1, Table 1) is similar to the construction of the 5.56x45 mm round with the SS109 bullet. Its piercing ability considerably exceeds the possibilities of usual 9 mm ammunition of Parabel-

lum. During firing from P90 submachine gun from the distance of 150 m, the 5.7 mm SS190 bullet with the core pierces 48 layers of Kevlar as well as American PASGT steel helmets and standard military steel bullet-proof vests [1].

However, recoil during firing new 5.7x28 mm ammunition is two third smaller than during firing from the 5.56 mm weapon and one third smaller than during firing 9 mm Parabellum rounds from the most of modern submachine guns.

**B. The 4.6x30 mm round of the H & K (Heckler & Koch) firm**

The general construction of the 4.6X30 mm round of the H & K firm (Fig. 2, Table 1) is similar to the construction of the miniaturized ogival round of the submachine gun. This bullet is made of the steel covered with the copper sheath [2]. The bullet of 15.3 mm length and only 1.7 g mass reaches the muzzle velocity of 725 m/s and the energy of 447 J, and simultaneously causes twice smaller recoil of the weapon than the recoil during firing 9 mm Parabellum round.

Fig. 1. The family of the 5.7x28 mm ammunition; from the left: the round with the usual bullet with the steel core, the round with the tracer bullet, the round with the subacoustic bullet, the blank round

Fig. 2. The family of the 4.6x30 mm ammunition; from the left: the round with the usual bullet with the steel core, the round with the tracer bullet, the round with the armour-piercing bullet, the blank round

Table 1. Parameters of 5.7x28 mm and 4.6x30 mm rounds

| Lp. | Parameters | 5.7x28 | 4.6x30 |
|---|---|---|---|
| 1 | Weight of the round with the usual bullet, g | 6 | 6 |
| 2 | Weight of the usual bullet, g | 2.2 | 1.7 |
| 3 | Length of the round with the usual bullet, mm | 40.5 | 38.5 |
| 4 | Muzzle bullet velocity, m/s | 715 | 725 |
| 5 | Muzzle bullet energy, J | 516 | 450 |
| 6 | Efficient range, m | 200 | 200 |
| 7 | Distance from which CRISAT ballistic shield is pierced, m | 150 | over 200 |

The bullet fired from H & K PDW from the distance of 5O m pierces the vest definite in the CRISAT programme and delivers the energy of 220 J to the block of the gelatine hidden under the bullet-proof vest (this energy is about 50 J more than the energy of the Belgian bullet, fired from the longer barrel). This bullet from the distance of 100 m also pierces the vest and penetrates the block of the ballistic gelatine

on to the depth 70÷80 cm with the energy of 115 J (however, FN bullet has the energy of 65 J). After the shot into the uncovered block from the distance of 50 m the bullet 4.6x30 mm penetrates the block from the ballistic gelatine to the depth of 280 mm.

## 3. Weapon constructions of PDW class

### A. The 5.7X28 mm submachine gun - FN P90

A first construction of submachine gun of the PDW class was the Belgian submachine gun P90 (Fig. 3), made in the latter part of the eighties.

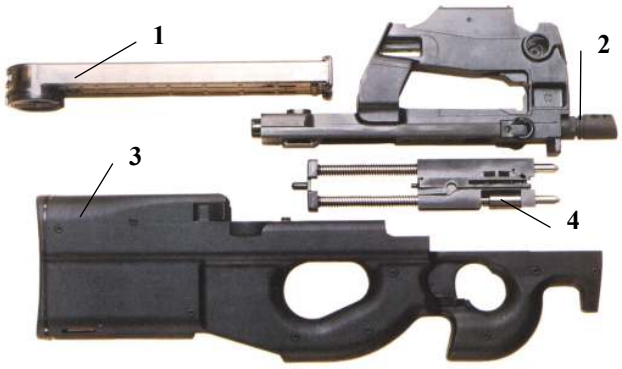


Fig. 3. The P90 submachine gun (partly separated) with the calibre of 5.7 mm: 1 - magazine, 2 - barrel and collimator sight, 3 - receiver, 4 - free bolt with recoil springs and poles

