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The Design Specificity of the Ammunition Supply and Storage Mechanism in Naval Weapon System OSU-35

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Abstract. The article presents the design of the ammunition supply and storage mechanism developed for the 35 mm Naval Cannon, which is an integral part of the Naval Weapon System OSU-35. The system for supplying and storing ammunition for the 35 mm KDA automatic naval cannon, was developed and manufactured in Zakłady Mechaniczne (Mechanical Plant) 'Tarnów' S.A. in Tarnów (Poland), as part of the project '35 mm Automatic Naval Cannon KDA with a Fire Control System Installed on the Ship Using the Sea Version of the ZGS-158 Integrated Tracking Head and Fire Control Station'. The manufactured ammunition supply and storage mechanism used in the 35 mm Naval Cannon has been tested in the factory, military training area and verified in real conditions during research conducted at sea. The sea tests of the Naval Weapon System, installed on board of Polish anti-submarine corvette ORP Kaszub, were carried out in real conditions and included tests of shooting at surface and air targets at various parameters and distances to the target.

The results of the tests carried out showed that the adopted design solutions met the assumptions that had been set and defined for the development of the 35 mm Naval Cannon, which is an integral part of the Naval Weapon System.
Keywords: armament, Naval Weapon System, Naval Cannon, 35 mm KDA

1. INTRODUCTION

We have been observing the development of the art of war since the appearance of man. Initially, it was a stone, then a stick, etc. With the development of technology, combat tools have been perfected, creating a type of weapon called firearms. These are weapons that uses the kinetic energy of gases produced during the combustion of gunpowder to propel the projectile.

The rifled cannon period began in the second half of the 19th century. The design of the cannons and the method of their loading with ammunition have undergone significant changes. The cannons were equipped with locks, the ammunition was loaded from the muzzle of the barrel, the projectile shape changed to cylindrical and, thanks to the threaded barrel, its stability in flight was improved by rotation around its axis. The targets for land and sea cannon fire are very diverse, differing in their properties and location, they can be fixed or movable, located at different heights or distances from the cannon. The actions on the battlefield proved that in order to perform a number of combat tasks, we need artillery weapons that were highly reliable, resistant to interference and cheap. It turns out that in some cases artillery has a higher efficiency compared to missile weapons.

2. 35 mm NAVAL CANNON

The design of the newly developed 35 mm Naval Cannon includes three basic assemblies (Fig.1):

- Foundation (pos. 3) is a stationary assembly attached to the ship's deck, inside which the cannon control blocks are located, in the upper part there is a bearing with a toothed ring and a rotation drive unit.
- Platform (pos. 2) is a rotating unit mounted on a bearing that can be rotated in a horizontal plane. On the platform, in the upper cradle, there is a pivot with a bearing for mounting the swing assembly, ammunition supply and storage mechanism, a hydraulic assembly for controlling the cannon bolts as well as controlling and operating the 35 mm KDA automatic cannon and cartridge removal assembly.
- Swing assembly (pos. 1) located in the upper cradle, on the rotating assembly, enables the gun barrel to be directed towards the target in the vertical plane. The 35 mm KDA automatic system with an electronic unit for controlling and monitoring its operation is assembled on the pivot pins of the swing assembly.

Fig. 1. View of the 35 mm Naval Cannon

3. AUTOMATIC CANNON AND AMMUNITION

The 35 mm KDA automatic system manufactured in Huta Stalowa Wola (Poland) under the license of the Swiss manufacturer of anti-aircraft weapons, Oerlikon-Contraves company. It is mounted in the swing assembly of the cannon. The design of the automatic system allows it to be supplied from the right or left side with 35x228 mm ammunition placed in DM70 cells.

As of today, Mesko S.A. Plant (Poland) produces T-PT 387 mm long tracer blanks, weighing 1588 g, and FAPDS-T 384 mm long sub-calibre tracer rounds with rotational stabilization, weighing 1460 g.

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Fig. 2. 35 mm rounds

4. ASSUMPTIONS FOR AMMUNITION SUPPLY AND STORAGE

At the first stage of developing the mechanism for storing and supplying ammunition for the 35 mm KDA automatic system mounted in the swing part of the Naval Cannon, the following assumptions were developed:

- Ammunition storage and supply should ensure the possibility of supplying belted ammunition to the 35 mm KDA automatic system.
- Storing and sending ammunition should enable supplying the automatic system from its right and left side.
- In order to facilitate cannon operation, the right and left ammunition storage and supply systems on the cannon should be the same or a mirror image.
- The design of the ammunition storage should prevent the movement of belted ammunition during the ship's heel.
- Loading of ammunition into ammunition magazines should be performed by the crew.
- Loading should be possible in sections of ten pieces of belted ammunition.
- To link sections of belted ammunition, a specialized device should be developed to facilitate their combination.
- When loading belted ammunition, it is allowed to use specialist aids to facilitate the loading process.
- The ammunition magazine should accommodate 100 pieces of ammunition on one side placed in DM 70 cells.
- Belted ammunition supply should be possible within the range of the automatic system lift angles from -10 ° to + 80 °.
- The ammunition magazine should allow the installation of a mechanism assisting in the supply of belted ammunition.
- The loss of voltage in the mechanism assisting in the supply of belted ammunition should not interfere with ammunition supply to the automatic system.
- The storage and supply system should be adapted to normal ammunition, sub-calibre ammunition and programmable ammunition under development.
- When supplying ammunition, the working conditions for ammunition placed in DM70 cells must be met.

5. WORKING CONDITIONS FOR AMMUNITION BELT

The 35 mm KDA automatic system is supplied by a detachable ammunition belt consisting of separate DM70 cells (Fig. 3). The main advantage of this type of ammunition belt is the ability to obtain any amount of ammunition available for direct feeding of the automatic system and firing. In the development of the supply and storage mechanism, we assumed 100 pieces of ammunition on both the right and left side of the automatic system.

The ammunition belt consisting of DM70 cells linked by means of their hooks, is 35 mm ammunition secured against disconnection. Classic 35 mm calibre and sub-calibre ammunition, placed in DM70 cells, has strictly defined operating parameters. The main advantage of this type of ammunition belt is the ability to obtain any amount of ammunition available for direct feeding of the automatic system and firing. In the development of the supply and storage mechanism, we assumed 100 pieces of ammunition on both the right and left side of the automatic system.

Fig. 3. DM70 cell

The 35 mm ammunition belted into DM70 cells is characterized by the following parameters:

- Low weight.
- Strictly defined pitch (distance between the axes of adjacent cells).
- Accuracy and reliability of ammunition positioning.
- Bending radii in two directions.
- The torsional angle between two adjacent cells.
- Resistance to weather conditions.
- Ease of ammunition belting and simplicity of un-belting.

6. SUPPLY AND STORAGE SPECIFICATIONS

The ammunition supply and storage assembly developed for the 35 mm Naval Cannon is located on the cannon's rotating platform on the right and left side of the automatic system. The left side of the ammunition supply and support is a mirror image of the right side and consists of similar assemblies. The right and left sides of the ammunition storage compartment hold 100 pieces of belted 35 mm ammunition each.

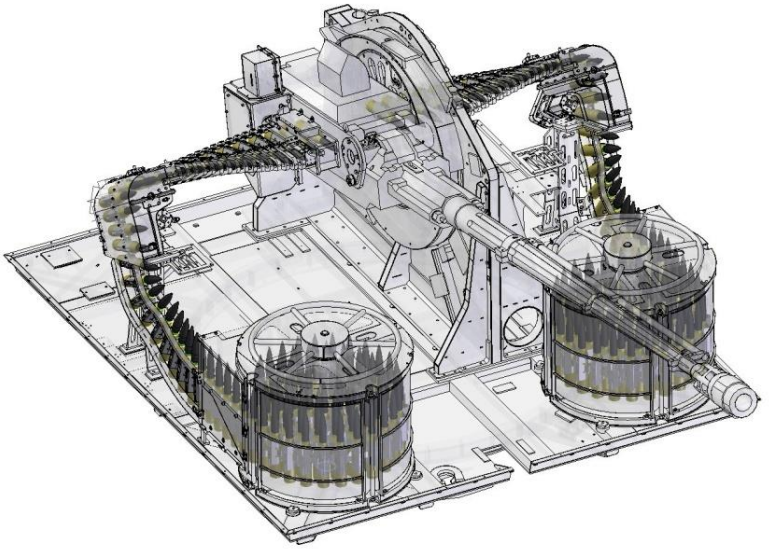

Fig. 4. Supply of 35 mm ammunition to the KDA automatic system

The ammunition supply and support assembly includes an ammunition magazine and a flexible ammunition belt guide.

