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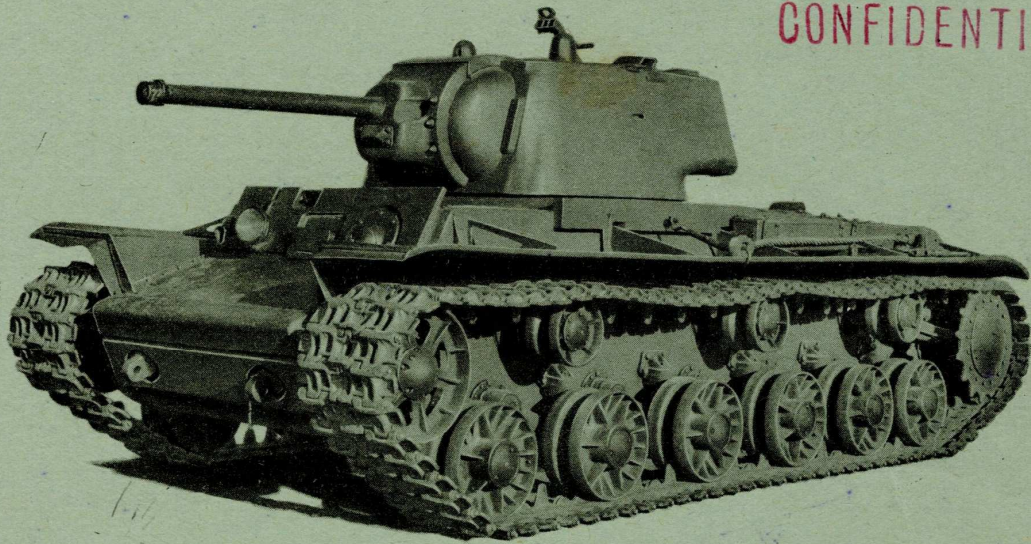
PRELIMINARY REPORT N^o1/O

RUSSIAN KV/1

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Military College of Science
SCHOOL OF TANK TECHNOLOGY
Chobham Lane Chertsey

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By _____ NARS, Date _____

February 1944

INCLOSURE... TO REPORT No. *69022*
MILITARY ATTACHE, LONDON.

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FOREWORD

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An example of the K.V.I. heavy tank reached the School on 22nd November 1943. The vehicle was new and complete in all respects, being fully stowed with ammunition, wireless and other fighting equipment. It was accompanied by a selection of spare parts and a supply of fuel and lubricants.

Copies of the Russian handbooks were received and translated in the School prior to the arrival of the tank and these have been used in the preparation of this report. As the vehicle is about to be submitted for gunnery and field trials no major components have been dismantled.

It is apparent that the Russians have aimed at mechanical simplicity, a general purpose gun, stout armour and, above all, a design facilitating quantity production with limited resources in specialised machine tools and skilled labour. As a result of the latter factor, less attention has been paid to the finish of certain features than would have been the case in this country, but a realistic outlook and a practical approach to the requirements of a fighting vehicle are strongly manifest.

A welded hull and cast turret are employed, the latter indicating that good heavy foundry technique is available. In the design of the hull, reduction of weight has to some extent been sacrificed to simplicity. For example, the transmission compartment is unnecessarily spacious and considerable reduction in weight of armour would be possible without increase of vulnerability.

The 76.2mm. gun is mounted in a three-man turret. The internal stowage arrangements are simple and the aim has been to carry the maximum quantity of ammunition irrespective of its accessibility.

The 39 litre 12 cylinder direct injection compression-ignition engine appears to have been developed from an aircraft power unit and, in contrast to other components, it is relatively costly to manufacture. The weight of all components is low - the main castings are in light alloy - and considerable courage has been shown by the designers in the adoption of certain features uncommon in modern British C.I. practice. It is a matter for surprise that although the Germans have developed apparatus for delivering hot water from another tank or external source, the Russians include no special provision for starting in extreme cold, although a compressed air starter is provided as well as an orthodox electric starter. A translation of a report published in the German paper "V.D.I.", which gives a fairly detailed description of the engine, appeared in "The Oil Engine" for December 1943. Except for the location of certain auxiliaries and increasing the output from 500 to 600 B.H.P. by governing at a higher speed (2,000 r.p.m.), the engine is the same as that fitted in the T/34 Cruiser tank which is 20 tons lighter.

The adoption of torsion bar suspension is interesting, and again the design is remarkably simple; the general layout resembles that of the German Pz. Kw. III.

Clutch brake steering is employed which is unusual on a tank weighing 47 tons, particularly as there is no power assisted control gear; a short cross-country run, however, revealed that the steering is surprisingly responsive, though the driver's controls are rather heavier than those in British A.F.V.'s. No evidence of the life of the brakes has yet been obtained.

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Materials have not yet been fully investigated, but there is no reason to suspect that they are not good. The machined surfaces of castings show no flaws. Aluminium is freely used for engine castings and gear cases. Where necessary for efficient functioning, for example in the periscopic dial sight, the fuel pump, and certain engine components, an excellent finish is attained, but where not essential, it is often rough. No military or mechanical advantage appears to be sacrificed thereby, but a more fully developed industry might be expected to show more refinement without expending more man-hours.