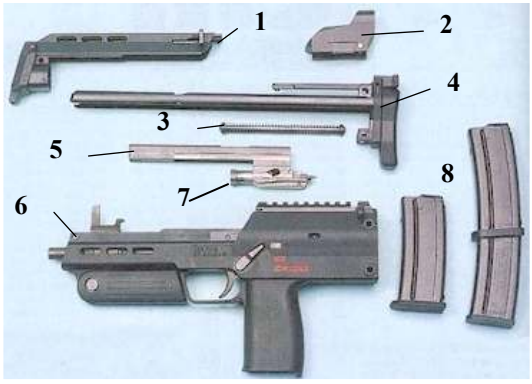


Fig. 4. The MP-7 submachine gun (partly separated) with the calibre of 4.6 mm: 1 - cover, 2 - collimator sight, 3 - recoil spring and guide, 4 - folding stock, 5 - lock frame, 6 - receiver, 7 - bolt, 8 - magazines

Except the shape, the outstanding distinctive features of P-90 submachine gun are: the system without the proper butt and the very capacious (50 rounds) magazine, placed over the barrel parallel to the barrel. Special rotatory follower, turning the round about 90$^{o}$, makes possible the ammunition supply. Cartridge cases are thrown out to the bottom by the opening in the gunstock. The weapon operation is based on the principle of the recoil of the free bold, typical for submachine guns.

The basic technical parameters of different kinds of pistols are presented in Table 2.

### B. 5.7X28 mm the pistol Five-seveN

After finishing of R & D works on the P-90 submachine gun, Five-seveN semiautomatic pistol (Fig. 5, 6, Table 2), shooting the same ammunition, was worked out.

In the pistol Five-seveN, the innovative rule of the operation, in-between semifree bold operation and short recoil of the barrel operation, was used. The backward movement of the bold is braked in the first phase by means of cam embedded in the framework and the cam makes the backward movement of the barrel. This pistol has most advantages and disadvantages of weapon with the short recoil of the barrel. The pistol mass is exceptionally small but the gun body mass of the pistol cannot in-

crease, eg. by screwing the effective snubber [3].

Fig. 5. The Five-seveN pistol


Fig. 6. The Five-seveN pistol partly separated: 1 - bolt, 2 - barrel, 3 - magazine, 4 - frame

Fig. 7. The HK UCP pistol

### C. 4.6x30 mm submachine gun MP-7 H & K (British Aerospace System)

After the production of P90 and Five-seveN Belgian pistols the MP-7 German pistol (Fig. 4, Table 2) was designed. In this pistol the gases downlead is through the side-opening in the barrel side, and the use of comparatively heavy lock frame (~ 400 g) indicates that the use of free bold for the 4.6x30 mm round [2, 4] is impossible.

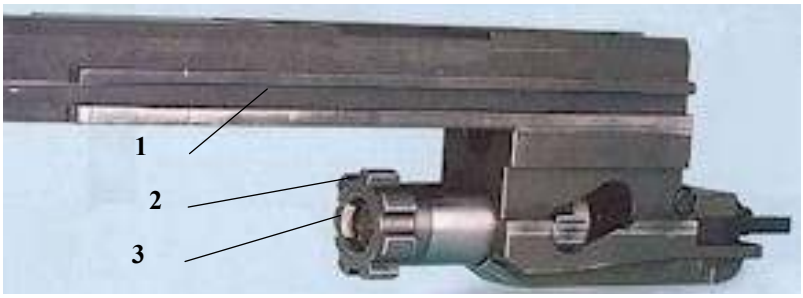


Fig. 8. Lock frame (1) with the MP-7 bolt and with bars (2), extractor (3) and pusher (modelled on the G36 carbine)

### D. The 4.6x30 mm semi-automatic pistol H & K UCP

The pistol H & K UCP (Fig 7, Table 2) is the last one worked out within the framework of the PDW programme. At present the producer does not throw open the data of the weapon construction. As contrasted with the competitor, producing Five-seveN pistol, the variant with the snubber was worked out and the same magazine as in the submachine gun, was used.

Table 2. Technical parameters of different types of pistols

| The specification | P-90 | MP-7 | Five-SeveN | HK UCP |
|---|---|---|---|---|
| The round | 5.7x28 | 4.6x30 | 5.7x28 | 4.6x30 |
| The barrel length, mm | 263 | 180 | 122 | |
| The length of weapon with the folded stock, mm | 500 | 340 | 208 | 200 |
| The length weapon with the unfolded stock, mm | - | 517 | - | - |
| The weapon height, mm | 210 | 172 | 137 | |
| The weapon width, mm | 55 | 42 | | |
| The weapon mass without the ammunition, g | 2540 | 1800 | 620 | 850 |
| The rate of fire, rpm | 900 | 950 | - | - |
| The capacity of the magazine, pcs | 50 | 20, 30, 40 | 20 | 20 |
| The muzzle velocity of the bullet, m/s | 715 | 725 | 650 | |

## 4. Propositions of the construction of Polish pistol of the PDW class

The choice of the operation principle of the PDW class weapon results directly from the used ammunition. The Belgian round for smaller loading of cartridge case during the shot can be used in the weapon with the free bold [4÷6]. It results from the following factors:

- the smaller maximum pressure;
- the greater diameter of the cartridge case;
- the smaller contact surface of the cartridge case with the cartridge-chamber.

For considerable loading of the cartridge case during the shot the German round it is necessary to use the weapon with interlocking bore of the barrel. This results from the following parameters:

- the greater maximum pressure;
- the smaller diameter of the cartridge case;
- the greater contact surface of the cartridge case with the cartridge-chamber.

On the base of above-analysis it results that the best pistol seems to be the pistol working on the basis of the downlead of powder gases through the side-opening of the barrel.

### 4.1. The pistol with the downlead of powder gases and with the 4.6x30 mm HK ammunition

The wrk out of the weapon with the downlead of powder gases on the basis of AK kbk weapon seems little rational for limited possibilities of the reduction of the mass and dimensions of the pistol. Besides this, the production costs of lock frame and the bold of the AK kbk weapon are considerably higher than the production costs of modern weapon.

Because of that it was decided that the project should be based on the AR-18 construction. The use of the short movement of the gas piston with the follower was designed. The bar unit was projected on the base of analyses of the following kinds of weapon: M16 (USA), AR-18 (USA), G-36 (Germany) and Steyr AUG (Austria). This is the construction most often used in new examples of the weapon.

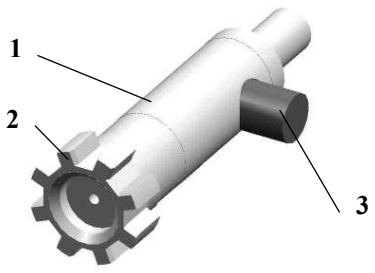


Fig. 9. The bolt (1) with bars (2) placed symmetrically every 45º, the leading pin (3) is separated from the bolt

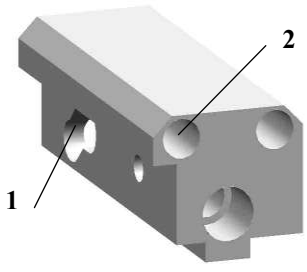


Fig. 10. The lock frame modelled on the AR-18 (it will be made of 35x35 mm profile):
1 - shaped recess for the pin co-operating with the bold,
2 - openings for the recoil springs

Fig. 11. The firing pin with only circular sections

The bold is the seven-bar one (Fig. 9) co-operating with the holder of the barrel (Fig. 12). Bars are placed regularly every 45º. Instead of lacking of the eighth bar there is an extractor. Two bottom bars are used to receive the rounds from the magazine. The location of the elastic ejector is planned in the left bar. In the back part of the bold the opening for the pin making the cooperation of the bold with the lock frame is placed. The limitation of the rotation of unbarred bold is achieved by the cooperation of the leading pin with its guide on the left side of the receiver.

The lock frame (Fig. 10) was modelled on the AR-18 weapon. Except the kbk AK 47 weapon, the AR-18 weapon is the most often produced construction. It is considerably simpler and cheaper and if exactly designed and made, shows comparable resistance to impurities.

The lock frame is a cuboid in shape with the oblong opening for the bold. On the left side there is a shaped recess for the pin co-operating with the bold. The recess makes the rotation of the bold about 22º, what causes its barring and unbarring. In the top part of the lock frame there are openings for the recoil springs with poles which operate as the guides of the bold. The firing pin (Fig. 11) with only cylindrical sections is a part of the bold unit.

The holder of the barrel (Fig. 12) is a basic element linking the barrel, the receiver and the trigger-chamber. The holder of the barrel has a central opening for the barrel which from the lock frame side is ended with eight interlocking protrusions. In the top part of the holder on the sides there are openings for the poles – the guides. The opening, where is the follower, is placed centrally. The receiver is connected by welding with the receiver.