6.1. Ammunition magazine

The ammunition magazine (Fig.5) consists of a drum ammo rack, pos. 1, fixed guide, pos. 2 and ammunition supply support unit, pos. 3.

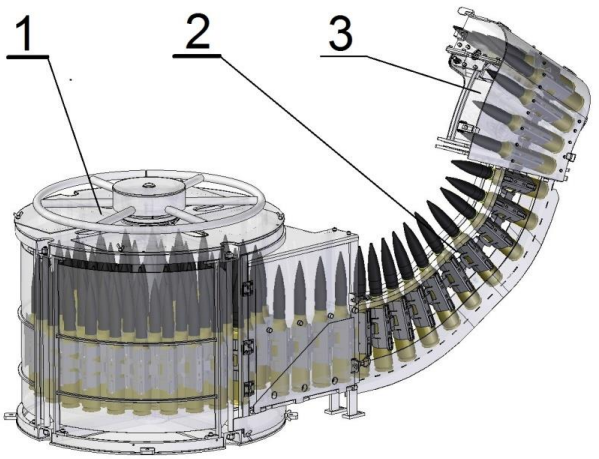

Fig. 5. Drum ammunition magazine

6.1.1. Drum ammo rack

The drum ammo rack has the shape of a cylinder, inside which there is a rotating mechanism with hooks, enabling the ammunition belt to be wound up. 35 mm ammunition is wound on the rotating mechanism in the DM70 ammunition belt. In the upper outer part of the drum ammo rack there is a round knob that facilitates manual winding of the belted ammunition onto the rotating mechanism. There is a brake between the knob and the rotating mechanism. During the reloading of the automatic system and firing, the brake is automatically released. If the fire is interrupted, the rotary mechanism is stopped automatically, protecting the wound ammunition against rotation caused by the forces of inertia.

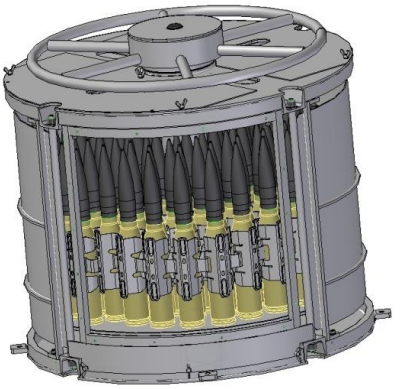

Fig. 6. Drum ammo rack

6.1.2. Fixed guide

The fixed guide connects the drum ammo rack with the ammunition supply support unit. Due to the structurally required change of ammunition position, the guide has the shape of an arc. In the lower part of the fixed guide, there are guiding elements on which the bottom of the cartridge moves and the guiding elements of the lower guide protect the ammunition from direct contact of the primer with the lower guide. In the upper part of the guide, there are two strips securing the correct movement of the ammunition.

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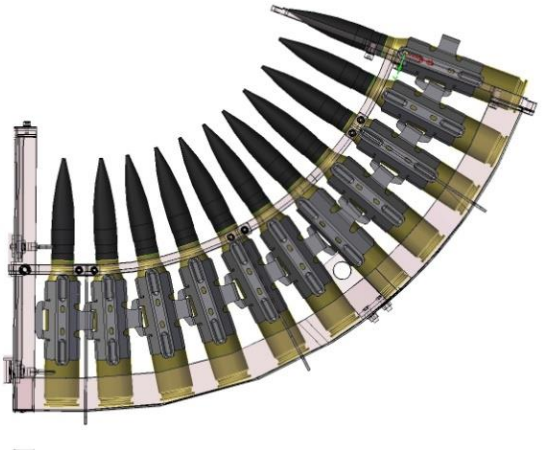

Fig. 7. Fixed guide

6.1.3. Ammunition supply support assembly

The ammunition supply support assembly connects the fixed guide with the flexible guide of the ammunition belt. Inside the ammunition supply support assembly body, on the rotating shaft, there are star wheels, the shape of which enables the change of the ammunition feeding direction by a 90° angle.

During shooting, the star wheel roller is powered by an electric motor whose rotation is closely related to the speed of feeding the ammunition to the automatic system. On the shaft with star wheels, there is a directional clutch that ensures the direction of the ammunition belt movement towards the automatic system only. In the event of the need to withdraw the loaded ammunition to the magazines, the outer part of the body houses a lever that allows you to unlock the directional clutch, enabling the rotation of the shaft with star wheels in any direction.

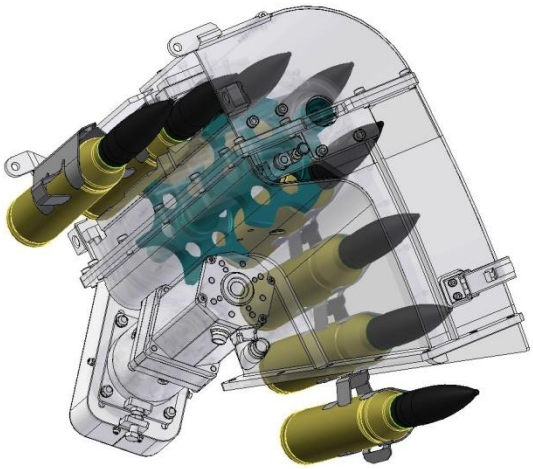

Fig. 8. Ammunition supply support assembly

6.2. Flexible ammunition belt guide

The flexible ammunition belt guide is used to guide the belted ammunition between the supply support mechanism and the automatic system throat. The designed flexible guide allows its 3-directional movement and ensures smooth movement of the belted ammunition inside it within the range of the automatic system's lifting angles. The flexible guide is designed with a series of movable clamps connected by means of plates. The shape of individual clamps is adapted to the dimensions of the ammunition placed in the DM70 cell. The flexible guide ends with frames that are equipped with retaining and connecting elements for the ammunition supply support mechanism and the throat.

Fig. 9. Flexible ammunition belt guide

7. AMMUNITION STORAGE AND SUPPLY TESTS

During the tests of the Naval Weapon System in sea conditions at ORP Kaszub, a number of checks were made and the movement of ammunition in various parts of the power supply and storage system was analysed.

The tests included checking the right and left side of the ammunition storage and supply system during single shots and bursts at different elevation angles in the range from -10° to + 80°.

Fig. 10. Sea tests

8. CONCLUSIONS

The storage and supply of the 35 mm ammunition of the Naval Cannon is the result of the creative work of the designers at the Mechanical Plant in Tarnów (Poland).

The developed design enables safe operation in sea conditions, also during high heels of the ship.

The conducted research has shown that the adopted solutions meet the assumptions that were defined at the developmental stage.

In order to confirm the effectiveness of all the implemented design solutions, a copy was made, which was subjected to tests carried out in a military training area and tests in real life conditions on board of ORP Kaszub.

The state of development of armaments, and mainly artillery, in each epoch reflected the level of technological development in a given country. The amount of modern weaponry is a reflection of not only military power, but also the technical and economic development of a country.

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Specyfika konstrukcji mechanizmu zasilania i magazynowania amunicji w Okrętowym Systemie Uzbrojenia OSU-35

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Streszczenie. W referacie przedstawiono konstrukcję mechanizmu zasilania i magazynowania amunicji opracowaną do 35mm Armaty Morskiej będącej integralną częścią Okrętowego Systemu Uzbrojenia. System zasilania i magazynowania amunicji do 35mm automatu KDA został opracowany i wykonany w Zakładach Mechanicznych „Tarnów" w ramach realizacji projektu „35 mm automatyczna armata morska KDA z zabudowanym na okręcie systemem kierowania ogniem wykorzystującym Zintegrowaną Głowicę Śledzącą ZGS-158 wykonaną w wersji morskiej wraz ze stanowiskiem kierowania ogniem". Wykonany mechanizm zasilania i magazynowania amunicji zastosowany w 35mm Armacie Morskiej został poddany badaniom zakładowym, poligonowym oraz sprawdzeniu w warunkach rzeczywistych podczas realizowanych badań morskich. Badania morskie Okrętowego Systemu Uzbrojenia posadowionego na pokładzie korwety zwalczania okrętów podwodnych ORP Kaszub, prowadzone były w warunkach rzeczywistych i obejmowały badania strzelaniem do celów nawodnych oraz powietrznych przy różnych parametrach i odległościach do celu. Wyniki przeprowadzonych sprawdzeń wykazały, że przyjęte rozwiązania konstrukcyjne spełniły założenia, jakie zostały wyznaczone i określone dla opracowania 35mm Armaty Morskiej będącej integralną częścią Okrętowego Systemu Uzbrojenia.

Słowa kluczowe: uzbrojenie, Okrętowy System Uzbrojenia, armata morska, 35 mm KDA