T-72B3 Main Battle Tank

Object 184 (184-1) with Sosna-U Multichannel Gunner's Sight

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(T-72B3 on Kamaz-65255 at Army-2017 defense expo. Via vitalykuzmin.net, cover photo as well)

Note to Reader:

This text is intended to provide the reader with a basic understanding of the procedures required to crew the turret of a T-72B3 main battle tank. While detailed, there are surely aspects relating to the topics covered which have been left out or insufficiently covered where a lack of adequate sources restricted what information could be confidently provided by the author, who is neither an "expert" nor a Russian speaker. Yandex and Google translate were often used to assist in understanding Russian language sources. As such (not to attempt to discredit anything in this work), remember that this is ultimately the boredom project of an enthusiast of Russian armored vehicles provided for free because why not. There are bound to be mistakes here and there.

The topics of zeroing, boresighting and menu functions are not discussed, nor are the subjects of the coaxial PKTM medium machine gun and commander's Kord heavy machine gun.

While the sources and citations section at the end covers credit, it is worth mentioning the two major inspirations for this project, thesovietarmourblog.blogspot.com, otherwise known as Tankograd and kotsch88.de, a website covering tanks from around the world run by German defense expert Steven Kotsch. The photographs and information contained within both and on vitalykuzmin.net are used frequently throughout to supplement the various T-72 and M-84 manuals from which the bulk of information contained hereafter is drawn from.

I have endeavored to cite all sources used. Plagiarism, perceived or otherwise, is never intended. I may be contacted via my Instagram handle, provided on the title page. Needless to say, the author does not recommend attempting to cite this manual itself as an acceptable source of information for any purpose other than recreation.

Russian mils, graduated on a scale of 6000 are used throughout as opposed to the more common 6283 scale or 6400 scale used for NATO artillery. Keep this in mind while reading.

(T-72B3 with TMT-K mine roller at the Army-2018 defense expo. Via vitalykuzmin.net)

Chapter 1: The T-72B3 Main Battle Tank

The T-72B3 main battle tank, otherwise known as the Object 184 (184-1) with Sosna-U Multichannel Gunner's Sight, was designed by the Russian state-owned armored vehicle manufacturer UralVagonZavod (UVZ) and first entered service in 2013 after successful field tests with the 138th Motorized Rifle Brigade. It serves to this day as the backbone of the Russian tank fleet and is ultimately based on the Soviet T-72B Model 1985 and maintains the same hull and turret.

(T-72B Model 1985, left. T-72B3 Model 2016, right. Via vitalykuzmin.net)

While 11 different versions of the T-72B3 exist, excluding common field modifications of course, this overview will only cover known in-service variants.

The T-72B3 Model 2011 was the low rate, initial production model that retained the same standard T-72B Model 1989 Kontakt-5 explosive reactive armor (ERA) placement on the right turret cheek despite the removal of the gunner's infrared searchlight on account of the presence of a thermal imaging system. The 2013 model is identical to the 2011 Model and simply corrected this weak spot. This version is considered to be the "standard" T-72B3 model. If any 2011 models survive, they will surely have been updated to the 2013 standard.

(T-72B Model 1989, left. T-72B3 Model 2011, right)

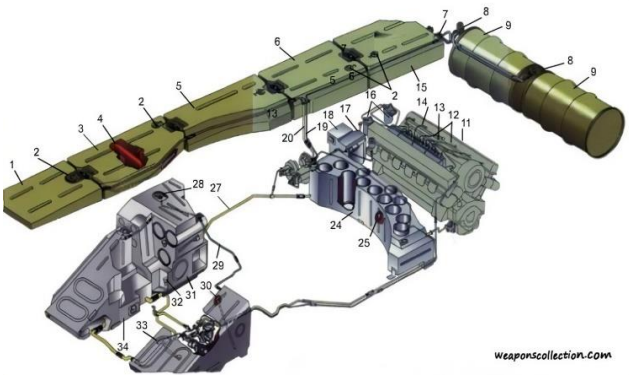
Each 2011/13 model cost 52 million rubles (over 107% inflation since 2013) and took 9 months to produce in peacetime. Not counting the general overhaul of each tank when it was upgraded, the T-72B3 Model 2013 was

actually just 22 million rubles, or a little over 750,000 USD in today's money. The effect of purchasing power parity and other economic factors on the real cost and value of the tank is not considered here.

Despite having entered service in the 2010s, the 2013 model sorely lacks many modern capabilities seen on Western MBTs such as a commander's independent thermal viewer (CITV) system, commander's remote weapon station (RWS) and even a GLONASS/GPS receiver. Moreover, the tank also retains the same level of ballistic protection as found on the T-72B Model 1989, meaning that it will only be effective against heavy antiarmor weapons from the late 1980s and early 1990s. Many antiarmor developments in NATO after the collapse of the Soviet Union were based on the protection standards of late Soviet armor obtained through various official and unofficial channels, including Russia herself.

(The German Panzerfaust 3-IT "Improved Tandem" antitank rocket. It is capable of frontally penetrating a T-80U, the armor protection of which is similar to the standard T-72B3)

Even improvements in ERA seen on newer Russian tanks such as the T-72B2 'Rogatka' which Russia had intended to upgrade its T-72Bs on the basis of in the mid-2000s and the recently unveiled Belarussian T-72BM2 fall short of contemporary norms. Nor did the Russians prioritize ammunition compartmentalization as much as they could have, considering the well-known shortcomings of stowing propellant charges and projectiles in the crew compartment. It would be remiss to continue without at least a mention of the T-72's use of conformally shaped fuel tanks to store most propellant charges in a type of "wet" storage to reduce the chance of severe ammunition cookoffs. Modern standards would again find this solution to be lacking, although it is even then fair to say that many NATO tanks like the Leopard 2 still suffer from the same issues albeit to a lesser extent.



(Conformally shaped fuel tanks in the T-72. Via weaponcollection.com)

As we will see later on, despite its shortcomings, the T-72B3 is not an entirely bad tank, simply out of its time in some regards and absolutely has the potential to be employed with deadly effect by a trained, well supported and motivated crew, something the Russians also find in short order at this time of writing.

(T-72B3 Model 2013 next to a BMP-2 infantry fighting vehicle. Via vitalykuzmin.net)

The T-72B3 saw its first combat at the Battle of Ilovaisk in Ukraine's Donbass region, which also served as the Russian military's first major direct action in the War in Donbass. Russia's unexpected attack and the lack of preparedness of the Ukrainian military ultimately had more to do with their defeat in Ilovaisk than any piece of equipment, and while its performance was not terrible, there was certainly much to be desired in terms of protection, situational awareness, and crew competency. By the time the Minsk 2 ceasefire agreement was signed on February 12, 2015, several dozen T-72B3 had been captured or destroyed in Ukraine. Both common sense and the results of the fighting in Donbass would eventually lead to the introduction of the second main model of the T-72B3 in 2016.

(Turret of a destroyed T-72B3 during the Siege of Debaltseve in 2015, left. Turret of a destroyed T-72B3 at the Battle of Ilovaisk in 2014, right. Russian interventions at Debaltseve and Ilovaisk were decisive during the War in Donbass.)

The T-72B3 Model 2014 received a commander's independent thermal viewer known as the PK-PAN, a modification of the PK-PAN (with T05BV-1 remote weapon station) used on the T-90M. In all other known aspects, it is identical to the T-72B3 Model 2013. Only about a company (usually 10 total) of these tanks was ever produced for Russia's annual tank biathlon, 3 of which have been lost in Ukraine.

(T-72B3 Model 2014. The PK-PAN sits on the right side of the Sosna-U and behind the commander's cupola, left. Close up of the PK-PAN, right)

In 2016 a 4th model of T-72B3 came out, known officially as the Object 184 (184-1) with Sosna-U Multichannel Gunner's Sight and Additional Protection. This model featured optimized Kontakt-5 placement in the frontal arc of the turret, including a half wedge over the driver's hatch and 4S24 ERA modules on the turret flanks. Some sources have reported the turret front ERA as Relikt; this is false, they merely use the same explosives. Cage armor on the aft portion of the turret and hull is also featured alongside an expanded auto loader and driver's MFD paired with a backup camera. A new gun, the 2A46M-5-01 was installed, the exact features of which are not fully confirmed. There is no known functional difference on the user end that would change the relevance of any information presented hereafter between the new and old guns. Except for the 4S24 ERA, some 2013 models have received the 2016 model's armor upgrades.

(T-72B3 Model 2016, left. Backup camera in the rear, right. Via vitalykuzmin.net)

In 2017 the Russian Airborne Forces, beginning with the infamous 76th Air Assault Division, received a special command version of the T-72B3 featuring the VDV's Andromeda-D C2 terminals. Except for the T-90A and T-90M this is the only other Russian tank in service known to feature a battle management system. At some point the 7th Mountain Air Assault Division may have also received the Andromeda-D T-72B3.

Sometime in 2021 all new produced T-72B3 Model 2016 began receiving Russian domestic thermals in their primary gunsights as discussed later.

In 2022, UVZ began to produce the T-72B3 Model 2022 which features ERA on the forward track guards and above the gun mask in a similar fashion to the T-90M. Additionally, this tank also received a remotely controlled sight cover for its Sosna-U, although some have been seen without. Slat armor is no longer attached to the rear third of the hull, being replaced with mounting points for UBKh side skirts across its entire length. The 4S24 ERA blocks now wrap around nearly the entire circumference of the turret and extensive Kontakt-1 ERA boxes cover the turret roof. It is unknown if there are further substantial upgrades to the tank, although it does not appear to be so. This version with limited improvements was likely born out of low-cost lessons learned from the Invasion of Ukraine.

(T-72B3 Model 2022 turret in production at UVZ, left. Fully produced 2022 model turret seen from the rear, right)

Known Russian Units Fully or Partially Equipped with the T-72B3 as of Late 2021 (full credit for this section goes to ALTYN73 on Live Journal):

. 138th Motorized Rifle Brigade (MRB)

. 76th Air Assault Division (AAD)

. 18th Motorized Rifle Division (MRD)

. 6th Tank Brigade (formed into the 47th Tank Division shortly before the Invasion of Ukraine)

. 2nd MRD

. 3rd MRD

. 20th MRD

. 150th MRD

. 4th Base, Southern Military District

. 42nd MRD

. 34th MRB

. 7th Base, Southern Military District

. 7th AAD

. 126th Coastal Defense Brigade

. 201st Base, Central Military District

. 90th Tank Division

. 21st MRB

. 35th MRB

. 74th MRB

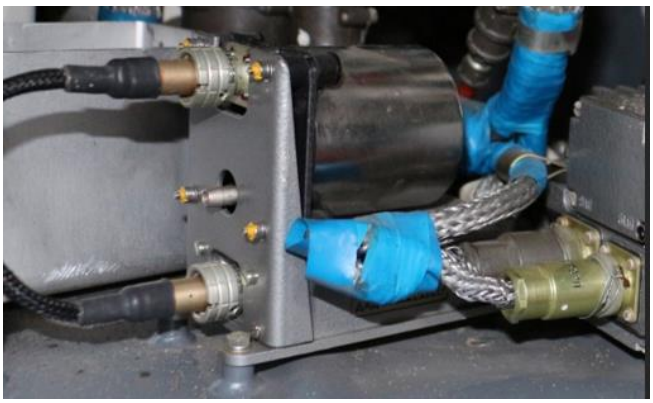
. 36th MRB

1A40-4 Fire Control System:

(Via @tankdiary on Instagram)

The 1A40-4 is the fire control system (FCS) found on all T-72B3 models. It is the most common Russian FCS and incorporates the Sosna-U multi-channel gunner's sight and the TPD-K1M backup day sight. It also includes a ballistic computer, wind sensor, atmospheric pressure sensor, air temperature sensor, charge temperature sensor, cant sensor, applied automatic lead calculator, automatic target tracking in the thermal channel, commander's duplicate gun controls and the Delta-D range adjustment system. The commander is afforded a limited independent hunter-killer capability using his optic, the TKN-3MK as found on the older T-72B.

(Sosna-U and TPD-K1M mounted next to each other in the gunner's position of a T-72B3, left. TKN-3MK in the commander's position of a T-72B3, right. See page 13 for a full image of the Sosna-U)




(Atmospheric pressure sensor, left. Charge temperature sensor, right)


(Air temperature sensor at the base of the DVE-BS crosswind sensor, left. DVE-BS in center, right. Via vitalykuzmin.net)

(T-72B3 Model 2016 reference image. Via vitalykuzmin.net)

1- 2A46M-5-01 125mm main gun, the port for the coaxial machine gun sits just right of the main gun, seen below

2- TPD-K1M backup day sight

3- Commander's OU-3GK infrared spotlight

4- Sosna-U multi-channel gunner's sight, easily identifiable by its large and blocky appearance compared to the old 1K13-49 sight

5- Commander's Kord antiaircraft/anti-material machine gun

6- DVE-BS crosswind sensor

7- 4S24 ERA

8- Gunner's periscope (the gunner also has a second forward facing periscope in front of his hatch hinge)

9- Tucha Type 902B smoke mortar system

10- Kontakt-5 (4S22) ERA

(Front facing view of the T-72B3's turret. Via vitalykuzmin.net)

The TKN-3MK sits directly below the OU-3GK IR spotlight. Just to the right of the main gun sits the oval shaped port from which the PKTM coaxial machine gun is fired. To the right of the gun mask the half Kontakt-5 block is clearly visible. It allows the driver to fit into his hatch while partially covering the old weak spot that had been there. With a full sized Kontakt-5 block the driver would not be able to get in and out.

In the TPD-K1M's former configuration as the TPD-K1 on the 1A40 and 1A40-1 FCS it also incorporated the UVBU automatic lead calculator, however this is no longer the case. The controls for the TPD-K1M are integrated with the Sosna-U and share some of its functions although the TPD-K1M cannot receive data from any of the tank's sensors linked to the ballistic computer including the DVE-BS, the reading of which was displayed as a lateral deflection requirement in mils through the eyepiece of the UVBU to be applied manually on older T-72 models.

The original Sosna was designed by Peleng, a Belarussian company that makes optoelectronic sighting systems for tanks and other armored fighting vehicles. Most notably, the Sosna was intended for use on the T-72B2 in the mid-2000s which never entered service. Its thermal channel, construction and general aperture are heavily related to the ESSA, a single channel thermal sight manufactured by Peleng for the T-90A series of tanks from 2006 and on.

(ESSA sight for the T-90A, left. T-72B2 with Sosna, right)

Both share a close resemblance to the Plisa and Buklet sights, the Plisa having been procured for limited use on the T-80UE-1. In its Russian license produced form it is known as the PNM-T and is manufactured by the Optical Mechanical Plant Vologda or "VOMZ". The same company also manufactured the French Catherine-FC 2nd generation thermal imaging system for the Sosna-U under license until the thermal channels in all newly produced PNM-T for the T-72B3 series were likely replaced with the Russian domestically designed FEM-18, a 3rd generation thermal imaging system about which little concrete information is known.

(T-80UE-1 with Plisa)

Previously the various tanks belonging to the T-72B and T-72BA series had used either the 1K13-49 night/ATGM guidance sight on B and BA standard tanks or the TPN-3-49 night sight on B1 and BA1 standard tanks (1A40-1 FCS). The Sosna-U occupies the space previously used by these sights instead of replacing the old day sight. This is in large part because it, like the 1K13-49, is a multichannel sight that allows the T-72B3 to carry out a night fighting

function but also because the structure of the sight is not large enough to allow it to sit directly in front of the gunner if it had replaced the TPD-K1. The old 1A40 rangefinder sight/FCS (integrates a modified TPD-K1) for the T-72B had contained a large gyroscope within the aft portion of the sight module while the Sosna-U contains its gyroscope and related functions within the sight head itself, above the mirror assembly. The portion protruding into the tank's crew compartment is thus much more compact.

(Standalone Sosna-U)

The total Sosna-U/PNM-T produced for Russian tanks from 2011-2022 can be seen below:

T-80BVM- 250+

T-72B3 Mod. 2013/2014/2017- 850+

T-72B3 Mod. 2016/2021/2022- 700+

T-90M- 150-200 approx. (modified PNM-T)

As you can see, there were approximately over 1800 Sosna-U in service prior to the Russian Invasion of Ukraine in February of 2022. By the time of this work's completion, more than 500 T-72B3 have been lost in combat according to the article Attack on Europe: Documenting Russian Equipment Losses During the 2022 Russian Invasion of Ukraine on oryxspioenkop.com of which about half are counted as having been destroyed.

Considering Russian procurement efforts and known numbers of what was in service, even in the face of such exorbitant losses the T-72B3 remains the primary Russian tank threat.

Sosna-U Sight Parameters: Durability

Multiple Shock Load: 250m/s with 10-15ms load duration (25g force)

Single Shock Load: 4900m/s with up to 2ms load duration (500g force)

Vibration Shock Limit: Up to 20m/s with up to 50Hz vibration frequency (repeated 2g force)

Internal Operational Temperature: -40C to 50C

Internal Operational Humidity Tolerance: 98% at 35C

Guaranteed Operational Altitude: 100m below to 4500m above sea level

Sight Adjustment Ambient Temperature Range: 15-35C

Sight Adjustment Atmospheric Pressure Range: 850-1066hPa

Sosna-U Sight Parameters: Day Channel

Magnification: 4x and 12x optical

Field of View: 12-degrees (4x mag.) and 4-degrees (12x mag.)

Stabilization Accuracy of Sight Head Mirror: 0.1 mils in vertical and horizontal axis at up to 30kmh

Sight Head Mirror Horizontal Travel: +/-7.5-degrees

Sight Head Mirror Vertical Travel: -10-degrees to 30-degrees

Exit Pupil Diameter: 4.5mm +/-0.5mm

Sosna-U Sight Parameters: Laser Rangefinder (LRF)

Wavelength: 1.064 microns

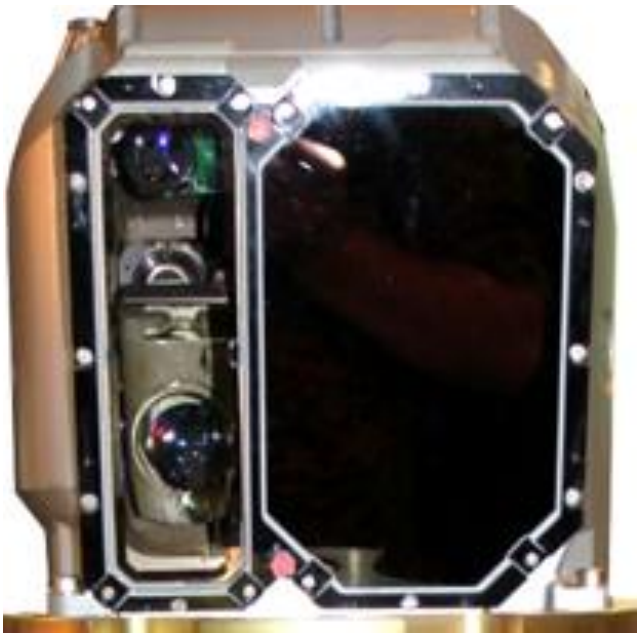
Maximum Range Measured: 10000m

Minimum Range Measured: 300m

Error Margin: 0.2% (+/-10m) at 5000m

Maximum Guidance Range Through Guidance Channel: 5000m (max. effective range of Invar ATGM)

Note: Never lase a target closer than 100m. The Sosna-U LRF is not eye safe.



The Sosna-U sight head inside and removed from the armored aperture on the T-72B3. The large germanium window on the right houses the Catherine-FC thermal imager behind it while the lower left section contains the day sight. The LRF and laser control channel for firing antitank missiles sit above the day channel. Originally the Sosna-U had used an LRF with a maximum effective range of 7500m compared to the Sosna's 5500m effective LRF, but this is no longer the case. It is unlikely that the tank can actually calculate a ballistic solution for any round out to 10000m and is probably capped out at around 6-7000m. The chances and utility of an engagement at that far of a range are scant.

Chapter 2: Primary Gunnery Procedures

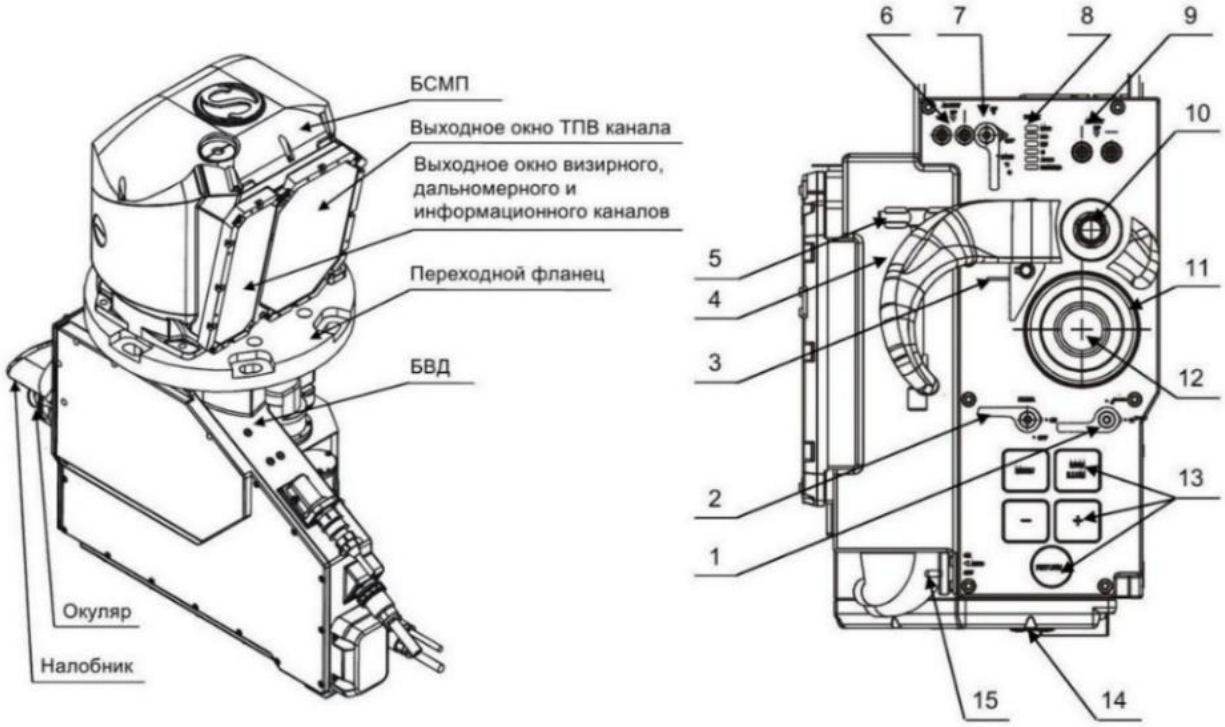
(Reference photo of gunner's position in a T-72B3, the manual turret lock can be seen disengaged below the gunner's MFD and left of the azimuth indicator, the turret can be traversed in any mode. The handle must be pulled back into the opposite vertical position to lock the turret in place while not in use)

Conduct an Inspection of the Main Gun Prior to Use:

- Ensure that the manual elevation locking lever is in the downward position and turret power is off
- Remove the canvas end cover from the muzzle of the gun
- Inspect the outer portion of the barrel. Take note of any visible dents or scratches for the next step
- Open the breach manually and inspect the inner surface of the bore. There should be no visible carbon deposits, abrasions, or dents. Visible cracking or blistering of the inner surface renders the gun immediately as category 4, pending removal and it should not be fired. Small scratches in length and width and small dents are allowed, but only those that can reasonably be determined by the operator to have been caused by natural barrel wear
- Perform a basic functions check on the mechanical trigger with the breach closed by placing it on safe and depressing the firing lever. Nothing should happen. Place it on fire and depress the firing lever and the pin should drop. Then reset the mechanical trigger to ensure the function of the reset lever

For any confusion on how to perform some of the functions above, see Chapter 4.

Turning on the Sosna-U:



- Undo the 4 bolts on the sight cover on front of the Sosna-U's armored aperture using a wrench
- Sun filter switch in ВБІКЛ, or off position (2 above) by switching it upward
- Switch for reticle adjustment mode in ВБІКЛ position (7 above) by switching it downward, on Sosna-U in service this will be a pin, not a switch. Use key 5 above to correct its position as needed
- АВТОМАТ, or AUTO switch for Sosna-U (15 above) should be in the ВБІКЛ position
- Toggle switch ПРИВОА, or DRIVE on the TPD-K1M control module on the right and below the ammunition selector panel to the on position (right switch shown on right image above). МЕХ Д, or DELTA/MECH-D can be turned on prior to driving or not at all based on operator preference
- Wait up to 70 seconds for the АВТОМАТ indicator LED on the Sosna-U's ready indicator section (8 above)
- Toggle the АВТОМАТ switch to ВКЛ, or on by moving it upward
- Wait up to 3 minutes for the ССУ, БВ and A LEDs on the ready indicator display on top of the Sosna-U day sight module

- Move the control handles for vertical and horizontal laying of the gun to ensure function
- The sight is now ready to be operated in the Main Mode for daytime gunnery or the user may now begin to turn on the thermal imager, see Chapter 6

Note: DO NOT TURN ON THE CENTER СТАБИЛ, OR STABIL SWITCH. TURN ON THE ПРИВОА AND МЕХ ЛД SWITCHES IN RESPECTIVE ORDER. IN EMERGENCY SCENARIOS WAIT TO MOVE THE GUNNER'S CONTROLS FOLLOWING THE AUTO SWITCH FOR 3 SECONDS MINIMUM

For turning on just the TPD-K1M alone see Chapter 8.

In cases where the temperature is 0-degrees Celsius or the sight is fogging up, one may turn on the sight protective glass heater by pressing the circular, black ВОЗВРАТ button on the bottom of the control module while not in digital menu access mode (unless the ammunition selector switch is in the ATGM position). The ОБОГРЕВ, or RETURN LED on the display will indicate red that heating is taking place. On Sosna-U in service (see below), this will be the bottom right LED.

The meaning of each LED ready light on the ГОТОВ, or "READY" display is as follows:

А- LRF is ready to operate

ОБОГРЕВ - Sight heater is on

БВ - Ballistic computer is working

ССУ - Stabilization and control system is working

АВТОМАТ - Sight can now be made ready to operate in Main Mode using the АВТОМАТ switch

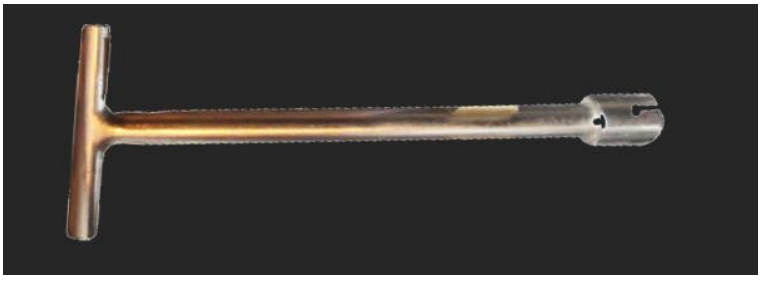
У- Laser control channel is ready to operate

(LED ready display on the Sosna-U, above. Labelled 8 on the above diagram. Via ShawshankRedemption on YouTube)

Other Elements of the Sosna-U Control Module:

The upper right black button labeled ЗАПИСБ/ПОДСВЕТКА, or MEMORY/ILLUMINATION turns on the day sight illuminated reticle. Apply pressure for up to 5 seconds when not in menu select mode. The upper left black button labeled МЕНЮ toggles menu mode when held for up to 5 seconds. By pressing the ЗАПИСБ/ПОДСВЕТКА button in menu mode it will input the selected value, adjusted using the +/- buttons. The circular mark labelled 10 is the Sosna-U's silica gel dehumidifier.

(Switch 15, ABTOMAT and the menu buttons are much more visible from this angle)



(Alignment key used to put the sight or laser control channel in and out of alignment mode, labelled 5)

Gunnery Modes:

The 1A40-4 uses 4 primary modes of operation.

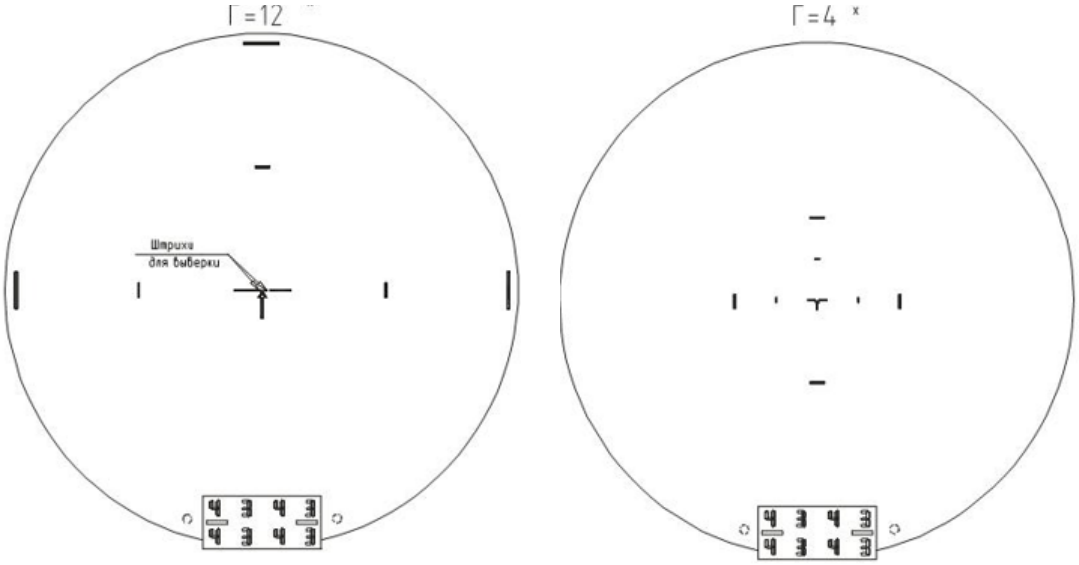
The first is the Main Mode, also known as Basic Mode, in which the gunner controls the primary day sight or thermal channel using his controls for detection, acquisition and destruction of the enemy. This is the most common mode of operation and the default.

The second is the Backup Mode in which the Sosna-U malfunctions or is irreparably damaged. The gunner will use the TPD-K1M as a backup sight to engage the enemy.

The third is the Duplicate Mode in which the commander takes control of the gun through the Sosna-U thermal channel using his PK72 controller, duplicate MFD and Catherine-FC control panel.

The fourth is the Target Designation Mode in which the commander uses his TKN-3MK system to slew the turret onto a target. This system is independent from the Sosna-U and TPD-K1M and cannot account for gun elevation, nor is the commander capable of controlling the main gun in this mode.

Day Sight and Gun Controls:



The day optical magnification mode has two settings, 4x and 12x optical magnification. To move between them, use switch 7 shown on the diagram in the last chapter. The left image displays the reticle in the 12x magnification setting and the right image displays the reticle in the 4x magnification setting. Both reticles are used as the battlesight for all engagements when paired with the Sosna-U's LRF which appears as a separate red dot projected onto the display when the LRF is ready. This illuminated red dot is used as the aim point for the LRF.

The number on the bottom displays the range to the last lased target and the upper indicator (shown above as a second range display) shows the ammunition type. The green LED (line on the left of the information display) indicates that a round is loaded and ready to fire and the yellow LED (line on the right) indicates that the sight is functioning in either Duplicate or Target Designation mode. When not in menu access mode, the square, black +/- buttons on the Sosna-U day sight can manually adjust the lased range up or down if the gunner so desires. The increments by which the range increases/decreases using the buttons is not stated, although the author believes it to be likely that it is in 20, 25 or 50m increments.

Because the 1A40-4 carries over the Delta-D range adjustment system from the original 1A40, it calculates the distance travelled forward by the tank and turret counterrotation (keeping the reticle on target) since the last lased range and is capable of automatically dropping the reticle without prompt to calculate a ballistic solution based on the new estimated distance to target. While it would generally be preferred to lase a second time, this system can cut down on engagement times in emergencies by removing the need to press the LRF button and wait to receive a readout.

The bracket marks on the reticle may be used to determine orientation during the switching of magnifications.

Controls for the sight are carried over from the TPD-K1M, in this case a TPD-K1 as standard with the 1A40-1 is displayed below but no structural difference exists between the controls of the TPD-K1 and the 1A40-4's TPD-K1M. The TPD-K1M is essentially the same as the first TPD-K1s placed on the T-72 Ural in 1975 but linked to the 1A40-4 and Sosna-U.

The handles may be depressed forward to lower the gun and pulled back to raise it. Grasping both handles and turning them from side to side will cause the turret to move horizontally. Small adjustments with gradually increasing speed based on the angle of input can be made with several degrees of lateral movement after which the drives will engage at maximum power for a rotation speed of 40-degrees per second or about 660 mils. At the minimum speed of rotation, the turret will turn at 0.054-degrees per second or about 0.9 mils.

The right thumb button will engage the LRF, and the right index finger button fires the main gun. The left thumb button will reset the measured range to 0 and the left index finger button will fire the coaxial PKTM medium machine gun. Pressing the +/- buttons simultaneously while not in menu select mode on the Sosna-U control module will also reset the last lased range to 0. Resetting the LRF is necessary to use the bullet drop compensator for the PKTM. This function is only found in the reticle on the TPD-K1M sight. Since the Sosna-U has an ammunition selector switch for the PKTM, it may be fired accurately at the lased range.

Unlike the previous UVBU automatic lead calculator equipped 1A40 sight, the Sosna-U employs an applied automatic lead calculator. This means that the speed of turret rotation and vertical gun laying are calculated into an automatic lead on a moving target based on the programmed ballistic characteristics of the selected round, range to target and speed of said rotation and laying. As such, it is not necessary for a gunner operating the Sosna-U portion of the 1A40-4 to add manual lead onto a moving target. When firing from the TPD-K1M backup sight it is necessary to estimate the lead by guessing the speed of the target and required deflection using the lateral mil scale.

While the stated stabilization accuracy of 0.1 mils for the sight head mirror of the Sosna-U is accurate, that only applies to laying of the reticle on target and not the drift error over time when the point of aim is not corrected. The reticle's point of aim will drift 0.11 mils every second off target (6 mils per minute) unless moved again, requiring occasional adjustment. There is no given direction for said drift, so after time it may approximately cancel itself out or become irregular. Since the 2E42-4 gun stabilizers have 0.4 mils of accuracy (0.6 in the horizontal axis), their incidental error can be compounded on top of the 0.1 mils stabilization/laying accuracy. Minor adjustments may be required from time to time when observing a fixed point for extended periods, especially at long ranges. In some cases, these discrepancies may not always be apparent to the operator.

Gun Level and Azimuth Indicator:

While not necessarily the recommended method of delivering indirect fires (IDF) on the enemy, the T-72B3 is still capable of doing so. Two primary scenarios may present themselves where this capability could have greater utility than other employment methods. The first is to serve as a stand in for specialized IDF assets like light artillery or 82mm mortars, a weapon that the Russian tank battalion lacks compared to motorized rifle units. Only counter battery fires or airstrikes can destroy IDF assets hidden behind friendly lines which requires the opposing force to first locate the firing positions and attack before they can displace. If commanders are afraid of losing tanks or lack the proficiency or mass to launch direct assaults this can be a viable way to harass the enemy.

Secondly, if a tank is firing in heavily obscured conditions or from defilade it can be difficult to discern and strike targets. In that case a forward observer or spotting drone can correct fire for the tank while it engages targets of opportunity that it cannot see for itself. From defilade, tanks in the defense can also deliver fires on a TRP.

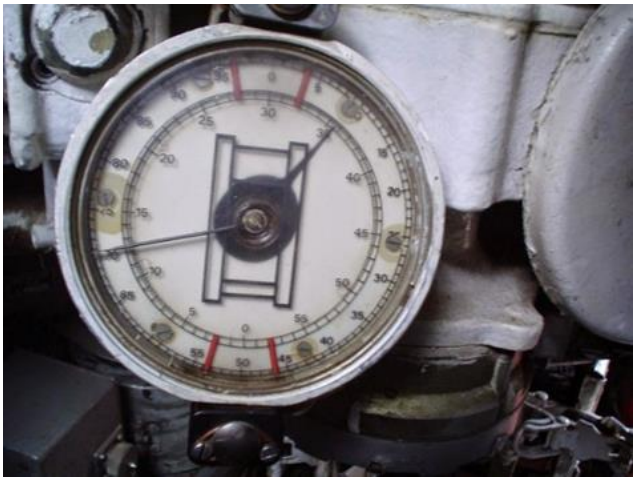
Tank rounds are generally not very effective in the IDF or non-line-of-sight (NLOS) firing role because of low gun elevation, high velocities, and significant drag from their stabilizing fins.

To employ the 2A46M-5 main gun in an IDF role, first ensure the tank is on level ground and engage the manual traverse and elevation drives. Using the solenoid trigger on the elevation mechanism is required. Operation of the aforementioned systems is described in Chapter 4. To begin the process of delivering IDF the commander must determine his location and bearing of the tank's hull as accurately as possible. Because the T-72B3 does not feature a GPS/GLONASS receiver, a handheld issued device such as the NPI-2, similar to the American DAGR or off-the-shelf equipment must be used.

Once the location and bearing of the tank have been determined and the required turret deflection and distance to target are known along with any other relevant aspect of the call for fire, there are two devices which will be used to lay the gun. Seen here and on the next page there is the turret azimuth indicator and gun level.

The turret azimuth indicator is designed to improve the situational awareness of the crew by allowing the gunner to comprehend the location of the turret in relation to the hull of the tank. This prevents disorientation during combat, whereas the commander has a panoramic view using his periscopes or may pop his hatch as needed, the gunner must remain seated in his workstation. The red brackets indicate the 0 and 180-degree positions.

On the azimuth indicator short hand, the scale shows 60 total tic marks, numbered by increments of 5 (inner scale). Each mark is 100 mils. When the short hand moves from one mark to the next, the long hand of the indicator makes one full rotation. The scale corresponding to the long hand (outer scale) has 100 total tic marks. Each mark is one mil. The gunner uses his turret traverse wheel to move the turret to the point instructed by the commander. This way the turret can be slewed within a measurable accuracy of 1 mil.



(Turret azimuth indicator. Via thesovietarmourblog.blogspot.com)

The gun level has two scales. The coarse mechanism is for large adjustments in increments of 1000m. Its markings range from 27 to 38. When the notch at the top of the triangle is sitting at “30” the gun is in a completely level position. Range increases successively from that number so that at the “31” position the round will fall at 1000m and so on. It is pushed back and forth using the gunner’s fingers. The fine mechanism has marks numbering from 1 to 100 on it, denoted every 10 marks. Each single mark is a 10m adjustment and each inscribed numeral is a 100m adjustment. Use the knob on the right to adjust the fine mechanism. Once it is set, the gunner must observe the white window at the bottom of the gun level and move the manual elevation mechanism by making fine adjustments until a bubble appears and is stabilized in the center of the window. Once the bubble is centered in the window the gun is prepared to fire.

The scales on the gun level only correspond to HE-Frag rounds and can reach out to a maximum effective range of 9000m.

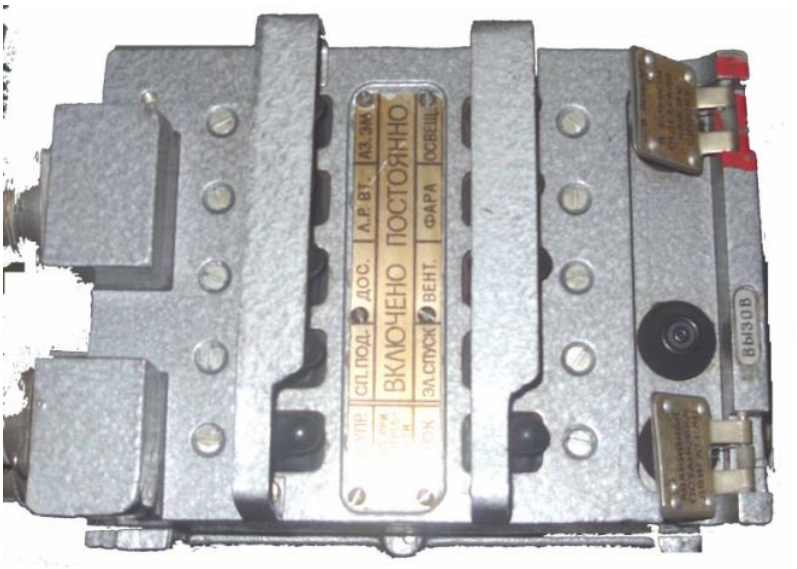
(Gun level. Via kotsch88.de)

Chapter 3: Automatic Loader Operations

P-11-5 Circuit Breaker/Master Control Panel and Turning on the Auto Loader:

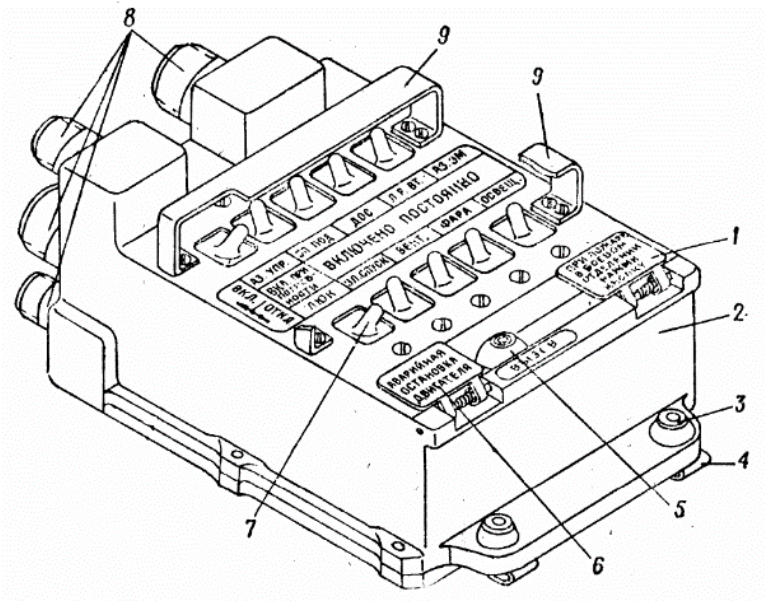
This process and the loading of the carousel are performed prior to turning on the sights.

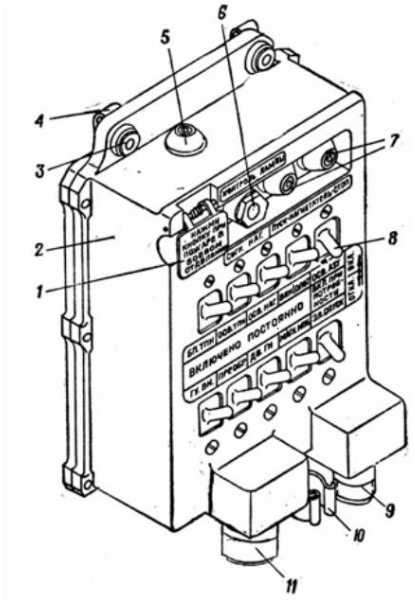
Ensure that all switches on the ammunition selector panel and AZ-184 control panel are set to automatic, including the primary automatic/manual switches. Double check that the cassette elevation mechanism is firmly in the lowest position and the lock for the carousel manual traverse ratchet lever is disengaged. The auto loader memory unit ammunition selector dial top cover should be closed and fastened shut. Ensure there are no objects in the way of the carousel or elevation mechanism that could obscure its operation. It does not matter if there is a stub casing in the ejector to start out with on a properly functioning auto loader.



(P-11-5 master control panel/circuit breaker box, left. Gunner's master control panel/circuit breaker box, right)

The А3.УПР switch on the leftmost upper row should be off (seen in such position in both images above). All other switches should be on except for the ЛУК switch on the lower row. Next, the СП.ПОД switch ensures that the automatic gun lashing process can occur. The ДОС switch gives power to the chain rammer. ЛР.БТ and А.З.ЗМ switches are turned on. The ЭЛ.СПУСК switch on the right control panel should be turned on while the ЭЛ.СПУСК switch on the left (gunner's) control panel should be off except when turning off the tank unless used for its intended purpose (discussed later). А3.УПР is also left on when the tank is turned off. Ventilation is turned on by the ВЕИТ, or ventilate switch. Ventilation should be on whenever firing from the main gun or coaxial machine gun. ФАРА gives power to the external lights on the tank for navigation and traveling under administrative conditions as well as the commander's OU-3GK infrared spotlight. ОСВЕШ switch is turned on as well.





(Commander's control panel found just forward and right of the commander in his seat, left. Gunner's control panel found to the left and behind the gunner in his seat, right)

More functions include the emergency engine stop button (6), the manual fire suppression system button (1) and the circuit breaker's automatic protection switch (7), labelled ЛУК. This is used to protect the tank's electrical systems in the case of a short circuit. Leave it in the off position. Button 5 is the call button driver-commander. Since the crew has an intercom system the purpose of 5 is not exactly apparent, however it probably serves as an alternate intercom system so the commander will always be able to verbally contact the driver if communications go down.

The gunner's control panel is very similar to the commander's. Besides the ЭЛ.СПУСК switch in the lower row, the automatic protection switch must also remain off, labelled 8 above. All the other switches are turned on. Button 1 manually turns on the fire suppression system. There are also the supercharger buttons (7), one of which is for the signal lamp, and the signal luminaire button/switch (6). Five does not seem to appear on the gunner's circuit breaker box for the Т-72В3. ДМУЧАША switch turns on the ventilator (it would seem to have been implied that this function works when the commander's ВЕИТ switch is on, or otherwise they both turn on the ventilator). НАЧАЛО.НАБОР switch gives power to the Tucha Type 902B smoke mortar system firing circuits. Л.Р switch gives power to the ejection port in the back of the turret.

For the purposes of general operation, simply turn the switches to the positions seen in the above 2 diagrams.

Ammunition Selector Panel:

The ammunition selector panel that sits on the TPD-K1M is seen above. Of the two LEDs, РУЧ indicates that the auto loader is in manual mode and the ПОДДОН LED indicates that a round has been fully loaded along with its respective propellant charge and is ready to fire. Moving to the right, a black button labelled ВКЛ.АЗ and switch labelled РУЧ./АВТ. can be seen. The button initiates the auto loading process once the desired ammunition has been selected. The switch when flipped up causes the auto loader to operate in automatic mode. If one desires to load the gun manually or with only partial assistance from elements of the auto loader such as the chain rammer, then the switch must be flipped down to the РУЧ position.

The T-72B3 can fire several different types of ammunition depending on the type of target to be engaged. These are high-explosive fragmentation (HE-Frag), high-explosive antitank (HEAT), armor-piercing fin-stabilized discarding-sabot (APFSDS) and antitank guided missiles (ATGM). Which type of ammunition the gunner will load is entirely at the commander's discretion. The ammunition selector switch is represented in the form of a dial below the LED display.

ЗАГР- Puts the auto loader in loading mode

О- Selects HE-Frag round

Б- Selects APFSDS projectile

К- Selects HEAT round

П- Selects the coaxial machine gun. This is not an auto loader function and will simply adjust the reticle for the lased range to use the coax.

У- Selects ATGM

УН- Selects APFSDS projectile (presumably used for ballistic switching to the newer 3BM-59/60 series of APFSDS projectiles or can be programmed by maintenance for another type of ammunition)

Note: Do not change the loader's mode of operation, switch ammunition types on the dial or attempt to load a new type of ammunition while the auto loader is in the process of loading a round.

Ammunition Capacity Display Dial:

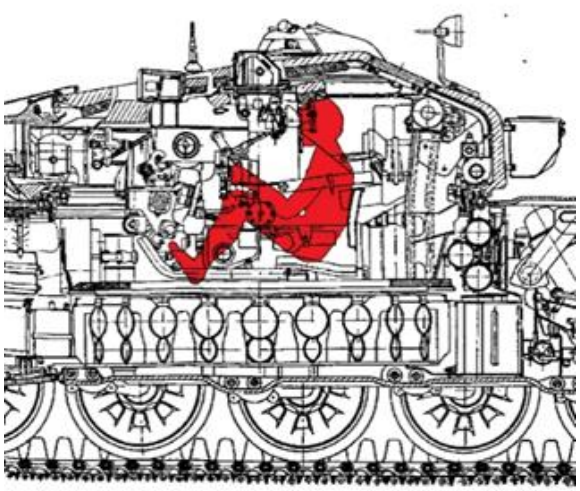
(Ammunition capacity display dial, left. Via thesovietarmourblog.blogspot.com. The ammunition capacity display dial can be seen sitting above the Catherine-FC control module, right)

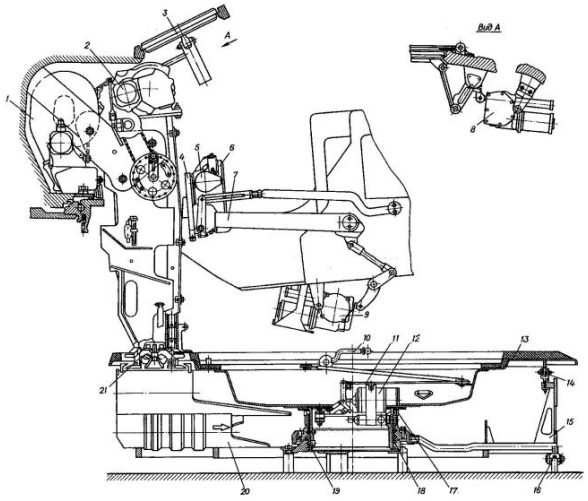
The ammunition capacity display dial shows how much ammunition is loaded in the auto loader's carousel for the selected ammunition type on the ammunition selector panel. The dial cannot display a higher capacity than 11 so that, for example, if 15 HE-Frag rounds were loaded, each round fired would only register as 11 on the dial until the total amount dropped below 11 rounds.

If loading more than 11 of one type of round, it is advisable to count the rounds as they are fired to maintain accurate stats on the tank's readiness.

There is a pin below the window with direction indicator arrows just above it (seen partially cut off in the image above) to manually adjust the round counter using a screwdriver if the round is displaying incorrectly. The counter must be manually adjusted to 11 shots after mock loading 11 rounds (program the positions in the memory unit without actually putting rounds in). With the 11 rounds programmed and the counter now at 11, unload those 11 rounds. Presumably just zeroizing the entire auto loader memory would be sufficient for this purpose.

AZ-184 Automatic Loader Operations:





(Cutout demonstrating the position of the AZ-184 relational to the gunner in a T-72B1, left. Via thesovietarmourblog.blogspot.com. Side diagram of the AZ-184 and 2A46M breach block, right)

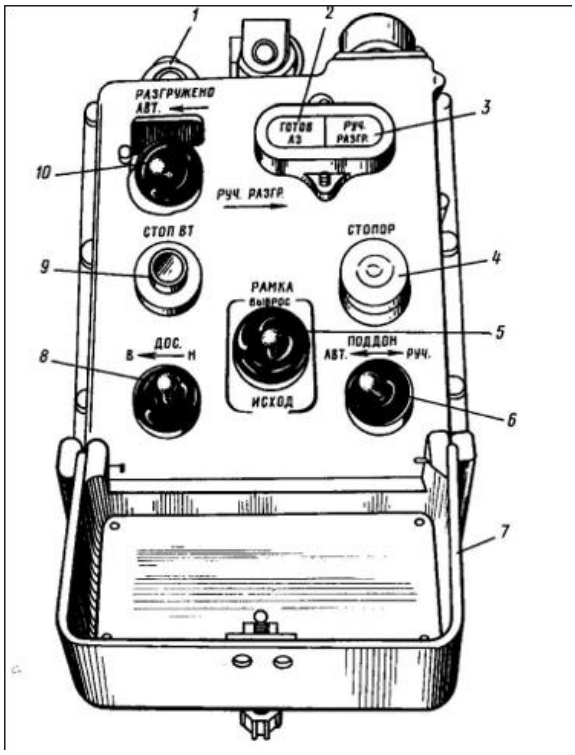
The AZ-184 auto loader is the carousel style auto loader in service since the T-72B. The T-72B3 Obr. 2016 uses an inwardly extended version capable of housing 3BM59 and 3BM60 series APFSDS projectiles. The AZ-184 is generally comprised of the ammunition selector panel, commander's control panel, ammunition gauge, ejection mechanism, carousel and cassette elevation mechanism, memory unit and control unit.

Cycle of operations (many steps will run concurrently and thus some of the order should be considered only notional):

- Gun raises to 3.5-degree loading angle and is lashed in place
- Breach opens
- Carousel rotates clockwise to nearest full cassette containing the selected ammunition type
- Stub casing ejection mechanism raises to launching position and ejects stub
- Elevator mechanism raises cassette to ramming position
- Round is rammed into the breach
- Elevator lowers to second ramming position and propellant charge is rammed into the chamber
- Breach closes
- Cassette elevation mechanism lowers back down to the auto loader
- Stub casing ejection mechanism lowers back down
- Gun is unlashed and returns to the line of sight
- Auto loader memory for that cassette is zeroized

Commander's AZ-184 Control Panel:

The auto loader control panel is used to regulate the operations of the auto loader when normal function is not possible. It sits to the right of the commander in his seat next to the crew intercom system.



1- Zeroizes the auto loader memory unit, all cassettes read "000"

2- Signals green when the auto loader is in automatic mode

3- Signals red when the auto loader is in manual mode

4- Unlashes cannon after loading, unnecessary during normal operation

5- Causes the stub ejection mechanism to elevate towards the ejection port and eject when in manual mode

6- Turns off the propellant stub casing ejection process, the stub must be removed from the ejection mechanism behind the breach manually. Set the auto loader briefly into manual mode prior to removing the stub by hand for safety.

7- Control panel protective cover, to be up when not in use and retained by the pin at its base

8- Actuates the chain rammer to ram rounds into the breach when in manual mode

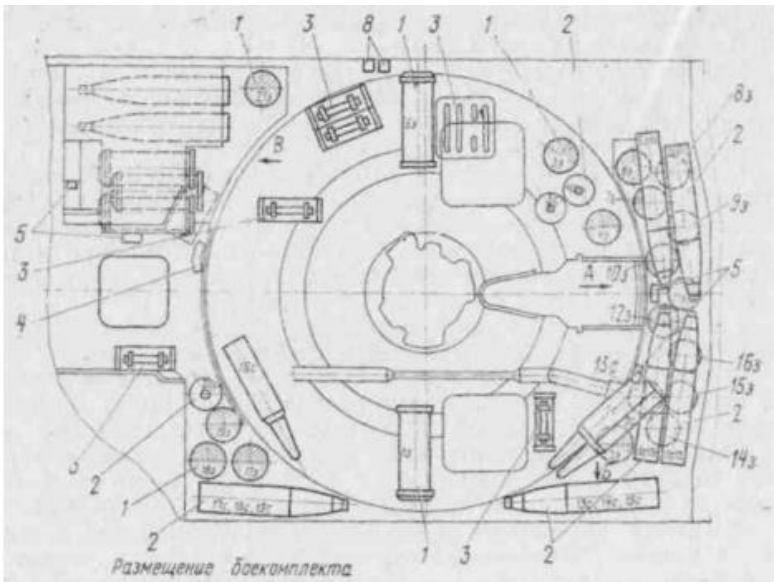
9- Signals green when the selected ammunition is in the ready cassette

10- Automatic/manual switch, analogous to that on the gunner's Ammunition Selector Panel

Note: The feed chain engagement switch is not used when setting the fuse on HE-Frag rounds. It is to be used in the event of mechanical failure of the auto loader while in manual mode. The bottom cover for the panel is opened and closed using a screw, seen at the bottom of the image above.

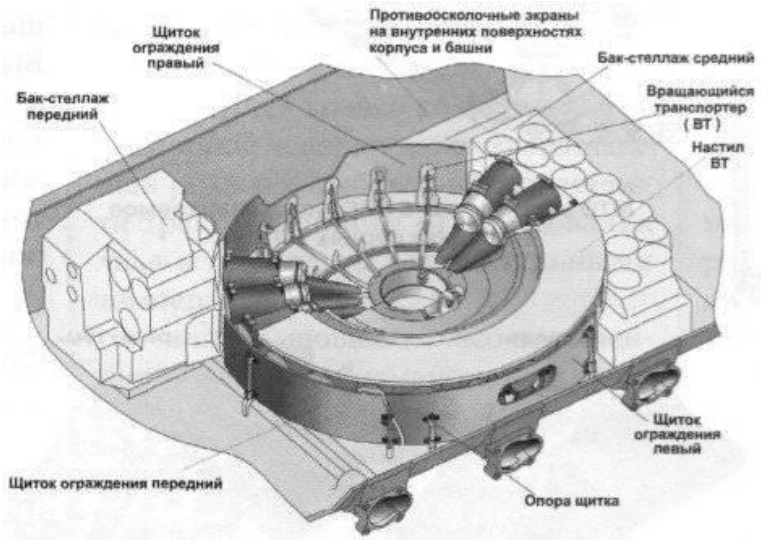
Loading the Tank:

The auto loader is reloaded from 23 extra stored rounds in the crew compartment. There are 22 ammunition cassettes inside the auto loader.



The standard ammunition load for any T-72B series tank is as follows. There will be 6 HEAT rounds, 19 HE-Frag rounds and 14 APFSDS projectiles plus an additional 6 extra rounds. If ATGMs are issued, they will always replace HEAT if possible. Depending on the mission and enemy, various types of loadouts may be issued. In Ukraine several Russian T-72s were captured with nothing but ATGMs in the carousel. Other missions with a low probability of confronting enemy tanks may facilitate extra HE-Frag or HEAT rounds. Ammunition availability and supply as always will have the final say in the actual equipping of the tank.

Stowed HE-Frag and HEAT rounds should never be placed in vertical stowage to avoid accidental arming in the case of shock impact on the tank's hull by a mine or IED and the placement of propellant casings should always be in the fuel tank wet stowage positions. The commander is responsible for loading the gun manually and removing these rounds and casings from their positions and may direct the gunner to rotate the tank's turret as necessary to access their location.



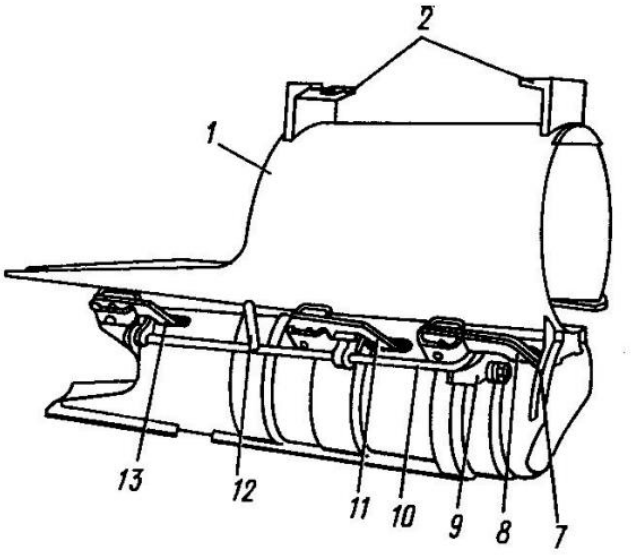
Common logic dictates that mission dependent and if the tank crew can avoid it, considering that stowed rounds are the most threatened by cookoffs in the event the tank is penetrated, extra rounds should not be taken into combat. This is purely a question of sustainment and mid-term combat effectiveness vs crew and investment survivability.

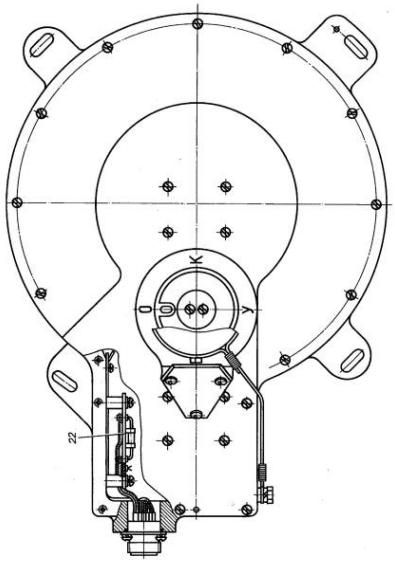
If the auto loader runs out in combat, the amount of time required to program and fully load it could be deadly. As described at the bottom of the next section, it may be worthwhile in some cases to simply load the gun manually or semi-manually from the stowed rounds in the crew compartment.

First lower the gun using the manual elevation drives to maximum depression. The stabilizers and sights should be turned off during the loading process. The commander's and gunner's seats are flipped down and the recoil guards are removed.

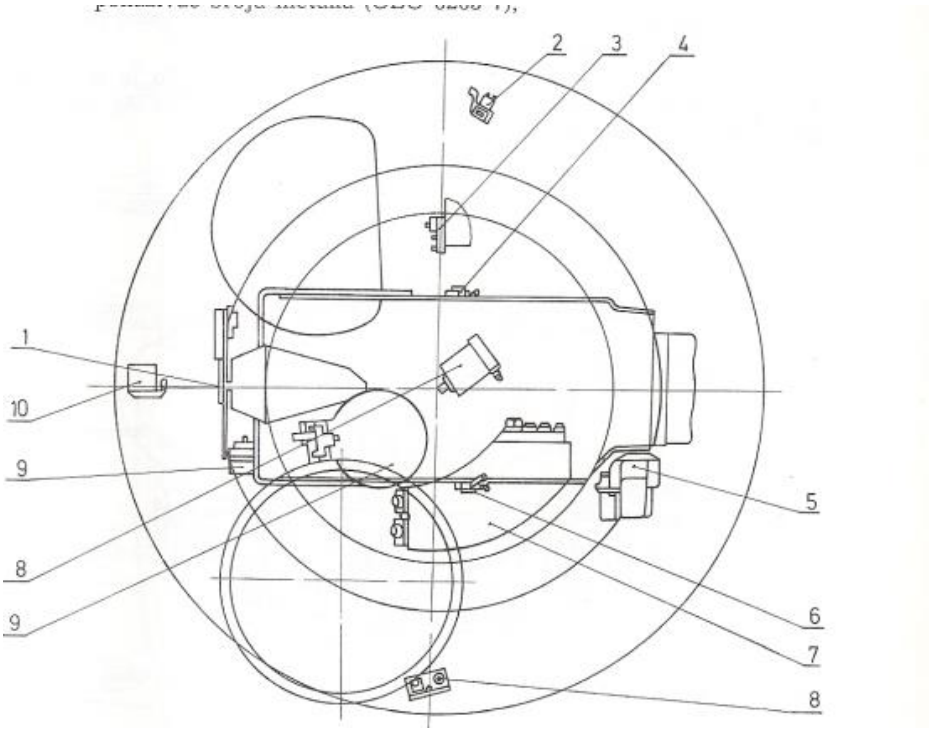
The АЗ.УПР switch is now turned on and the ЭЛ.СПУСК switch on the gunner's master control panel.

Place the ammunition selector into the ЗАГР position, ensuring that the auto loader is still in manual mode and press the load button on the ammunition selector panel or commander's РК72 control module. The carousel will rotate until it reaches the nearest cassette with a reading of "000", or empty and then automatically elevate the corresponding cassette. Reach down to the memory unit and open the top cover. There will be a rotating dial with ammunition markings mirroring the ammunition types displayed on the ammunition selector panel.





Each cassette is opened and closed by using the latches on its side. The propellant charge goes on top while the projectile goes on the bottom. After loading a round into the empty cassette, rotate the dial to the ammunition that you loaded into the cassette and depress the dial, keeping the dial depressed only until the elevation mechanism begins lowering and immediately release. DO NOT attempt to press the rotary dial while the carousel is rotating. Once the cassette is fully lowered the carousel will rotate to the next cassette reading "000" and elevate. If it is desired to temporarily stop the cycling process at any point, disengage the АЗ.УПР switch. Continue to repeat the above steps until the full carousel is replenished.



(A top-down display of the carousel and centrally located memory unit on a Yugoslavian M-84. Number 9 points to the memory unit. The turret is facing to the right of the image so that the commander's cupola is on the bottom and gunner's hatch on the top. Displayed is the old memory unit on the AZ-172 with fixed buttons for HE-Frag, HEAT and APFSDS only although its position is the same. The cassette elevator sits at 1 and chain rammer at 10.)

Turn all the switches back to their normal operating positions as described in the first section of this chapter once the loading process is complete.

Note: Ensure the protective steel cover over the commander's MFD is flipped down (see chapter 9) while loading to avoid damaging it by accident, as it is directly below and forward of his hatch. The gunner and driver-mechanic should stand outside the tank and hand the commander rounds and propellant charges through his hatch.

Lastly, to reduce average gun loading speed one should attempt to place rounds in the carousel when replenishing with the most even distribution between types possible, causing the smallest number of cassettes with the non-selected ammunition to be passed over before reaching the correct one in the loading cycle.

Unloading the Carousel:

The process of unloading the carousel is carried out in the same manner as loading it but instead of placing the ammunition selector dial on ЗАГР you will select a round type. The load button is used to cycle.

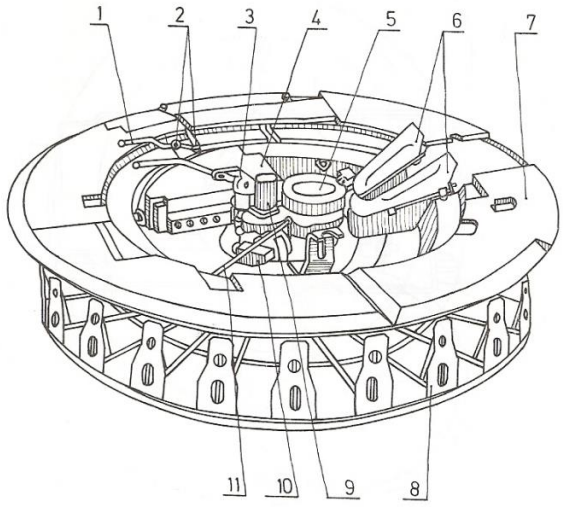
Chapter 4: Manual Gunnery and Remedial Actions

Manual Operation of the AZ-184:

Should the AZ-184 fail to operate under normal conditions, the rotation of the auto loader and raising of ammunition cassettes to the loading position may be done manually.

Place the auto loader in manual mode, rotate the ejection mechanism upwards, open the breach manually and slowly raise the gun to the loading angle using the manual drives after the turning the СТАБИЛ switch to the off position. It should lash in place and will need to be removed using switch 4 on the commander's AZ-184 control panel once the loading process is over. Moving the gun up and down over the loading angle, marked red on the recoil guard frame on the gunner's right may be necessary to cause the gun to lock fully in place. Do not attempt to operate the loader manually while in automatic mode. Once the gun is locked in place turn the stabilizer back on again.

The auto loader carousel is traversed manually using 2 levers on top of the carousel by the commander's feet. Pulling the one on the right (1 below) up disengages the manual lock. The left handle (the larger of the two, leading out from 3 below) should be pulled upwards to traverse the auto loader until light 9 on the AZ-184 control panel turns on or the desired ammunition is visibly in place. This lever is connected to a ratchet which is attached to a bevel gear. The output of the bevel gear is engaged with the toothed inner ring of the carousel. At this point, the manual elevation mechanism is required. Switch 5 on the AZ-184 control panel should be engaged to elevate the shell casing ejection mechanism so that the cassette elevation process can occur. It is important to note that there is no stated requirement that the stub casing must be caught as long as the CBRN switch on the AZ-184 control panel is on. If one is ejected from the breach, it should be taken from the top of the carousel cover or wherever it has fallen and either removed from the tank or placed in a free storage space designated by the commander. In manual mode using the empty cassette works fine.

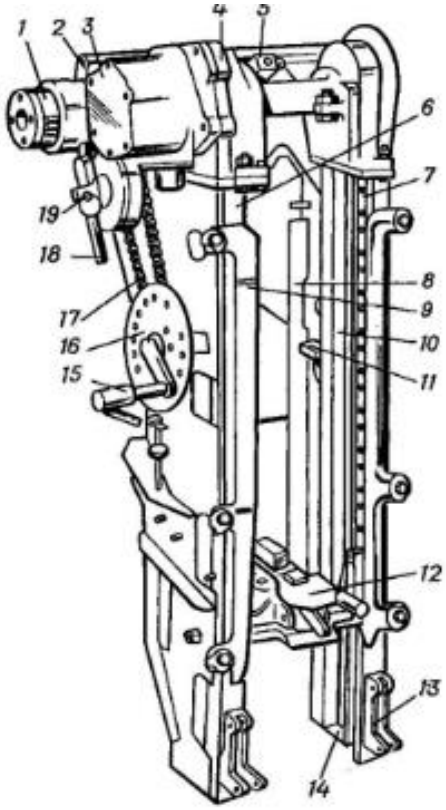


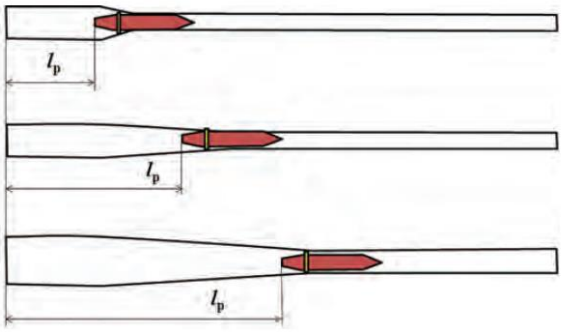
(Diagram of the carousel from within a Yugoslavian M-84, left. Auto loader top cover with both levers in a T-72B3, right. Via topwar.ru)

To the commander's left there is an elevation mechanism with a turn handle (15) on it. Depress the lever on the turn handle while rotating it to remove the spring pin from the holes on the locking disk (16).

Push handle 18 backwards while pulling the ring 19 forwards towards the front of the tank. Rotating the handle (15) left until it stops will complete the raising of the cassette. Pull the ring (19) forwards again without touching the handle (18) to disengage it. Generally speaking, this process should occur each time the cassette is halted or moved to lock the elevation mechanism. Engage switch 8 on the AZ-184 control panel to ram the round into the breach. If this fails, the task must be done by hand and completed using the provided wooden ramming rod (clipped to the upper left turret roof by the commander's position) until the round is fully seated and cannot move forward anymore.

Ensure that the round is fully seated into the chamber as far as it can go so that it will not slide out and the obturator fully engages with the forcing cone. This exact position may change depending on the erosion state of the barrel (shown only for illustrative purposes below, where the top image displays a category 1 barrel, middle category 2 and bottom category 3). Simply using the chain rammer if it is available will alleviate any of these potential issues.





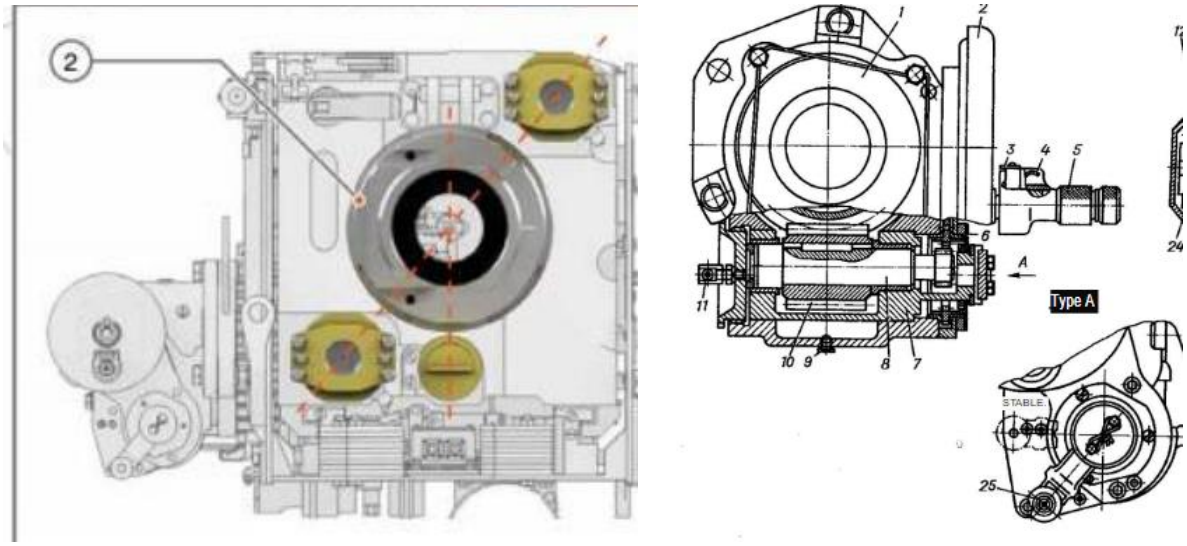
Reengage the handle (18) as described in the above paragraph.

Turn the handle (15) right until the top of the lower cassette (previously housing the ammunition) is even with the red indicator line below line 9. Disengage handle 18 by pulling the ring (19) again. Engage switch number 8 again or complete manual procedures as before to ram the propellant charge into the breach. Reengage the handle (18) with ring 19 to continue lowering the cassette back down to the carousel and disengage the handle for a final time.

Use switch Number 4 on the AZ-184 control panel to cause the gun to return to the line of sight once the loader is set back to ABT, or AUTO.

Note: If the rammer mechanism has failed, it may be prudent to expend the supply of stowed ammunition in the crew compartment prior to using the auto loader as that process will be faster, and in the event of total auto loader failure, much easier to complete. One the gun is loaded, temporarily turn the auto loader back to automatic mode if all other systems are functional as THE PRIMARY ELECTRICAL TRIGGER CANNOT BE FIRED IN MANUAL MODE.

Manual Traverse and Elevation:



(The lower left protrusion demonstrates the elevation flywheel (5, right) and its position in relation to the breach of the 2A46M-5, left. Via topwar.ru. The same mechanism can be seen from a different angle on the right)

After turning off the stabilizers the gunner should release the manual lock (25) which sits forward and in front of his knees by pulling it upwards. Directly to the gunner's left sits the turret traverse flywheel.

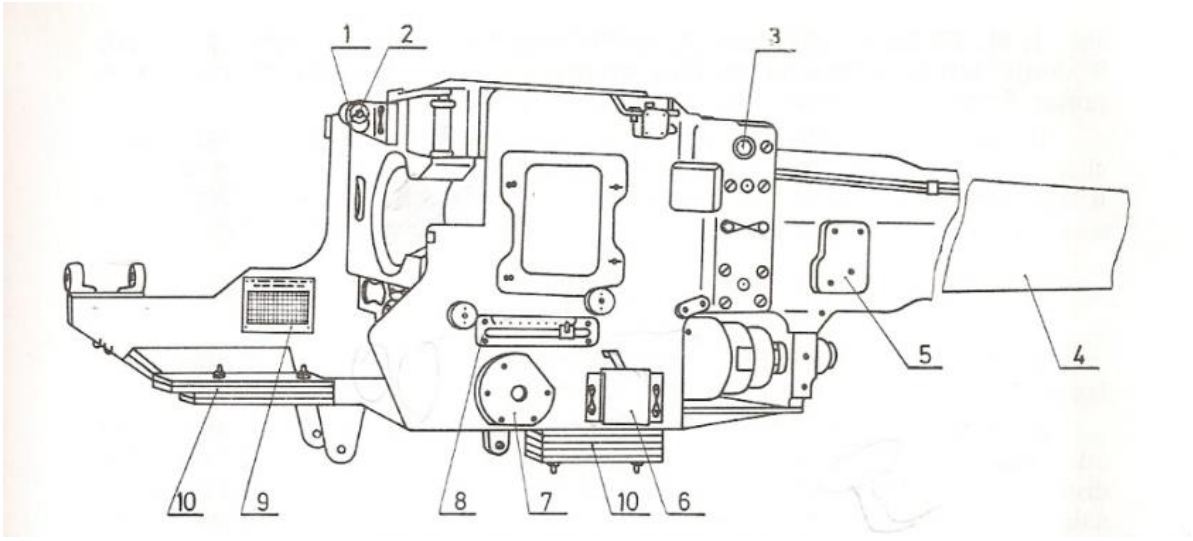
Towards the base of the handle, the solenoid trigger (4) for the manual elevation drives can be seen. When firing, it is necessary to use this as the gunner would not be able to reach his normal trigger on the TPD-K1M control module and it would be turned off anyway.

The gunner will have to remove his right hand from the elevation wheel after placing the red laser rangefinder dot on target to lase it using the standard gunner's controls. Use of the +/- buttons on the Sosna-U or manual range adjustment wheel and stadiametric rangefinder on the TPD-K1M is also possible if there is an LRF malfunction as well.

Move handle 25 down to disengage the manual traverse and elevation drives.

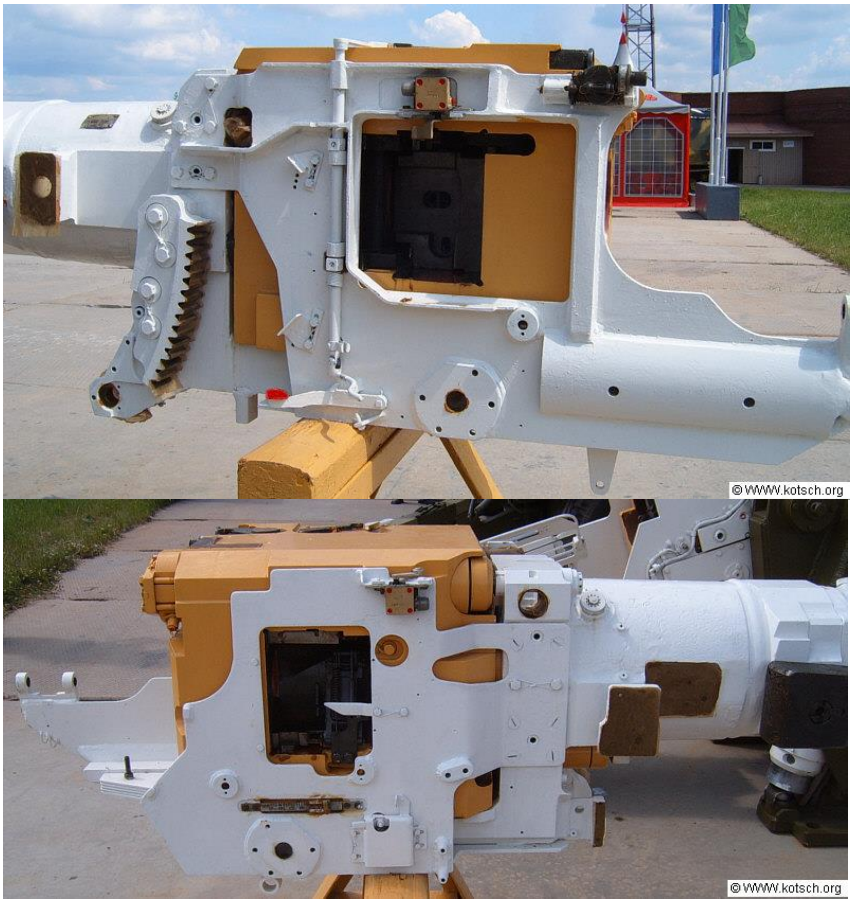
(The turret traverse flywheel sits just forward of the azimuth indicator. It also houses the trigger for the coaxial machine gun)

Manual Operation of the 2A46M-5 Breach and Mechanical Trigger:



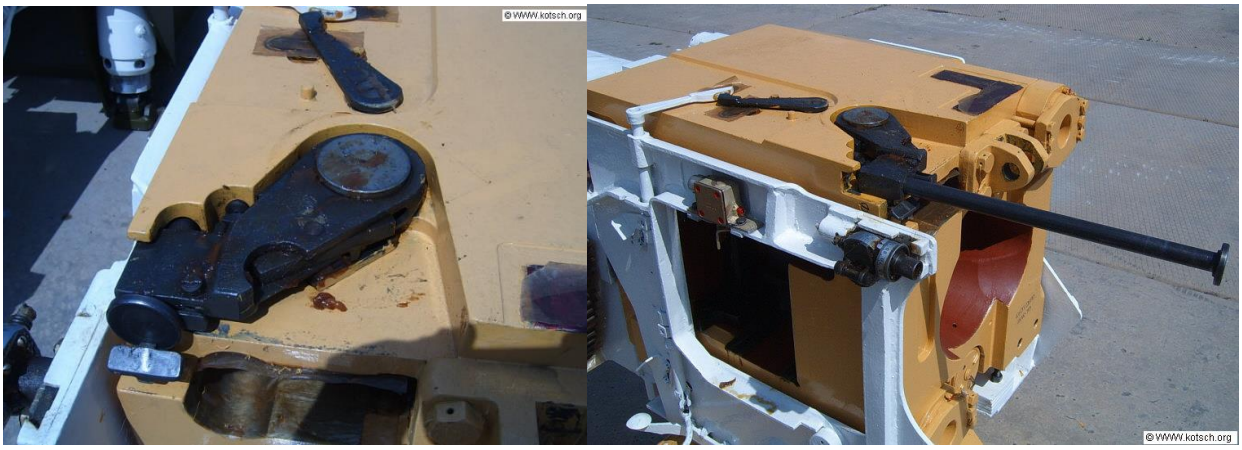
(Breach block of a 2A46 main gun. While an older model, the safety mechanism is the same with the exception of a small paddle that presumably must also be depressed prior to use. This paddle can be seen on the second image below)

To start the process of firing the gun using the mechanical trigger in the event of a misfire the commander will disengage his safety (6) by pulling it back and out of the ЗАVЛ position.



(Via kotsch88.de)

When given the verbal command to fire by the tank commander, the gunner then depresses the handle (the end of which is painted red in the above image, top) of the mechanical trigger and fires the gun. This handle is directly across from the commander's safety switch on the other side of the breach block.



(In order to reset the mechanical trigger in the event of a second misfire, a smaller black lever can be on the top left of the breach block in front of the manual sliding breach lever. Pull this lever back and push it forward again with force. Normally opening the breach will reset the trigger. Via kotsch88.de)

To operate the breach manually the gunner must depress the locking mechanism below the black, circular handle on the left side of the breach block and the lever arm for breach operation will begin to slide out under spring tension (see right image). Once fully extended, the breach may be fully opened and closed under its power. Never open the breach in such a manner without first placing the auto loader in manual mode.

Note: The last 4 photos from this section were obtained from kotsch88.de and belong to their owner.

Remedial Actions in General:

If at any point the auto loader fails to perform the loading cycle in full and freezes or somehow fails to load a round, the go to solution should almost always be to turn the loader to manual and perform the rest of the loading cycle in that manner so that the gun is ready to fire. This way the auto loader will register that the loading process has occurred and can function in the next cycle. If problems beyond the operator's level persist, then fully manual procedures may be warranted. Do not attempt to operate a malfunctioning auto loader.

Prior to entering into any remedial action, it is advisable although not necessary to turn off the ЭЛ.СУСК, or trigger circuit switch on the commander's master control panel and the gun stabilizer.

Sliding Breach Closed on Chain Rammer:

Switch the auto loader to manual operation mode. Engage switch 5 on the AZ-184 control panel to elevate the ejection mechanism and open the breach using the manual lever. Turn off the ДОС switch on the master control panel to retract the chain if it does not do so automatically when the breach opens. Manually lower the cassette back into the carousel. After the cassette is lowered, put the loader back in automatic mode and turn the ДОС switch back on.

Gun Fails to Lash at Loading Angle:

If the gun is being loaded by hand, then it is not a necessity to lock the gun in position while loading. In instances where this is required however, turn the auto loader to manual mode, open the breach, raise the ejection mechanism using the commander's AZ-184 control panel, lower the gun to maximum depression and then slowly raise it to the loading angle. The gun should lash in place. Move it back and forth across the loading angle if necessary until it stay put.

Stub Casing Fails to Eject/Ejection Port Does Not Open Under Normal Operation (causing casing to not eject):

Set auto loader to manual mode and use the latch on the side of the ejection mechanism to open the ejector and remove the stub casing by hand. Unless the ejection mechanism is turned off the ejector must be empty to use the gun.

Ejection Port Fails to Open:

Turn off the Л.Р switch on the gunner's master control panel and attempt to remove any ice from the port. Apparently, this is one of the more common malfunctions of the ejection port that can be fixed at the user level.

Water can easily seep into the cracks around the port and freeze in cold weather. Unless the ejection mechanism is in manual mode, this stoppage will also cause the ejection mechanism not to work.

(Round ejection port in the rear of a T-72B3 Model 2016's turret. Via vitalykuzmin.net)

Misfire Procedures on the 2A46M-5:

Should the gun fail to fire after pressing either the electrical trigger on the standard controls or the solenoid trigger on the gun manual elevation flywheel (depending on the mode of operation at the time), the gunner will inform the commander that a misfire has occurred. At this point the commander will place the safety to fire by pulling it rearwards as described in the last section and when ready, give the gunner the command to fire.

The gunner will depress the manual trigger and when the pin falls the round should fire. If the round does not fire (the mechanical trigger should have been op-checked prior to use) the gunner calls "misfire, misfire, misfire" and proceeds to wait 60 seconds, keeping the gun pointed downrange and at the target. ONLY after 60 seconds is up, the gunner cocks the mechanical trigger again and attempts to fire. According to safety regulations no crew member should have any body part in the breach block's recoil path when loaded to prevent injury. Because the gunner must reach up and over his recoil guard to reset the trigger, this would be in violation of these standards and generally unsafe according to common sense.

If no shot occurs after the second attempt to fire, the gunner waits another 60 seconds. After that the commander puts the trigger back on safe. The gunner then opens the breach after placing the auto loader on manual using the appropriate switch on the ammunition selector panel and with the assistance of the commander if required, removes the rounds using his hands. Crew should NEVER attempt to push any round through the muzzle of the gun.

After getting rid of the defective round, select a new one from the stowed ammunition in the crew compartment and fire that by inserting it into the breach using the provided wooden ram rod or feed chain. Place the auto loader back on the automatic setting again.

Note: On opening the breach, the extractor levers within the breach block should assist in removing the propellant charge. Ensure this does not fall back into the tank as it may be faulty and thus unsafe.

(4Zh63 propellant charge and 3BM44 APFSDS projectile and incremental charge, left. 4Zh40 propellant charge, right. The propellant charge in the projectile-charge combination must be removed following a misfire that cannot be corrected.)

AZ-184 Performance Check:

Load and program a mock propellant charge into the carousel in the same manner as a standard round/charge combination would be. Complete a full loading cycle of the loader and ensure the process occurs in accordance with the previously described parameters. Download the mock charge manually. If the loading cycle does not function properly and no known user error occurred, switch to manual mode unless it can be fixed with confidence. As previously stated, do not attempt to operate a malfunctioning auto loader.

If using a live charge of any kind for the check, make sure to turn off power to the electrical trigger to avoid the chance of a negligent discharge.

Chapter 5: Main Gun Ammunition

(The term “obr” or “obrazets” is simply another term to describe the year model of an armored vehicle. Via @tankdiary on Instagram.

Take note that this is only a theoretical load out. While crews should always receive 300 12.7mm rounds, 2000 7.62mm rounds and 8 3D6/17, the actual number and type of rounds selected to go inside the tank is mission and supply dependent. The ten hand grenades may only be sporadically issued. Their greatest utility to a crew is frankly to render a tank’s systems unusable (after removing the ammunition) when it is to be abandoned.

High Explosive Fragmentation: 3VOF36

The primary HE-Frag round issued to Russian tank crews is the 3OF26 (3VOF36 with 4Zh40 or 4Zh52 propellant charge while in breach). 3OF26 has a kill area of approximately 462m^2 with the fragmentation pattern spreading most majorly towards its flanks thanks to its cylindrical body. Directly out of the muzzle it is propelled to a speed of 850m/s under normal temperature conditions using the 4Zh40 or 4Zh52 propellant charges and is technically the farthest-reaching weapon on the T-72B3, considering its area effect and gun level. Fuse arming occurs at 5-7m due to the deceleration force of the expanding stabilizer fins (see bottom of next page).

Before use all ammunition should be inspected for physical damage to the body of the round and fins. If any HE-Frag or HEAT round has fallen onto a hard surface from a height of more than 1.5m or onto its fuse on any surface it should not be used. If the fuse appears damaged or is deemed unsafe for any reason, it should be removed and placed in a dud pit at a minimum distance of 50m away from the tank and dismounted personnel.

Such a high effectiveness of the round is owed not just to its explosive potential but its versatile V-429E fuse. Two mechanical fuse settings, “O” or “Fragmentation” and “3” or “High Explosive” are provided to be alternated between by the commander using a special key. The plastic end cap provides the 3rd and 4th fuse settings in that it may be removed to reveal the thin skin of the ignitor membrane on the nose of the round. Only 3 of the fuse settings will commonly be used in combat. For auto loader operation to set a V-429E fuse, see the image description of the commander’s master control panel below.

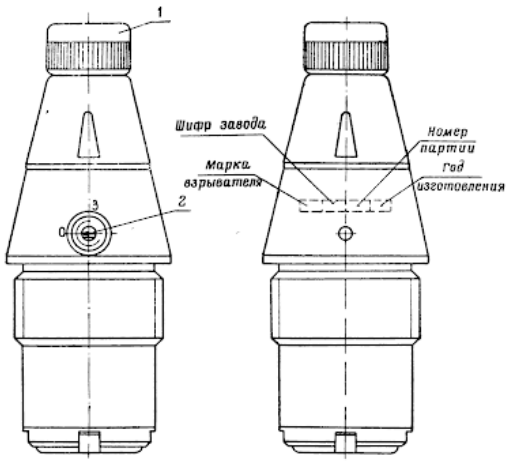
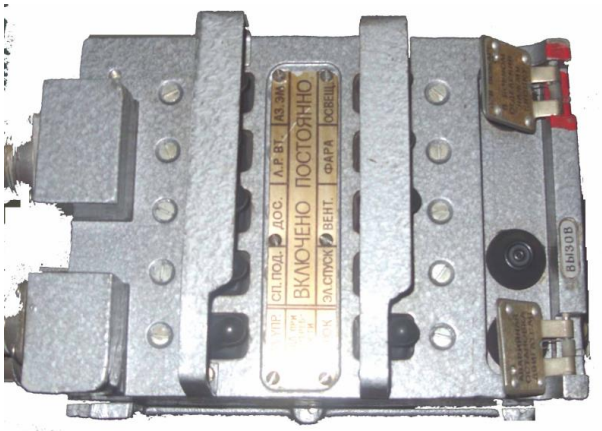


Рис. 66. Взрыватель В-429Е (общий вид):
1 — предохранительный колпачок; *2* — установочный кран

Those 3 primary fuse combinations are delayed, Frag and superquick. The fuse comes automatically set in the Frag mode which is considered the all purpose mode. In this mode the mechanical fuse is set to “O” and the plastic cap is screwed in to delay the detonation of the round. The fuse delay on the HE-Frag mode is on average 0.027 seconds on soil and will pass through rain, tall grass, leaves etc. to reach its target. The fuse setting will elicit a more rapid detonation response based on the hardness of the material it is impacting. Lightly entrenched fortifications, troops in the open or behind temporary cover and light unarmored vehicles are best engaged with 3OF26 set in the HE-Frag mode.

By inserting the fuse key into the fuse and completing a quarter turn clockwise, the commander may set the fuse in delayed mode. Thus, the fuse will be set to “3” and the plastic end cap will remain fixed. On average after 0.063 seconds a 3OF26 round will detonate on this fuse setting. Prepared defenses, including trenches, bunkers and other field fortifications, light and medium armored vehicles and buildings may be struck with the round in the delayed fuse setting, although in rapid engagement Frag would suffice.

Frag is the final fuse setting available to the commander. This setting is achieved by removing the plastic end cap from the round and leaving the mechanical fuse set to the factory default or “O”. Since the ignition membrane is only 0.12mm thick, at and near muzzle velocity a 3OF26 set in the Frag fuse setting may be triggered by obscurants such as rain, leaves and tall grass. It is up to the commander to determine the necessity of this fuse but in general it can be most useful when firing upon fully exposed troops to which there is a clear line of sight, tanks and suspected/known enemy hiding within the first 10-20m of a tree line. By firing the round into trees or other foliage, it can perform a rudimentary airburst function when set in the Frag mode.



(3OF26 HE-Frag round with its stabilizing fins deployed. The discarding band and shear pins can be seen to the right of the round, left)

(Commander’s master control panel. By disengaging the ДОС switch before pressing the load button, the auto loading process will interrupt prior to ramming the round into the breach. This is when the commander may adjust the fuse setting on a 3OF26. By disengaging the switch, the loading process continues as normal, right)

High Explosive Antitank: 3BK12M, 3BK14M and 3BK18M

These are the 3 primary HEAT rounds used by the 2A46M-5, although others have been developed, they are not discussed here. Understanding the basic capabilities and use of HEAT rounds is important although in many cases their role can be supplanted by HE-Frag. 4Zh40 or 4Zh52 propellant charges may be used with these rounds.

3BK12M

Muzzle Velocity: 905m/s

Average RHA Penetration: 420mm

Fuse: I-238

Detonation Speed: 0.005 seconds (hard target)

Note: When striking soft targets that do not immediately deform the nose, the delay on this round can reach as high as 0.25 seconds. This is because the inertial deceleration forces on an armed I-238 causes the electrical contact pin to touch the contact sleeve by sliding forward, which is followed by the chain detonation of the rest of the fuse as opposed to the immediate ignition by the contact sleeve being crushed into the pin.

3BK14M

Muzzle Velocity: 905m/s

Average RHA Penetration: 500+mm

Fuse: V-15

Detonation Speed: Unknown, nearly instantaneous

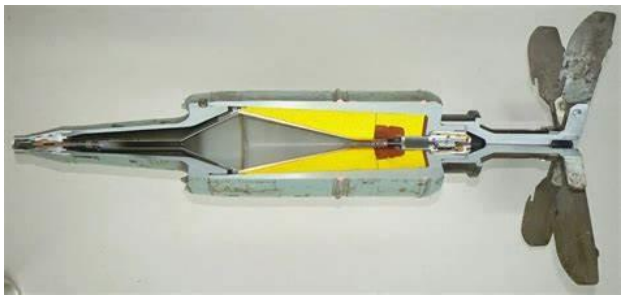
3BK18M

Muzzle Velocity: 905m/s

Average RHA Penetration: 534mm

Fuse: V-15

Detonation Speed: Unknown, nearly instantaneous



(3BK18M)

HEAT rounds should be used against slower moving or stationary armored vehicles within reasonable ranges and on the flanks and rear of most tanks if APFSDS projectiles have run out. As a structure reducing round, in many cases the superior penetrative capabilities of HEAT rounds compared to conventional HE-Frag and ATGMs can make them ideal. If a crew is issued ATGMs then the allotted amount of HEAT ammunition taken on board will usually be reduced.

Armor-Piercing Fin-Stabilized Discarding-Sabot: 3BM32, 3BM42, 3BM42M, 3BM59/60

APFSDS projectiles are reserved almost exclusively for the antitank role. They have no fragmentation or explosive characteristics and are completely inert. While commonly referenced, the RHA penetration of APFSDS projectiles is of secondary importance to their effectiveness against enemy composite armor arrays. Based on captured examples and anecdotal evidence from Ukraine, it would appear that the late-Soviet 3BM42 is still the standard issue round. It could be that the Russian command simply does not view Ukrainian tanks as the major threat and does not want to lose expensive newer rounds when they may not be needed. Tank on tank fights have been relatively rare and many Russian tanks simply cannot even fire most newer ammunition.

3BM32 “Vant”

Muzzle Velocity- 1700m/s (4Zh52/63)

Penetrator Length- 380mm

Average RHA Penetration- 560mm at 0-deg

3BM42 “Mango”

Muzzle Velocity- 1700m/s (4Zh52/63)

Penetrator Length- 532mm (total length, penetrator is segmented)

Average RHA Penetration- 500mm at 0-deg

3BM42M “Lekalo”

Muzzle Velocity- 1750m/s with 4Zh63

Penetrator Length- 570mm

Average RHA Penetration- 650mm at 0-deg

3BM59/60 “Svinets-1/2”

Muzzle Velocity- 1750m/s with 4Zh96 “Ozon-T” propellant charge (4Zh63 may also be used)

Penetrator Length- About 660mm

Average RHA Penetration- Likely up to 700mm at 0-deg

Note: This round may only be fired with the AZ-184 as found on the T-72B3 Model 2016 and its derivatives. Svinets-1 uses a depleted uranium alloy penetrator while Svinets-2 uses a tungsten heavy alloy penetrator.


(3BM59 Svinets-1 APFSDS projectile and 4Zh96, left They can be easily identified by the presence of a red band. 3BM42 Mango APFSDS projectiles on the assembly line, right)

Antitank Guided Missile: 9M119M "Invar"

(Via bastion-karpenko.ru)

Maximum Range: 5000m

Average Velocity: 350m/s (450m/s average at muzzle)

Average RHA Penetration: 700mm (112mm precursor charge)

Time of Flight to 5km: 17.6 seconds

Hit Probability at 5km: 0.8

The 9M119M "Invar" is the primary guided round for the 1A40-4 FCS. The loading and lasing process occurs as normal. The gunner keeps his reticle fixed on the target in the 12x magnification mode. The trigger button for the gun is also fired as normal. Keep the reticle on target and wait for an impact. The missile will fly an average of 3m above the LOS until 800m before the target, where it will begin its descent. A tank's speed when engaging a target with an Invar should not exceed 30kmh and the lateral target speed should not exceed 70kmh.

DO NOT attempt to “fly” the missile by making manual corrections or establishing lead if you believe it is not heading towards the target in proper fashion. A malfunctioning missile cannot be fixed by manual correction, you will most likely waste a perfectly good missile on nothing. If the laser control channel had an undiagnosed breakage and there are no laser commands being given after a missile is fired then the red LED in the optical FOV will begin to flash.

If the target needs to be fired on immediately, do not lase the target first, simply fire and hold the reticle on target and the missile will fly approximately along the gun LOS to target. If the target is within the stated range and there is time to lase, do so and press the ОБОГРЕВ button on the Sosna-U day sight. This will cause the missile to fly along the direct line of sight to target. This method should be used as default if the target is within approximately 1200m. After firing a missile, press the ОБОГРЕВ button to turn of the laser control channel if it is not desired to fire any more missiles.

Note: In the tank’s ammunition load out, typically HEAT rounds are replaced with ATGMs as they fill similar roles and ATGMs offer a significant advantage in range and accuracy. Invar should only be fired with the 9Kh949 charge, pictured above and to the right. Standard 4Zh40 or 4Zh52 propellant charges are not to be used under any circumstances as they will destroy the missile and risk damaging the gun.

Glass heating should either be turned off using the record button prior to selecting an Invar or will automatically turn off when it is selected by the selector panel (unclear to the author at this time) as the ОБОГРЕВ button performs a different function when in ATGM mode.

Chapter 6: Thermal Channel

Sight Parameters: Catherine-FC

Scanning Range: 8-14 micron (most sources, including official Russian military publications cite 12 micron as the maximum scanning range)

Optical Mag: 3x and 6x

Digital Mag: 12x

WFOV/NFOV: 9x6.75-deg/3x2.25-deg

Digital FOV: 1.5x1.12-deg

Refresh Rate: 50Hz

Thermal Sensitivity: <70mK

Power On Time: Variable up to 6-7 minutes in hot weather, 3 minutes in cold weather

Time of Continuous Operation: 6 hours (12 hours under combat conditions is authorized)

Detection/Recognition Range of a Tank in the Open: 10.5/4.5km

Detection/Recognition Range of Infantry in the Open: 5.5/2.2km (this is very consistent with combat footage from Ukraine showing a T-80BVM engage Ukrainian infantry in the open at just over 4300m. T-80BVM also uses the Sosna-U and Catherine-FC)

The Catherine-FC:

The Sosna-U thermal channel consists of the French Catherine-FC 2nd generation thermal imaging system designed originally by Thomson-CSF (what would eventually become Thales Group in the early 2000s). It is good by the standards of its time and can be found on the majority of Russian armored vehicles featuring thermals from tanks and IFVs to tank destroyers like the Khrizantema-S. The Catherine-FC components come in the form of 3 separate pieces of equipment relevant to the gunner. The VSU-12 multi-functional display (MFD) unit upon which the video is viewed in 754x576p, the Catherine-FC control module and the automatic target tracking engagement switch panel. The MFD and control module are shown in the above left image. The actual Catherine-FC can be seen with a cutout on the right below which displays the inside layout of the imaging system.

It uses a cooled 4x288 Mercury-Cadmium-Teluride (MCT) sensor matrix designed and originally manufactured by SOFRADIR and a single plane rotating mirror assembly to ensure full capture of the required image. As with any thermal imaging system, the output of the bolometers is displayed using light emitting diodes, the intensity of which corresponds to various temperature readouts, thus creating a display that can be viewed in the form of an image.

Turning on the Catherine-FC:

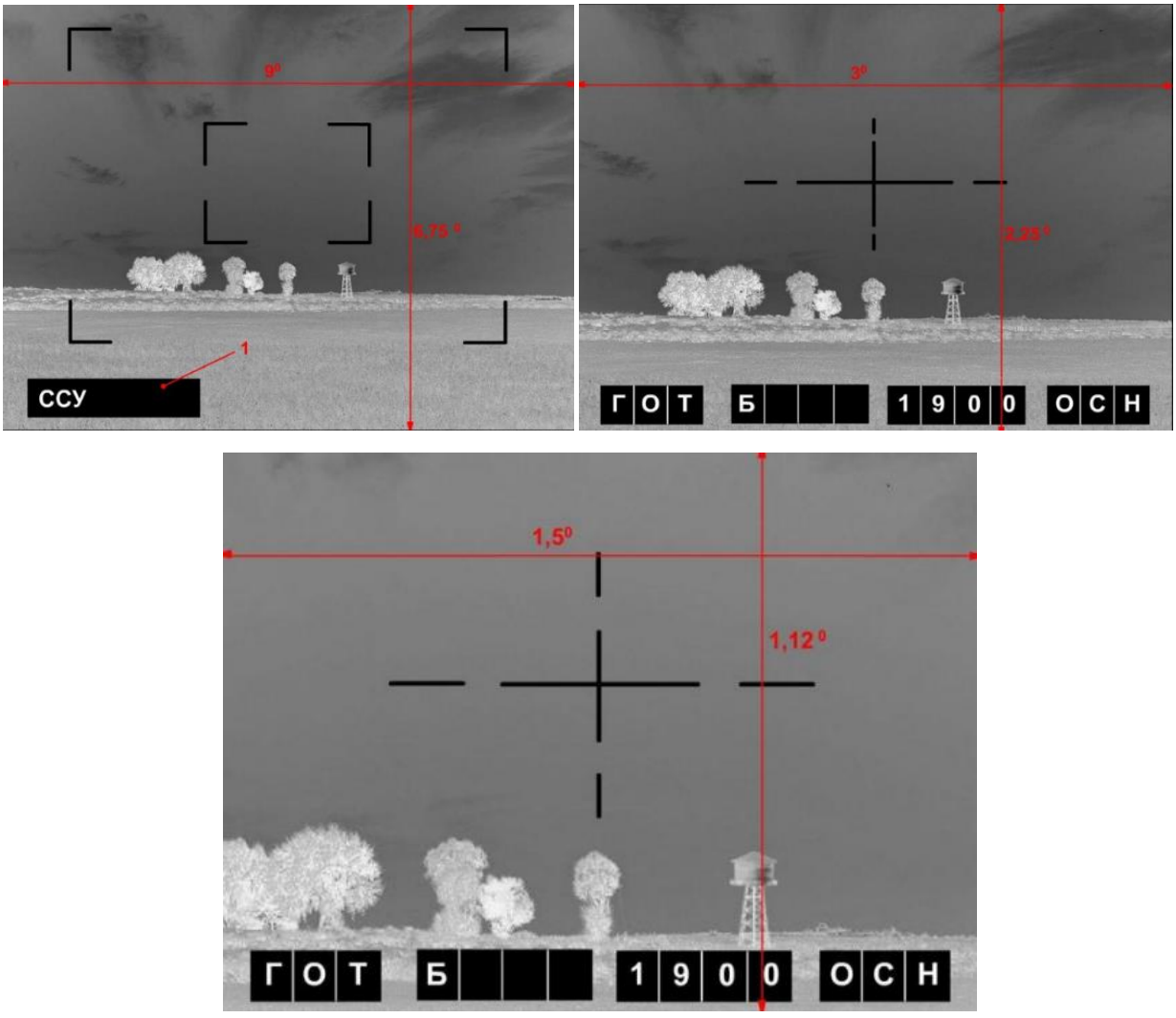
Turning on the Catherine-FC is simple. Turn on the Sosna-U. After doing so, remain in the 4x magnification mode and ensure all unnecessary switches are disengaged. Turn on the power switch found on the left side of the

Catherine-FC control module (pictured above). The switch is on the upper left. Allow for up to 3-7 minutes for the sight to turn on depending on ambient temperature.

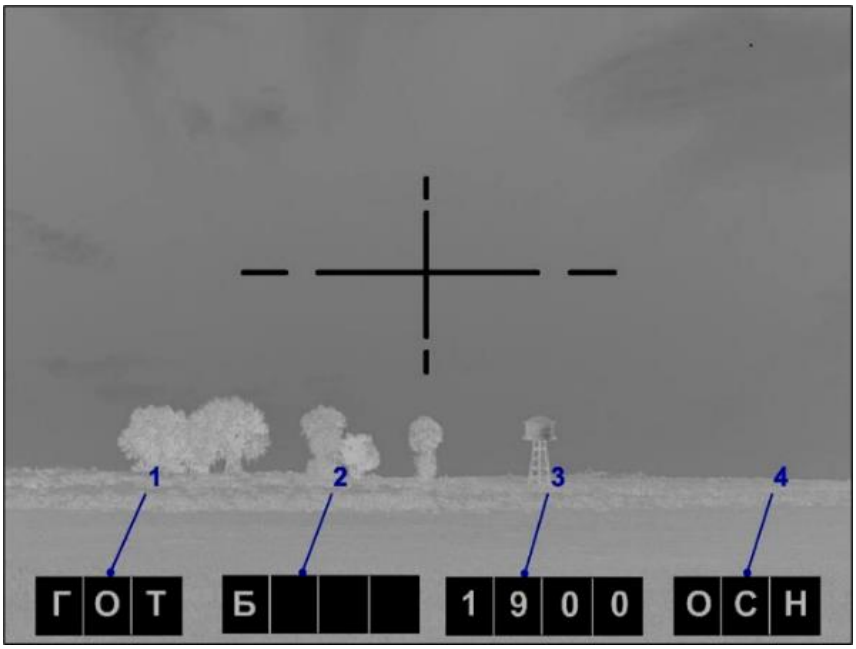
The only difference between the gunner's and commander's modules is the power on/off switch. The "I" position turns on the sight and puts it in standby mode, the "power" symbol turns on the sight and the "O" position turns it off. When in standby mode the sight is cooled to operating temperature but not turned on, preserving its readiness for immediate use. On most Catherine-FC in service this standby feature also seems to appear on the gunner's Catherine-FC control module.

Note: Ensure that the automatic target tracker switch is also turned off prior to turning on the sight

Display:



The primary FOVs of the Catherine-FC are seen displayed above from left to right. The optical WFOV is the display shown in the upper left corner above. The upper right and lower images above, respectively show the 6x optical and 12x digital NFOV. It is through these modes that gunnery will be carried out, although engagement with the automatic target tracking system may only be used in the 12x mode. Place the crosshair on the target using the gunner's controls and engage as you would in daytime.



Text box 1 displays the stabilization and control system status indicator. When showing ГОТ as in the above images a round is ready to fire. This will be the default display in that case whereas НА indicates that the system is functioning with no round loaded or one is in the process of being loaded. When the ССУ indicator in text box 1 appears this simply notifies the user that the sight is still preparing itself to be used or is in the 3x magnification mode.

Text box 2 displays the type of ammunition selected in the auto loader control panel.

Text box 3 displays the last lased range in meters. Since there is no LRF mark in the thermal channel, the center crosshair in the 6x and 12x viewing modes should be used to lase the target. It is unclear at this time if there is another method, considering the position of the LRF dot in the day sight reticle of the Sosna-U is not necessarily linked to the actual position of the ballistic reticle. Apparently, the difference is calculated by the sight when using the thermal channel to account for this fact. If no return is received from the LRF then "----" will display in text box 3, this is not necessarily a malfunction indicator so attempt to lase again using a different point.

Text box 4 displays the gunnery mode that the thermal channel is operating in. Unlike the day sight channel, the thermal channel can also operate in Duplicate Mode using the commander's РК72 control module. ДБЛ will display when in Duplicate Mode. The standard display when functioning in the Main Mode is OSH. ТСУ will display when in Target Designation Mode.

Should the sight malfunction, the malfunction indicators corresponding to the numbers below will also be displayed in text box 4. "S" and "H" have their normal Russian analogues while "Ш" is both together.

ОШ 1- No voltage/power to sight

ОШ 2- No gyroscope motor

ОШ 3- Gyroscope sensor is not ready (might also pop up if the sight is turned on too fast)

ОШ 4- Low sight voltage/power

ОШ 5- Failure of the automatic gyroscope lock to connect in the Sosna-U. This feature is manual on the TPD-K1.

ОШ 6- No coordination with the thermal channel with the sight

(Pictured above is the Catherine-FC control module, gunner's MFD and automatic target tracking switch. They can be found between the Sosna-U and Type 902B smoke mortar system control panel.)

The Catherine-FC Control Module:

Besides the already described power on/off and standby switch, the Catherine-FC control module features a malfunction warning light indicated by the triangle below the power switch and a menu toggle button below that. Like the menu toggle button on the Sosna-U day sight control module it must be depressed for up to 5 seconds to enter menu mode.

The two adjacent buttons surrounded by the highlighted white rectangle adjust the optical magnification settings of the Catherine-FC. The bottom one toggles the 3x magnification WFOV and the top one toggles the 6x magnification NFOV.

The bottom righthand button switches the MFD display from black to white hot and back again by each subsequent press.

The central knob controls the functions of the 2 buttons indicated towards it by white lines. The button on the lefthand side of the knob is the focus button. Turning the knob to the right will increase the focus as shown by the indicator bar below the knob. The button on the righthand side is the gain button. Knob functions remain the same. The last pressed button is the function adjusted by the knob.

VSU-12 Multi-Functional Display:

The VSU-12 MFD displays the image generated by the thermal imager in 754x576p. It includes a black hot/white hot button and +/- buttons for the digital zoom function. More likely these actually adjust the brightness of the MFD where the NFOV button on the control module controls both the optical and digital FOV functions.

It is unclear at this time why the Russian MoD did not choose to procure a system with greater magnification or zoom capabilities especially considering the T-90A Model 2006 has 6 and 12x optical magnification and 24x digital zoom on its ESSA sight and uses the exact same thermal imager.

While the optical capabilities are sorely lacking, it is important to remember that “not good” will not always translate to “not good enough” as evidenced by the previous example and expected average terrain line of sight distances in the intended theatre of use must also be taken into account. They will typically not exceed 2500m over 90% of terrain in Central and parts of Eastern Europe. Multiple combat videos from within a Russian T-80BVM (also uses the Sosna-U) show the Catherine-FC being used to engage Ukrainian infantry in the open at over 4300m, albeit inaccurately as a result of the commander’s negligence in spotting rounds and offering proper corrections to the gunner. Of course, this is still no excuse when put up against the failure to procure optics with better performance characteristics, however in many instances this will be found by both the operator and receiving party of the tank’s fire that this simply does not matter.

Note: Pressing the “+” and “-“ buttons on the MFD will reset the lased range in the same manner as on the Sosna-U day sight.

Automatic Target Tracker:

When in the 12x digital magnification mode, the switch sitting directly above the smoke mortar control panel and below the Catherine-FC control module may be used to turn on the automatic target tracking capabilities. Using a bounding box around the initial target, assuming a clear enough distinction can be made between it and the background, the fire control system tracks the target via pixel recognition. The auto tracker switch may be turned on by moving it to the ВКЛ position. When the tracker is turned on the right thumb button on the gunner's controls will engage the tracker and determine the range to target. The left thumb button will disengage the current track, but not turn the tracker off. As an indication of the readiness of the auto tracker to lock onto a target, a box with brackets will appear around the target.

If the target begins to move, the tracker will follow it and remain fixed on the center mass of the selected target as accurately as possible. It is unknown if the Catherine-FC automatic target tracker suffers from the same problems as relatively contemporary systems like the auto tracker in the American M2A3 Bradley's IBAS, where it will bound onto "ghost" targets or suddenly lose connection with the tracked threat and lock onto something such as a boulder or tree.

As soon as visual connection is lost on a moving target that has taken cover or gone behind an obstacle/obscurant, the system will enter the inertial tracking mode and continue leading the gun forward for 6 seconds at the target's last known speed. Unless the target is recognized again and a lock can be established within those 6 seconds, the automatic target tracking will be cut off and the gun will switch back to manual mode for the gunner to take control of again. The tracker will remain on and continue to attempt to identify targets where it is pointing until the switch is placed back in the ВБІКЛ position.

Auto tracking is enabled for all types of ammunition, including the coaxial РКТМ.

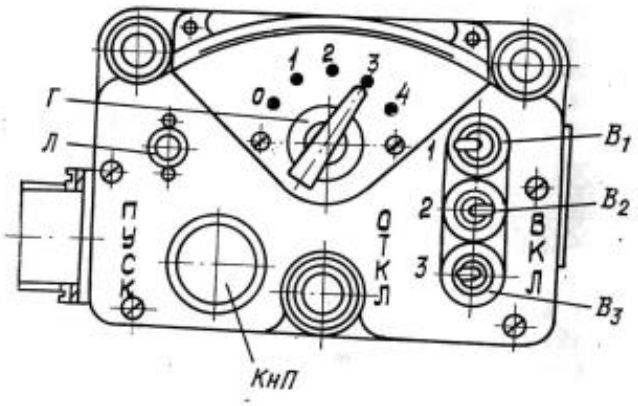
Chapter 7: The Tucha Smoke Mortar System

(Via vitalykuzmin.net)

Type 902B Tucha:

The Type 902B Tucha, or “cloud” (henceforth referred to as Tucha) has been one of the most ubiquitous pieces of Russian military equipment for decades. With few exceptions, the majority of Russian ground combat vehicles featuring smoke mortars use the Tucha. The image below was actually taken from a T-62M tank manual. On the T-72B3 series of tanks the Tucha system is mounted to the left of the gunner next to the MFD. Usually the commander on a tank is responsible for the employment of smoke so as not to distract the gunner with secondary responsibilities, however the Russians did not see this as an issue.

A total of 8 mortars are equipped on the T-72B3.



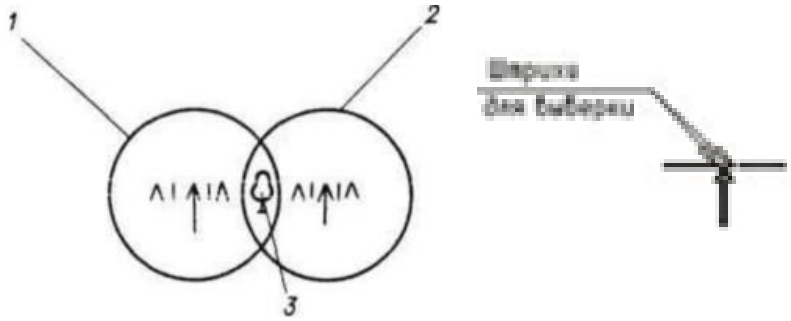
First, ensure the НАЧАЛО.НАБОР switch on the gunner’s control panel is turned on. Perform a basic functions check of the system by turning switch Г from the 0 position to 4 and then back again on each number. The Л LED should light up when the switch 5 is over any number other than 0 if the mortars are loaded. ALL BANKS of mortars

should be off throughout the check. When the large black button labelled КиП is pressed, this will fire the smoke mortars with the number of grenades launched corresponding to the number switch 5 is pointing to.

Switches В1 and В2 are used to select the 2 banks of 4 launchers each, located concentrically on the Т-72В series of tanks. Neither will function unless the other is turned off. Switch В3 is not used as there is no third bank. It remains in the off position to the left. Move switch Г to the desired number of mortars and press the КиП button. Bank 2 has been selected in the image above while banks 1 and 3 are off.

To reload the banks of launchers, turn off the НАЧАЛО.НАБОР switch, place switch Г on the 0 position and insert the ammunition through the muzzle of the mortars by hand.

(Side view of the bank of smoke mortars on a T-72B3 Model 2013, the rubberized caps on the ends of the smoke mortar rounds will remain fixed when firing. Via vitalykuzmin.net)



Aim the gunsight reticle at the object or direction you wish to create a screen against and offset the reticle by 4-8 mils to the left or right and then repeat the process on the other side. Use the edges of the lateral markings on the Sosna-U reticle if needed (the left image is based on the TPD-K1 reticle). Otherwise, the gunner should employ the Tucha as seen fit by the commander, including firing individual grenades or groups of 2 while traversing the turret. Keep in mind that overhead fires are not allowed.

Tucha Ammunition:

Tucha as found in service with the Russian military uses 2 types of 81mm ammunition, the 3D6 and 3D17.

Once the gunner launches the 3D6 it will travel between 250 and 350m before falling to the ground. After a duration of 7-12 seconds the grenade detonates and disperses smoke which is capable of obscuring visible and infrared light within the 0.4-1.56 micron wavelengths. Smoke will emit for approximately 60 seconds, and it can take up to 20 seconds to fully obscure the tank.

Newer 3D17 grenades that were first introduced alongside the Shtora-1 electro-optical countermeasure system will detonate after a maximum duration of 3 seconds at approximately 75-90m from the tank and emit smoke for up to 10 seconds. Unlike the previous 3D6, the 3D17 is capable of obscuring within the 0.4-14 micron wavelengths. This means that it can temporarily prevent observation of the tank by thermal optics (including the seeker heads on missiles like the Javelin) whereas the 3D6 would only be effective against standard night vision optics. Both grenades of course block all light within the visible spectrum as demonstrated by the image below.

(Upside down 3D17, left. 3D17 in action, right)

To be effective against fire and forget weapons like the Javelin, especially after they have already been launched, the commander or gunner would somehow have to spot the missile incoming and proceed to launch smoke in a deliberate manner all in the space of just several seconds. Without some type of radar or infrared warning system to detect strikes, the ability of smoke mortars to act as a preemptive defense system is limited.

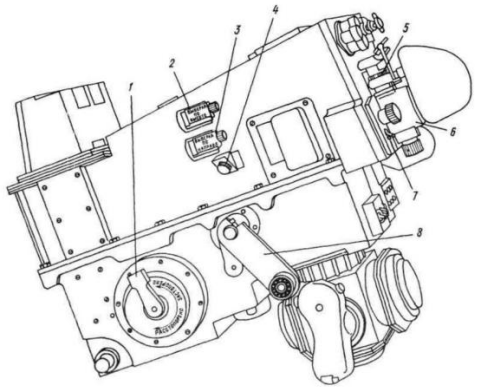
Ensure that grenades do not get wet in any way prior to use and clean the insides of the launchers of all grease and residue with a pad or rag before inserting the grenades. It is fine if they spin after being inserted when turned by hand as long as they are fully seated into the base.

Chapter 8: TPD-K1M Backup Sight in Brief

(Sosna and modified TPD-K1 inside of what is likely an export-oriented T-72M1M. Note the old Sosna sight control module, English labelling and old style of ammunition selector panel, featuring a user interface with more similarities to the ammunition selector panel on the T-72B. Nevertheless, this stands as a fine picture showing the current TPD-K1M and Sosna-U's relationship)

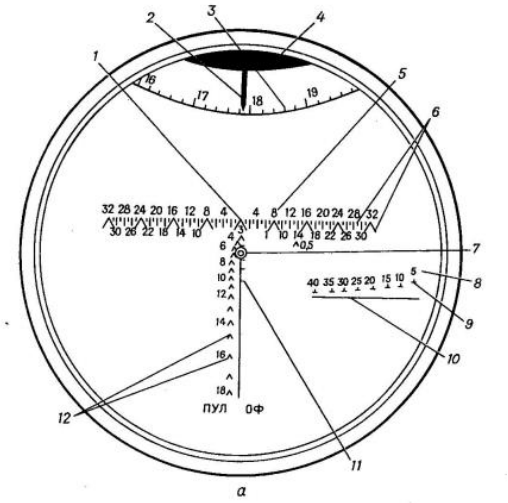
If you recall from chapter 1, the TPD-K1M is the backup day sight used in conjunction with the 1A40-4 FCS although everything but the controls are cut off from the majority of the tank's ballistic calculation abilities. It is capable of a fixed 8x magnification and 0.2 mils of stabilization accuracy. Even the UVBU automatic lead calculator has been removed, relegating the TPD-K1M to the same state (minus its connection to the 1A40-4) it found itself in on the T-72 Ural. There is no backup night sight for the gunner and the commander is incapable of firing and accurately aiming the gun with his TKN-3MK.

Turning on the TPD-K1M in the event that the Sosna-U experiences an irreparable malfunction or is destroyed follows the same process as turning on the Sosna-U. In this case all 3 switches underneath the ammunition selector panel are turned on, including the СТАБИЛ switch in the center. After turning on the drive switch no less than 1 ½ minutes should pass before unlocking the gyroscope using the handle (1) shown below. According to the manual, if the drive switch is off the gyroscope should be locked at all times. Also after the 1 ½ minute period, the СТАБИЛ switch can be turned on.



By using switch 11 (see Sight Control Module section) the LRF can be turned on. There are 2 settings, automatic and manual. The switch should be set to manual before turning the sight off and when using the range adjustment wheel (ribbed dial just above the gunner's controls) to manually adjust the scales. Switch 16 should be in the central position. The maximum effective range of the LRF and maximum setting on the manual dial is 4000m.

Reticle Configuration and Use:



1- Main firing mark, tip of the chevron is the point of aim

2- Range indicator, points to last lased or adjusted range on the range display wheel

3- Range display wheel with numbers 0-40 where each number x100=range (37=3700m)

4- Firing readiness indicator, lights red when the loading process is complete

5- Lateral mil scale number indicators

6- Lateral mil scale

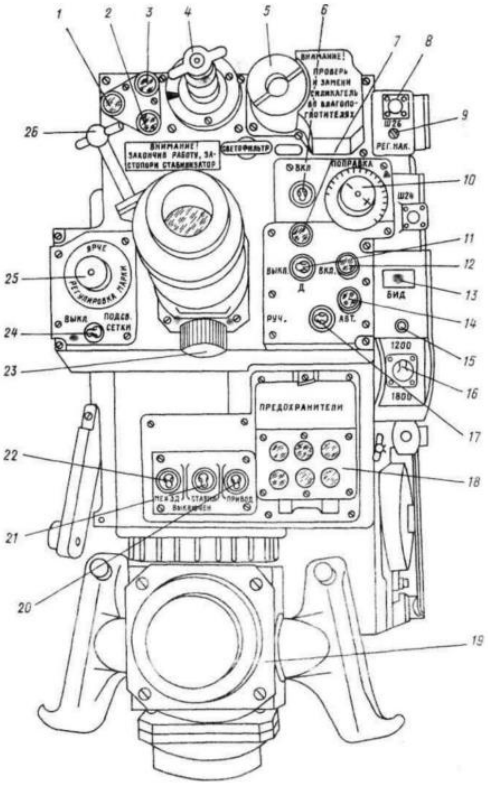
7- LRF aim point dot

8,9, 10- Stadiametric rangefinder, based on a target height of 2.7m

11- HE-Frag round drop compensator with holds at 4200m, 4600m and 5000m, set range manually to 4000m before using

12- Coaxial MG bullet drop compensator, put the LRF in manual mode, set ammunition type to HE-Frag and range to 0m before using, effective out to 1800m

Sight Control Module:



1- HE-Frag indication light

2- HEAT indication light

3- APFSDS indication light

4- Manual ballistics switch. Use this to switch the ballistic cam to the desired ammunition by pulling outward and turning until the desired light (1-3) is on. The ammunition selector panel must be set to 3АГР for this to function

6- Eyepiece heating switch

10- Ballistic computer input dial (explained in following section)

11- Turns on the LRF, wait up to 1 minute for the ready light to turn on

13- Range readout (also displayed in the reticle)

15- LRF in operation indicator light

16- All range readouts below 1200m or 1800m are excluded in case of suspected LRF malfunction. The central position is off where the LRF will function as normal

17- Automatic/manual (РУЧ./АВТ.) switch for LRF, if using the stadiametric rangefinder and/or manual range wheel, set to manual

18- System ready light display

20- Turret T&E drives actuation switch

21- Stabilizer actuation switch

22- Delta-D actuation switch

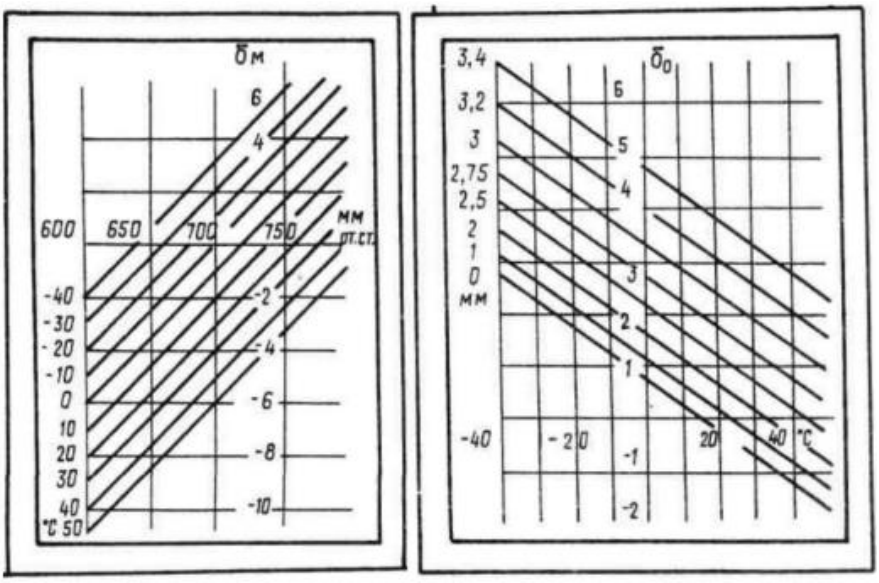
23- Diopter adjustment knob

24- Switch to illuminate the reticle

25- Dial adjusts the brightness of the illuminated reticle

The handle for the wiper on the TPD-K1M's outer protective glass is the large gold colored lever that sits above the sight. The switch to turn on the sun filter sits just behind the padded forehead rest.

Ballistic Computer Input Dial:



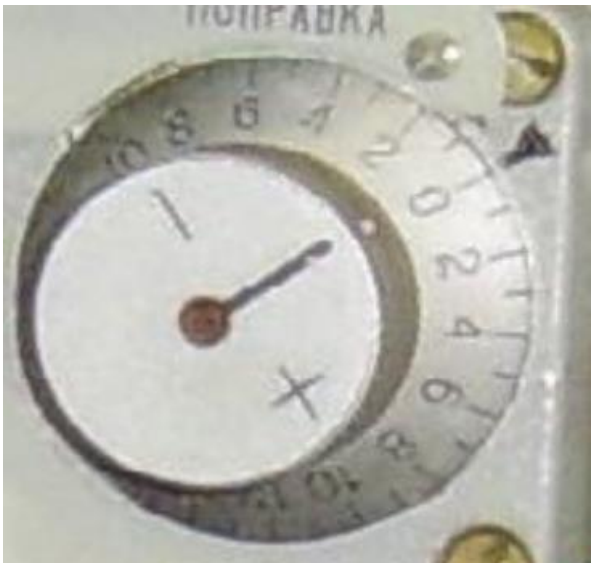
(N1, left. N2, right)

Although the TPD-K1M cannot accept any data from the ballistic computer since its introduction it has had the capability to input atmospheric data and other metrics into its ballistic calculations. The nomogram above is used to determine the correct adjustment percentage on the ballistic computer input dial.

The X-axis on N1 represents air pressure and the Y-axis temperature.

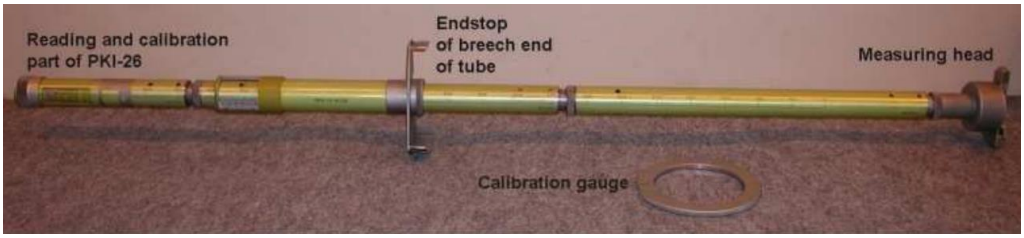
The X-axis on N2 represents air temperature and the Y-axis barrel wear.

Once the commander has added up the totals from each chart, the gunner rotates the dial to the required position. The standard position, represented by “0” as seen below is 750mmHg, 15-degrees and no barrel wear.



(Ballistic computer input dial, labelled 10 in the previous section)

Exact barrel wear can be determined by a bore measurement device such as the PKI-26, inserted through the breach to take a reading 10-360mm from the end of the forcing cone where maximum erosion is expected to occur.



(PKI-26, inserted into the breach by the commander measuring head first. The handle in the top image is used to calibrate the device)

The standard width of the bore should be about 125.15mm in a new 2A46 gun. The maximum width of the bore should not exceed 128.3mm, where 128.4mm is considered the maximum erosion limit at which point the gun becomes classed as category 4, subject to removal followed by category 5, ready for disposal.

Chapter 9: Commander's Position

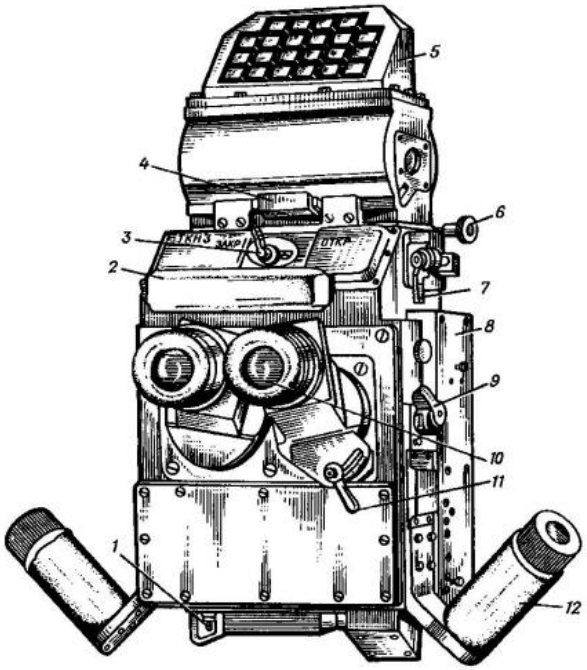
(Reference photo for the commander's position. Via topwar.ru)

Note the auto loader carousel manual drive and locking lever at the commander's feet and duplicate Catherine-FC control module above the commander's MFD. The small, black indicator arrow just above the Catherine-FC control module in the center of the image shows the cupola's position in relation to the tank turret in mils.

Behind the group of equipment on the right is the P-11-5 master control panel.

TKN-3MK:

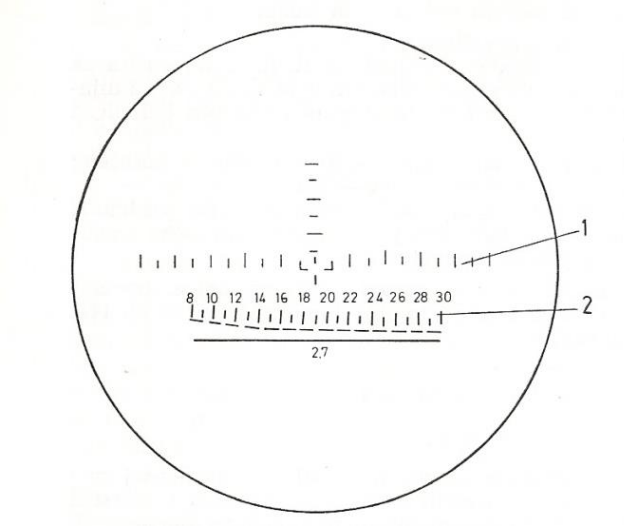
The commander of the T-72B3 is granted access to the exact same unstabilized day/night multichannel optic used since the introduction of the T-72B. In fact, in terms of independent gunnery essentially nothing has changed between the 2 models.



The TKN-3MK is in general a simple night vision optic that affords the commander a fixed 5x magnification in the 10-degree day FOV and 4.2x magnification in the 8-degree night FOV. Since the TKN-3MK uses a 2nd generation night vision optic, it is limited in how far it can reasonably see at night to only about 500-800m depending on ambient lighting conditions. Using the commander's OU-3GK infrared spotlight is not recommended on the modern battelfield as it can be rapidly detected. It would be reasonable to integrate IR flashes using the spotlight into a unit's PACE plan however. That is beside the point and as with IDF, also out of the scope of this work.

The 2 large handgrips on either side of the device are for the commander to rotate his cupola with, manually. The button at the end of the left handle will cause the tank to enter Target Designation Mode and automatically slew the turret to the approximate angle of the commander's sight at maximum speed. This allows the commander to designate targets independently for the gunner, albeit not horizontally. It will also briefly turn on the OU-3GK infrared spotlight unless it is completely switched off. Since the gunner would be looking at the target through thermals anyway, having the new target be illuminated, as may have been required with the old 1K13-49 or TPN-3-49 sights is not a necessity. The button at the end of the right handle causes the commander's cupola to counter-rotate against the turret so the commander can maintain observation of his sector.

Since the sight has no LRF, the commander must use a stadiametic rangefinder, similar to that on the TPD-K1M, scaled to a height of 2.7m. The central aiming mark of the reticle is where the target designation system will attempt to place the gun when the thumb button on the left handle is pressed. All lateral and horizontal mil markings are spaced 4 mils apart with the large lines 8 mils apart in total.



(TKN-3MK reticle)

First, switch 1 powers on the sight. Flipping switch 9 downward turns on the night vision channel by causing the light inside the sight to be redirected away from the night vision tubes and directly into the day channel. Switch 3 opens (right position) and closes the protective shutter on the night vision channel to avoid damage from excessive light input. Switching from the night vision channel to the daylight channel does not close the shutter on its own, this function must be performed separately by the commander.

Switch 7 is used to turn on and off the sun filter. Clamp 11 fixes and adjusts the eyepieces in place and must be unscrewed to adjust.

The switch on the upper left turns on and off the OU-3GK as well as setting it in temporary mode. The central position is off and the left and right positions are on and temporary respectively. The function (and lack of

necessity) of the temporary mode has already been discussed. If the commander chooses to illuminate a target by briefly switching on and off the OU-3GK, he will use this switch. Besides these circumstances only the on and off positions should be used.

To the right of the first switch above the TKN-3MK is the operation switch for the sight heater on the TKN-3MK which may be turned on and off as needed to prevent fogging or freezing of the protective glass.


Above, the TKN-3MK in a T-72B3 as seen from the commander's position when seated. The switch by the left handle is used to turn on the fan by the commander's position, used in hot weather or when extra air circulation in the turret may be required. It is off when switched to the left. To the rear of the commander's cupola (see right image above) are another 2 switches, the left switch turns on and off all rear lights on the tank and the right switch turns on all forward facing lights on the tank.

The fixed ring around the inside of the commander's position, just inside the cupola, is labelled with mil markings for both situational awarness and to help call out targets to the gunner, seen best in the chapter title photo, a small black arrow indicates the bearing of the cupola in relation to the tank's turret.

Commander's Gun Controls:


(Via topwar.ru)

The commander's SSU-12 MFD has essentially identical functions to the gunner's, to include the Catherine-FC control module. It affords the commander only a duplicate view of what the gunner can see and has no target designation capability. Since rounds will be loaded into the auto loader by the commander, his MFD has a steel protective cover that may be flipped up and down as needed to prevent cracking of breaking of the screen. For general safety purposes when not in use, this should always remain in the downward position.

The PK72 control module is used by the commander to control the main gun when in Duplicate Mode. It is based roughly off of the older BPV29 control module found on other tanks such as the T-80UD.

The commander grips the orange handle on the right and controls the movement of the gun using his thumb, placed on the joystick just above the handle. From the top left, there is a load button for the auto loader and 2 LEDs. The exact meaning of the left LED display is unknown at this time to the author (possibly Target Designation Mode) and the right LED indicates that the tank is operating in Duplicate Mode. Below that is the white ammunition selector dial. Just below the ammunition dial is a final button which will transfer the FCS into Duplicate Mode. Behind the handle (out of sight) are the buttons for firing the main gun/coax and LRF.

If the automatic target tracker is turned on, the LRF button on the PK72 will function in the same manner as the LRF button on the gunner's controls. It is unclear if there is a separate button to disengage the tracker like the gunner's left thumb button on his set of controls.

Commander's Menu Controls:

For the commander's menu access, he is given a separate control block with similar functions to the Sosna-U day sight control module. The central button turns on the menu mode by holding it for up to 5 seconds. The arrows can toggle between menu functions with the left/right arrows also doubling as value input buttons or (presumably) manual range input buttons when not in menu mode for the Catherine-FC like those on the day sight. See the section on day gunnery for more information. The save button is in the upper right. Holding the central menu button again will exit menu mode.

Major Sources and Citations

(Object 172, the first T-72 prototype and its designer, Leonid Nikolaevich Kartsev. Left image via otvaga2004.ru)

Kartsev was a decorated veteran of the Great Patriotic War and former tank commander himself, achieving the rank of captain before the war's end. From 1953 he served as the Chief Designer at the UKBTM design bureau in Nizhny Tagil until he was effectively fired in 1968. Following this he served in the Main Automotive-Armored Directorate of the Ministry of Defense of the Soviet Union for 10 years when he was forced to retire. Kartsev then worked at the Moscow Research Institute of Engines until the 1990s. He passed in 2013, the same year the T-72B3 entered service with the Russian Ground Forces.

"It all came to me in a dream"

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The title page of this manual is cut off

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Finally, a special thanks to @tankdiary, @afv_recognition, @_taktonik_, @tank.identification and @hulscher33 on Instagram for assisting in the review and editing of this manual.