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Autoloader for AFVs Literature Survey

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Abstract: ***Most of the Current Armored Fighting Vehicles (AFVs) have four men crew configuration and the ammunitions are loaded into the gun barrel manually. A rate of firing of ammunition of around 8 rounds per minute is achieved with manual loading in the favourable condition. The rate of loading will diminish during sustained firing and the crew will become fatigue due to continuous loading. Hence there is a need for automatic loading of ammunitions into the gun to improve the rate of firing during sustained operation. An autoloader is a machine aid for the replacement of the human operator that extracts the ammunition from the storage bin and loads it into the gun chamber. In this paper a survey has been made on different types of autoloader employed in the AFVs.***

Keywords: Autoloader, Carousal, Bustle mounted

1. Introduction

Most of the Current AFVs have four men crew configuration. The Driver is seated in the hull and Turret accommodates three men crew- Gunner, Commander and loader. Main Armament of current AFVs is capable of firing Anti Tank ammunitions like FSAPDS, HESH / HEAT and AT Missiles with high accuracy. A total of around 40 Nos of Main Gun Ammunitions are stowed in this vehicle out of which ten rounds are stowed in the turret bustle as ready to fire condition. The Configuration of the ready round bin is shown in Figure 1 and Figure 2.

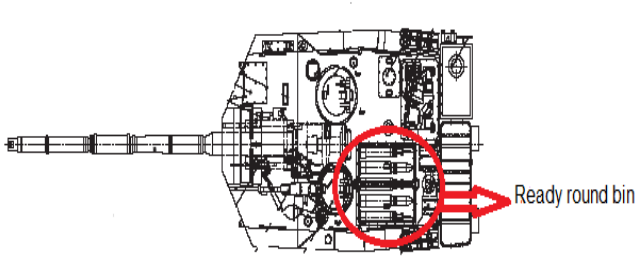

Figure 1: Turret Bustle mounted Ready round Bin

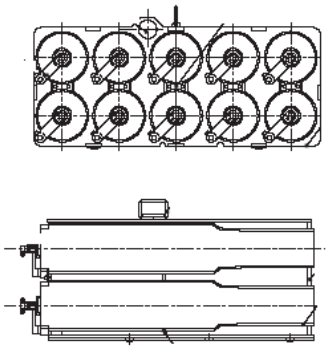

Figure 2: Ready round Bin Configuration

The ready round bin is mounted in the turret bustle and secured to it with screws. It is reinforced with steel strips. A handle is provided on the top to lift the bin. Three supports are provided, one each at the front, middle and rear, to house the FRP tubes. The tubes are retained in their position by the retainer provided in the front support. A locking handle is provided to retain the ammunition in its FRP tube.
A helix grooved spring loaded plunger allows the handle to move forward for locking, and backward for unlocking. A spring loaded thrust disc exerts pressure on the ammunition stub to prevent the movement of ammunition when the tank is moving. A charge temperature unit is installed in the bin to indicate the temperature of the charge.

2. Need for Auto Loading System

In most of the four men crew configuration of AFVs, the ammunitions are loaded into the gun barrel manually. The loader has to draw the ammunition from the ready round bin and reverse the shell and ram into the barrel before firing. The sequence of manual loading is listed as below:

- Open the bin top lid.
- Engage the round with finger near obturator.
- Pull the round from bin till it is out of bin.
- Turn and align the round with damper axis.
- Keep the projectile in the mouth of the chamber and obturator on deflector guard.
- Push the round in to chamber.
- Ram the round with adequate force and velocity till the breech is closed automatically.

In current AFVs, a rate of firing of ammunition of around 8 rounds per minute is achieved with manual loading in the favourable condition. The rate of loading will diminish during sustained firing and the crew will become fatigue due to continuous loading. Hence there is a need for automatic loading of ammunitions [1] into the gun to improve the rate of firing during sustained operation with adequate safety measures built in the system. Due to introduction of auto loading system, the number of crew can be reduced by one and also the autoloader requires less space than human loader, allowing for a reduction in turret size. This reduces the silhouette of the AFVs, which in turn reduces the amount of surface area that needs to be armored and decreases in weight and size.