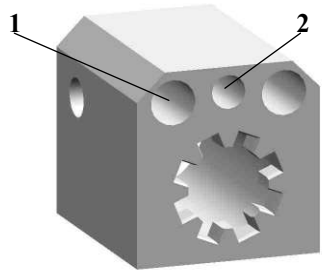


Fig. 12. The holder of the barrel with openings for the guides of the lock frame (1) and the follower (2)

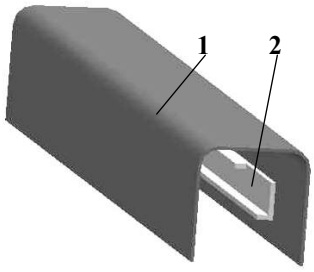


Fig. 13. The receiver (1) with the guide (2) protected against the rotation of the unbarred bolt

Fig. 14. The trigger-chamber with the butt

The receiver (Fig. 13), made from metal sheets, is „open” from below and behind that makes possible the cooperation with the trigger-chamber and the extraction of the bold with the lock frame. The location of the sight rail is planned on the upper surface of the receiver. Inside the receiver on the left side there is the guide of the pin preventing the rotation of the unbarred bold.

The trigger-chamber (Fig. 14) is made from the plastic and joined to the pistol from below. The trigger-chamber contains the following mechanisms: the trigger-preservative mechanism, stopping the lock frame in the rear position after shooting of the last shot and the magazine catch.

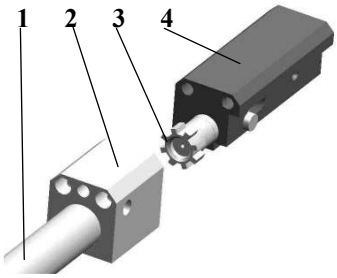


Fig. 15. The bolt with the lock frame in the unbarred position the guide of the pin and lock frame - invisible):
1 - barrel, 2 - holder of the barrel, 3 - bold, 4 - lock frame

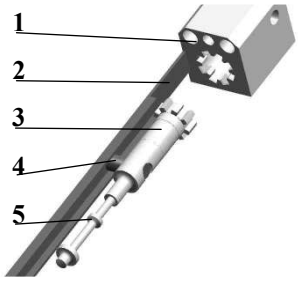


Fig. 16. The manner of the safing against the rotation of the bold during the return as a result of its own inertia (the lock frame - invisible):
1 - holder of the barrel, 2 - guide, 3 - bold, 4 - leading pin, 5 - firing pin

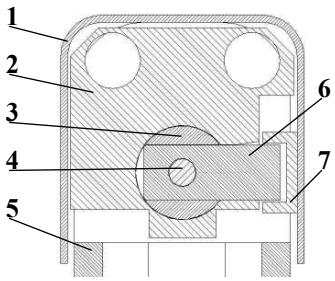


Fig. 17. The manner of the bolt shifting of the bold inside the receiver (minimum about 50% of the length increase of the shoulder of the bolt shifting of the bold was assumed):
1 - reciver, 2 - lock frame, 3 - bold, 4 - firing pin, 5 - trigger-chamber, 6 - leading pin, 7 - guide

The interlocking of weapon follows as a result of the rotation of the bold. The rotation is caused by the thrust of the shaped recess of the lock frame (Fig. 15) on the leading pin of the bold. Preventing the rotation of the bold in the rear position (Fig. 16) results from the cooperation of the leading pin with its guide, situated on the internal left side of the receiver.

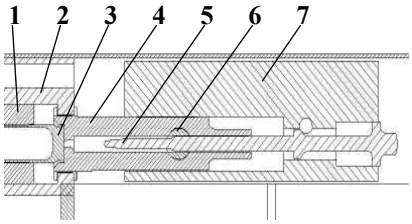


Fig. 18. The section of automatic units of the weapon before and after interlocking. 1 - barrel,
2 - holder of the barrel, 3 - case, 4 - bold, 5 - firing pin, 6 - leading pin, 7 - lock frame

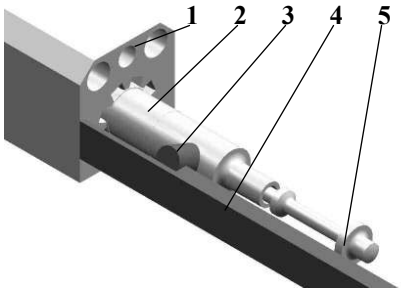


Fig. 19. The bold in the interlocking position (lock frame - invisible), the leading bolt is behind the recess in the guide: 1 - holder of the barrel, 2 - bold, 3 - leading pin, 4 - guide, 5 - firing pin

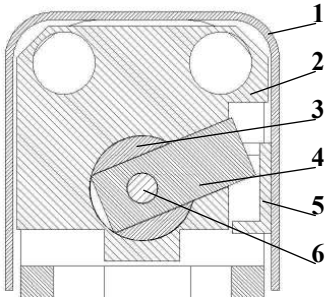


Fig. 20. The bold in the interlocking position, the leading bolt is behind the recess in the guide: 1 - receiver, 2 - lock frame, 3 - bold, 4 - leading pin, 5 - guide, 6 - firing pin

### 4.2. The pistol with the free bold for the 5.7x28 mm FN ammunition

In the pistol with the free bold the experience from newly worked out 9 mm PMM submachine gun of the modular construction can be used [7]. On the base of the literature the impulse of the recoil of the round 5.7x28 mm carries out 1.95 Ns, and for the bold with the mass of 0.4 kg the energy of recoil will be ~ 4.5 J [5, 6]. This value is sufficient for the operational reliability of the pistol. The use of the classical construction will make possible the use of the more reliable arched magazine (Fig. 21).

Fig. 21. The approximate view of the PMM pistol for the 5.7x28 FN ammunition

Contrary to current opinions about the similar weapon construction of main rivals - Belgian and German rounds, they represent completely different approach to the personal defence weapon.

The Belgian round was projected in order to achieve the best useful effect and the minimum manufacturing costs. For that reason the constructions, tested with the universally used 5.56x45 mm NATO carbine rounds, were applied. The SS190 bullet was designed similarly to SS109 bullet of the 5.56x45 mm round. The PDW round is shorter than the carbine round and its maximum pressure is smaller. It made possible to work out the weapon of simple construction, operating on the principle of the recoil of free bold.

However, the German round was projected in order to achieve maximum performance and it is a precursor of the new type of the ammunition. It is the first small arms round manufactured with the steel bullet which is only coppered galvanically. It caused the necessity to work out the special manner of gun rifling of barrels. In spite of the smaller calibre and the smaller bullet energy the maximum pressure of the powder gases is higher (in comparison with the Belgian round). At the stage of R & D works the problems with the repeatability of the pressure occurred. The use of so advanced technologies can be an advisable action in case of choice this round as the NATO standard. The difficulties in working out the national equivalents of pistol will stimulate the purchase of the foreign pistol. The price of the HK PDW (MP-7) submachine gun carries out about 1600 $, i.e. it is three times higher than the price of the typical carbine of the 5.56 mm calibre, what collides with the idea of the cheap weapon for the soldiers who do not participate directly in the fight.

## 5. Conclusions

On the ground of the foregoing analysis it can be stated that the following variants of the PDW class weapon can be worked out in our country:

1. The Belgian 5.7x28 mm round will be chosen as a new standard NATO. It is the most advantageous variant because it makes possible the quick preparation to produce the pistol on the base of experiences during works on 9 mm PMM submachine gun. The implementation of the production of the Belgian ammunition in ZM „MESKO" firm also should not be difficult for the resemblance of the Belgian round to the 5.56x45 mm round with the RS bullet, which are produced in this firm.
2. The German 4.6x30 mm round will be chosen as a new standard NATO. It is the less advantageous variant because it would lengthen the R & D works for the inexperience in the production of this type of the pistol and the ammunition in our country. The implementation of the production technology of barrels and ammunitions of the 4.6 mm calibre in Poland on the level assuring their comparable life to

the German weapon life seems little probable. A long period of the R & D works and the lower life of the Polish weapon will induce national users to purchase the German weapon and ammunition.

3. NATO will not choose any round, leaving the matter of the choice to users. In this situation the choice of the round by USA will be the deciding factor. Consequences will be analogical to variants 1 and 2.

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Streszczenie

Przedstawiono przebieg dotychczasowych prac, realizowanych w ramach programu NATO, dotyczącego rozwoju amunicji i broni do obrony osobistej. Opisano dwa konkurujące naboje (belgijski 5,7x28 i niemiecki 4,6x30) oraz rodzaje pistoletów do nich przystosowane. Zaproponowano dwa warianty polskiego pistoletu w zależności od rodzaju wybranego naboju.