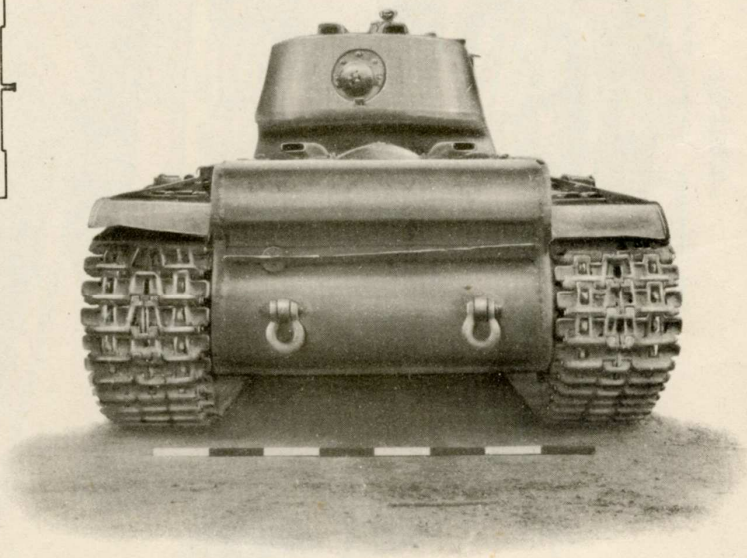
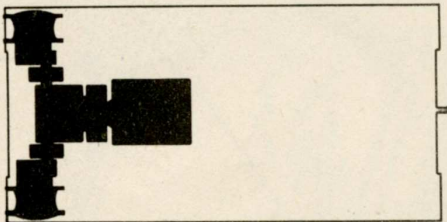
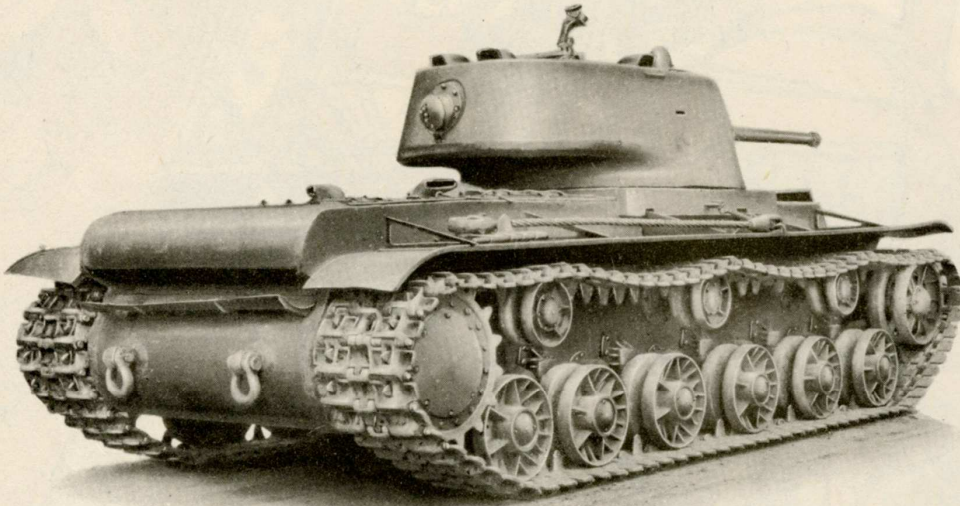
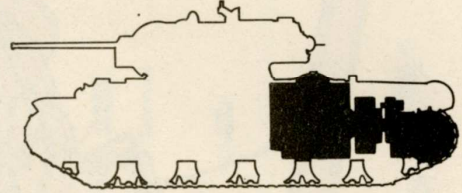
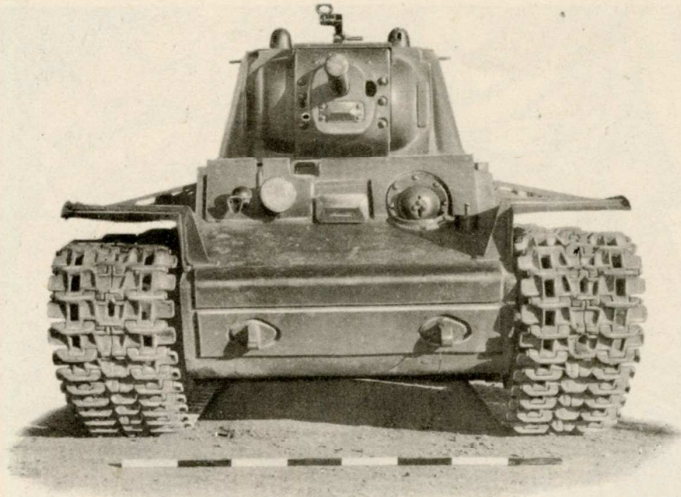
The design shows a clear-headed appreciation of the essentials of an effective tank and the requirements of war, duly adjusted to the particular characteristics of the Russian soldier, the terrain and the manufacturing facilities available. When it is considered how recently Russia has become industrialized and how great a proportion of the industrialized regions have been over-run by the enemy with the consequent loss or hurried evacuation of plant and workers, the design and production of such useful tanks in such great numbers stands out as an engineering achievement of the first magnitude.

This vehicle has been examined by the various specialist sections of the School of Tank Technology, and the report prepared and collated by the Foreign Vehicle Section.

The comments and opinions of various outside specialists who have inspected the machine during the period of examination have in many instances been incorporated.

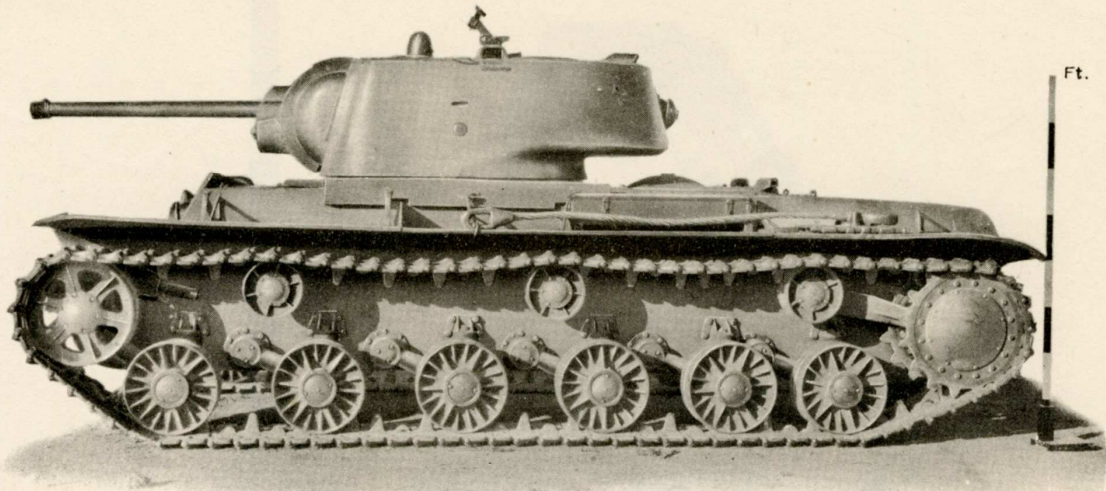
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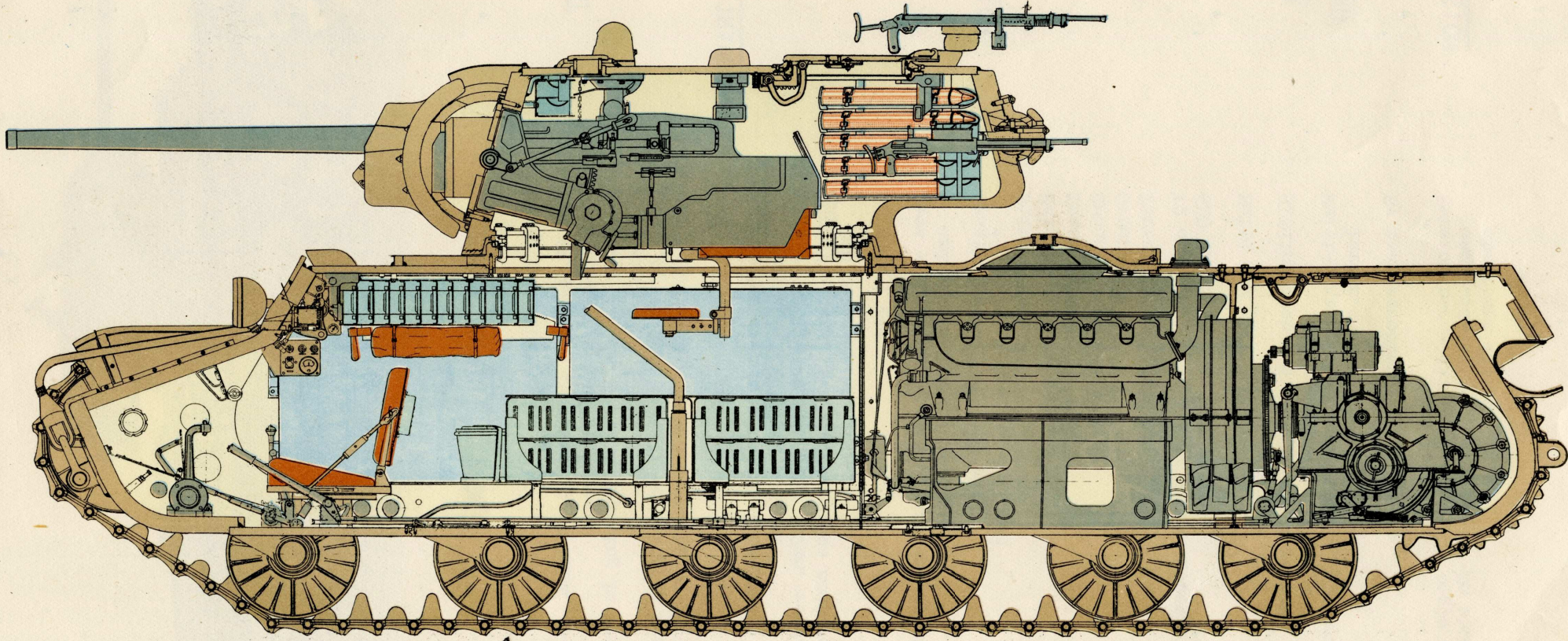
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I. GENERAL SPECIFICATION

<u>TYPE</u>	Heavy Tank K.V.I.	
<u>ARMAMENT</u>	One 76.2mm. gun and one M.G. 7.62mm. co-axial in external mantlet in turret. One M.G. 7.62mm. in ball mounting in front vertical plate One M.G. 7.62mm. in ball mounting in rear of turret One M.G. 7.62mm. in A/A mounting on cupola.	
<u>TURRET TRAVERSE</u>	360° - hand or electric	
<u>ARMOUR</u>	<u>Hull</u> - Basic 75mm. Additional on nose - 26mm. and on front vertical plate - 31mm. Belly - 40mm front, 32mm. rear. <u>Turret</u> - cast. 95 - 100mm. sides and rear. Top rolled plate 30mm.	
<u>WEIGHT</u>	46 tons 7 cwt.	
<u>CREW</u>	Five - Commander, Gunner, Wireless Operator, Driver and second Driver/Mechanic.	
<u>DIMENSIONS</u>	Length (overall without gun)	22' 2 $\frac{1}{2}$ "
	" (with gun at 12 o'clock)	22' 8 $\frac{1}{4}$ "
	Width (overall)	10' 11 $\frac{1}{4}$ "
	Height	9' 7 $\frac{1}{4}$ "
	Track Centres	8' 7 $\frac{1}{4}$ "
	Ground Clearance	1' 5"
	Ground Contact	14' 5 $\frac{3}{8}$ "
	Turret ring diameter	5' 1 $\frac{1}{2}$ "
<u>ENGINE</u>	12 cylinder. 60° V four stroke Diesel. 38.88 litres 600 B.H.P.	
<u>CLUTCH</u>	Multi dry plate	
<u>GEARBOX</u>	Sliding mesh - 5 forward and 1 reverse	
<u>STEERING</u>	Multi-plate clutch brake units. Operated by steering levers.	
<u>DRIVE</u>	By rear sprocket	
<u>SUSPENSION</u>	Torsion bar - six equally spaced bogie wheels each side on trailing arms. No shock absorbers fitted.	

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2. GENERAL CONSTRUCTION

HULL

The hull is constructed of a minimum number of armour thicknesses which are of rolled plate. Extensive use has been made of plate bending particularly in the nose and tail. The maximum bent plate thickness is 75 mm.

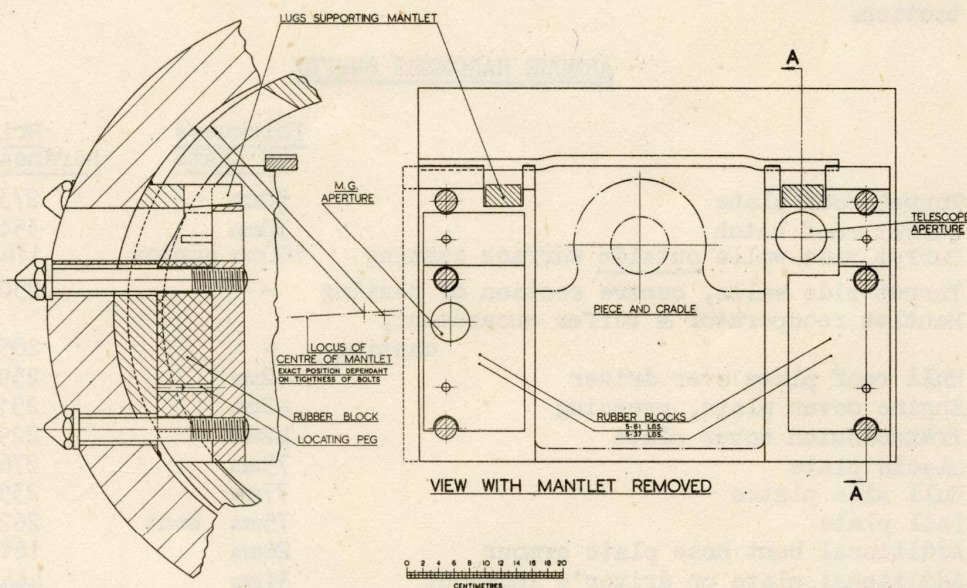
The construction of the hull has been considerably simplified, possibly at the expense of stowage space, by avoiding any "building out" over the tracks.

The front section of the belly plate is 40 mm. thick, probably with a view to giving maximum protection against A/tank mines.

There are additional 26 mm. plates welded on to the front nose plate and a further 31 mm. plate bolted on to the driver's front vertical plate. This latter plate is extended to give some protection to the turret race. Additional plates have also been welded to the top of the hull in an effort to give all round protection to the turret race joint.

TURRET

The turret is cast, except for the roof plate which is of rolled armour welded into position. The casting appears to be sound, suggesting good steel foundry practice. There is a large bulge in the back of the turret which is used for ammunition stowage and the housing of a rear M.G.



MANTLET

A robust cast external mantlet is fitted, but no special precautions appear to have been taken against bullet splash.

An unusual feature is the employment of large rubber blocks between the mantlet and the gun cradle. These are quoted by Russian sources as being fitted for the purpose of reducing impact shocks on the mantlet assembly.

WELDING

The whole of the construction is assembled by welding. The welding is rough by outward appearance and seems to have been done with but small use of fixtures and manipulators. From visual examination the majority of the welding appears to be austenitic, but there are positions where evidence of the use of ferritic rods is to be found.

No special joint preparation has been made, but there is no evidence that the standard of work is not adequate for its purpose.

3. ARMOUR

<u>ARMOUR</u>	<u>BASIC</u>	<u>EXTRA</u>	<u>ANGLE</u>
C. Turret top front	30mm		90° (Hor.)
D. " " rear	30mm		90° (Hor.)
E. " sides	100mm		15°
F. " rear	97mm		15°
G. " front	82mm		15°
H. Gun mantlet	90mm		Round
J. Front vertical plate	75mm	31mm	32°
K. " glacis plate	75mm		72°
L. " nose plate	70mm	26mm	25°
P. Side hull plate	77mm	77mm *	0° (Vert.)
Q. Top front plate	42mm		90° (Hor.)
R. Top rear plate	42mm		90° (Hor.)
S. Top rear engine cover plate	42mm		90° (Hor.)
U. Belly plate (front)	40mm		90° (Hor.)
" " (middle)	32mm		90° (Hor.)
W. Tail plate (upper)	52mm		Curved
" " (lower)	75mm		Curved

(The "Angle of Plate" given is the angle between the plate surface and the vertical, which is equal to the "Angle of Impact" for horizontal attack)

* Extra plates 6 $\frac{1}{4}$ " x 66" welded to top of hull sides for turret ring protection.

ARMOUR HARDNESS SURVEY

	<u>Thickness of plate</u>	<u>Brinell hardness figures</u>
Turret roof plate	30mm	273 - 277
Turret roof hatch	30mm	356
Turret side walls <u>outside</u> surface casting	100mm approx	174 - 184
* Turret side walls, centre section of casting	-	250
Mantlet recuperator & buffer encasement, casting	-	205
Hull roof plate over driver	4.2mm	259
Engine cover plate, pressing	4.2mm	251
Transmission cover plate	4.2mm	229
Glacis plate	75mm	276
Hull side plates	77mm	239 - 257
Tail plate	75mm bent	262
Additional bent nose plate armour	26mm	161
* Additional plate on driver's look-out	31mm	444 - 461
* Additional turret race side protection plates	77mm	283 - 290

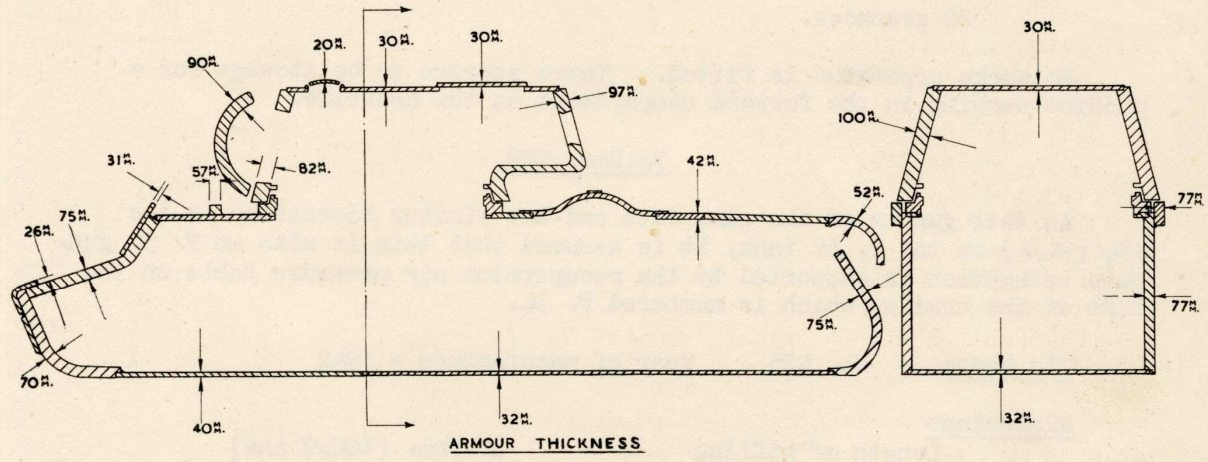
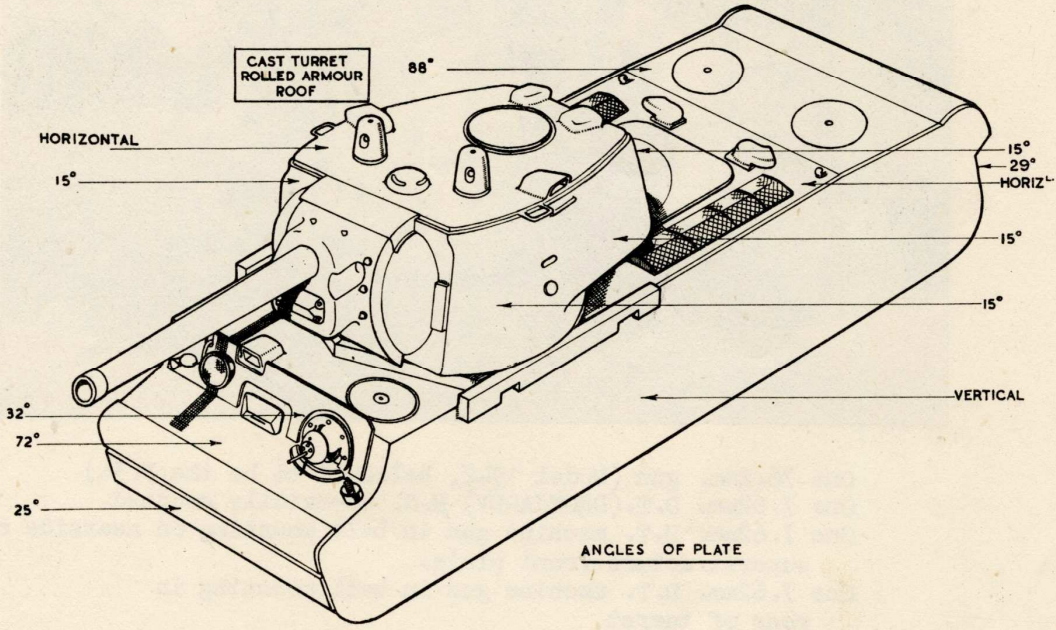
All the above readings have been obtained with the "Poldi" portable Brinell equipment with the exception of those marked by an asterisk.

The "Poldi" figures have been taken on the surface of the armour involving a material removal of not more than .030" - it is probable that the armour is decarburised to some degree and therefore the readings are likely to be low.

In the case of the cast turret approx. .050" of decarburisation was found thus accounting for surface Brinell figures of 174 - 184 whilst sectional examination gave a centre hardness of 250 Brinell. Such a marked difference is most unlikely to be found in the rolled plate.

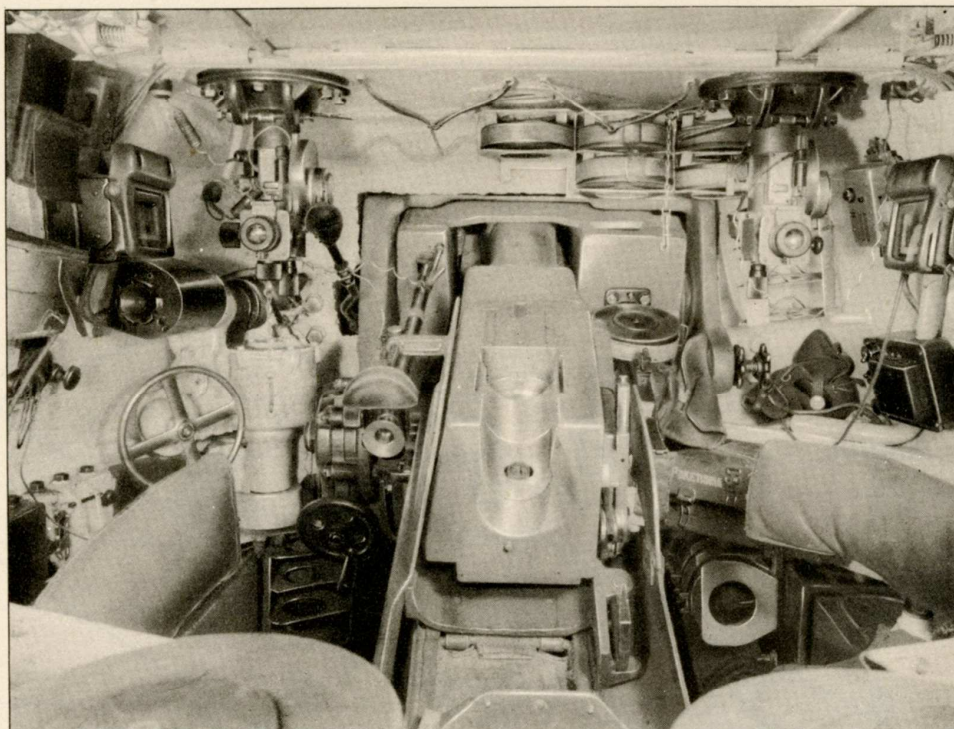
There is no evidence of face-hardened armour and the bulk of the armour, other than the additional plates, is of homogeneous machineable quality comparable in hardness with British I.T. 80D.

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4. ARMAMENT

One 76.2mm. gun (Model 1942, believed to be the F.34)
 One 7.62mm. D.T. (DEGTJAREV) M.G. co-axially mounted
 One 7.62mm. D.T. machine gun in ball mounting on nearside of
 superstructure front plate.
 One 7.62mm. D.T. machine gun in ball mounting in
 rear of turret
 One 7.62mm. machine gun in A/A mounting on cupola
 20 grenades.

No smoke apparatus is fitted. There appears to be stowage for a
 machine carbine in the forward compartment on the nearside.

76.2mm. GUN

As this gun is of the same date and has similar dimensions to the
 F.34 (F.34) on the T. 34 tank, it is assumed that this is also an F. 34 gun.
 This assumption is supported by the recuperator air pressure table on the
 left of the cradle, which is numbered F. 34.

The Piece - No. 425 Year of manufacture - 1942

Dimensions

Length of rifling	2546mm. (100.2 ins)
Length of chamber	410mm. (16.1 ")
Length of bore	2956mm. (116.3 " or 38.7 cal)
Depth of breech opening	212mm. (8.3 ")
Overall length of piece	3168mm. (124.6 ")

Twist: Uniform right hand, one turn in 25 cal.

Rifling:

No. of grooves	32
Depth of grooves	1 mm.
Width of grooves	5.5 mm.
Weight	455 Kg (1003 lbs)

Diameter of base of cartridge case	83.5 mm.
Diameter of rim of cartridge case	90.0 mm
Diameter of neck of cartridge case	76.5 mm
Diameter of bore	76.2 mm
Length of cartridge case	380.0 mm

Construction

The gun is of monobloc construction with a detachable breech ring secured by a locking ring. Two securing rings round the chase, retained by locking rings, carry the recoil cylinders and guides underneath the gun.

Breech Mechanism

The breech mechanism consists of a falling wedge breech block, with hand or semi-automatic operation. Percussion firing is employed, the breech block carrying a readily removable striker and mechanism. Striker protrusion is 2 - 2.38 mm. To open the breech by hand, the breech mechanism on the right of the breech ring is pushed forward against the compression of a breech closing spring, also on the right of the breech ring. It may then be returned to the vertical without opening the breech, by pushing in the catch on its forward edge. The breech block is held in the open position by inserting a round in the breech or by lifting the extractor release lever on the right hand end of the extractor shaft. The shoulders on the breech block are renewable; there is no firing hole bush.

The semi-automatic gear is very similar to that on the United States 75mm. M.3 tank gun. It consists of an actuating lever with a stud which engages a spring loaded cam on run out. The actuating lever is on the right hand end of the actuating shaft, under the breech mechanism lever. The upward movement of the breech block is limited by a stop inside the right side of the breech ring. This stop can be withdrawn to allow the upward removal of the breech block.

The Cradle

The cradle is of cast construction, the lower portion being in the form of a "U". The sides of the "U" are formed at the upper edges into guide rails for the recoil of the piece. The cradle cap is bolted to the front of the cradle and has three drillings - two for the buffer and recuperator rods and one for filling the buffer by means of the cranked filler pipe. Access to the cradle cap through the mantlet is obtained by the removal of the cover in the front of the mantlet and its four securing bolts. Just forward of the centre of the cradle are cast two side pieces containing recesses into which are welded the trunnions. The left hand trunnion carries the operating lever for the periscopic sight linkage. The left hand trunnion casting contains the aperture and the forward part of the mounting for the T.M.F.D. sighting telescope. The aperture has a shutter, which may be opened or closed by the handle above the telescope. The right hand trunnion casting carries the ball mounting for the co-axial M.G. and the recess for the elevation lock plunger. The gun is centrally mounted in the turret.

The front end of the cradle and recoil gear is protected by a bulge cast in the external mantlet. The rear end of the cradle carries the following:

On the left:

- Folding deflector guard on the rear plate of which is a fibre pad
- A small capacity (eight cases) empty cartridge bag
- The externally toothed sector of the elevating gear
- The hand firing gear for the 76.2mm gun
- The browpad for the T.M.F.D. telescope
- The recoil indicator

On the right -

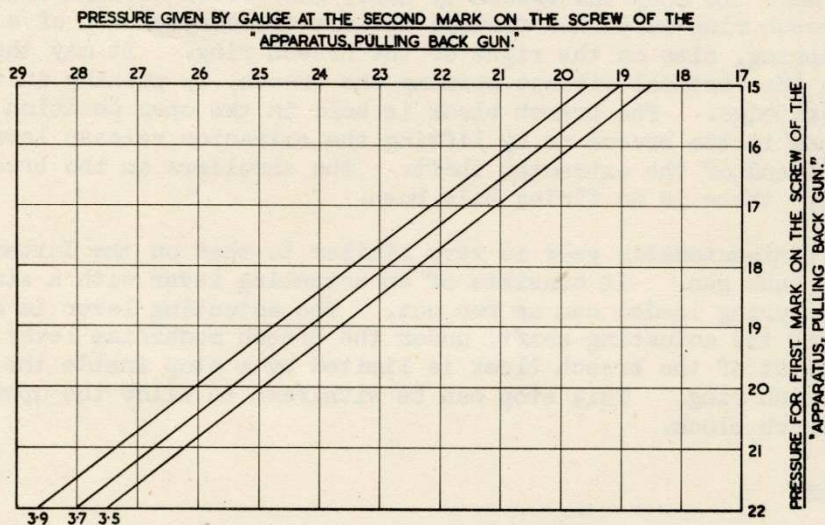
- The semi-automatic cam

The cast external roller mantlet is bolted to the front of the trunnion casings. In addition there is an adapter plate, for strengthening purposes, welded to the mantlet and secured to the cradle by dowels. Rubber shock absorbing pads are inserted between the mantlet and the trunnion castings.

An elevation stop, welded to the turret front plate, is engaged by the rear top face of the mantlet.

Recoil System

The recoil system comprises a hydraulic buffer on the right and a hydro-pneumatic recuperator on the left. These are carried beneath the gun in eyes formed in the lower part of each securing ring. The piston rods are stationary and are secured to the cradle cap.



The recuperator is filled through the hole in the cradle cap between the two cylinders. The recoil indicator on the left of the cradle is graduated from 310 mm. to 390 mm. (12.2 ins. to 15.34 ins.). The Russian Handbook gives the normal recoil of the gun as from 320 mm. to 370 mm. (12.6 ins. to 14.56 ins.) and metal to metal recoil as 390 mm. A graph by which the quantity of liquid in the recuperator may be calculated, is bolted to the left cradle side plate.

Two air pressure readings are taken, one with the piece fully run out (plotted on the vertical scale) and one with the piece pulled back 250 mm. (plotted on the horizontal scale). The intersection of these two readings is read against a curve, if the intersection is on the curve, the recuperator is correctly filled, if it is below, the recuperator needs topping up, and if it is above, the recuperator is too full.

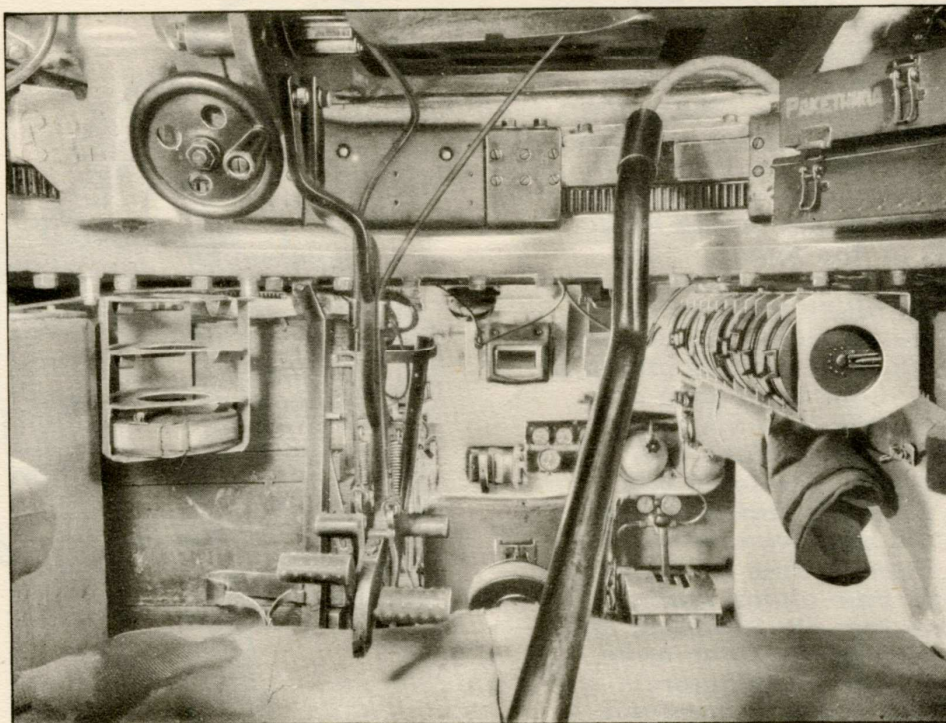
Mounting

The mounting is muzzle heavy, and to compensate for this a cast iron block of 48.4 lbs. weight is bolted to the underside of the cradle. The mounting, however, still remains somewhat muzzle heavy.

Firing Gear

Hand and foot firing are provided for both the 76.2 mm. gun and the M.G. The foot firing of both guns is done from two pedals provided with return springs, and mounted on either side of a vertical pillar bolted to the left hand trunnion bearing cheek. The gun firing pedal is on the left and the M.G. pedal on the right, both are connected to hand triggers on the guns by flexible cables. Foot rests are also provided on the pillar above the pedals.

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The hand firing gear on the 76.2 mm. gun consists of a spring loaded lever which presses on a plunger passing through the left hand breech ring side plate. This plunger bears on another spring loaded plunger, mounted on a transverse axis in the breech block, which carries the sear, which in turn holds back the cocking lever.

Elevating Gear

Hand elevating gear is fitted. The handwheel is mounted on a longitudinal axis at about 30 degrees to the horizontal. It is on the gunner's right side and mounted on the left hand trunnion bearing cheek.

Radius of handwheel	3 1/4"
Elevation	24° 30'
Depression	4°
Total arc	28° 30'
No. of turns of handwheel to cover total arc.	30
Ratio	1°/turn approx.

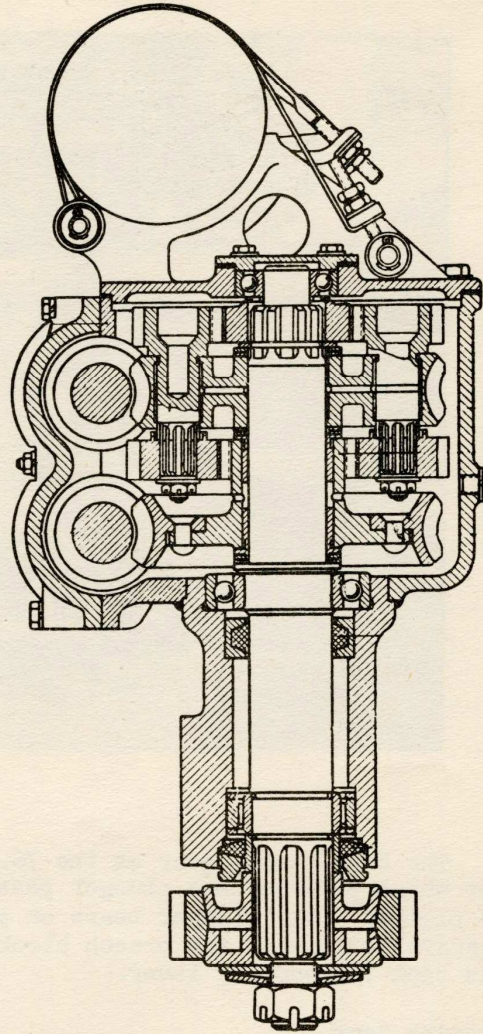
The elevating gear is of the sector and pinion type; the sector which is secured to the cradle has external teeth. Drive is transmitted from the handwheel to a worm and wormwheel. The wormwheel shaft also carries the elevating pinion. There is considerable play in the handwheel, and the operation is jerky and not easy. The clearance between the sector and pinion teeth is .012". The position is cramped and the gunner tends to catch his knees while elevating. The elevating lock is of conical screw plunger type and is mounted in the right cheek of the mounting. It engages a recess in the cradle. A star locknut is provided for clamping the gun, which can only be locked in the horizontal position.

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Traverse Gear

This differs from that fitted in the T.34. Both hand and power units drive a common spur type differential through irreversible worms. These are all housed in a gearbox, mounted as one unit with the handwheel and traverse motor and situated on the left of the turret ring in front of the gunner. The motor worm drives a wormwheel on a vertical shaft carrying two axles free to rotate independently. Both axles carry a pinion on each end. The upper pair of pinions mesh with a sun wheel splined to the vertical rack pinion shaft, the lower pair with a sun wheel formed on the hub of the hand traverse wormwheel, which is free to rotate about the rack pinion shaft. The drive from the handwheel is transmitted to the lower wormwheel through a bevel gear. No selector lever is required.



The power traverse is merely a three speed electrical switching (not laying) gear, controlled for speed and direction by a star wheel, having three positions in either direction and mounted on the rheostat to the left of the traverse motor. There is no positive indication of the three positions, but a catch automatically locks the wheel every time it is turned to "Neutral". The electrical gear comprises a 20 volt, 1350 watt electric motor (stated to give 5800 R.P.M. using 110 amps) and a rheostat mounted on the turret wall above and behind the motor. Drive from the motor is geared down through a flexible coupling to its wormwheel. The handwheel is on a horizontal axis. The rack pinion is carried on a double cone clutch, keyed to the rack pinion shaft and spring loaded by means of a washer, instead of a coil spring, as on the T. 34.

Radius of handwheel $4\frac{5}{8}$ "
 No. of turns to cover 360° 725
 Ratio $.5^\circ/\text{turn approx.}$

Power Traverse Speeds

	<u>Left</u>	<u>Right</u>
Speed 1	4.02°/second	2.95°/second
Speed 2	4.16°/second	4.33°/second
Speed 3	4.87°/second	5.08°/second

Owing to the larger handwheel, the hand traverse is easier to operate than that on the T. 34, and, as there is more room, the left hand may be used for traversing. The backlash is so great that the traversing handwheel may be given one complete turn without moving the turret. The clearance between the traversing rack and the rack pinion is .03". A traverse lock of screw plunger type is situated on the turret retaining clip to the left of the gunner.

CO-AXIAL MACHINE GUN

This is the 7.62mm. D.T. light machine gun. It is gas operated and magazine fed from drum magazines holding 63 rounds. It has a shoulder piece, with notched adjustment for length, butt strap and pistol grip, which, when used in conjunction with the bipod provided in the stowage, permit of its use dismantled as an L.M.G.; the foresight for ground use is on the bipod. It has a very light barrel, which cannot be changed once the gun is mounted; No spare barrels are carried.

The magazines are filled or unloaded on a crudely knocked up filling platform with a key, and appear to be extremely simple and easy to fill. The action of filling at the same time winds up the spring. A small empty cartridge bag is fitted under the gun.

Dimensions

Weight of complete gun (without bipod)	19 lbs.
Weight of barrel	4 lbs. 5 oz
Weight of bipod and foresight	2 lbs. 10 oz
Overall length (shoulder piece fully extended)	1152mm. (45.4 ins.)
Overall length (shoulder piece closed)	977mm. (38.8 ins)
Length of barrel	605mm. (23.8 ins)
Length of chamber	53mm. (2.08 ins)
Weight of full magazine	6 lbs. 5 oz
Weight of empty magazine	3 lbs. 5 oz
Rifling: No. of grooves : 4. Right hand twist	
The gun gives automatic fire only, a safety catch is fitted	
Maximum range on sights	1000 metres
Sight radius	42.6 mm.

The M.G. mounting is of ball type and is held in a carrier bolted and welded to the right hand side of the 76.2mm. gun cradle. The gun is held in the ball by a rotating locking ring provided with three internal interruptions, which engages with a similar ring, with external interruptions, on the gun. Zeroing the gun can be carried out after slackening the three bolts which lock the ball to its casing.

Firing Gear

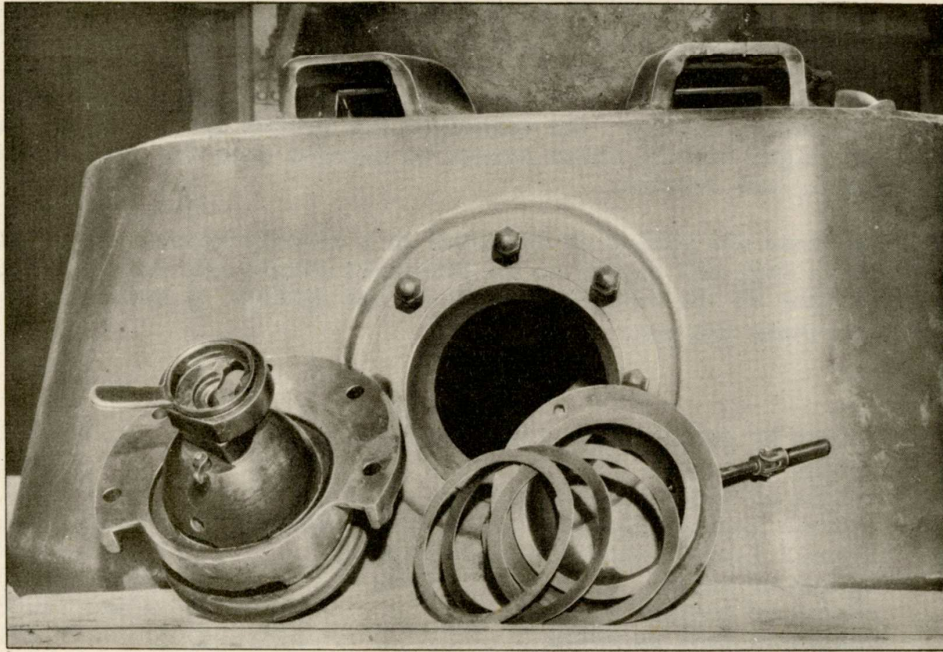
The gun may be fired by the gunner from the right hand foot pedal or by the loader from the trigger on the gun. The foot firing pedal is connected by Bowden cable to a lever with a spring return, clamped to the M.G. trigger guard, which operates the trigger on the gun.

AUXILIARY HULL MACHINE GUN

This is also a 7.62mm. D.T. light machine gun, mounted in a ball mounting similar to that of the rear turret M.G. in the nearside of the superstructure front plate.

Elevation	15°
Depression	5°
Total Arc	20°
Traverse left	15°
Traverse right	15°
Total Arc	30°

Clearance at top of ball .003"

REAR TURRET MACHINE GUN

This is of the same type as the co-axial M.G. and is mounted in a ball mounting slightly to the nearside of the rear wall of the turret. The mounting has an external mantlet and integrally cast armoured jacket for the gun, welded to the internal ball. The ball is inserted from the rear and retained by a horseshoe shaped ring bolted to the housing. The method of mounting the gun is the same as that for the co-axial M.G. An open sight aperture with shutter and foresight nib is provided in the mantlet.

Elevation	15°	Traverse left	15°
Depression	15°	Traverse right	15°
Total Arc	30°	Total Arc	30°

Clearance at the top of ball - .004 ins.

The gun is fired by the trigger on the gun itself and is controlled for elevation and traverse by the pistol grip. A travelling lock of screw plunger type, which locks the gun pointing rearward and downward is fitted at 8 o'clock in the ball carrier.

A/A MACHINE GUN

The A/A D.T. machine gun is mounted in the turret hatch, and has 360° traverse independently of the turret. The mounting is ingenious and consists of two races, upper and lower: the lower race is bolted to the turret roof, the upper race, fully rotatable and supported on balls, carries the elevating gear and gimbal mounting on one side and the turret hatch cover and balance gear on the other. The gun is secured in the gimbal mounting, having 360° independent traverse and limited elevation, on the base of an inverted "L" shaped bracket. The top of the "L" is pivotally mounted in a channel secured to the upper race, with a torsion return spring to balance the weight of the gun. The right hand channel wall is extended and shaped to form an externally toothed quadrant. A pinion engaging this quadrant is mounted centrally on the long arm of the "L" bracket and is turned by a handle on the left of the arm. Thus, turning the handle elevates or depresses the mounting by rotating the pinion around the quadrant. A spring loaded plunger incorporated in the handle engages in drillings in a circular disc on the handle axis, and locks the mounting at any desired elevation. The method of locking the gun in the gimbal mounting is similar to that used to secure the bipod of the ground mounting.

A plunger type traverse lock is also incorporated in the rear of the hatch balance gear on the upper race, It locks the whole mounting in the 12 o'clock position. The mounting is well balanced and easy to operate.

Arc of elevation of arm	2°	100°	
Independent elevation arc of gun in gimbal	24°	+ 17°	} limited by gun } shoulder piece } fouling turret } roof
Total elevation arc of mounting	24°	117°	
Traverse	360°		

5. SIGHTS

(a) TURRET ARMAMENT

The F. 34 gun and the co-axial D.T. machine gun are sighted by means of either:

- (i) a periscopic dial sight PT 47 or
- (ii) a cranked telescopic sight, type TMFD

(i) Periscopic dial sight PT 47

This is a periscopic telescope with rotating head, moveable top prism and illuminated moving graticules. It is mounted in the front of the turret roof on the nearside. The head of the periscope may be rotated independently of the turret by means of a knob on the vertical axis under the sight body. A scale is connected to the head which may be read through a window in the rear of the body, above the eyepiece - this is graduated from 0 - 60 (at 6° intervals) and gives the angle in a horizontal plane between the line of sight and the axis of the bore of the 76.2mm. gun. For sighting the head must be locked at "30". The object prism in the head may be depressed and elevated with the gun by means of a cranked linkage with turnbuckle adjustment connecting an arm on the left hand trunnion to a rotating arm on the right of the sight body. The arm on the sight is geared to a vertical push rod, against which the prism is spring loaded. Deflection of the cross-wires is possible by means of the knob on the left of the eyepiece, and range is put on by the knob under the eyepiece. Three range scales are provided:

Scale " II " - M.G. - 0 - 1000 in 200 metres
 Scale " B " - A.P. - 0 - 3600 in 200 metres
 Scale " O " - H.E. - 0 - 2100 in 50 metres

(The zero is displaced to allow for negative jump.)

A deflection scale graduated left and right from 0 - 32 in mils is provided under the range scales. Both the deflection and range scales are engraved on a glass carried in the vertical part of the body, whereas the cross-wires are in the eyepiece body. Separate lamps for range and deflection scales, the crosswires, and the external scale for the rotating top prism, are provided, current being taken from the tank battery via a junction box on the sight body. The intensity of illumination is not adjustable. A rotatable armoured hood with a vision aperture, covers the object head of the sight and is rotated with it by means of an additional collar on the head which engages a stud on the inside of the hood.

Magnification	x2.5		} