INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

724

S-E-C-R-E-T
NO FOREIGN DISSEM

LVDoC

50X1-HUM

COUNTRY USSR

REPORT

SUBJECT Technical Document on the Armament of the Soviet Antiaircraft Gun ZSU-57-2

DATE DISTR. 29 August 1962

NO. PAGES 1

REFERENCES RD

50X1-HUM

DATE OF INFO.

PLACE & DATE ACQ.

50X1-HUM

THIS IS UNEVALUATED INFORMATION. SOURCE GRADINGS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

A 56-page, English-language translation of Chapter III of the Soviet document Rukovodstvo po materialnoy chasti i ekspluatatsii zenitnoy samokhodno- 50X1-HUM
artilleriyskoy ustanovki ZSU-57-2 (Manual on the Equipment and Operation of the Antiaircraft Self-Propelled Artillery Mount ZSU-57-2)

Chapter III is 50X1-HUM
entitled "Armament" and contains, among others, subsections on: arrangement of the gun; turret; conveyor; automatic antiaircraft site; ammunition; safety precautions; care and maintenance; and instructions for gun drill. Photocopies of original graphics are included.

50X1-HUM

5
4
3
2
1

S-E-C-R-E-T
NO FOREIGN DISSEM

GROUP 1
EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION

STATE	ARMY	NAVY	AIR	NSA	OCR	DIA	AID NIC
X	X	X	X	X	X	X	X
							SAC X

(Note: Washington distribution indicated by "X"; Field distribution by "#".)

INFORMATION REPORT INFORMATION REPORT

CHAPTER I

50X1-HUM

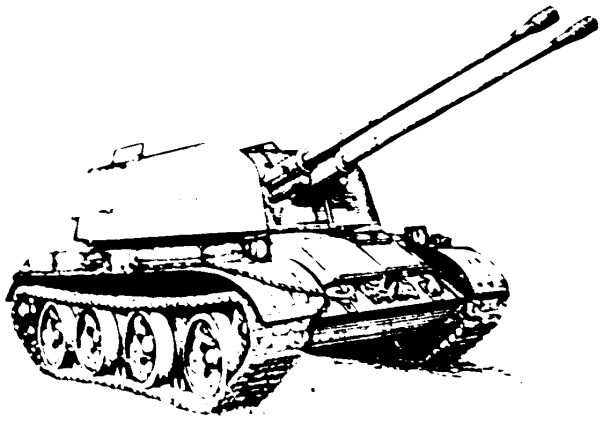


Fig 1

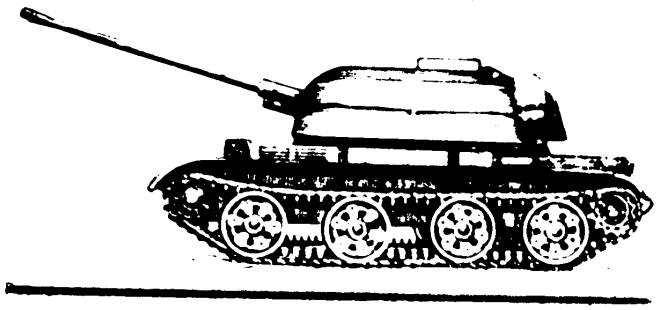


Fig 2

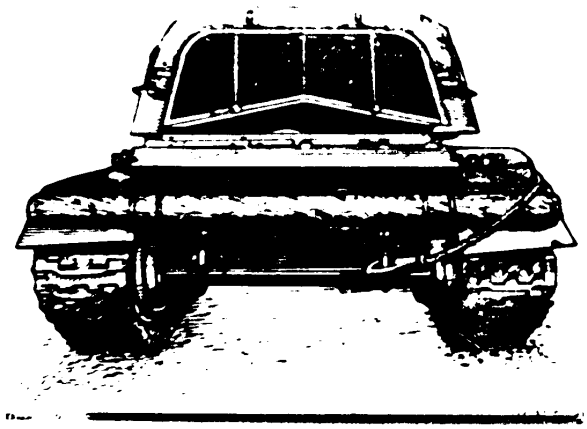


Fig 3

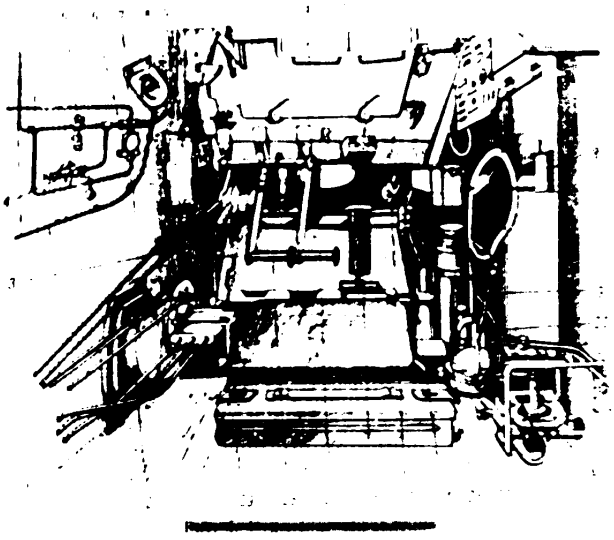


Fig 4

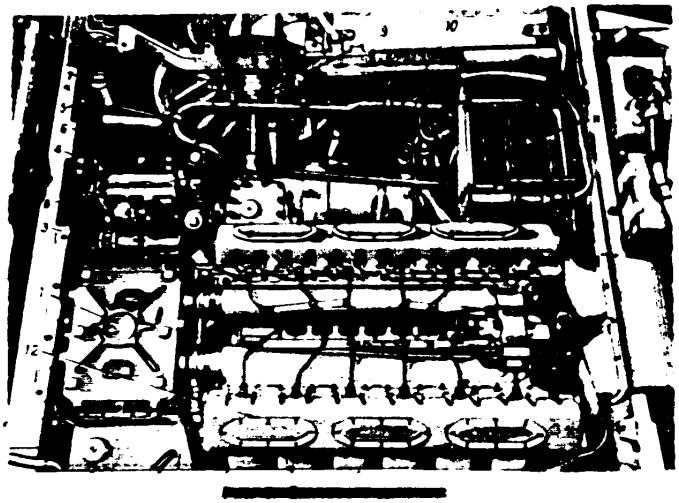


Fig 5

ARMAMENT

GENERAL INFORMATION

In the turret of the vehicle is mounted a 57 mm twin automatic anti-aircraft gun type S-68 (figs 21 and 22). The gun consists of two automatic mechanisms. The left and right automatic mechanisms of the gun are of identical construction - that is to say the parts of the right mechanism are a mirrow-image of those of the left. The ammunition feed takes chargers with a four-round capacity. The rounds are fed laterally (to left and right) from the ramming line.

An anti-aircraft course and speed type sight is fitted to the gun for the engagement of both air and ground targets. In the driver's compartment there is a tilt indicator which permits the horizontal position of the vehicle during firing to be controlled to an accuracy of 1°.

In the rear part of the turret are strapped two automatic rifles, the personal weapons of the crew members, and a signal pistol with a set of signal cartridges. These are kept wrapped in tarpaulin covers.

The gun may be laid for bearing and elevation either by an electro-hydraulic gear or manually. Electro-hydraulic gear laying uses a D.C. electric motor working through a universal speed governor (URS). This last ensures that the necessary laying speed is achieved and that target tracking is smooth. The manual gear is used as a stand-by method in case the electro hydraulic gear is out of action. The manual method requires two crew members for its operation.

On the muzzle ends of both barrels of the gun are self-releasing tarpaulin covers. It is not necessary to get out of the vehicle to remove these covers.

The laying mechanisms of the gun allow targets to be engaged at angles of elevation/depression of -5° to $+85^{\circ}$. The gun has all-round traverse.

Fig. 21. The S-68 gun mounting (viewed from above)

1. muzzle brake (right and left) 2. barrel (right and left) 3. cradle (right and left) 4. right magazine feed framehand cocking lever. 5. right magazine 6. right magazine loading tray 7. right breech cocking handle 8. traversing gear drive universal coupling 9. right-hand loader's seat 10. electro-hydraulic and manual traverse mechanism selection lever 11. reduction gear and traverse mechanism control column 12. cranked traversing handle 13. universal speed governor (URS) 14. right collimator 15. moving part of sight 16. detachment commander's seat 17. sight socket 18. sight testing flat 20. elevation handwheel 21. ammunition conveyor manual drive handwheel 22. ammunition conveyor reduction gear 23. ammunition conveyor drive coupling lever 24. relay box 25. sight-setter's seat 25. sight base casing 27. aircraft model (target course indicator) 28. sight base 29. layer's seat 30. left collimator 31. electric firing gear button 32. universal speed governor control column 33. elevating gear reduction gear 34. elevating gear universal speed governor 35. cranked elevating handle 36. left automatic mechanism firing pedal 37. right automatic mechanism firing pedal 38. elevating gear drive selector lever 39. left-hand loader's seat 40. left breech cocking handle 41. interlocking device lever * 42. left magazine loading tray 43. left magazine 44. left magazine feed frame cocking handle. 45. backsight.

Fig. 22. The S-68 gun mounting (viewed from the rear)

1. G-731 electric motor 2. turret platform guard 3. course stabilizer pedal 4. Course stabilizer disengaging box 5. left loading tray

*Translator's note:- For purpose of this mechanism, see P.60 of this translation.

6. universal speed governor rod 7. hydraulic drive engaging box
8. ranked elevating handle 9. left collimator 10. sight base
11. rear mounting opening cover 12. relay box 13. right collimator
14. cranked traversing handle 15. warning light box 16. radio set
17. ammunition conveyor manual drive handwheel 18. right loading tray
19. course stabilizer gear 20. - 21. junction box 22. casing
23. start-stop device 24. ammunition stowage under turret platform
25. turret platform.

BRIEF NOTES ON THE ARRANGEMENT OF THE GUN

The 57 mm gun S-68 (figs 21 and 23) consists of the following main parts: the moving parts (the right and left automatic mechanisms), the mount and ammunition conveyor, horisontal laying mechanism, vertical laying mechanism, automatic anti-aircraft sight and the electrical equipment.

The moving part of the gun consists of two parallel-mounted automatic mechanisms joined together in one block by cradles.

The main parts of each automatic mechanism are as follows: a barrel with a spring type recuperator and hydraulic buffer, a bracket with the accelerating mechanism, a breech, magazine, firing and semi-automatic cam mechanisms, hydraulic breech buffer and cradle.

The moving part of the gun is balanced by weights fastened to the cradles. In the travelling position the moving part of the gun is clamped down.

The moving part of the gun is attached to the mount by two trunnions, which take the form of a large ball-bearing race. The inner rings of bearings are fastened to the gun cradle, and the outer are bolted slots in the right and left mounting side plates.

The gun mount (fig. 24) is mounted on the turret floor and provides a base to which are fastened the moving part, the automatic anti-aircraft sight, the laying mechanisms and electrical equipment.

The mount consists of a body with a bracket, a travelling clamp device and the ammunition conveyor. A plate is welded to the front lower part of the mount body to secure it to the turret floor. In the plate are eight drilled holes, through which pass the bolts and pins which fasten the mount to the turret. A plate welded to the lower rear of the mount serves as another fastening surface. Eight bolts are screwed into the threaded holes in this plate: they fasten the mount to the rear part of the turret floor.

A welded bracket (7) is bolted to the central part of the mount. On the lower widened part of this bracket is a surface on which the laying mechanisms universal speed governors and electric motors are mounted and fastened.

The turret embrasure is closed in front by two moveable armoured shields which are bolted to the gun cradle brackets. Between these two shields is bolted a third armoured shield (17) which forms an immovable gun mantlet.

The cradles of each automatic mechanism guide the barrels and breeches during recoil and run-out and apply angles of elevation to the barrels when the elevating mechanism is in use. The main parts of the cradles are: the breech hand-cocking mechanism, the anti-jump catch disengaging mechanism, and the hydraulic breech buffer. On each cradle there are also the following: magazine, hydraulic buffer, the upper part of the firing mechanism, armoured shields, jackets and counterweights.

Fig. 23. The right automatic mechanism (longitudinal section)

1. Upper counterweight 2. rear cover 3. and 9. breech springs 4. hydraulic breech buffer 5. foot and electric firing lever 6. automatic firing lever (automatic sear) 7. slide 8. accelerating mechanism cam 10. breech 11. ammunition clip ejection opening 12. recoil indicator 13. clip and bracket 14. accelerating mechanism crank 15. barrel actuating cam. 16. breech block locking bolt 17. hydraulic buffer 18. cradle 19. barrel 20. spring type recuperator 21. buffer compensator 22. piston rod gland nut 23. lower counterweight 24. rear counterweight 25. breech screw 26. breech stop 27. electric firing gear housing 28. bracket a cam to withdraw breech stop.

Fig. 24. The S-68 Gun Mounting (viewed from the left)

SECRET. Insert No.2.

1. Upper mounting plate 2. gun ball race securing socket 3. mounting hatch cover 4. ejector with cover plate 5. roller 6. electric motor supporting ring 7. mounting bracket 8. handle 9. cam 10. clamp 11. universal speed governor mounting plate 12. supporting roller 13. roller 14. triangular metal tooth 15. ammunition conveyor belt 16. tension adjusting mechanism 17. front armoured shield 18. hook 19. arc 20. splined shaft 21. and 22. bearing bushes 23. catch 24. actuating catch 25. tension adjusting mechanism bracket. 26. sleeve 27. piston 28. spring 29. sleeve 30. rollers 31. spring 32. catch actuating lever 33. support.

The Gun Firing Mechanisms

There are three types of gun firing mechanism on this equipment: automatic, electrical, and foot. The automatic mechanism is mounted on the upper part of the left and right cradles. It will cause the equipment to continue firing as long as ammunition is being fed into the magazines. If only one round should remain in the magazine, automatic fire ceases and the automatic fire lever holds the breech casing to the rear. When a further clip is inserted into the magazine, the automatic fire lever falls clear and firing is continued.

The foot and electrical firing levers (5, fig 23) are fitted on the cradles next to the automatic firing lever (6).

The electrical firing mechanism contact switches are on the cranked elevating handle and on the electro-hydraulic laying gear column handwheel. When the foot firing pedal is in use the pedal guard must be removed and the pedal depressed with the foot. The foot pedal firing mechanism acts as an alternative to the electrical mechanism, and is fitted to the left side of the gun. When the electrical firing button or the foot firing pedal is pressed, the lever (5) is disengaged from the breech casing. If at the same time the automatic firing lever is depressed, the breech will run forward.

The electrical firing switches of the right and left automatic mechanisms are fitted to the left of the detachment commander on the junction box next to the warning light box (15 fig 22). The equipment may be fired simultaneously with both automatic mechanisms or separately from each automatic mechanism.

To fire simultaneously from both automatic mechanisms, both circuit switches of the electrical firing mechanism must be switched on or else both pedals of the foot firing mechanism must be depressed.

To fire from only one automatic mechanism, only the corresponding circuit switch or foot pedal need be depressed.

The Gun Clamp

To the left of the detachment commanders seat on the mounting bracket plate (7 fig 24) is fitted the clamp which prevents the moving part of the gun from moving while in the travelling position. The clamp mechanism consists of a clamp (10) and a shaft (20), on the splines of which are mounted a cam (9) and a handle (8) and locking pin.

The handle can be held in two positions by a catch (23) which fits into a slot in the arc (19).

The arc (19) is fitted on two supports (33) which are welded to the mounting bracket plate (7). The shaft rotates in two bearing bushes (21 and 22) which are welded to the right and left mounting bracket (7) plates. The end of the cam is inserted into a groove in the clamp (10) and the handle (8) is fitted on to the splined section of the shaft (20).

To clamp the gun in the travelling position:-

1. Apply an angle of elevation to the piece such that the graduating line marked on the left mounting side plate coincides with that on the left cradle upper counterweight.

2. Disengage the catch (23) from the arc (19) using the actuating catch (24), and move the handle (8) to the rear until the catch no longer engages in the arc slot.

As the handle (8) moves, the shaft (20) and the cam (9) turn. The end of the cam displaces the clamp (10) and inserts it into the corresponding slot on the cradle counterweight.

To bring the gun into the fighting position from the travelling position, push the handle (8) forward and set it on the catch.

The Gun Elevating Mechanism

The elevating mechanism is on the left side of the mounting and has two drives: electrohydraulic, with a smooth laying speed adjustment (up to 20° per second) and manual, which has a laying speed of 4° to one turn of the handle. The main sub-assemblies of the elevating mechanism are: the electric motor, the worm reduction gear, the geared* reduction gear, the auto-stop box with the control column and the universal speed governor (URS).

Fig. 25 Kinematic diagram of the elevating mechanism

1. toothed arc. 2. arc actuating pinion. 3. worm wheel. 4. worm and shaft. 5. universal couplings. 6. spur gear. 7. cam coupling. 8. selector lever 9, 10, 11, 12 bevel wheels. 13. cranked handle. 14, 15, 16, 17 spur gear wheels. 18. rings 19, 20 bevel wheels. 21. spur gear wheel. 22. rack. 23. spur gear. 24. bevel wheel. 25. arc. 26. universal speed governor control column. 27. G-731 electric motor. 28. universal speed governor (URS) 29, 30. spur gear wheels.

The elevating gear electric motor is fitted under the gun mounting bracket together with the traversing gear electric motor and has a drive to the universal speed governor of the elevating gear. In addition the shafts of the two electric motors are coupled so that they can simultaneously rotate the elevating and traversing gear universal speed governors with a redistribution of the load.

/The

* i.e. gear wheels as opposed to the worm gear.

The elevating gear worm reduction gear (fig 26) is fitted to the left cradle. It transfers the turning movement from the geared reduction gear to the cradle toothed arc. The worm reduction gear consists of a worm wheel (9), worm (1), main shaft (7) and coupling (13) buffer (12) and main gear wheel (8). When the vehicle is moving with the gun unclamped, a moment is exerted through the toothed arc on to the gear wheel (8). On the end face of the gear wheel are two toothed projections which engage in the coupling (13). The gear wheel (8) is thus able to turn on the main shaft (7) owing to the axial movement of the coupling (13).

The coupling (13), moving axially, is pressed against the gear wheel (8) by the spring buffer, which prevents the gear wheel (8) and the teeth of the arc from damage caused by abrupt movements of the moving part of the gun. There is a spring buffer (4) on the worm spindle (2) which allows the worm to move axially along the spindle splines and thus absorb minor shock loads.

The geared reduction gear (fig 27) transfers the movement from the manual and electrohydraulic drives to the worm reduction gear. The reduction gear consists of level wheels (2, 4, 6, 9) spur gear wheels (13, 14, 15) a cam coupling (10) and a column (18) with a cranked handle.

The level wheel (9) and gear wheel (15) on the end faces linked to the cam coupling (10) have two projections each and are a free fit on the shaft (7).

The cam coupling, connected to the shaft by a splined coupling, can move axially along it and engage with the projections on gear wheels (9) and (15), thus switching in the geared reduction gear to the electrohydraulic or manual drives.

The elevating gear universal speed governor is similar in construction to that of the turret traverse mechanism and ensures a jerk-free vertical gun laying speed.

The elevatinggear universal speed governor control mechanism (fig 25) consists of a column with a universal coupling, a moving arc (25), bevel wheel (24), gear wheel (23) and rack (22), joined to the universal speed governor spindle by a gear wheel (21).

Fig 26. The Gun Elevating Gear Worm Reduction Gear

1. worm 2. worm spindle 3. plug 4. worm buffer 5. bush 6. eccentric bush 7. main shaft 8. main gear wheel 9. worm wheel 10. gasket 11. plug 12. main gear wheel buffer 13. cam coupling 14. eccentric bush.

Fig 27. The Gun Elevating Gear Geared Reduction Gear

1. shaft 2, 4, 6, 9 bevel wheels 3. electrical firing gear actuating rod 5. shaft 7. shaft 8. half-coupling 10. cam coupling 11, 12. plugs 13, 14, 15 spur gears 16. shaft with universal coupling. 17. selector lever 18. column.

The elevating gear universal speed governor automatic cut-off mechanism (fig 25) consists of a kinematic train of gears (14, 15, 16, 17), a shaft with a series of wheels (18), and the gear wheels (19, 20). When the gun is being elevated with the electrohydraulic or manual drives, the turning movement is transferred from the main shaft of the geared reduction gear through the intermediate gears (14, 15, 16) to the gear wheel (17).

This last gear wheel transfers this rotation to the bevel gear (20) through the series of wheels (18) all of which can turn freely through 316°, only if a maximum angle of depression or elevation is being applied. In such a case the hydraulic coupling rotates and the hydraulic pump in the universal speed governor ceases to operate.

/Operation

Operation of the Elevating gear

The main drive of the elevating gear is electrohydraulic. To operate this drive the engaging gear selector lever (38 fig 21) must be set in the position "Motor", the cranked handle (35) removed, the control column (32) fitted on to the splined part of the shaft and the electric motor switched on. There is one switch for both the elevating and traversing gear electric motors: it is on the vertical laying gear hand drive column.

The turning movement is transferred from the electric motor to the universal speed governor shaft, from there to the geared reduction gear and so on through the worm reduction gear to the toothed arc on the left cradle. When the column (26 Fig 25) is moved in the vertical plane parallel to the longitudinal axis of the gun, the universal speed governor hydraulic coupling spindle turns, and the speed at which the hydraulic motor shaft is rotating changes. As the column is tilted further, the gun laying speed will increase smoothly.

If the column is tilted forwards, an angle of depression will be applied: if to the rear (towards the layer), an angle of elevation.

To operate the elevating gear with the manual drive, the cam coupling selector lever (38 fig 21) must be set in the position "Hand", the control column (32) removed and the cranked handle (35) fitted. When the handle is turned, the gun will receive an angle of elevation or depression depending on the way it is turned: laying speed will be 4^{6} to each complete turn of the handle.

THE TURRET TRAVERSE MECHANISM

The traversing gear is designed to lay the gun in the horizontal plane and maintain its aim on a target. It is mounted on the right side of the gun on the turret floor and consists of the following main sub-assemblies: electric motor, universal speed governor (URS), universal speed governor control mechanism, geared reduction gear and worm reduction gear.

The electric motor (22 fig 28) is fitted under the mounting bracket next to the elevating gear electric motor. The shafts of the two motors are joined by a chain and together rotate the shafts of the elevating and traversing gear universal speed governor and hydraulic pumps.

The geared reduction gear (fig 29) is fastened to the mounting bracket to the right of the gun and is designed to transfer the rotary movement from the universal speed governor and the traversing hand drive to the worm reduction gear. The reduction gear consists of gear wheels (9, 10, 11), a cam coupling (15), bevel wheels (2, 3, 15, 16) and a handle (6).

The worm reduction gear (fig 30) consists of a casing, in which are mounted gear wheels (5 and 6), a work (4), worm wheel (3) and shaft (9), on which is fitted a gear wheel (2) and a clutch. The worm reduction gear clutch presents the traversing gear from damage caused by the barrels coming into contact with obstacles. It consists of a set of driving and driver plates (10) and springs (11) which compress them. There are 32 driving plates, the inner teeth of which fit into splines on the vertical shaft (9). There are 31 driver plates: their outer teeth fit into the inner slots of the gear wheel (2), which engages with the toothed turret ring.

The upper (12) and lower (13) vertical shaft packings take the form of self-adjusting bellows-type oil seals.

An intermediate support (14) is fitted to the vertical shaft to limit the load put upon it.

Fig 29. The Traversing Gear Geared Reduction Gear

1. shaft 2,3,5,16 bevel wheels 4. shaft 6. selector lever
7. intermediate shaft 8. shaft 9, 10, 11 spur gears
12,13,14 plugs 15. cam coupling. 17. oil reservoir containing oil AGM for the universal speed governor.

Fig 30. The Traversing Gear Worm Reduction Gear

1. clutch adjusting nut 2. traversing gear main gear wheel 3. worm wheel 4. worm 5,6. spur gear wheels. 7. universal coupling 8. casing 9. vertical shaft 10. plates 11. clutch springs 12,13 self-adjusting bellows type oil seal 14. intermediate support.

Fig 28. Kinematic Diagram of the Traversing Gear

1. toothed turret ring 2. traversing gear main spur gear 3. worm wheel 4. worm 5,6 spur gears 7. shaft with universal couplings 8. gear wheel 9. cam coupling 10. selector level 11,12,13,14. bevel wheels 15. cranked handle 16. gear wheel 17. rack. 18,19,20. spur gears 21. universal speed governor control column 22. electric motor 23. traversing gear universal speed governor 24,25. spur gears 26. rod 27. rack.

OPERATION OF THE TURRET TRAVERSE MECHANISM

The main drive of the turret traverse mechanism is electro hydraulic. To traverse the turret using the electro hydraulic drive set the engaging gear selector lever (10 fig 21) to the "Motor" position, remove the cranked operating handle from the manual drive, fit the control column (32) on the splined part of the column shaft and switch on the laying gear electric motors. The output shaft of the hydrometer does not move until the control column is turned a given angle in one direction or the other, depending on the bearing applied to the gun and the horizontal laying speed.

When the column is turned, the universal speed governor output shaft begins to rotate. By means of the gears and coupling of the geared reduction gear this rotary action is transferred to the worm reduction gear. As the shaft (9 fig 30) in the worm reduction gear turns, the friction between the driving and driver clutch plates causes the turning movement to be transferred to the gear wheel (2) and the toothed turret ring in which it engages.

To traverse the turret with the hand drive set the engaging gear selector lever (6 fig 29) in the "Hand" position, remove the control column and fit the cranked handle on to the splined part of the shaft. In this position the coupling will be connected to the level wheel and pinion (5, 16) and the spur gear (9), fitting freely on the shaft (8) will be disconnected.

When the cranked handle is turned in one direction or the other, the kinematic gear train will consist of two pairs of level gears (2, 3, 5, 16) a coupling (15), shaft (8) intermediate shaft (7), the gears of the worm reduction gear and the toothed turret ring.

THE UNIVERSAL SPEED GOVERNOR (URS)*

The universal speed governor (figs 31 and 32) takes the form of a hydraulic reversing gear box. It ensures a smooth change of speed of rotation for the gun elevating and traversing gear drives within a wide range, with a constant direction of rotation and number of revolutions of the electric motor

The universal governor, which is not separable, consists of two main assemblies (fig 31): the hydraulic pump and hydraulic motor, which are mounted in one block.

The hydraulic pump is a ten cylinder piston pump of the spatial type with an output of 92.3 litres per minute at 500 r.p.m

Normal operating pressure in the pump is 15 kg/cm^2 (the maximum permissible in 75 kg/cm^2). Normal r.p.m. is 500. The pump is driven by an electric motor.

The pump's function is to force oil into the hydraulic motor and to pump it back out again.

A control device is fitted to the hydraulic pump casing which permits the amount of oil being pumped to be adjusted and also the flow of oil to be stopped completely without stopping the hydraulic pump.

*Translator's note: I have kept to a literal translation of this mechanism, but it appears in all respects to be identical to the 'VSG' variable speed transmission gear made by Vickers-Armstrongs Ltd.

Fig. 31. General view of the turret traverse gear universal speed governor

1. hydraulic pump 2. hydraulic motor 3. topping-up tank

The hydraulic motor is a ten cylinder piston motor of the spatial type, identical in construction to the hydraulic pump.

Power produced by the pump* is 2.5 litres per second at an oil pressure in the operating chamber of 15 kg/cm^2. Normal r.p.m. = 500.

The hydraulic motor's function is to convert the energy produced by the flow of oil into the rotary movement of the output shaft.

*Translator's note: I think this is an error in the text and should read 'motor'.

Fig. 32. Longitudinal section of the universal speed governor

1. control spindle shaft 2. locking collar 3. radial thrust bearing 4. hydraulic pump casing 5. filler plug 6. gasket 7. hydraulic pump cylinder barrel 8. ball bearing 9. pipe to topping-up tank 10. bronze bearing shell 11. hydraulic motor casing 12. piston 13. nut 14. piston rod 15. combined ball bearing 16. stay bolt 17. bearing shell 18. bronze bush 19. oil seal cap 20. output shaft 21. hydraulic motor guide cup 22. combined ball bearing 23. locking pin 24. hydraulic motor tilting box 25. hydraulic motor drum 26. distributor disc 27. topping-up valve 28. gasket 29. drain opening 30. spring 31. hydraulic pump tilting box 32. hydraulic pump guide cup 33. anchor piece and trunnions 34. input shaft.

Possible Faults in the Turret Traverse Mechanism

Fault	Cause	Remedy
Considerable effort needed to turn the hand control hand wheel (more than 11 kg)	Dirt on the turret ring and worm gear wheel. Dents and burrs on the gear wheels.	Clean and file off burrs
Turret moves of its own accord when the electrohydraulic drive is switched on.	Clutch slip in the worm reduction gear.	Compress the spring in the worm reduction gear. If the fault persists, strip the clutch, clean and oil the plates and replace faulty plates.

THE TURRET CLAMP

On the turret floor on the left side, to the rear of the commander's seat is the turret travelling clamp. (Fig 33.)

Fig 33. The Turret Clamp

1. bush 2. clamp casing 3. spring 4. nut 5. handwheel 6. handle 7. ball bearing 8. screw 9. clamp axle 10. plug 11. prismatic key 12. nut 13. screw 14. nut 15. clamp rib 16. indicator.

The function of the clamp is to clamp the turret firmly in the travelling position and to ensure that no load is placed on the turret traverse mechanism. The clamp consists of the following main parts: casing (2), rib and bush (15 and 1), axle (9), handwheel (5), and handle (6) and spring (3).

Two lines missing ..... In the lower part of the rib bush there is a longitudinal groove, into which fits the end of the stop screw (13); as a result the rib can move axially. The stopscrew is fastened by a nut (12). On the square section on the end of the axle (9) is a handwheel (5) with a handle and locknut (4).

On the rib (15) there is a cylindrical spring (3), one end of which rests on a stud on the rib, and the other on the fixed clamp casing. This spring prevents the clamp from releasing itself when the vehicle is moving.

The turret is clamped by inserting fully the rib into the teeth of the turret ring.

To avoid jamming the teeth of the rib against those of the turret ring when clamping up, it is necessary to turn the turret slightly one way or the other using the manual laying gear.

To unclamp the turret, the rib must be removed from the teeth of the turret ring by turning the handwheel not less than 4 turns anti-clockwise. When the vehicle is moving off the handwheel locking catch should be tightened up.

THE CONVEYOR

A conveyor (fig 34.) is mounted inside the gun mounting to remove empty cases and clips from the fighting compartment of the turret to the spent cartridge bin.

The conveyor consists of a belt (10), tension adjusting mechanism, selector lever drive shaft (9) and the rollers and spindles that support the belt.

The conveyor belt is driven by an electric or hand drive fitted in the rear part of the mounting. The tension adjusting mechanism is in the front part of the mounting.

The conveyor geared reduction gear consists of a bush (18) fastened to the shaft (9), a gear wheel (8) freely seated on the bush (18), an intermediate gear wheel (16), and a gear wheel (14) on the electric motor shaft (13). On the splined part of the shaft (9) is a coupling (6) which transfers the conveyor drive from electric to hand and vice versa, and a freely turning sprocket. The sprocket (5) is joined to the sprocket (2) by a chain, and the sprocket (2) is mounted on the hand drive handwheel axle. When the electric drive is in operation, the coupling (6) is engaged with the gear wheel (8) by means of the selector lever (7), and when the hand drive is in use, with the sprocket (5).

The tension adjusting mechanism is designed to adjust the tension of the conveyor belt. The main parts of this mechanism are: the piston (27 fig 24), the spring (28) and the adjusting sleeve (26) in which it is fitted. The outer surface of the adjusting sleeve is threaded. The sleeve is screwed into .... one line missing ..... using a key or spanner the sleeve turns in any direction, and by gradual movements increases tension on the belt through the spring (28) and piston (27). The access opening through which the belt tension is adjusted is in the front part of the right side plate of the mounting.

Triangular metal teeth are fitted to the belt to hold the spent cases and clips.

To operate the electric drive the selector lever (7) (fig 34) must be set and firmly clamped in the position "P" , the electric drive switch on the junction box to the left of the commander switched on, and the "Start" button pressed.

When the gun is being fired with the electrical firing gear, it is not necessary to press the "start" button, since as soon as the electric firing contact switch is pressed, the conveyor electric motor starts up automatically. This is done by employing a tappet switch relay fitted to the rear of the mounting. When the firing button is released, the conveyor continues to operate for 9 seconds.

To operate the conveyor using the hand drive, the selector lever must be set and firmly clamped in the "P" position, and the handwheel turned as indicated by the arrow marked on it. To avoid damage to the mechanism, selection of hand or electric operation must only be carried out when the conveyor is not moving.

POSSIBLE FAULTS IN THE CONVEYOR

Fault	Cause	Remedy
When the electric drive is working, the conveyor moves slowly.	1.Belt is slack	1. Adjust with the tension adjusting mechanism.
	2. Belt is catching on projecting parts of the mounting.	2. Remove any projections
	3. Belt is oiled up.	3. Clean.
The belt does not move on either electric or hand drives.	1. The 80 amp fuse on the drivers panel is burnt out.	1. Change the fuse.
	2. Belt has jammed.	2. Free the belt.
Effort needed to turn the hand drive hand-wheel is more than 11 kg.	The sprocket, chain and reduction gear gearwheel are dirty.	Clean and oil the sprocket, chain and reduction gear gear wheel.

Fig. 34. The Conveyor Reduction Gear

1. handwheel 2. sprocket 3. leaf spring. 4. chain 5. sprocket
6. cam coupling 7. selector lever 8. spur gear 9. shaft
10. conveyor belt 11. bevelled peg 12. rollers 13. electric motor
14. spur gear 15. bevelled peg 16. intermediate gear
17. reduction gear casing 18. bush.

THE AUTOMATIC ANTI-AIRCRAFT SIGHT

The sight is designed to determine the point of impact of a shell and a target, whether ground or aerial.

To resolve the problem of the point of impact of the shell and the target, the following initial data must be determined and set on the sight: target speed, target course bearing and slant range.

Target speed is determined according to the type of aircraft.

Target course bearing is determined by the apparent direction of movement of the target.

Range to the target is determined visually or with a range finder.

When the electro hydraulic drive is in operation, two members of the detachment operate the sight: the layer lays the gun for bearing and angle of sight, and the sight setter sets the initial data on the sight-speed, bearing and range, and, if required, the dive or climb angles.

When the hand drive is in operation, three members of the detachment are required to operate the sight. The detachment commander lays the gun for bearing, the layer lays for angle of sight and the sight setter sets the initial data on the sight.

Short description of the sight

The sight consists of the following three main sub-assemblies (figs. 35 and 36):

1. The sight supporting bracket with left and right collimator sights.
2. The sight corrector
3. The course stabilizer.

The sight supporting bracket with the collimator sights (1) consists of a range mechanism, tangent elevation mechanism, An balancing mechanism*, sight parallel linkage, collimator sights, vertical parallel linkage, actuating rod and clamp, which are mounted as one sub-assembly on a frame with guide sockets. The frame is fixed by an axis pin to the bracket (9), which is fastened to a surface on the gun mounting.

The sight supporting bracket is joined to the gun cradle by the parallel linkage actuating rod. As a result it is able to move in the vertical plane through angles equal to the angles of elevation or depression of the gun.

The collimator sight graticules are marked with a scale graduated every 0-05 and two concentric rings with radii 0-50 and 1-00.

* Translator's note: lit: "the mechanism for striking an anti-aircraft balance" - the bookkeeping term is used here.

The sight corrector (17) is of closed construction and consists of a target speed setting mechanism, an angle of climb or dive setting mechanism and the target course stabilizing mechanism.

.....One line missing ..... of the corrector, which is suspended from the guide socket by means of a hole, and moves in the vertical plane by means of the tangent elevation cam.

Fig 35. The automatic anti-aircraft sight

1. VK-3 collimator sight 2. parallel linkage activating rod 3. sight supporting bracket 4. clamp handle 5. frame 6. sight parallel linkage 7. range setting handwheel 8. range scale 9. bracket 10. course stabilizing mechanism engaging box 11. box 12. receiving gear 13. foot pedal 14. angle of dive and climb gear 15. target speed scale 16. target course bearing scale 17. sight corrector 18. aircraft model (target course indicator) 19. sighting scale.

The course stabilizing mechanism consists of a box (11) with a receiving gear (12), engaging box (10), two cardan shafts and an aircraft model (target course indicator). The gear ratio of the course stabilizing gear is 1.

The stabilizing gear ensures that the course scale on the corrector is stabilized in relation to any selected bearing.

Fig 36. General view of sight, from the left side

Legend as for fig 35.

..... line missing .... probably

(Operation of the automatic AA sight)
(fig 37)

The sight bracket on which the sight axle (14) sits is firmly fixed to the gun mounting. The frame base (13) rotates, according to the angle of elevation, around the sight axle, actuated by the parallel linkage actuating rod which is universally - linked with the cradle.

Fig 37 Kinematic diagram of the sight

1. parallel linkage actuating rod. 2. frame 3. collimator sight 4. gear 5. worm 6. and 7. gears 8. handwheel 9. gear 10. rack 11. bracket 12. range scale 13. frame base 14. sight axle 15. vertical rod 16. gear 17. slide 18. target speed scale 19, 20, 21, 22. gears 23. turret ring 24, 25. gears 26. stabilizing gear engaging coupling 27. cardan shaft 28, 29. gears 30. cam 31. gear 32. rack 33. gear 34. rack 35, 36. gears 37, arc 38. feeler rod 39. sight scale (rule) 40. sight parallel linkage.

The frame (2), which carries the sight parallel linkage (40) and the collimator sights (3), moves along the guide-base. The range is set on the range scale (12) with the range setting handwheel (8). When the handwheel is turned, the movement is transmitted through a bevel gear and wheel (7 and 9), a worm gear and wheel (4 and 5), a gear (6) and the frame rack (10).

The length of the gun rule is determined by the amount of frame movement.

The target speed is set by handwheels on the scale (18). When the handwheels are turned, the gears (19) rotate and displace the slide (17) with the vertical rod (15). The upper end of the rod is universally-coupled with the sight scale (rule) (39), which by means of a crank and parallel linkage (40) transmits deflection angles to the sights. The rod (15), swivel-coupled to the slide, moves the course frame along the guides in the gear wheel (16) and can itself move vertically in relation to the frame.

The length of the course rule (R) is set by moving the frame in the sight.

Fig 38. The VK-3 collimator sight

1. light filter 2. sight illuminating gear socket 3. graticules 4. mirror 5. spring 6. cover 7. body 8. object glass 9. casing 10. reflector 11. casing cover 12. rough alignment sight 13. catch 14. rod.

On the diagram: collimator graticules.

To guide the course rule along a horizontal course, the head is turned around the vertical axis Y-Y: to set an inclined course (dive - climb) the head is turned around the axis X-X.

To strike the AA balance on the sight rule there is a curved groove. When the target speed is fed in, the length of the sight rule changes and the curved groove rotates the feeler rod (38). The rotation of the feeler rod (38) is transmitted through the arc (37) to the gears (35 and 36) and the rack (34). The rack (34) is connected to the scale gear wheel (31). When the feeler rod turns, the division of the range set on the scale deviates from the index mark. The sight setter, by bringing the real range division into coincidence with the index mark, sets into the sight the length of the gun rule, which is the amount of deflection.

The cam (30) works out tangent elevation angles. When the range is set by means of the gear (33) the rack (32) moves with ..... one line missing ..... of the sight, and together with it the swivel coupling of the sight rule by an amount h, proportional to the lowering of the trajectory under the line of a shot to the future position of the target.

To maintain a set course bearing in the sky when laying for bearing there is a course stabilizing mechanism. The course stabilizing mechanism consists of gear wheels (16, 28, 29), a cardan shaft (27), a stabilizer engaging coupling (26), bevel gears (20, 21, 25, 24) and a gear (22) which meshes in the turret ring (23). The ratio of the whole train is 1. The system will turn in the opposite direction to the direction of rotation of the corrector gear wheel.

To prevent the sighting mechanism from jolting when the vehicle is in motion, a clamp is fitted to the sight.

The sight clamp is mounted on the surface of the upper part of the frame tube.

Positioning the vehicle for firing

When firing at aerial targets, it is essential that the vehicle is on a level platform. Any tilt can be measured with the tilt indicator. A tilt of up to 3° is acceptable. The vehicle may be levelled by turning within its own tracks.

The tilt indicator (fig 39) is mounted on a special bracket (5) to the right of the driver and consists of: the tilt indicator proper (1), in which there is a spherical liquid-filled level; a cover (2) with a bulb (4) which illuminates the tilt indicator scale: the cover locking mechanism, which holds the cover in the open or closed positions, and which consists of an axis pin (3) with a cam and spring (6).

On the face of the level is a scale, one division of which is worth 1°.

To use the tilt indicator:-

1. Open the cover.

2. Switch on the switch on the driver's electrical instrument panel: the bulb should light up.

The tilt indicator must not be removed from the bracket, since this upsets the level adjustment.

Fig 39. The tilt indicator

1. the tilt indicator proper 2. the cover 3. axis pin 4. bulb 5. bracket 6. spring.

Inspecting the sights before firing

The sights will always be inspected before firing.

To carry out this inspection, the sights must be unclamped and all the individual mechanisms tested.

The target speed and range mechanisms are tested by rotating the corresponding handwheels and handle. The course stabilizing mechanism is tested by turning the turret with the mechanism switched on and off (i.e. with the pedal depressed or released). The angle of dive and climb mechanism is tested by turning the sight corrector head base.

Check that the collimator sights' cross-wires are illuminated. Brilliance can be regulated by turning the rheostat handle. Before firing, the sights must be tested set at zero.

Testing the zero sight settings

To engage a target with aimed fire it is essential that the zero line of sight setting be parallel to the axis of the bore of the left barrel. This can be found by testing the sight by the distant object method or with a sight-testing target.

To adjust the zero line of sight setting:-

1. Position the vehicle on a level platform.

2. Set the sights to zero.

3. Lay the blade sight on the left barrel on to a distant object, not less than 1000 metres away. The cross-wires of both collimator sights should coincide with the point of aim.

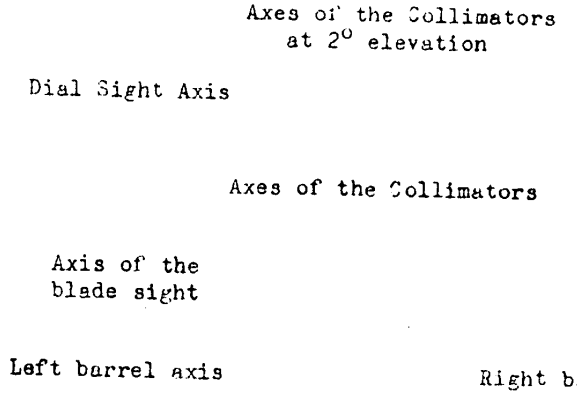
If it is impossible to test the zero line of sight setting using the distant object method, a sight-testing target must be set up 20 metres in front of the gun muzzle face, with markings (fig 40) ..... one line missing ..... lay the blade sight on the corresponding cross on the target. The collimator cross-wires should also be aligned on their corresponding target crosses.

4. If the crosswires are not aligned, maintain the point of aim of the blade sight on the selected object and by turning the collimators' adjusting screws, align the centres of the crosswires on the point of aim or the corresponding target crosses.

If it is impossible to test the sights at zero settings, adjustment may be carried out with the barrels at 2° elevation. The target must be raised until the barrels coincide with the appropriate marks, and the upper crosses used for the collimator crosswire.

Careful maintenance of the sights will ensure a long period of trouble-free operation. The detachment must handle them carefully. When using them, the handwheels must not be turned abruptly or forced. Optical parts must be cleaned with a soft dry cloth and never oiled.

Fig 40. The sight-testing target



AMMUNITION

The vehicle's first line ammunition holding consists of 316 fixed rounds for the gun, 600 rounds for the sub-machine gun, 20 hand grenades F-1 and 20 signal flares. The rounds for the gun have HE tracer and AP tracer shells.

AMMUNITION STOWAGE

The gun rounds are stowed in special racks in the turret and hull of the vehicle. (Figs 41, 42, 43). The greater part of the ammunition (264 rounds) is fitted into chargers before loading on to the vehicle and is stowed in the turret (192 rounds) and the front of the hull (72 rounds). A portion of the ammunition (52 rounds) is not carried in chargers, and is stowed in special compartments beneath the turret turntable platform. The rounds with AP shells are in chargers and are stowed in the rear part of the turret to right and left of the gun mounting.

There are four rounds in every charger. of the 48 chargers stowed in the turret, 45 are fitted vertically around the perimeter of the turret floor and 3 horizontally on the sloping sides of the turret side plates.

The full chargers are fastened in the turret on base plates (1) welded to the turret floor, and by strips (2) with catches (5). The strips are hinged to the sides of the turret. The base plates (1) act as guides for the loaded charges. The strips (2) when locked down hold the rounds by the neck of the cartridge case.

Fig 41. Stowage of rounds in the turret

1. base plate for securing the chargers.

2. strip for securing the tops of the chargers.

3. racks for 5 chargers 4. stowage for 2 chargers on the turret right side plate.

5. strip catch 6. stowage for one charger on the left turret side plate.

Fig 42. Stowage of rounds in the front of the hull

1. left stowage racks 2. upright support 3. hinged strip axis pin
4. spring 5. hinged strip. 6. right stowage racks 7. loaded charger.
8. round grip 9. catch.

..... one line missing ..... are stowed in racks which have 5 shelves. the rounds are held from cross displacement by hinged strips (5) with springs (4) and catches. The strips are hinged to the vertical support (2).

The rounds stowed under the turret turntable platform are in special compartments (fig 43) and are packed and fastened in them with strips (4) and clips (6). There are covers above the compartments, which are at the same time part of the turntable platform. When all the rounds in the compartment have been expended, the space is used for spare chargers.

Fig 43. Stowage of rounds on the floor of the vehicle

1. support (wooden packing) 2. rubber packing 3. rounds
4. upper strip 5. section of corner piece 6. clip 7. holders for wooden packings when not in use.

The sub-machine gun rounds, 360 in number, are kept in 20 magazines, 30 rounds per magazine. 10 magazines are kept in 2 tarpaulin bags fastened to the rear wall of the turret, and 2 magazines in pockets sewn to the S.M.G. covers. The remaining rounds, 240 in all, are kept in three tarpaulin bags on the left rear angle plate of the turret.

The F-1 hand grenades, 20 in number, are kept in tarpaulin bags and are held on special racks on the sides of the turret and the hull of the vehicle: 5 grenades on the hull floor behind the commander's seat, 10 grenades in the cavity shelf of the turret right side plate and 5 grenades on the vehicle hull glacis plate by the driver.

The signal flares, 20 in number, are kept in 2 bags with 10 in each. The bags containing the rockets and the holster with the signals pistol are fastened to the right rear turret corner plate behind the commander's seat.

Short Description of the Ammunition

The S-68 57 mm gun uses the following ammunition:-

- UOR-281 fixed round with the OR-281 HE tracer shell and MG-57 nose percussion fuze, with self-destroying element. (fig 44, b).

- UBR-281 fixed round with the BR-281 AP tracer shell and MD-10 base fuze (fig 44, a).

Weight data for these rounds and their components is shown at Table 1.

Fig 44. Markings of the S-68 gun ammunition

a - markings of the round with the AP tracer shell.

b - markings of the round with the HE tracer shell.

factory
lot number

calibre
weight marks

abbreviated
round designation

calibre and type
of gun

mark of propellant,
lot, year of production,
factory code marking.

lot, year of assembling,
and no. of arsenal or
base assembling the round

indicates desensitizer

type of explosive

fuze designation

shell designation

Marks on the other
side of the shell

HANDLING THE AMMUNITION

Inspection of ammunition before loading on to the vehicle

The rounds with HE tracer and AP tracer shell are loaded on to the vehicle ready to be fired.

Before loading commences the condition of the stowage racks must be checked, each round inspected and all mud, grease and sand removed from shell and cartridge case, each round checked to ensure it is an S-68 gun round, and the rounds sorted by markings and weight signs.

Rounds with the following defects must not be loaded on to the vehicle:-

- fuze screwed out of shell, fuze without safety cap, or fuze with damaged cover plate.

- noticeable looseness between the shell and the cartridge case.

- cracks in the base and cylindrical parts of the cartridge case.

- dents or cuts on the shells or cartridge cases.

- primers not screwed fully home into the cartridge cases.

The detachment may undertake the following repairs to ammunition.

- screwing home loose fuzes into the shells, using the special key held in the spare parts kit.

- screwing out or screwing in primers, if they jut out or sink in more than 0.3 mm from the base of the cartridge case.

The operations detailed above may be carried out if the correct safety precautions are observed. They will be carried out a distance of 20-30 metres from the vehicle under the supervision of an artillery artificer or the detachment commander.

Handling the Ammunition during loading on to the vehicle and during firing

After inspection, sorting and cleaning, the rounds are loaded into chargers and passed on to the vehicle through the top of the turret for stowage. To avoid any accidents during loading into chargers and stowing in the vehicle, it is forbidden to knock them against the metal parts of the vehicle or drop them on a hard surface. Rounds which have been dropped on to a hard surface ..... one line missing ..... removed from the vehicle.

The rounds must not be allowed to come into contact with the battery lead connections, since this may cause the propellant charge in the cartridge case to explode.

Before beginning firing, ensure that there are no foreign bodies (sand, grease, rags, pieces of earth etc) in the bore of the barrels, and that the muzzle covers have been removed.

When firing with UOR-281 with MG-57 fuzes, the safety caps must be removed from the latter. The caps and cotter pins will be kept in the vehicle until firing has finished. When firing with UBR-281 with the MD-10 base fuze, no setting is required. When firing with UOR-281 or UOR-281U with MG-57 fuzes without safety caps, no preparation is required before firing. These shells may be fired at a slant range of up to 6 km and an angle of elevation of not less than 10°, since at lower angles the shells may not destroy themselves in the air,

/and

and will explode on impact with the ground.

Table 1

Round Designation	Mark of Gun	Round Index	Shell Index	Shell Weight kgs	Mark of fuze	Charge		Fixed Round Weight kgs	Rounds per Box	Weight of Rounds and Box kgs
						Mark of powder	Charge weight kgs			
57 mm fixed round with UOR-281 HE tracer shell	S-68	UOR-281	OR-281	2.8	MG 57	Piroxilin 11/7 with densensit-izer	1.2	6.61	5	48
57 mm fixed round with AP tracer shell UBR-281	S-68	UBR-281	BR-281	2.8	MD 10	ditto	1.2	6.61	5	48

Ammunition not expended during firing

When firing has ceased, all ammunition with cap off (fuze MG-57) not expended, must be re-capped and cotter pins replaced. UOR-281 rounds must not be stored or transported without caps.

When the ammunition unloading point is reached, unexpended rounds should be re-packed in the correct ammunition boxes. To protect ammunition from bullet hits, shell gragments, rain, snow, sunlight and dust, the ammunition boxes must be stored on supports in bunkers, emplacements, or pits and covered with a tarpaulin or canopy.

PREPARING THE GUN FOR FIRING AND MOVEMENT

The life of the gun and the reliable operation of its mechanisms depends on careful handling, regular servicing, repair and careful preparation for firing and battle.

Inspection and preparation of the gun comprises: general inspection of the gun, sight, laying gear; adjustment of the zero line of sight and inspection of the mounting and conveyor. The gun must also be inspected before moving off on a mission, on firing practice, before a march and on its completion.

Inspection of the mechanisms and assemblies before firing must be done in the following sequence, for each automatic mechanism:-

- barrel:
- sleeve and bracket:
- breech mechanism:
- automatic loader:
- buffer:
- cradle and its mechanisms:
- firing gears:
- automatic mechanisms:
- laying mechanisms:
- mounting and conveyor:
- automatic anti-aircraft sight (adjusting the zero line of sight):
- the gun electrical equipment:
- ammunition stowage.

During this inspection attention should be paid not only to the serviceability of the mechanisms, but also to the presence of split-pins, lock screws and washers, the tightness of nuts and bolts, and the quality of the oil on the working surfaces.

Inspection of the Barrels. Before the barrels are inspected they must be cleaned. The object of this inspection is as follows:-

- to check the condition of the lands and rifling, and to see that there are no cracks or bulges in the bore:

- to ensure that the muzzle brakes are firmly secured to the barrels: it is forbidden to fire with a loose muzzle brake:

- to inspect, through the inspection opening in the cradle neck, the barrel - barrel sleeve connections, and to check that the barrel actuating cam bolts are firmly locked:

- to check the condition of the interrupted locking ribs on the breech and barrel, and to ensure that the metal is not dented or chipped:

If weaknesses are discovered in the muzzle brake or actuating cam fastenings, or if the teeth on the breech end of the barrel are damaged, they must be remedied immediately. The barrel or cracked muzzle brake must be changed immediately.

/The

The inspection of the barrel sleeves and brackets comprises checking the operation of the accelerator crank and the condition of its roller. To check the operation of the crank, open the cradle upper hatch cover, pull back the breech to the extreme rear position, lift the crank right up and release it. If it returns sharply to its former position under the influence of its spring, it is working satisfactorily. In checking the condition of the roller, ensure that it moves freely on the axis pin and that it and the crank hub are lubricated with graphite grease.

Check that the axis pin, joining the guide sleeve with the bracket, is firmly secured.

Inspection of the breech mechanisms. When inspecting and testing the operation of the breech mechanisms, the following must be checked:-

- that there are no cuts on the outer surface of the breech screw and on the interrupted screw threads:

- that the lock washers of the rollers on the breech casing lever are firm, and that the rollers themselves are serviceable: rollers ..... one line missing ..... must be replaced by new ones from the spare parts kit:

- that the breech lock is serviceable:

- that the extractors are serviceable and securely fastened: if the extractors are at all loose, the screws securing them must be tightened fully and secured with split-pins:

- striker protrusion: to check striker protrusion, the striker opening must be cleaned of all carbon deposit and grease, the pin joining the breech screw to the breech casing removed and the breech screw pressed flat against the breech casing and the gauge inserted. Striker protrusion should be from 1.6 - 1.9 mm.

- the action of the anti-jump catch, which should, when depressed, spring sharply back to its original position under the influence of its spring:

- the condition of the working surfaces of the guides on the breech casing, of the bearing surface of the breech casing which takes the accelerator crank, and of the surfaces joining the breech screw to the breech casing sleeve: if any of the above surfaces are burred, or if the breech screw moves stiffly in the breech casing sleeve, the burrs must be filed off.

On periodic inspections when the breech is removed, the condition of the rack on the breech casing and that of the breech ramming springs must be examined.

Inspection and testing of the automatic loaders.

When inspecting the automatic loaders and testing the operation of the mechanisms incorporated in them, the following must be checked:-

1. Test the ammunition feed mechanism. To do this, disengage the interlocking mechanism setting the catch lever ЭК (fig 45) to the "Off" position. Cock the feed frame manually and, letting it slide back smoothly, ensure that it moves freely and without jamming. If it does jam at all, the feed mechanism must be stripped, any burrs filed off and the mechanism lubricated with graphite grease. To check the operation of the feed frame feed pawls, pull the breech back a little, and, releasing it smoothly, ensure that the front feed frame pawl in the lowered position does not foul the breech screw or breech casing. When the feed pawls (upper and lower) are depressed by hand, they should spring back sharply into their former position. Clearance between the front feed pawl and the breech screw should be 1 - 1.5 mm.

2. Test the operation of the cam lever: move the feed frame into the extreme rear position and turn the cam lever by hand until it stops. It should then return sharply to its former position when released.

3. Test the operation of the interlocking mechanism: throw over the mechanism lever into the "Engaged" position:

- by turning the feed frame hand cocking lever A, set the feed frame on the interlocking mechanism catch:

--load a charger of practice rounds into the automatic loader, so that the first round rests on the rear lower feed pawl: in this position the feed frame catch should release the feed frame and allow the rounds to move forward (with the feed frame) under the influence of the feed frame spring. Clearance between the feed frame catch tooth and the frame itself in the free position, with the interlocking mechanism disengaged, should be 0.5 - 1.5 mm.

Fig 45. The right automatic loader (viewed from above)

1. right cradle upper cover. 2. cover catch.

A - handle connecting the parasite gear with the breech and anti-jump catch rack.

Б - pawl B- hand breech cocking handle.

А - hand automatic loader cocking handle.

Ж - interlocking mechanism lever.

Inspection and testing of the buffers. When inspecting the buffers, check:-

- that there are no leaks:

- that the buffer piston rod is firmly joined to the accelerator mechanism: the nut securing the piston rod must be fully tight and split-pinned.

- that the buffer cylinder are firmly attached to the cradle:

- that the buffer contains the correct quantity of fluid.

To check the quantity of fluid in the buffer, apply an angle of elevation of 20° to the gun and unscrew one of the two plugs from the buffer cylinder: the fluid should then flow from the hole. If it does not, the buffer must be topped up, first having removed the other plug to allow the air to escape.

Inspection and testing of the cradle. To inspect the cradles and the mechanism pertaining to it, the following must be checked:-

1. Test the operation of the recoil indicator. The slide should move along the scale with slight hand pressure.

2. Inspect the cradle slides through the upper hatch with the breech drawn back.

3. Check the amount of fluid in the hydraulic buffer:-

- slacken the two bolts joining the upper counterweight to the lower:

- unscrew the bolts joining the rear cover to the gun and remove the cover:

- apply the maximum angle of depression to the gun:

/ unscrew

- unscrew the centre plug in the hydraulic buffer rear plate, insertthe graduated scale held in the spare parts kit and measure the distance to the end face of the buffer rear plate. If there is a sufficient amount of fluid in the buffer, the distance read will be (taking into account the thickness of the rear plate wall) 117 + 2 mm.. If there is insufficient fluid (119 mm or more) the buffer must be topped up.

4. Inspect the cradle quadrant and remove any faults in it.

Inspection and testing of the firing mechanisms. The firing mechanisms are tested in the following way:-

1. Set the breech on the firing lever, using the breech hand cocking mechanism.

2. Disengage the automatic firing gear: this is done by cocking the automatic loader feed frame, and by turning the handle in the opposite direction, set it in the extreme rear position.

3. Disengage the handle (B) cog by turning the ratchet (6).

4. Switch on the electrical firing gear for the automic loader being tested.

5. Holding the turning handle (B) with the hands, press the electrical firing button and ensure that the firing lever has operated and that the breech has begun its forward movement.

This test should be carried out not less than twice for each of the electrical firing buttons and for each of the mechanical foot pedals. Foot pressure on the pedals should not exceed 40 kg.

It is forbidden to release the breech without a practice round in it without engaging the hand breech cocking mechanism, since otherwise the parts are subjected to increased wear and deformation.

If the mechanical or electrical firing gear fails to work, the course must be ascertained and the fault corrected immediately.

Testing the interaction of the automatic mechanism devices. This is carried out in the following sequence for each automatic mechanism:

1. Using practice ammunition, carry out initial loading of the gun, ensuring that all mechanisms are working normally without sticking.

2. Release (fire) the breech. This is done by:-

- connecting the breech rack with the breech cocking mechanism (lower handle A):

- taking the pressure exerted by the ramming spring on the handle (B), pressing on the appropriate foot firing pedal, and smoothly releasing the breech for the full length of its travel. During this operation ensure that movement of the breech along its slides, the release of the breech screw locks, barrel locking and the action of the anti-jump catch is normal.

3. Having re-set the breech on the firing lever, unload the automatic loader, and push out with a rammer the round from the breech screw extractors on to the conveyor, ensuring that the cut-off in the breech screw is working normally (the lock protrudes beyond the breech screw face and the stirrup link has turned).

/Inspection

Inspection and testing of the laying mechanis

To test the operation of the hand laying mechanisms, the electromotor switch must be switched off, the control column removed, the cranked handles fitted, and the drive selector levers set to "Hand".

When laying the mounting for angle of elevation and bearing, ensure that the laying is smooth and light.

To inspect and test the operation of the gun laying mechanisms when the electrohydraulic drive is in use:

1. Unclamp the turret and gun.

2. Check the level of the AGM oil in the universal speed governor compensating reservoirs. To do this:

- open the plug in the reservoir;

- measure with a graduated dipstick the level of oil in the reservoir (oil level should be 100-135 mm);

- if necessary, top up the oil in the reservoir.

3. Set the drive coupling engaging lever to "Motor".

4. Remove the cranked handles and stow them on the turret floor.

5. Fit the electrohydraulic drive control column in the working position.

6. Check the serviceability of the chair drive from the electromotors to the universal speed governors and switch on the electromotors.

7. Check the operation of the traversing and elevating mechanisms through the whole range of angles in the vertical and horizontal planes and at all laying speeds. If the laying mechanisms are in good working order, laying should be smooth and without jolts.

In case of faults in the laying mechanisms they must be inspected, with any dirt and surplus grease on the toothed connections removed, and if necessary ..... one line missing ..... of any artillery artificer.

During periodic inspections of the universal speed governor, the oil should be removed from the drip-trays and oil added to the reservoirs.

During inspections of the conveyor and mounting check:

1. That the transporter drives - hand and electric - engage easily.

2. That the conveyor belt does not rub on any parts when passing through the mounting side walls. This is done using the hand drive.

3. Force needed to turn the conveyor hand drive handwheel. This should not exceed 11 kg.

Inspection of the ammunition stowage is carried out when preparing the gun for firing and for a march. All the stowage sub-assemblies and parts are checked, and all the gun ammunition, 7.62 mm round magazines, grenades, signal flares and sub-machine guns must be firmly secured. Any faults discovered must be remedied immediately to avoid accidents when the vehicle is moving.

/Gun

SAFETY PRECAUTIONS WHEN FIRING

Firing may be carried out safely if the following precautions are observed:-

1. Before any inspection, ensure that there are no rounds in the automatic loaders or breeches.

2. When a misfire occurs, wait not less than 20 seconds before reloading.

3. Do not leave a round or shell in the bore more than three minutes if the gun has fired 40-50 rounds, or two minutes if the gun has fired 70-75 rounds. If it is found impossible to extract the round before the times given above have elapsed, the breech must be opened (when possible), the automatic loaders unloaded and the detachment ordered to take cover in a safe place. Work on unloading can only be resumed when the barrels have cooled.

4. If long recoils are noted (370 mm or more) or sharp knocking can be heard as the breech casing hits the hydraulic buffer, firing must be stopped immediately, the hydraulic buffer and buffer inspected and the fault remedied.

5. ..... two lines missing .....

6. When loading the automatic loaders, the hands must be removed from the charger as soon as the lower feed pawls engage on the first round.

7. When firing has finished, switch off the electrical firing gear switch or replace the foot pedal guard immediately, before any unloading is carried out and before the gun is transferred to the travelling position.

8. It is not permitted to fire a continuous burst of more than 60-65 rounds from each barrel, since this causes barrel overheating. To speed the barrel cooling process during intense firing, it is recommended that the maximum angle of elevation should be applied to the gun, the breach opened and the inner surfaces of the barrels cooled by compressed air from the air compressor.

Transferring the gun to the travelling position to transfer the gun from the fighting to the travelling position:

1. Switch off the electrical firing gear, the sight illuminating gear, the tilt indicator lamp, and throw back the foot pedal guard. Close the tilt indicator cover.

2. Unload the gun, replace the caps and pins on to the UOR-281 shells with MG-57 fuzes, stow away the loaded charges, and see that all ammunition, spare parts and accessories are firmly secured.

3. Secure the sight in the travelling position, clamping the carriage and course bearing mechanism.

4. Replace the covers on the barrels, automatic loaders, sight corrector, and UK-3 collimators.

5. Clamp the gun and turret for travelling, barrels forward, paying special attention to the clamping.

6. Set the laying gear drive selector handle to the "Motor" position, remove the cranked hand operating handles and stow them away.

7. The vehicle must not be allowed to move off with the drive set to "Hand" and the driver's upper hatch open.

/8.

8. Fit the loaders' seats into their t[illegible]

9. Close the turret vision slits and the drivers upper hatch (if the vehicle is moving with the turret unclamped). If the driver's hatch is opened, the turret must be clamped.

10. Clear the spent cartridge bin and the conveyor bunker of spent cases and chargers. Replace unloaded charges under the turntable platform.

11. Close the conveyor discharge opening and the hinged cover on the spent cartridge bin.

CARE AND MAINTENANCE

Whether in battle, after exercises or firing, care and maintenance of the gun will consist of cleaning and oiling it and inspecting its parts and mechanisms.

Cleaning the gun after firing

After firing the gun will be cleaned in the following manner:-

1. After firing, and before the barrels have cooled, grease the bores with AF-70 grease, as the grease softens the fouling and facilitates its removal. To do this, wind a thin rod soaked in gun grease on to the cleaner rod brush, insert the brush into the bore and grease the bore along its whole length.

2. Using a rag, clean the dust or mud from the outer surface of the barrels. If this is excessive (in very dry climates) wash down with water and dry off.

3. 2-3 hours later, when the carbon deposits have softened, remove the grease from the chamber and bore, using a wad and rags soaked in herozine or diesel fuel, and start washing the bore.

Before washing the bore, set the breech on the firing lever, using the hand breach cocking mechanism but not disengaging the hand cocking mechanism from the rack. Apply a small angle of elevation to the barrel, and insert the wooden cleaning rod into the chamber, having wound rags around it. Care must be taken not to touch the firing mechanisms during this operation.

The bore is washed with kerosine or diesel fuel or hot soapy water, prepared to the formula - one half bucket if water to 50 grams of soap.

Pour into the bore from the muzzle end about three litres of the prepared soap solution or 1-1.5 litres of kerosine, and using the cleaning rod, wash the entire length of the bore for 10-15 minutes. Then pour off the dirty liquid and, repeat the washing operation as above. Wash the bore not less than twice with kerosine and three times with soapy water. After washing with kerosine or soapy water, rinse the barrel through with clean hot water and clean it with a pad.

If kerosine or soap is not available, hot water may be used provided the water is changed 5-6 times. In winter it is recommended that only kerosine or diesel fuel be used.

After washing out the bore, drain off all the remaining liquid by depressing the gun. Knock the wadding from the chamber with the rod. Wind a clean rag on the wad and insert it in the chamber. Without withdrawing the rod from the barrel, screw on to its end ..... one line missing ..... remove all traces of liquid from the barrel.

/4.

4. Clean through the bore by pushing a wad wound tightly with clean dry linen strip through it 5 or 6 times.

The strip wound on to the pad should be of such a thickness that 3-4 men are needed to push it through the bore.

As a check on the cleanness of the bore, a check wad with a tightly would clean (white) dry rag should be pushed through it. If there are dark fouling stains, traces of grease of rust, further dry cleaning with a linen wad must be carried out until the check wad is absolutely clean (traces of blue from the metal are permissible). If there is a considerable amount of fouling, the bore should be washed out again. If the check wad sticks or slides suddenly on being pushed through, the bore must be inspected to see if there is any bulging, heavy coppering or damage to the rifling grooves and lands.

5. When the bore has been cleaned, the chamber and interrupted locking threads for the breech screw must be cleaned. The chamber and muzzle end of the barrel must be cleaned of grease and fouling with dry rags.

In battle it is not always possible to carry out the complete barrel cleaning drill. The partial cleaning drill consists of the following:

1. When firing has stopped, grease the bores as shown above.

2. After 2-3 hours remove the grease and re-grease the bores.

If conditions permit, when the first lot of grease has been removed, wash out the barrles with kerosine or diesel oil, wipe dry with rags and re-grease.

Cleaning the breech

Periodically the breech and accelerating mechanism should be stripped and cleaned, the interval depending on their condition. The breach screw is fully stripped, but the extracters and breech lock are not removed. The parts removed are wiped with rags or washed in kerosine or hot water, then dried again. Special attention must be paid during breech cleaning to the cleanliness and condition of the breech casing guide groove surfaces, the accelerator mechanism bearing surface and the cylindrical portion of the breech casing. After firing the breech screw and breech should be cleaned of dust, dirt and old grease with a dry rag: for this it is not necessary to strip the breech and remove its breech screw from the breech casing. Carbon deposits on the breech screw face and other parts of the breech should be removed with a rag soaked in grease.

Cleaning the cradle, loading trays, buffer and other parts

The automatic loaders, loading trays, and cradles and buffers are cleaned with dry rags inside and out, when time permits and without stripping them, after firing and exercises.

If very dirty, the breech should be removed and the inside surface of the cradle cleared of dust and old grease. Special attention in cleaning should be paid to the cradle slides and accelerating mechanism actuating cam.

To remove dust from the gun and ammunition, compressed air from the air compressor may be used.

Cleaning the automatic anti-aircraft sight, the mounting and conveyor, and the laying mechanisms

The above mentioned assemblies must be cleaned after firing practice, exercises and moves. Dust should be removed with compressed air and dirt with rags.

It is essential to switch off all current before starting cleaning. When cleaning the anti-aircraft sight, clean the sight scales, and wipe the collimator glasses with a flannel or chamois leather. Shake out the gun and sight covers to remove dust. It is forbidden to place damp covers on the gun or sight.

Inspecting the gun after cleaning

After cleaning, the gun is inspected with a view to finding and remedying faults. The following sequence is recommended:

1. Inspect the barrel inside and out and check:

   - that there are no bulges, heavy copper deposits, cracks, pitting or burrs in the bore;
   - that the sleeve and chamber are serviceable;
   - that the jacket is firm on the barrel;
   - that the muzzle brake is firmly fitted;
   - that there is no leakage of fluid from the buffer, universal speed governor and hydraulic buffer. If there is, the appropriate mechanism must be topped up. If there is a large amount of oil in the universal speed governor drip trays, check the oil level in the reservoirs and top up if necessary; remove the oil from the drip trays and press off the felt gaskets;
   - that the buffer is firmly fixed to the cradle, and that the buffer piston is securely joined to the recoiling parts.

/2.

2. Inspect the breech and automatic loader mechanisms and check:

- that the metal is not deformed, the springs and fastenings and split-pins are serviceable;

- that thereis not too much free play in the sight mechanisms and collimator sight fastenings.

- two lines missing

After cleaning, the bore and chamber are greased with AF-70 grease. The grease is applied in a thin even layer, using a cleaner rod. To grease the bore:

1. Open the cradle hatch cover (by the automatic loader).

2. Draw the breech back to the rear and set it on the sear, having first taken the precaution of switching off the electrical firing gear and throwing forward the foot pedal safety guard.

3. Insert the cleaner rod from the muzzle end, pushing its end up to the hatch cover.

4. Wind a clean fine cloth soaked in grease on to the cleaning rod head, and screw the head on to the end of the cleaning rod.

5. Pull the cleaning rod up and down the bore with a smooth action, finally removing it without unscrewing the head.

If necessary repeat the above operation 2-3 times, so that the whole of the bore, and in particular the rifling is evenly greased.

The breech and accelerating mechanism, whether stripped or not, are cleaned with a rag soaked in oil. The cylindrical part of the breech casing, the slides in the casing, and the barrel sleeve are lubricated more thickly.

The parts of the automatic loader and cradle are covered with a thin layer of grease. The parts of the sight are wiped externally with an oily rag. The parts of the laying mechanisms are greased only when stripped.

Leather parts are greased with accoutrements grease, in the summer-monthly, winter-once every two or three months.

Armament technical servicing schedule. On the quick inspection check:

1. Gun ready for action.

2. Elevating and turret traverse mechanisms, on hand and electric drives.

3. Clamps.

4. Sights.

5. Covers.

6. Ammunition stowage.

When testing the readiness of the gun for action, check the automatic loaders and conveyor, and see that there is AGM oil in the universal speed governors.

Sight adjustment is carried out when required, as shown in the section on the automatic anti-aircraft sight in Chapter Three:

On technical servicing No. 1 check:

1. Gun clamps.

/2.

2. Automatic mechanisms, recoil mechanisms, gun firing gears. If necessary clean the bore of the gun.

3. Ease of rotation of the laying mechanisms. If the elevating gear is stiff, clean the teeth of the elevating gear main gear and of the toothed arc. If the traversing gear is stiff, clean the teeth of the driving gear and the turret ring. Grease the cleaned surfaces. If necessary wash and grease the turret ring. This is to be done in the manner shown in the section on turret maintenance.

4. Covers. These must always be on, and only removed and stowed in the turret when necessary. Covers are provided for the following sub-assemblies: muzzle brakes, left and right automatic loaders, sight corrector, collimator sights, headlamp, radio set and telegraph key.

To test the electrical firing gears, first ensure that the gun is unloaded, then cock the breeches and, holding the breech cocking handle, press the electrical firing button. During this operation, by turning the breech cocking handle, slowly close the breeches without letting them move forward too fast. Repeat the operation twice.

5. The electrohydraulic and hand drives of the turret traverse gear (right and left), and of the elevating gear (at angles of elevation and depression).

6. The electric drive for the conveyor, by pressing the button on the gun junction box: the electrical firing gears, and the tappet switch. At the same time check the conveyor or hand drive.

On technical servicing No. 2 carry out all the tasks detailed in technical servicing No. 1 and in addition check:

1. Fastening and serviceability of the electrohydraulic drive assemblies.

2. Fastening of the turret traverse and elevating mechanisms.

3. Top up the universal speed governor, remove the oil from the drip trays and felt gaskets.

On technical servicing No. 3 carry out all the tasks detailed in technical servicing No. 2, and in addition.

1. Clean off dirt and oil and re-grease the teeth of the traversing gear turret ring gear wheel, and the worm reduction gear driving gear.

When the worm reduction gear is stripped, pour into the casing 1.4 - 1.5 kgs of graphite grease to the following specification:

(a) AF-70 grease (GOST 2967-52) - 53%

(b) AGM oil (TU GAU No. 01563) - 35%

(c) S-1 colloidal graphite preparation (GOST 5261-50) - 12 - 1.5%

Clean the dirt from the teeth of the elevating gear arc and main gear. Remove old grease and re-grease.

POSSIBLE FAULTS AND THEIR REMEDIES

Fault	Cause	Remedy
Misfire	1. If the mark of the striker is sufficiently deep, the primer is faulty.	1. Change the round and continue firing.
	2. If the mark of the striker is weak or missing, the breech is dirty or unserviceable or the striker broken.	2. Remove dirt and superfluous grease from the breech. Change any damaged parts of the striker mechanism.

/The

Fault	Cause	Remedy
The feed frame does not release the automatic firing mechanism lever	Rounds jammed or inclined in the automatic loader	With a screwdriver press off the automatic firing lever actuating rod. Remove the automatic loader casing. Inspect the parts of the feed frame cocking device, establish where jamming is occurring, strip, smooth off and grease with graphite grease.
Breech will not hold on the automatic firing lever.	Incomplete cocking of the breech on the automatic firing lever due to short recoil or burrs on the breech casing surface which takes the crank and on the accelerator crank, or on the accelerator cam working surface	Unload the automatic loader, depress the lower pawls by turning the transfer lever, move the round resting on the breech into the automatic loader and remove it. Cock the breech. Inspect bearing surfaces and, if they are burred, smooth off. After this insert a new loaded charger and load. It is permissible for the breech face to protrude in relation to the guiding surface of the automatic loader rear wall up to 0.5 mm.
Incomplete ram causing a case to jam in the breech screw extractors.	Accelerator mechanism crank does not return to initial position, causing the crank hub to jam in the bracket hole or breakage of the crank return spring.	Strip the accelerator mechanism, smooth off burrs, change the broken spring.
Rounds on the slant in the automatic loader	Cartridge case rim guide rib in the automatic loader dirty	Unload, clean and dry, reload.
Round jams in automatic loader	1. Dents in the cartridge case rim. 2. Primer protruding	1. Unload and re-load with fresh charger 2. Remove and inspect rounds, carefully screw in primer.
Round fed beyond the ramming line	1. On initial loading, when the breech screw clamp is depressed, the round is fed too energetically by the feed frame.	1. Hand cock the breech and set it on the firing lever: without disconnecting the breech rack from the cocking mechanism, remove the round from the breech screw extractors. Feed the round into the breech screw extractors again. Disconnect the breech rack from the hand cocking mechanism. To avoid stoppages it is essential to feed the first round smoothly, holding back the feed frame hand cocking handle.
	2. At automatic fire, the cut-off mechanism in the breech screw does not operate.	2. Remove the breech screw from the breech casing, strip the cut-off mechanism, clean dry and inspect it.

Fault	Cause	Remedy
Simultaneous feeding of two rounds into the ramming line.	Cut-off in the automatic loader not operating, due to broken spring or dirty or damaged rod. As a result the first round is fed into the breech screw extractors, and the second between the breech and the cradle wall. On ramming a jam occurs.	Unload the automatic loader, draw back the feed frame, depress the lower pawls by turning the transfer lever, and move the round lying between the breech and the cradle wall into the automatic loader. Hand cock the breech, set it on the firing lever without disconnecting the breech rack from the breech hand cocking mechanism. Unload the gun. Re-load and continue firing.
missing	missing	If stoppage re-occurs, stop firing, remove and strip automatic loader.
Round not fed from automatic loader into the ramming line.	Charger jammed owing to bent charger: firing stops, breech remains cocked.	Engage the breech rack with the hand cocking mechanism to avoid damage to the breech. Unload, disengage the breech rack from the hand cocking mechanism and re-load with a fresh loaded charger. If the charger is bent, hammer out through a copper or wooden packing. Test it against a charger curve gauge: curvature should not be more than .5mm in one length of the charger.
Cartridge case not ejected from extractors when next round fed.	Premature rotation of the stirrup link and protrusion of the clamp beyond the breech face as a result of dirt on the breech cut-off mechanism, weakening of the spring or wear of the nose of the actuating stud and of the clamp cam face. The case cannot move from the extractors and remains held against the clamp by the next round fed into the ramming line.	Cock the feed frame, move the next round into place with a screwdriver, depress the clamp and set the stirrup link in its normal position. Feed the next round into the ramming line. After firing clean the mechanism and replace damaged parts.
Short recoil	1. Excessive friction on the working surfaces of the recoiling parts due to burrs etc. 2. Increase in the viscosity of the buffer fluid due to a fall in air temperature.	1. Inspect and smooth off all working surfaces. 2. Do not stop firing, since after a few single rounds the liquid will warm up and recoil will be normal, allowing automatic fire.

/Long

Fault	Cause	Remedy
Long recoil (more than 370 mm). Do not continue firing.	1. Lack of fluid in the buffer	1. Top up to normal (1.5 litres in the buffer)
	2. Recuperator spring weak or broken	2. Remove the barrel and replace the recuperator spring.
	3. Wear on the floating piston head on the buffer piston rod	3. Measure the diameter of the floating piston. If the measured diameter differs from that given in the gun log book by more than 0.25 mm, change it. Send the buffer for repair.
Conveyor stops. (Warning light goes out)	1. Electric motor cut-out actuated by extreme load on the conveyor or belt jamming.	1. Unjam the conveyor using the handdrive. Unload the conveyor, ensure that the conveyor works normally, switch on the electric motor cut-out and by pressing the button, start the electric motor.
	2. During volley firing in long bursts at extreme angles of elevation, a cartridge case may slip between the conveyor belt and the ejected chargers, causing the "AZS" circuits cut-out to operate and the conveyor to stop. The warning light goes out.	Apply an angle of elevation of 30-40°. Switch on the "AZS" circuit cut-out and press the conveyor test start button. Unload the conveyor. If this does not clear the blockage, then when the "AZS" cut-out operates again: - switch over from electrical to hand drive; - remove the cartridge case blockage by turning the handwheel 2-3 turns anti-clockwise then clockwise until the cases are ejected into the spent cartridge bin: - transfer the hand drive to electrical drive: - apply the required angle of elevation, continue firing.
	3. Spent cartridge bin filled with spent cartridge cases and chargers.	3. Unload the spent cartridge bin.

Transferring the gun from the travelling to the fighting position

NO FOREIGN DISSEM

To transfer the gun from the travelling to the fighting position, the following drill will be observed:

1. Remove the turret canopy.

2. Remove all covers: from the barrels, automatic loaders, sight connector and collimator sights. Stow the covers in the rear part of the turret.

3. Fit the electrohydraulic drive control column in the working position and set the selector lever to "Motor".

4. Switch on the radio set and prepare it for operation.

5. Unclamp the gun and turret from their travelling clamps.

6. Close the driver's hatch and open the vision slits in the front of the turret.

7. Remove the loaders' seats and stow them in the compartment on the turntable platform (under the universal speed governor).

8. Unclamp the sight carriage and course bearing mechanism.

9. Run the recoil indicator slides forward.

10. Prepare the ammunition for firing.

11. Switch on the electrical current, open the tilt indicator cover and illuminate the tilt indicator. At night switch on the collimator sights illuminating set, the sight corrector illumination and the turret bulkhead lights.

On taking up a fire position, tilt must not exceed 1^{0}* by the tilt indicator.

Loading drill

Initial loading of the gun willbe carried out in the following way:

1. Set the breech to the extreme rear on the firing lever. This is done by:

- unclamping handle B (fig 46 a);

- lowering handle A, so that the clamp fits into the clamp socket, and at the same time turning handle B (fig 46, 6 to reduce strain on the hand cooking gear teeth as they engage with breech rack teeth;

- engaging the cog (fig 46, B) by turning the ratchet;

- winding back the breech to the rear by turning the handle B in the direction shown by the arrow, until the breech engages on the firing lever (this can be determined by the characteristic click and increased pressure on the handle).

- disengaging the cog by turning the ratchet B, and clamping the handle B in the slot on the cradle (fig 46. 2)

* Translator's note: This does not agree with the amended version on P.70 at the text, which states that up to 3^{0} is permissible.

2. Feed the round into the ramming line:

- place on the loading tray a charger loaded with four rounds and push it along the tray until it rests on the front cut-off, at the same time controlling the engagement of the lower pawls on the rounds (fig 46 d);

- unclamp the handle A and by turning it in the direction shown by the arrow, cock the feed frame so that its pawls engage on the rounds (to stops);

- by turning the handle A in the opposite direction, introduce a round into the breech screw extractors (fig 46. e);

- by raising the handle A until its clamp engages in the clamp socket, disengage the parasite gear of the hand cocking mechanism from the breech rack;

- turn the lever F to the "Engaged" position and prepare the next charger for loading.

To fire, the electrical firing gear circuit switch must be switched on and the firing button or mechanical foot pedal depressed.

After the first few rounds, the recoil length must be checked. If length of recoil is more than 370 mm, cease firing and check the recoil mechanism.

Gun-fire is controlled by the automatic anti-aircraft sight by constant sighting on the target through the cross-wires of the UK-3 collimator sights. When the target appears within range, the detachment commander will determine visually the following initial data: range, course bearing, and target speed, and, if necessary, the angle of dive or climb. The sight setter sets these data on the corresponding sight mechanisms, constantly changing the range during the engagement.

Laying the gun on to the target is carried out by the layer, who, using the electrohydraulic drive control column, holds the cross-wires of the UK-3 collimator sight on the target and fires the gun. If the hand laying drive is in use, laying for angle of elevation and bearing is carried out separately by two members of the detachment. Laying for angles of elevation is carried out by the layer, for bearing by the detachment commander.

Fig 46. Loading drill (legend as on fig 45).

When using the electrohydraulic drive for laying, it must be borne in mind that the batteries must not be permitted to discharge below 21 v under load. Therefore systematic checking of the batteries and regular re-charging is one of the most important items in maintaining the vehicle in battle-readiness. If the battery voltage should drop below the permitted level, the engine must be revved up and firing continued with the engine revving.

For automatic fire it is necessary for the loader to maintain a constant feed of ammunition without delays. The length of a burst depends on maintenance of pressure on the electrical firing button or foot pedal and the rate at which loaded chargers can be fed into the loading tray.

To ensure uninterrupted and effective fire the detachment must be well trained in correct and rapid introduction of loaded chargers into the automatic loader, must be able to find the target quickly, set the initial data on the sights and hold the collimator sight crosswires on the target. To avoid the necessity of having to re-load if the feed of the next charges into the automatic loader is delayed, there is an interlocking device in the automatic mechanism which permits automatic fire by two methods: one, by holding the last round in the charger and two, without holding it.

/If

If fire is maintained with the held round method (the lever ✱ set in the "Engaged" position), firing stops when no further rounds are fed into the automatic loader, but one round is left in the loader; firing therefore recommences as soon as the next charger is loaded and the firing button or foot pedal depressed.

If fire is maintained without the held round method (the lever ✱ set in the "Off" position), no rounds are left in the automatic loader when firing stops and the feed frame and breech are run fully forward: there is also a spent case in the breech extractors which is rammed into the chamber. To recommence firing in this event it is necessary to insert the next loaded charger into the automatic loader and repeat the whole initial loading cycle.

Since considerable time is wasted when continual reloading is necessary, and it is undesirable to have a spent case left in the chamber, it is recommended that firing should always be carried out with the held round method, except where absolutely impossible.

Misfire drill

When a misfire occurs, the detachment will:

- wait not less than 20 seconds, bring the gun to the horizontal and extract the round from the extractors. To do this, by turning the hand cocking handle B, draw the breech to the rear and set it on the firing lever;

..... two lines missing .....

- by turning the handle A against the direction shown by the arrow, feed the next round smoothly into the extractors;

- without switching on the conveyor, remove the misfire round through the upper hatch of the mounting and take it some distance from the vehicle;

- ensure that the next round is fed into the extractors and continue firing.

If, on opening the breech, a cartridge case without a shell appears, the case must be inspected. If the charge is still in the case, it means that the shell is still in the bore. In this case the case must be removed from the extractors and the shell knocked out from the barrel using the ejector projectile or fired out using a special reduced charge with a shortened cartridge case.

Unloading drill

To unload the gun, the round in the automatic loader must be removed. This is done in the following manner:

- apply an angle of elevation of 0-10° to the gun;

Fig 47. Unloading drill (legend as for fig 45)

3 - transfer lever 4 - movable cover

- having turned the transfer lever (3, fig 47a depress the lower loader pawls until the clamp fits into the loader socket:

- using the special movable cover (4 fig 47b) raise the upper pawls on the feed frame: to facilitate disengagement of the pawls, cock the feed frame slightly, push in the movable cover, and then return the feed frame to its original position;

- remove the rounds in the automatic loader: to facilitate their removal, the rounds and the cover should be pulled simultaneously, pressing the rounds up with the hand through the lower automatic loader openings or the upper cradle hatch (fig 47B).

If there is only one round left in the gun to be unloaded, the following drill must be carried out in addition to that above:

- disengage the interlooking mechanism, setting the lever [illegible] to the "Off" position;

- holding the automatic loader cocking lever, release the feed frame and extract the round from the automatic loader.

Remove the round from the breech screw extractors. To do this:-

- turn the transfer lever (3) and depress the lower automatic loader pawls;

- cock the feed frame and set it on the catch on lever [illegible].

- knock the round out of the breech screw extractors into the automatic loader through the upper cradle hatch;

- remove the round from the automatic loader in the sequence shown above.

After unloading, the breech must be run forward, the feed frame released, the lower pawl transfer lever set to its original position and the handles clamped.

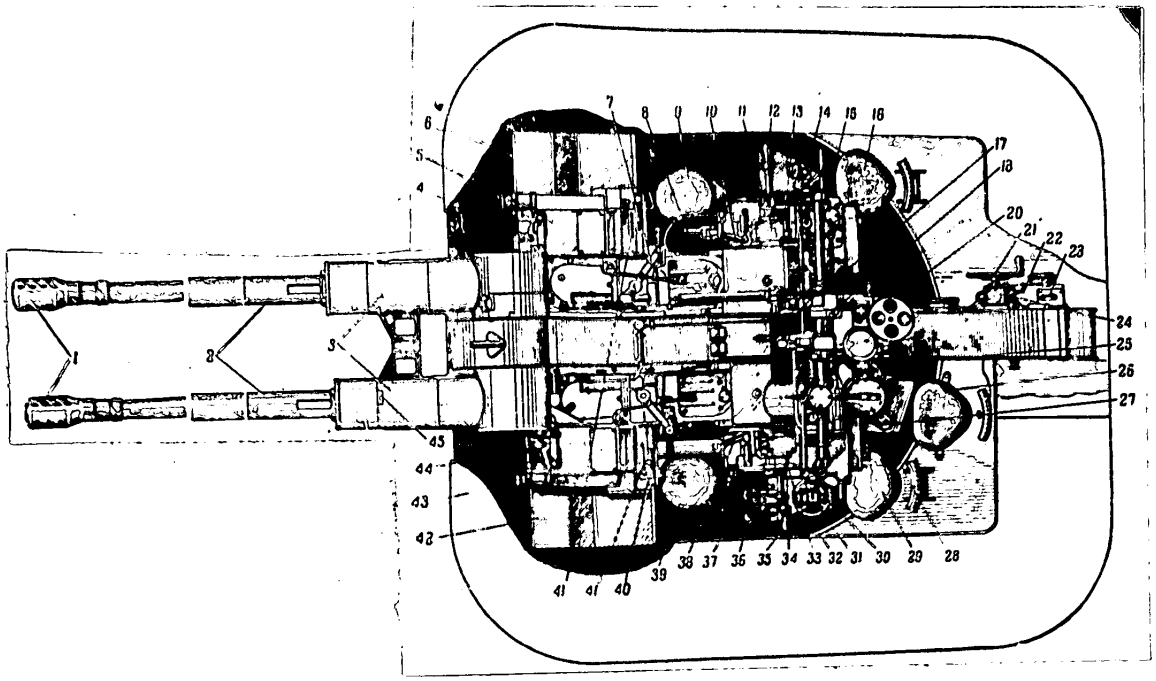


Fig 21. The S-68 Gun Mounting (viewed from above)

1. muzzle brake (right & left). 2. barrel (right & left). 4. right magazine feed frame hand cocking lever. 5. right magazine. 6. right magazine loading tray. 7. right breech cocking handle. 8. traversing gear drive universal coupling. 9. right-hand loader's seat. 10. electro-hydraulic and manual traverse mechanism selection lever. 11. reduction gear and traverse mechanism control column. 12. crank traversing handle. 13. universal speed governor (URS). 14. right collimator. 15. moving part of sight. 16. detachment commander's seat. 17. sight socket. 18. sight testing flat. 20. elevation handwheel. 21. ammunition conveyor manual drive handwheel. 22. ammunition conveyor reduction gear. 23. ammunition conveyor drive coupling lever. 24. relay box. 25. sight base casing. 26. sight setter's seat. 27. aircraft model (target course indicator). 28. sight base. 29. layer's seat. 30 left collimator. 31. electric firing gear button. 32. universal speed governor control column. 33. elevating gear reduction gear. 34. elevating gear universal speed governor. 35. crank elevating handle. 36. left automatic mechanism firing pedal. 37. right automatic mechanism firing pedal. 38 elevating gear drive selector lever. 39. left hand loader's seat. 40. left cocking handle. 41. interlocking device lever. 42. left magazine loading tray, 43. left magazine., 44. magazine feed frame cocking handle. 45. backsight.

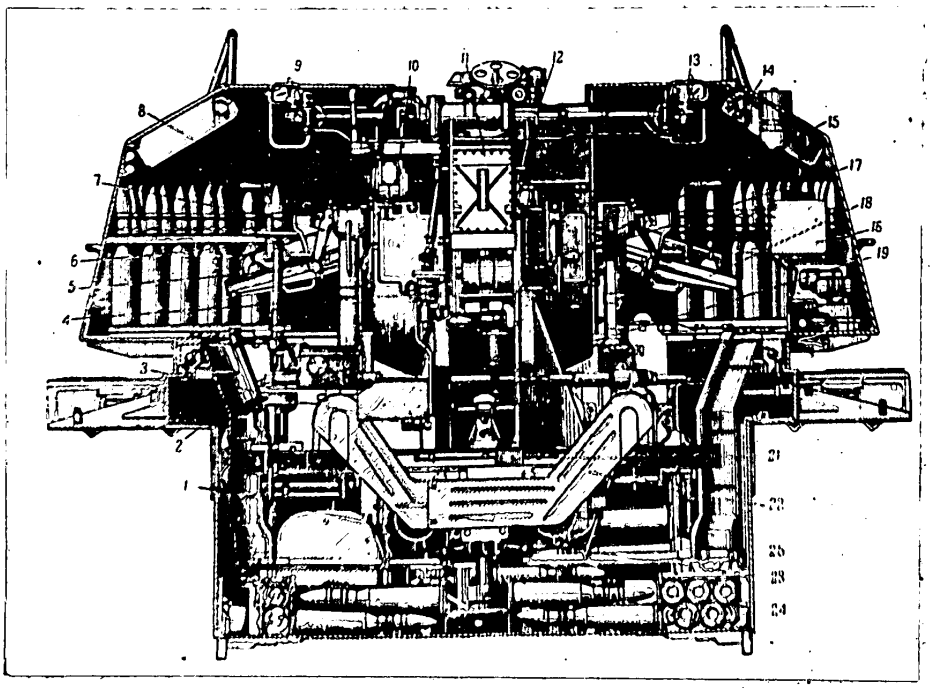


Fig 22. The S-68 Gun Mounting (viewed from the rear)

1. G-731 electric motor. 2. turret platform guard. 3. course. stablizer pedal. 4. course stabilizer disengaging handle. 5. left loading tray. 6. universal speed governor rod. 7. hydraulic drive engaging box. 8. crank elevating handle. 9. left collimator. 10. sight base. 11. rear mounting opening cover. 12. relay box 13. right collimator. 14. crank traversing handle. 15. warning light box. 16. radio set. 17. ammunition conveyor manual drive handwheel. 18. right loading tray. 19. course stablizer. 20 & 21. ammunition stowage under turret platform. 25. turret platform.

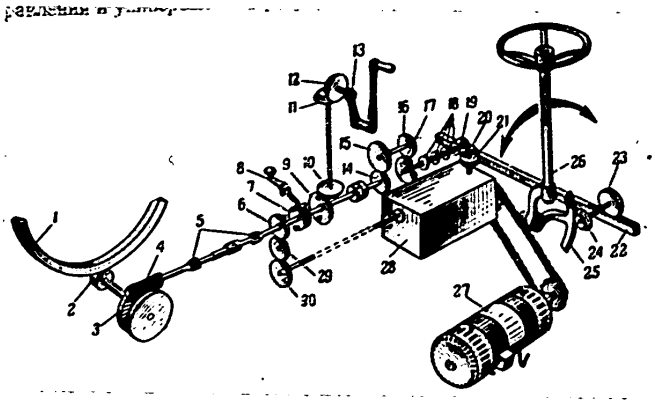


Fig 25. Kinematic diagram of the Elevating mechanism

1. toothed arc. 2. arc actuating pinion. 3. worm wheel. 4. worm and shaft. 5. universal couplings. 6. spur gear. 7. cam coupling. 8. selector gear. 9, 10, 11, 12. bevel wheels. 13. crank handle. 14. 15. 16. 17. spur gear wheels. 18. rings. 19. 20. bevel wheels. 21. spur gear wheel. 22. rack. 23. spur gear. 24. bevel wheel. 25. arc. 26. universal speed governor control column. 27. G-731 electric motor. 28. universal speed governor. 29. 30. spur gear wheels.

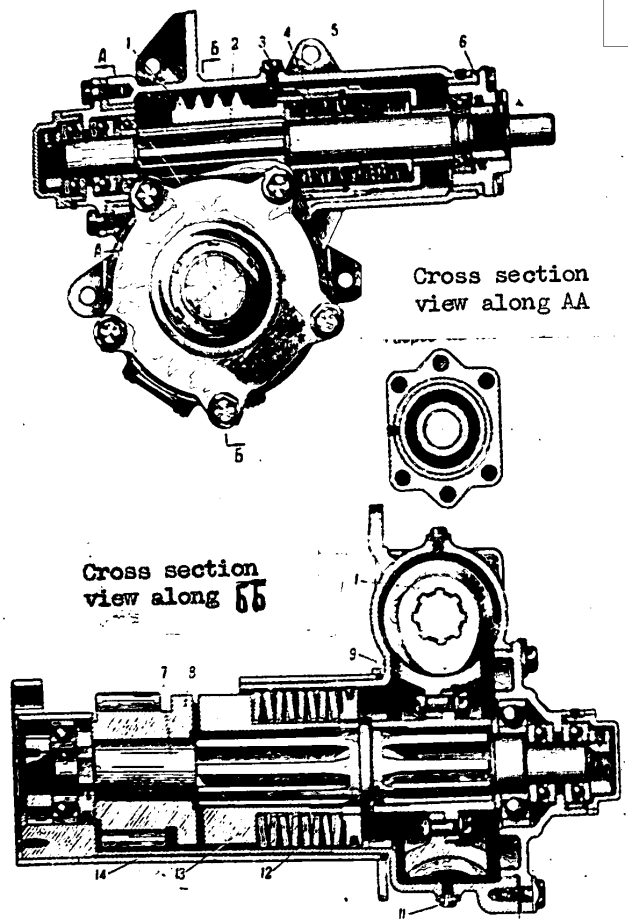


Fig 26. The Gun Elevating Gear Worm Reduction Gear

1. worm. 2. worm spindle. 3. plug. 4. worm buffer. 5. bush. 6. accentric brush. 7. main shaft. 8. main gear wheel. 9. worm wheel. 10. gasket. 11. plug. 12. main gear wheel buffer. 13. cam coupling. 14. accentric bush.

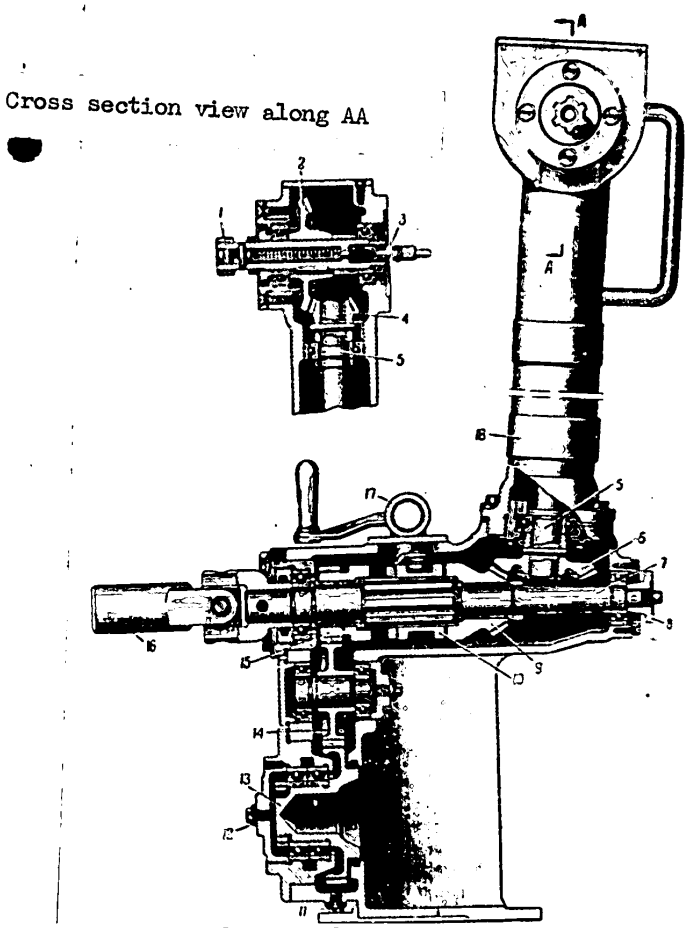


Fig 27. The Gun Elevating Gear Geared Reduction Gear

1. shaft. 2, 4, 6, 9, bevel wheels. 3. eleectric firing gear actuating rod. 5. shaft. 7. shaft. 8. half-coupling. 10. cam coupling. 11. 12 plugs. 13. 14. 15 spur gears. 16. shaft with universal coupling. 17. selector lever. 18. column.

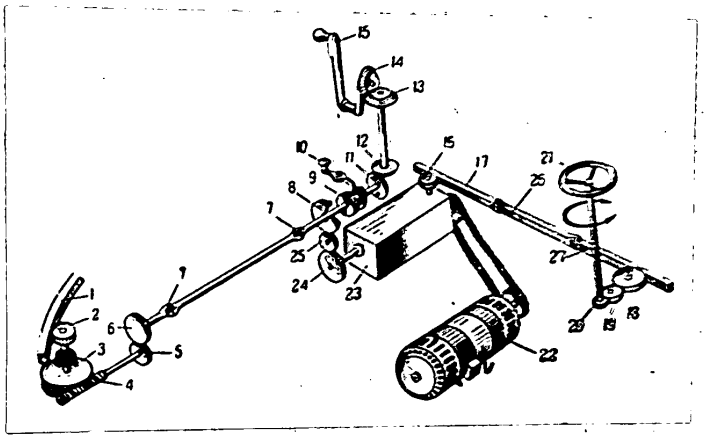


Fig 28. Kinematic Diagram of the Traversing Gear

1. toothed turret ring. 2. traversing gear main spur gear. 3. worm wheel. 4. worm. 5 &6. spur gears. 7. shaft with universal couplings. 8. gear wheel. 9. cam coupling. 10. selector lever. 11. 12. 13. & 14. bevel wheels. 15. crank handle. 16. gear wheel. 17. rack. 18. 19 & 20. spur gears. 21. universal speed governor control column. 22. electric motor. 23. traversing gear universal speed governor. 24. & 25. spur gear. 26. rod. 27. rack.

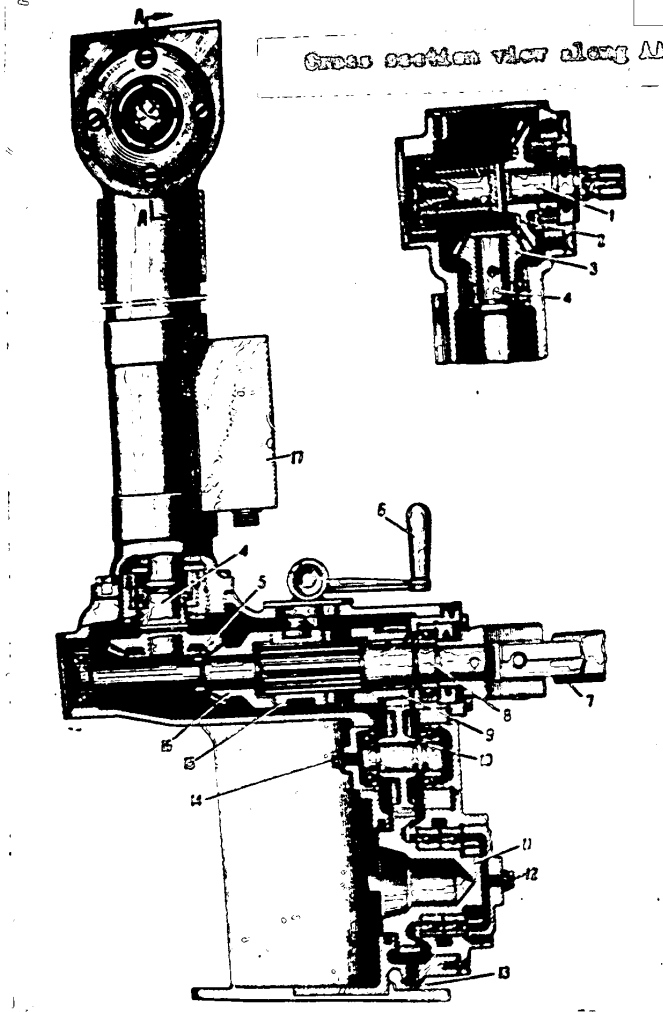


Fig 29. The Traversing Gear Geared Reduction Gear

1. Shaft. 2, 3, 5, & 16. bevel wheels. 4. shaft. 6. selector lever. 7. intermediate shaft. 8. shaft. 9, 10 & 11. spur gears. 12, 13 & 14. plugs. 15. cam coupling. 17. oil reservior containing oil AGM for the universal speed governor.

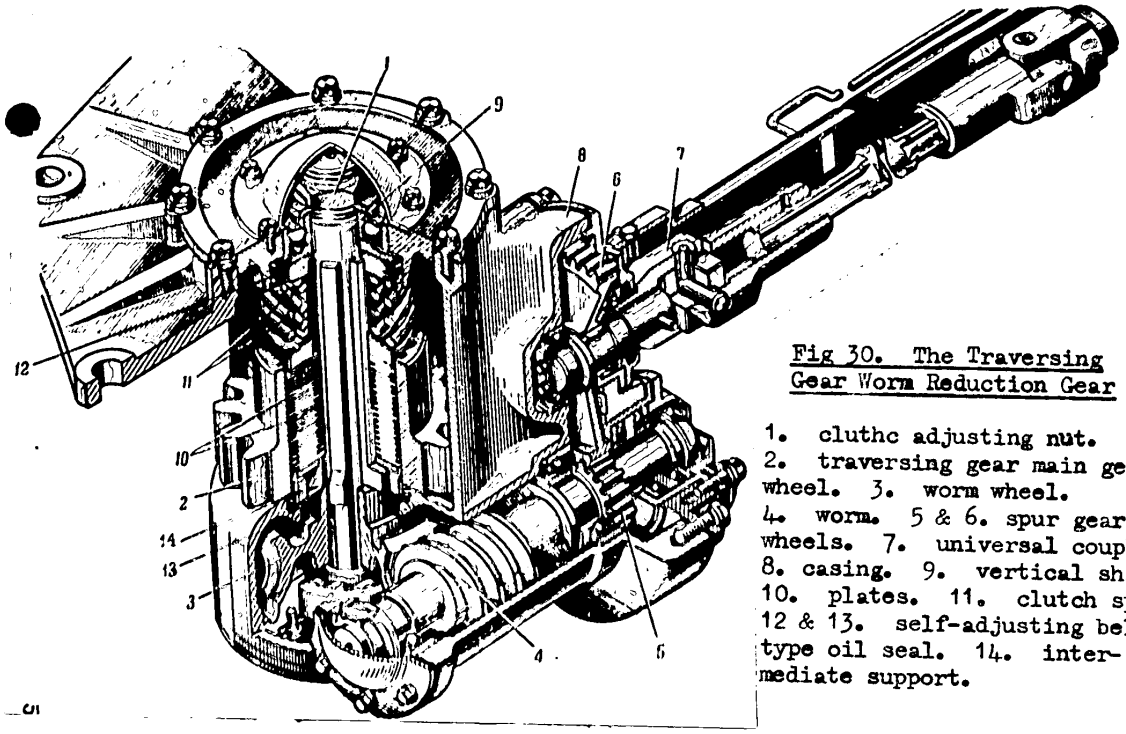


Fig 30. The Traversing Gear Worm Reduction Gear

1. cluthc adjusting nut. 2. traversing gear main gear wheel. 3. worm wheel. 4. worm. 5 & 6. spur gear wheels. 7. universal couplings 8. casing. 9. vertical shaft. 10. plates. 11. clutch springs. 12 & 13. self-adjusting bellows-type oil seal. 14. intermediate support.

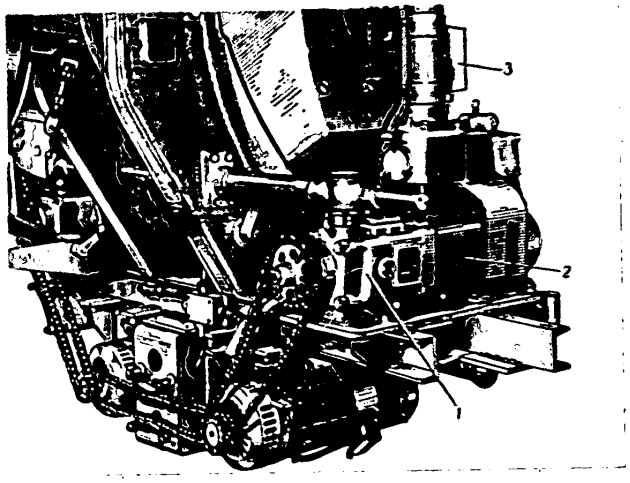


Fig 31. General View of the Turret Traverse Gear Universal Speed Governor

1. hydraulic pump.. 2. hydraulic motor. 3. topping-up tank.

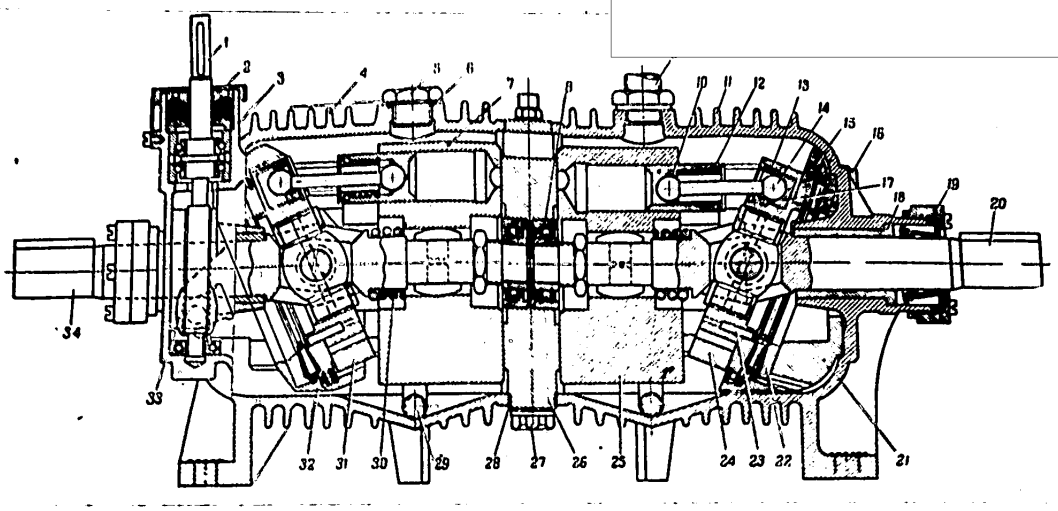


Fig 32. Longitudinal Section of the Universal Speed Governor

1. control spindle shaft. 2. locking collar. 3. radial thrust bearing. 4. hydraulic pump casing. 5. filler plug. 6. gasket. 7. hydraulic pump. cylinder barrel. 8. ball bearing. 9. pipe to topping up tank. 10. bronze bearing shell. 11. hydraulic motor casing. 12. piston. 13. nut. 14. piston rod. 15. combined ball bearing. 16. stay bolt. 17. bearing shell. 18. bronze bush. 19. oil seal cap. 20. output shaft. 21. hydraulic motor guide cup. 22. combined ball bearing. 23. locking pin. 24. hydraulic motor tilting box. 25. hydraulic motor drum. 26. distributor disc. 27. topping up valve. 28. gasket. 29. drain opening. 30. spring. 31. hydraulic pump tilting valve box. 32. hydraulic pump guide cup. 33. anchor piece and trunnions. 34. input shaft.

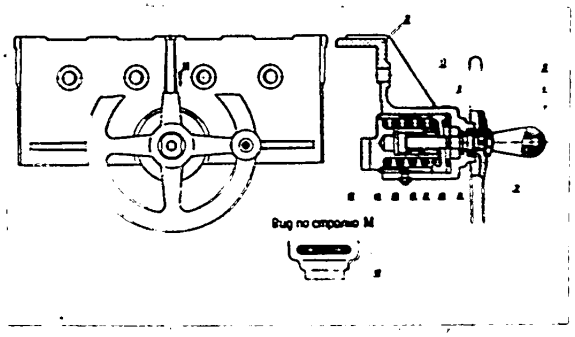


Fig 33. The turret clamp

1. bush. 2. clamp casing. 3. spring. 4. nut. 5. handwheel. 6. handle. 7. ball bearing. 8. screw. 9. clamp axle. 10. plug. 11. prismatic key. 12. nut. 13. screw. 14. nut. 15. clamp rib. 16. indicator.

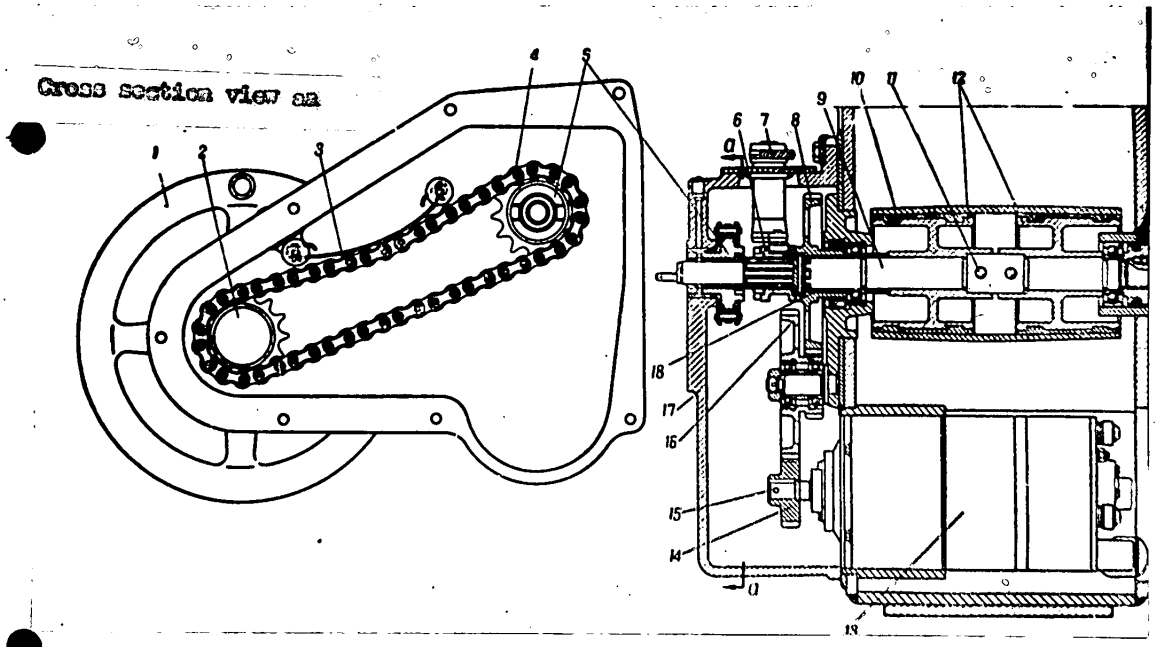


Fig 34. The Conveyor Reduction Gear

1. handwheel. 2. sprocket. 3. leaf spring. 4. chain. 5. sprocket. 6. cam coupling. 7. selector lever. 8. spur gear. 9. shaft. 10. conveyor belt. 11. bevelled peg. 12. rollers. 13. electric motor. 14. spur gear. 15. bevelled peg. 16. intermediate gear. 17. reducti. gear casing. 18. bush.

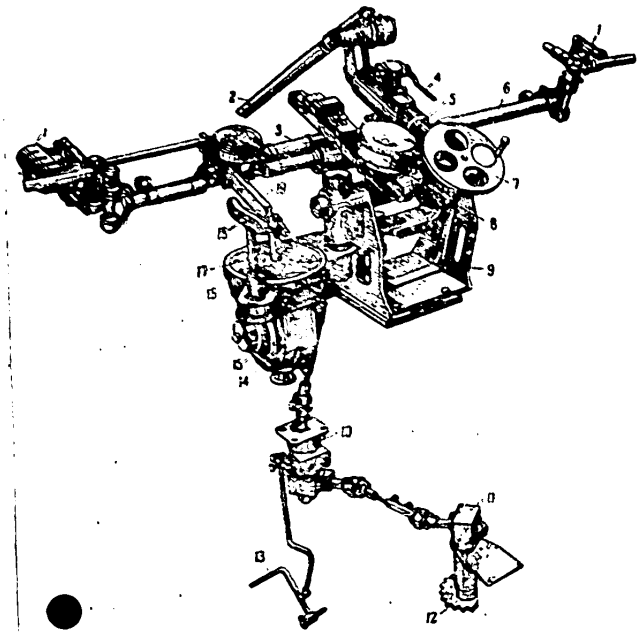


Fig 35. The Automatic Anti-Aircraft Sight

1. VK-3 collimator sight
2. parrallel linkage actuating rod.
3. sight supporting bracket.
4. clamp handle. 5. frame.
6. sight parallel linkage.
7. range setting handwheel.
8. range scale. 9. bracket.
10. course stabilizing mechanism engaging box. 11. box.
12. receiving gear. 13. foot pedal.
14. angle of dive and climb gear.
15. target speed scale.
16. target course bearing scale.
17. sight corrector.
18. aircraft model (target course indicator. 19. sighting scale.

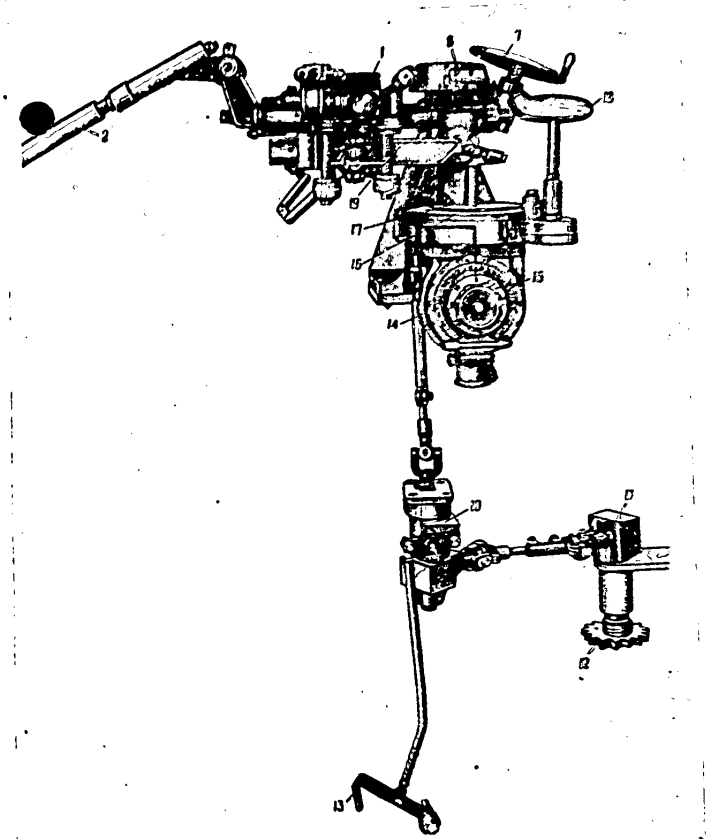


Fig 36. General View at Sight from the left side

Legend as for Fig 35.

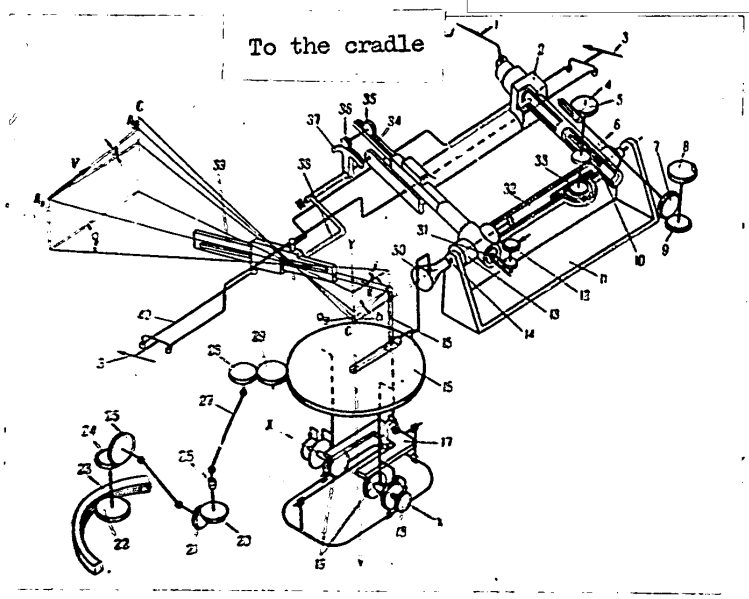


Fig 37. Kinematic diagram of the Sight

1. parallel linkage actuating rod. 2. frame. 3. collimator sight. 4. gear. 5. worm. 6 & 7. gears. 8. hand wheel. 9. gear. 10. rank. 11. bracket. 12. range scale. 13. frame base. 14. sight axle. 15. vertsical rod. 16. gear. 17. slide. 18. target speed scale. 19, 20, 21, 22, gears. 23. turret ring. 24. 25. gears. 26. stabilising gear engaging coupling. 27. cardan shaft. 28, 29. gears. 30. cam. 31. gear. 32. rack. 33. gear. 34. rack. 35, 36. gears, 37. arc. 38. feeler rod. 39. sight scale (rule). 40. sight parallel linkage.

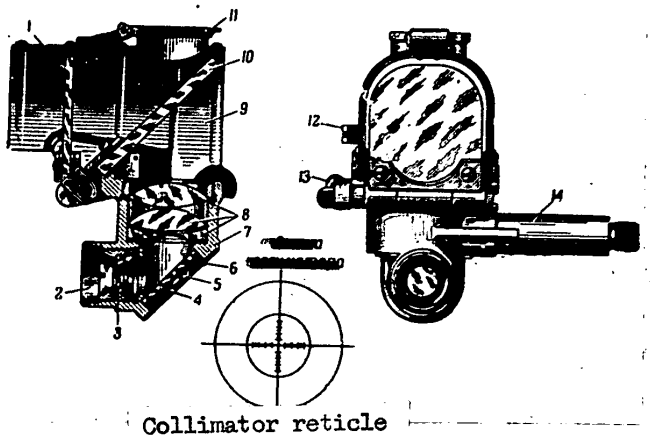


Fig 38. The VK-3 collimator sight

1. light filter. 2. sight illuminating gear socket. 3. graticules. 4. mirror. 5. springs. 6. cover. 7. body. 8. object glass. 9. casing 10. reflector. 11. casing cover. 12. rough alignment.sight. 13. catch 14. rod.

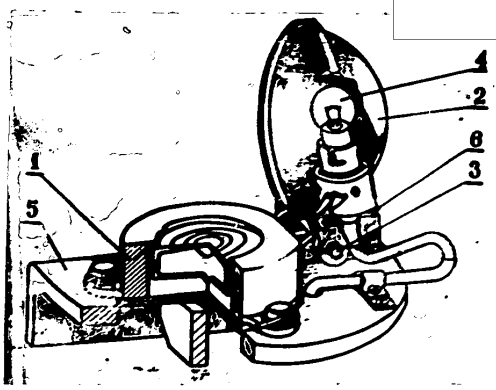


Fig 39. The tilt indicator

1. the tilt indicator proper. 2. the cover. 3. axis pin. 4. bulb. 5. bracket. 6. spring.

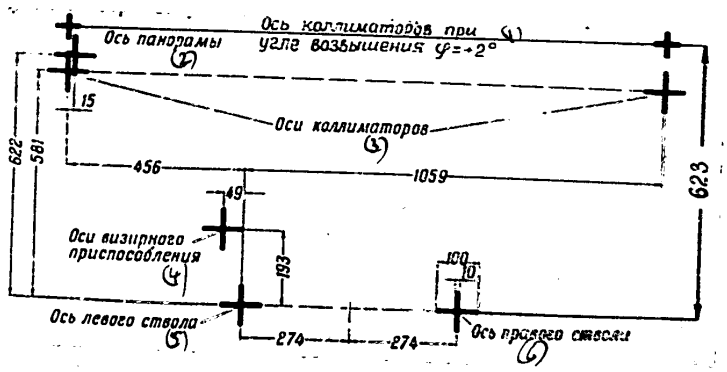


Fig 40. The sight-testing target

1. axis of the collimators at 2° elevation. 2. dial sight axis. 3. axis of the collimators. 4. axis of the blade sight. 5. left barrel axis. 6. right barrel axis.

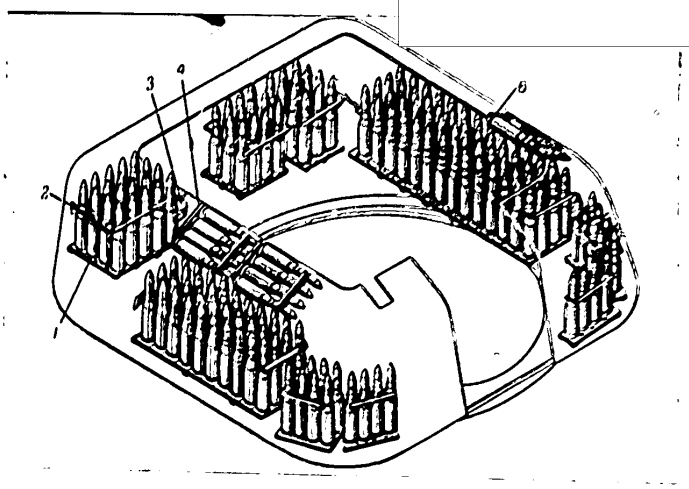


Fig 41. Stowage of rounds in the turret

1. base plate for securing the chargers. 2. strip for securing the tops of the chargers. 3. racks for 5 chargers. 4. stowage for 2 chargers on the turret right side plate. 5. strip catch. 6. stowage for one charger on the left turret side plate.

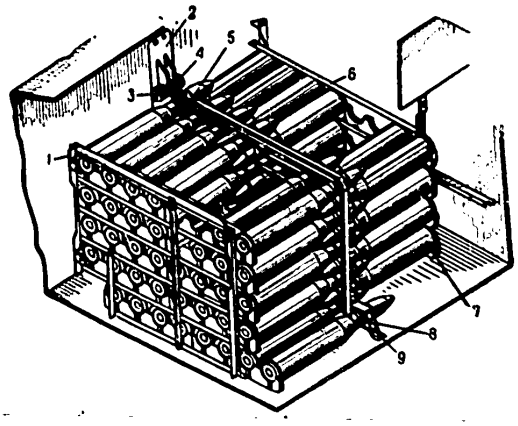


Fig 42. Stowage of rounds in the front of the hull

1. left stowage racks. 2. upright support. 3. hinged strip axis pin. 4. spring. 5. hinged strip. 6. right stowage racks. 7. loaded charger. 8. round grip. 9. catch.

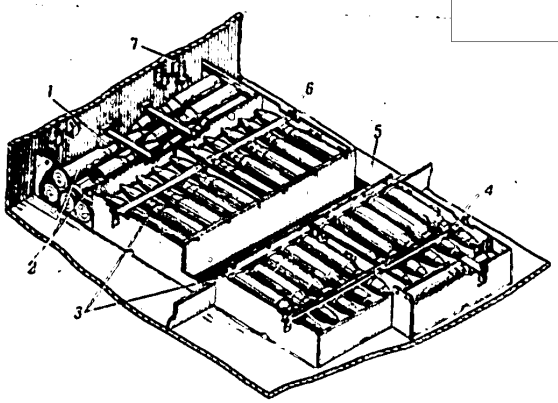


Fig 43. Stowage of rounds on the floor of the vehicle

1. support (wooden packing). 2. rubber packing. 3. rounds. 4. upper strip. 5. section of corner piece. 6. clip. 7. holders for wooden packings when not in use.

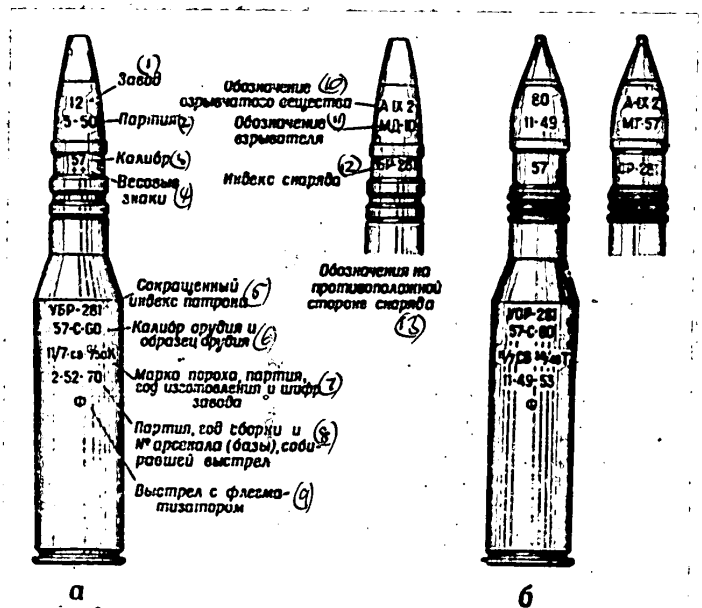


Fig 44. Markings of the S-68 Gun Ammunition

a. markings of the round with the AP tracer shell.
b. markings of the round with the HE tracer shell.

1. factory. 2. lot number. 3. calibre. 4. weight marks. 5. abbreviated round designation. 6. calibre and type of gun. 7. mark of propellant, lot, year of production, factory code marking. 8. lot, year of assembling, and no of arsenal or base assembling the round. 9. indicated desensitiser. 10. type of explosive. 11. fuze designation. 12. shell designation. 13. marks on the other side of the shell.

50X1-HUM

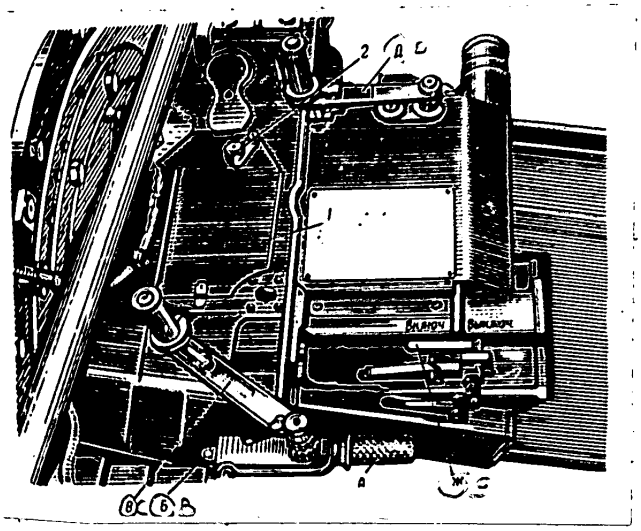


Fig 45. The right automatic loader (viewed from above)

1. right cradle upper cover. 2. cover catch.

handle connecting the parasite gear with the breach and anti-jump catch rack.

hand breach cocking handle

hand automatic loader cocking handle

interlocking mechanism lever.

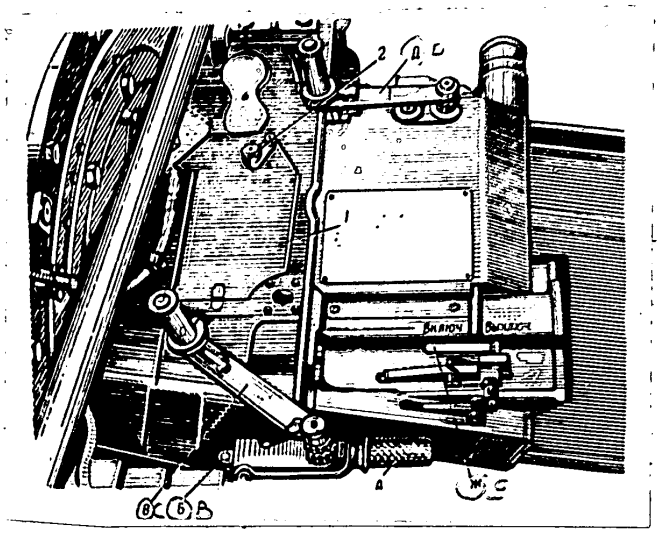


Fig 45. The right automatic loader (viewed from above)

1. right cradle upper cover. 2. cover catch.

handle connecting the parasite gear with the breach and anti-jump catch rack.

hand breach cocking handle

hand automatic loader cocking handle

interlocking mechanism lever.

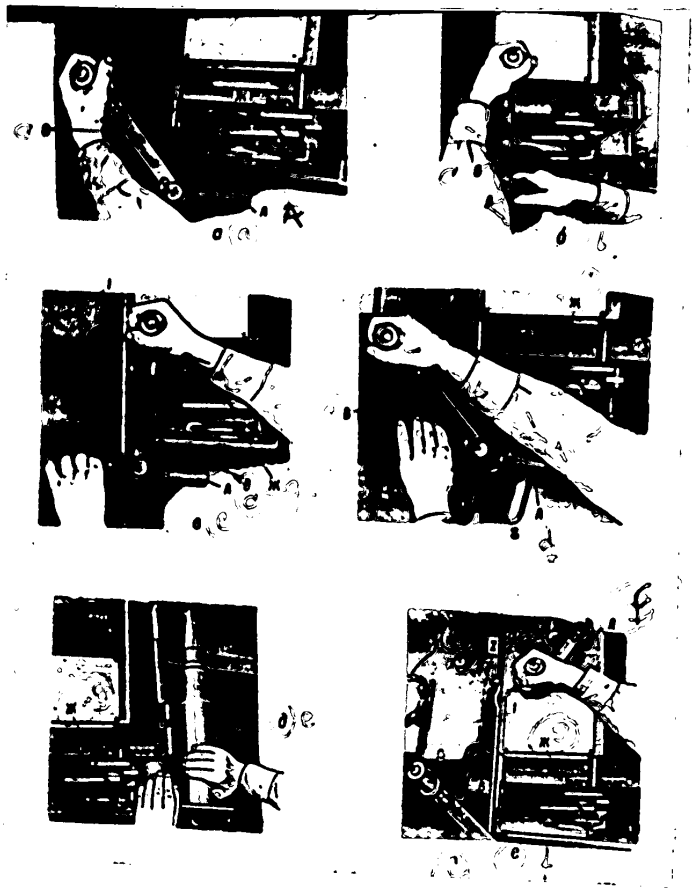


Fig 46. Loading drill

Legend as on Fig 45.

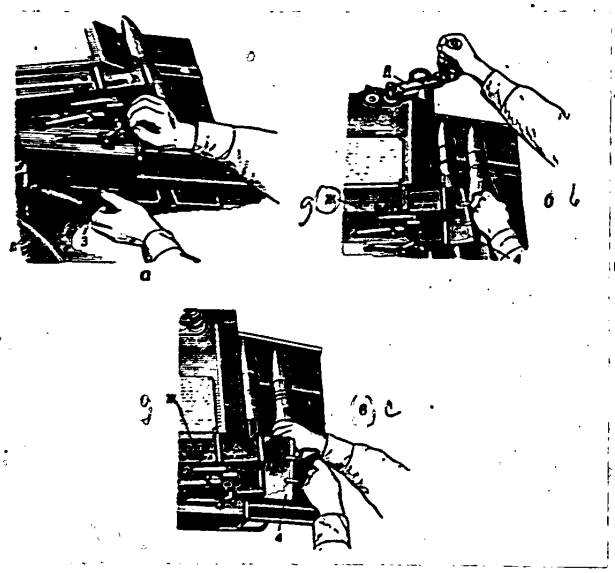


Fig 47. Unloading drill

Legend as for Fig 45.

3. transfer lever. 4. movable cover.

COPY NO. 8 OF 10

NO FOREIGN DISSEM

50X1-HUM

ZSU-57-2 S.P. AA GUN

HANDBOOK

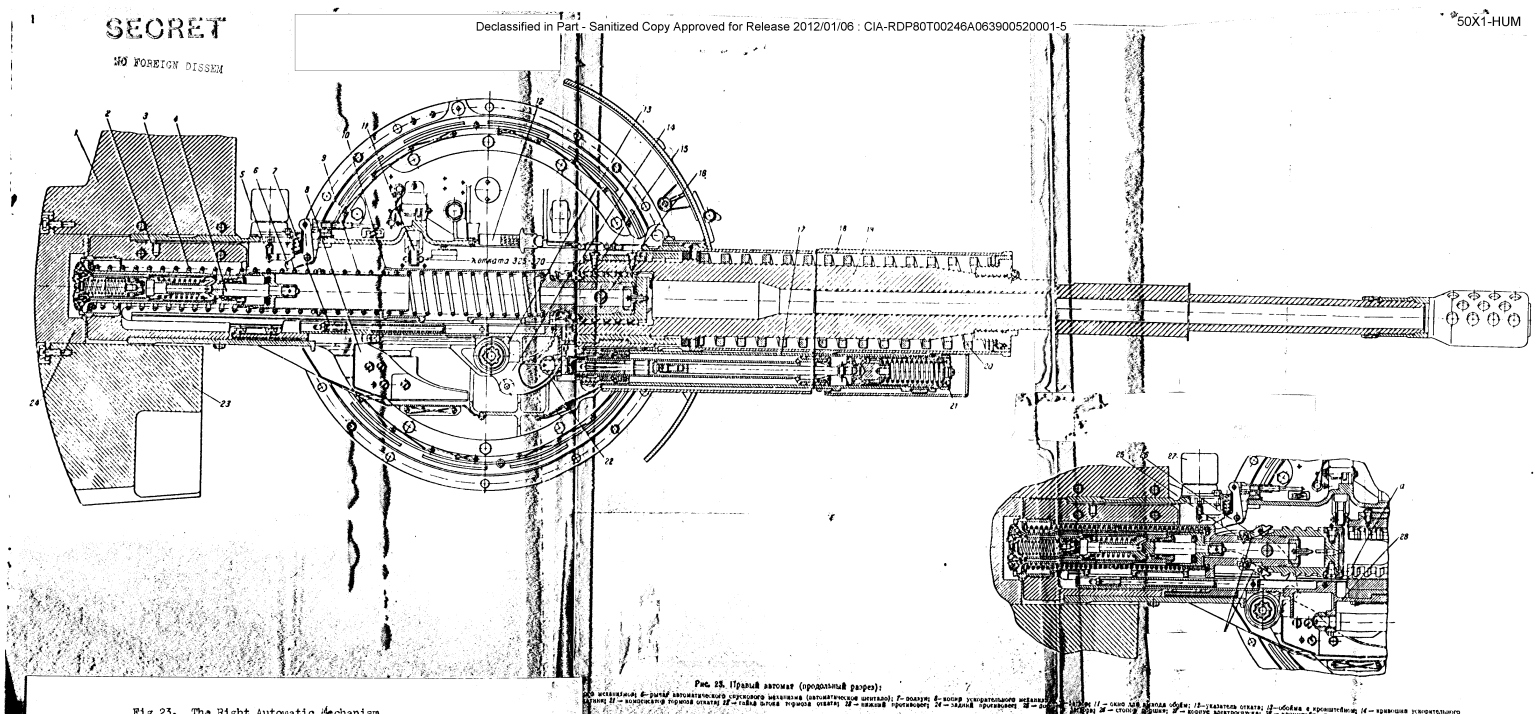


Рис. 23. Правый автомат (продольный разрез):

Fig 23. The Right Automatic Mechanism
(longitudinal section)

1. upper counterweight. 2. rear cover. 3 & 9. breech springs. 4. hydraulic breech buffer. 5. foot & electric firing lever. 6. automatic firing lever (automatic sear). 7. slide. 8. accelerating mechanism cam. 10. breech. 11. ammunition clip ejection opening. 12. recoil indicator. 13. clip and bracket. 14. accelerating mechanism crank. 15. barrel actuating cam. 16. breech block locking bolt. 17. hydraulic buffer. 18. cradle. 19. barrel. 20. spring type recuperator. 21. buffer comensator. 22. piston rod gland nut. 23. lower counterweight. 24. gear counterweight. 25. breech screw. 26. breech stop. 27. electric firing gear housing. 28. bracket a cam to withdraw breech stop.

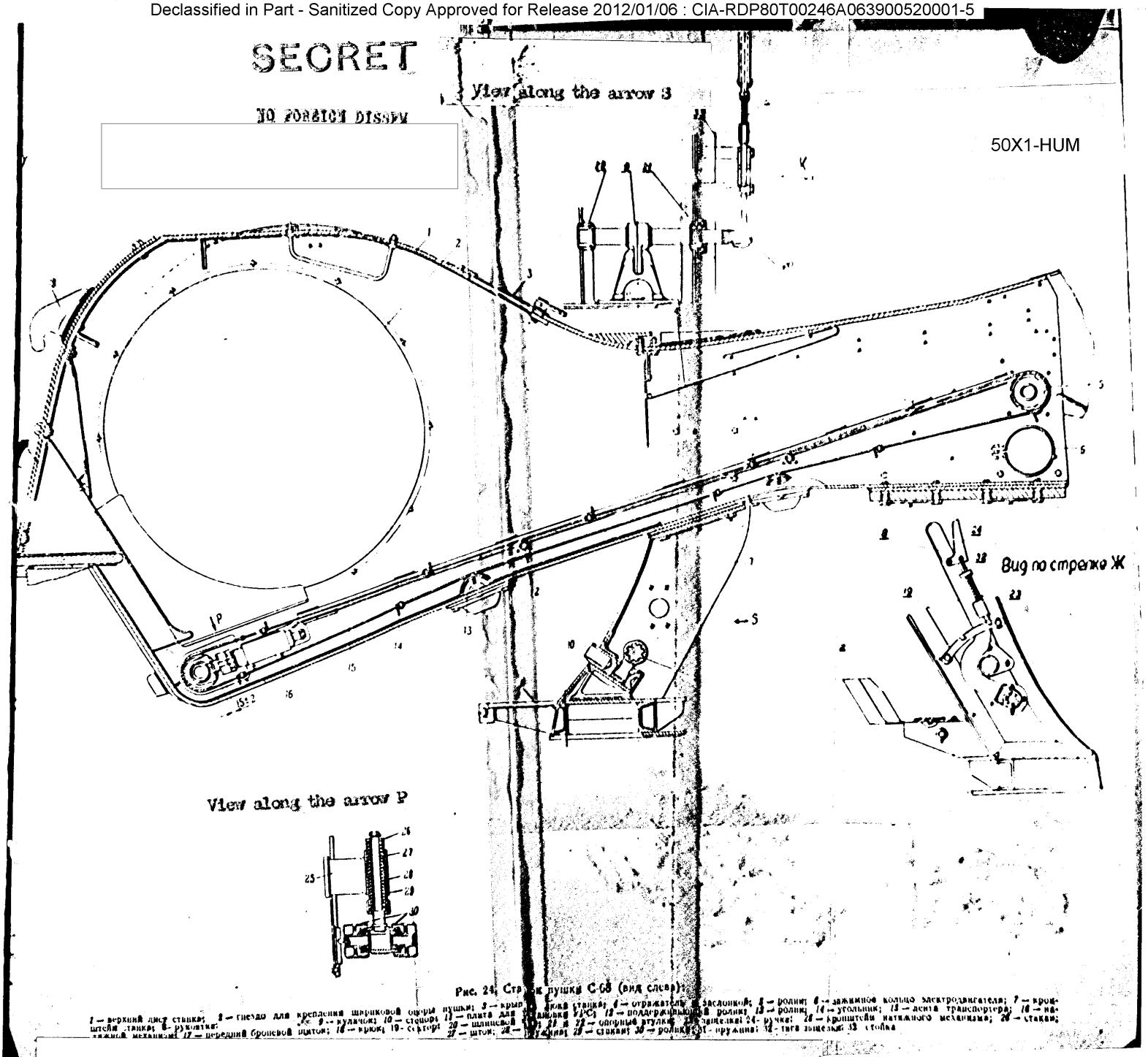


Рис. 24. Стрелковая пушка С-68 (вид слева):

1 — верхний лист станка; 2 — гнездо для крепления шарикового опора пушки; 3 — крышка станка; 4 — отражатель с заслонкой; 5 — ролик; 6 — движковое кольцо электродвигателя; 7 — кронштейн станка; 8 — рукоятка; 9 — кулачок; 10 — стопор; 11 — плата для крепления УПС; 12 — поддерживающий ролик; 13 — ролик; 14 — уголок; 15 — лента транспортера; 16 — натяжной механизм; 17 — передний бронещит; 18 — крюк; 19 — сектор; 20 — шлицевой вал; 21 и 22 — опорные втулки; 23 — защелка; 24 — ручка; 25 — кронштейн натяжного механизма; 26 — стакан; 27 — шток; 28 — пружина; 29 — стойка; 30 — ролик; 31 — пружина; 32 — тяга защелки; 33 — стойка

Fig 24. The S-68 Gun Mounting (viewed from the left)

1. upper mounting plate. 2. gun ball race.securing socket. 3. mounting hatch. 4. ejector with cover plate. 5. roller. 6. electric motor supporting ring. 7. mounting bracket. 8. handle. 9. cam. 10. clamp. 11. universal speed governor mounting plate. 12. supporting roller. 13. roller. 14. triangular metal tooth. 15. ammunition conveyor belt. 16. tension adjusting mechanism. 17. front armoured shield. 18. hook. 19. arc. 20. splined shaft. 21 & 22. bearing bushes. 23. catch. 24. actuating catch. 25. tension adjusting mechanism bracket. 26. sleeve. 27. piston. 28. spring. 29. sleeve. 30 rollers. 31. spring. 32. catch actuating lever. 33. support.

View along arrow Ж