3. Automatic loading of ammunition

3.1 Carousal Type Autoloader

In Russian T-Series tanks [2], this auto loading system replaced the human loader, which resulted in three men crew configured vehicle. This carousal auto loading system is

located under the turret floor. The carousal type auto loader [3] consists of the following basic components:

- Rotary conveyor;
- Cell lifting mechanism;
- Cartridge base disposal mechanism;
- Rammer;
- Motor-operated gun lock;
- Control unit;
- Distributing boxes;
- Gunner's control panel;
- Loading control unit;
- cell position sensing unit;

The sequence of operation of the autoloader is shown in the schematic diagram (Figure 3).

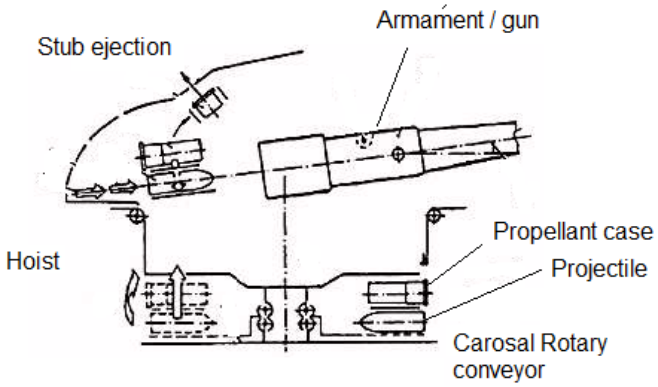

Figure 3: Carousal Type Autoloader [3]

The Main gun ammunitions of T-Series tank are of two piece forms (separate Projectile and propulsion case) and these ammunitions are stowed in the carousal as shown in the Figure 4. It accommodates 22 projectiles at the bottom and 22 propellant cases on the top.

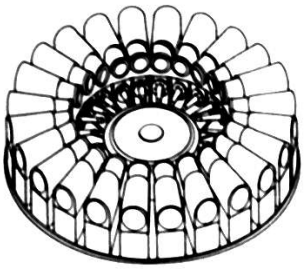

Figure 4: Carousal Conveyer [3]

While stowing the ammunition into the carousal, the gunner records the type and location of each projectile and the same will be indicated in the gunners control panel. When the gunner/ commander select the ammunition to be fired through the control panel, the carousal will automatically rotate until that particular ammunition aligns with the loader's hoist. The hoist then lifts the cassette up to the rear of the breech and when the gun has automatically reached the correct elevation for loading, the projectile & the case are rammed into the gun. After loading, the gun automatically returns to the prior engagement angle and the gunner may then adjust his aim and fire the weapon. After firing, the base stub from the cartridge case will be extracted by the stub case ejector, after which a small hatch will open in the rear roof and the stub will be tossed out of the turret. The limitations of carousel-based autoloaders [4]:

- The ammunition is placed inside the fighting compartment and there is no no proper blast venting measures, the compartment is not well protected due to accidental explosion of the ammunitions. Also the autoloader is susceptible to accidental damage by the crew.
- The round follows a fairly complex path during loading, which reduces the loading speed and increases the risk of malfunction.
- Placement of autoloader under the turret ring leads to increase in the height of the tank.
- The carousel autoloader layout puts serious limitations on the dimensions of the rounds that can be accommodated.
- Replenishing the autoloader will be a slow and hard task, due to its location.

3.2 Bustle mounted Autoloader

Most of the western tanks have single piece tank ammunition. Stowing these ammunitions underneath the turret carousal & its retrieval will require more space, and hence bustle mounted auto loader were preferred these tanks. The advantage of bustle mounted auto loader [4] is given below:

- The autoloader module is mounted outside the fighting compartment, and compartmentalized.
- In the event of the ammunition fire, blowout panels will blown up and vent out the explosion and thus protecting the crew compartment.
- The loading cycle consists of a single ramming movement without the need for any complex trajectory.
- The autoloader has a simple & rugged design and allows to store substantial amount of ammunition.

The configuration of the Nexter bustle mounted autoloader in the Leclerc MBT [5] is shown in Figure 5.

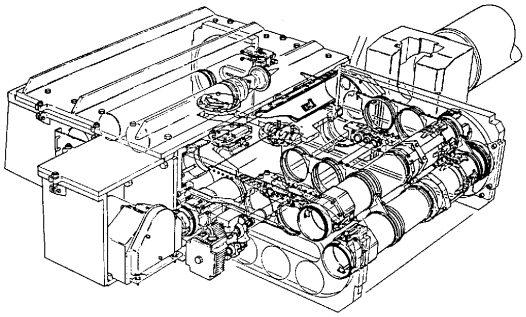

Figure 5: Bustle mounted auto loader

The autoloader consists of the following modules:

- An Automatic System
- Ready use round magazine
- Telescopic Rammer
- Hand operated device for reloading the magazine
- The loading door.

The Leclerc automatic loader consists of following components:

- Conveyor system which stores the ammunitions with their noses facing the front of the tank

- Telescopic rammer which transfers the ammunition from the loader to the open breech of the gun
- Motorized transmission mechanism for automatic loading and a transmission mechanism for manual loading.
- Electronically operated loading door unit fitted on the armoured wall
- An ammunition supply system fitted near the loader. It can be manually operated from inside the turret and from outside the turret through an aperture in the turret rear.

Automatic loader handles five different types of ammunitions. The ammunition stored is recognised automatically by two bar code sensors fitted on the conveyor.

The selection of a particular type of ammunition is automatic upon command from the Operators Control Panel (OCP) in the turret. The selected round is collected from the rack in the turret bustle, transported to the loading position and rammed into the breech. When the weapon is fired, the gun recoils, the breech is opened and the empty cartridge case is ejected out of a door in the turret bustle. The gun will automatically returns to -1.8° for loading again.

Control of the automatic loader is through a micro-sequencer-controlled electronic unit commanded from the OCP which also communicates with the Built-in Test Equipment (BITE) to identify any fault quickly. There is also a partial manual reversion mode that enables the crew to select a round before the manual loading of the gun.

A maximum rate of fire of eight rounds per minute can be achieved. Cycle time is around 7 seconds. A single brushless DC motor and its associated motor control unit provide motion control in three planes.

The automatic loader is operated by an electronic system connected to the databus.

4. Autoloader – System Requirement

The System Requirement of autoloader [5] [6] for bustle mounted Autoloader is given below:

- System shall accommodate 22 to 24 rounds of ammunition (containing 7 different varieties of Ammunitions).
- The stowage bin shall be completely containerized with blow-off panel, so that in case of any ammunition fire, explosion shall be vented out.
- The system shall eject the ammunitions automatically through single door for loading it into the main Armament/Gun.
- The system shall have the capability for automatic identification of ammunitions stowed in the bin.
- The system shall be interfaced with IFCS of the AFV so that the auto loader function can be controlled through gunner / commander control panels thus synchronizing the operation of main armament (Gun) with autoloader.
- System shall have bi-directional indexing capability, so that when particular ammunition is required, the same ammunition is brought to retrieval position with minimum distance automatically.
- The system shall have the following operating modes:
  - Automatic;
  - Semi-automatic (step-by-step);
  - Manual (emergency)
- Duration of one loading cycle of the system will be:
  - min: 7 sec;
  - max: 12 sec. th
- Replenishment of e ammunition can be done from inside as well as outside the tank with the replenishment time of less than 15 min.
- The complete system shall be enveloped within the available space of Height: 500 mm X Width: 2600 mm X Length: 1400 mm.
- The ammunition can be loaded into the gun when the vehicle negotiates a gradient with a slope 30 deg or side slope of 15 deg.

5. Conclusion

This paper highlights the different types of autoloader employed in the Armored Fighting Vehicles (AFVs) with their merits & demerits and the system requirement of bustle mounted autoloader AFVs from the available literature in a capsule form which will be useful for the people working in the development of AFVs.

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Author Profile

J. Roopchand is a Mechanical Engineering Graduate from Anna University, Chennai. Presently he is working as senior System Designer at CVRDE, Avadi, Chennai.