MATERIALS AND DEVELOPMENT OF TECHNOLOGIES ENSURING THE LIFE OF ARTILLERY BARRELS, WEAPONS

Mamanazarov Rakhmatjon Akhmadjonovich
Senior Lecturer of the Department of Aviation Weapons
Institute of Military Aviation of the Republic of Uzbekistan

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This article reflects on the durability, reliability of aviation artillery gun desks, the materials used in their preparation.

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The barrels of various guns and small arms are used in various atmospheric and climatic conditions by troops of varying degrees of preparedness. Therefore, various materials and technologies for their processing are used.

The requirements for barrels are divided into identical and specific ones and differ significantly depending on the combat purpose of the guns, the installation on the vehicle, as well as the caliber. The barrel is the most loaded part of the weapon and has a significantly shorter service life than all other components and parts of the weapon. The factors affecting weapons and cannon barrels, materials for the manufacture of barrels and methods of their processing are considered [1].

There are both identical requirements for small arms barrels and operating conditions, as well as specific requirements depending on the type. Identical requirements include: durability, reliability, accuracy, durability, ergonomics. Specific requirements include: low cost, high manufacturability for combat weapons barrels, high accuracy of fire for automatic service and combat weapons, minimum weight, various special requirements for service weapons, high thermal conductivity for automatic combat weapons, etc.

It should be borne in mind that the most important characteristics of barrels
– durability and accuracy of shooting

– depend on maintenance, which can be well organized for sports, hunting, service, and combat weapons in peacetime, but deteriorate significantly in wartime for a variety of reasons.

Thus, the barrels, at least of military weapons, should be unpretentious and easy to maintain.

The requirements for cannon barrels can also vary significantly depending on the combat purpose of the guns (field, anti-tank, anti-aircraft, fortress, coastal defense), from installation on a military vehicle (aircraft, tank, ship, railway, self-propelled), as well as the caliber of the barrel.

Summarizing the most devastating effects on artillery barrels. For cannons and small arms, the following main factors can be distinguished:

– friction between the projectile or bullet and the rifling of the bore;

– short-term pressure of powder gases during detonation of the charge in the longitudinal and transverse directions;

– erosive wear of the bore as a result of firing;

– chemical interaction of the combustion products of gunpowder with the metal of the walls, enhanced by high temperature;

– environmental influences – moisture, heat, cold, light, dust, sand, low and high pressure, radiation and other similar factors [2-5].

Let’s look at some materials for making small arms barrels.

Bronze is an alloy of copper with tin, as well as other components, except zinc and nickel, based on copper. Due to its high viscosity, bronze is a very reliable material that resists rupture of an overstressed barrel. Bronzes are insensitive to the effects of harmful environmental factors. This metal is not an expensive material, in addition, worn-out barrels can be sent for remelting and new barrels can be manufactured at minimal cost. However, in modern production of bronze barrels, they are rarely used due to their low strength and hardness, which prevents the use of ammunition that creates high gas pressure during detonation, and mainly during the assembly of multilayer barrels, including bronze pipes and a steel channel.

Titanium alloys are low–density and non-magnetic in the presence of high strength. High cost, poor machinability, low heat resistance and high activity when interacting with powder gases make these alloys unsuitable for manufacturing barrels of various weapons.

Special heat–resistant cobalt-based alloys alloyed with nickel, chromium, molybdenum, and iron have high heat resistance and heat resistance, but have not been widely used due to the high cost of components, and these alloys are extremely difficult to process.

Aluminum alloys (slumming, duralumin, etc.) have not been used due to their low mechanical properties, in particular, tensile strength, modulus of elasticity, heat resistance, and low heat resistance.

Composite materials, which are various combinations of parts made of steel, plastic, ceramics, etc., are characterized by low weight, resistance to erosion by powder gases, and low visibility for metal detectors [7].

The disadvantages of such materials include low thermal conductivity, high cost, low impact strength (in the case of a ceramic barrel, difficulty in manufacturing and poor maintainability), which determined the scope of their application – not for barrels of mass–produced army weapons, but for weapons used by special services.

Currently, steels of various chemical compositions are considered to be the best materials that resist the entire range of adverse effects on the barrel. Steels are not expensive materials, are sufficiently technologically advanced in the case of mass production, do not contain scarce components, and are maintainable in the field if necessary.

The classic steels for small arms barrels are steel grades 50, 50RA. The following grades of steel are also used: 30KHN2MFA, 30KHRA (barrels for the AK family of assault rifles are made from this steel, in particular), 30KHMA, 38KHMA [8].

In practice, corrosion-resistant steel of type A20X13 is also used. However, it is not suitable for mass-produced military weapons due to its low thermal conductivity and low strength properties. Barrels made of corrosion-resistant steels are installed only on hunting rifles.

The choice of materials for the manufacture of the barrel is also determined by its manufacturability during processing. Since most small arms and barrel artillery are equipped with rifled barrels, the material must be well pressure-treated and machined.

Currently, the following processing methods are the most common [13-17].
The method of making barrels by cutting is the most accurate; it allows to obtain an almost ideal internal geometric shape of the channel in terms of the size of the fields and rifling, but a rather long processing time (the processing period of one barrel is from 2 to 8 hours) [18].
Rotary forging is a very fast method (~ 3 minutes per barrel production), which makes it possible to obtain barrels with a good internal surface and sufficient accuracy for most tasks. The disadvantage of this method is the extremely high cost of the equipment. During is the stretching of a carbide mandrel head through the bore. The head has a certain profile corresponding to the caliber, number and pitch of the rifling. The mandrel broaching operation itself takes from one minute to several tens of minutes, however, it requires very high-quality preparation, primarily in terms of the finishing size of the channel, its cleanliness, and lubricants [19].
After pulling the mandrel, the hole is made of a larger caliber, and to obtain an accurate size and stress relief, the barrel is placed in a special furnace, where it slowly heats up and cools down for ~ 50 hours. The disadvantage of this method is the difficulty of selecting the thermal conditions to obtain the desired size of the barrel. Electrochemical etching – an electrode with a rifling profile is stretched through the channel and an electric current is applied, at the point of contact, the metal of the barrel is etched and rifling is obtained.
The method is quite accurate and fast, but it is not applicable to all steels. Current trends in improving the technology of manufacturing gun barrels can be clearly seen on the example of tank guns, for which the problems of increasing the destructive power of moving and stationary armored or reinforced targets by increasing the velocity of the projectile, as well as reducing the mass of the gun to lighten and reduce the volume of the turret are very urgent. In order to reduce the warping of the barrel, a thermo protective casing is used, which also performs a number of other functions. Thus, the use of high-rigidity composites contributes to the accuracy of guidance and the reduction of dynamic stresses associated with the high velocity of the projectile.
The composite casing performs the function of reducing the radio visibility of the tank, and also hides the barrel heated after firing from detection by infrared guidance

systems of enemy tank destruction systems. The modern design of the muzzle brake requires that it be integrated with the barrel, so the high-strength steel used to make the barrel must be.

LITERATURE

1. Каблов Е.Н. Конструкционные и функциональные материалы – основа экономического и научно-технического развития России // Вопросы материаловедения. 2006. №1. С. 64–67.

2. Оспенникова О.Г. Стратегия развития жаропрочных сплавов и сталей специального назначения, защитных и теплозащитных покрытий // Авиационные материалы и технологии. 2012. №S. С. 19–36.

3. Туканов А.Г. Технология производства стрелково-пушечного и артиллерийского оружия. М.: Машиностроение, 2010. 238 с.

4. Hasenbein R.G. Wear and Erosion in Large Caliber Gun Barrels: RTO-MP-AVT-109. U.S. Army Armament Research, Development & Engineering Center. P. 16-1–16-14.

5. Nowotny S., Spatzier J., Kubisch F. et al. Repair of Erosion Defects in Gun Barrels by Direct Laser Deposition // Journal of Thermal Spray Technology. 2012. Vol. 21. Issue 6. P. 1173–1183.

6. Каблов Е.Н. Материалы и химические технологии для авиационной техники // Вестник Российской академии наук. 2012. Т. 82. №6. С. 520–530.

7. Emerson R., Kaste R., Carter R. et al. Approaches for the Design of Ceramic Gun Barrels. U.S. Army Research Laboratory Weapons & Materials Research Directorate. P. 1–7.

8. Крекнин Л.Т. Производство автоматического оружия: Ч. 1. Ижевск: Ижевский гос. технич. ун-т, 2012. 236 с.

9. Тонышева О.А., Вознесенская Н.М., Шалькевич А.Б., Петраков А.Ф. Исследование влияния высокотемпературной термомеханической обработки на структуру, технологические, механические и коррозионные свойства высокопрочной коррозионностойкой стали переходного класса с повышенным содержанием азота // Авиационные материалы и технологии. 2012. №3. С. 31–36.

10. Вознесенская Н.М., Елисеев Э.А., Капитаненко Д.В., Тонышева О.А. Оптимизация технологических режимов получения тонких листов и ленты из коррозионностойкой стали ВНС-9-Ш // Металлы. 2014. №1. С. 46–51.
11. Орлов М.Р., Оспенникова О.Г., Громов В.И. Развитие механизмов водородной и бейнитной хрупкости конструкционной стали в процессе эксплуатации крупногабаритных конструкций // Авиационные материалы и технологии. 2012. №S. С. 88–93.
12. De Rosset W.S., Montgomery J.S. Cobalt-Base Alloy Gun Barrel Study. Army Research Laboratory. July, 2014. P. 119–123.
13. Орлов Б.В., Ларман Э.К., Маликов В.Г. Устройство и проектирование стволов артиллерийских орудий. М.: Машиностроение, 1976. 432 с.
14. Жук А.Б. Стрелковое оружие. М.: Воениздат, 1992. 735 с.
15. Алферов В.В. Конструкция и расчет автоматического оружия. М.: Машиностроение, 1977. 248 с.
16. Федосеев С.В. Оружие современной пехоты. М.: Астрель, 2001. Т. 1. 351 с.
17. Полная энциклопедия боевых танков и самоходных орудий / под. ред. О.В. Дорошкевича, В.С. Ликсо, К.Л. Архипова. М.: АСТ; Минск: Харвест, 2008. 384 с.
18. Способ изготовления ствола артиллерийского орудия: пат. 2419757 Рос. Федерация; заявл. 31.05.10; опубл. 27.05.11, Бюл. №15. 11 с.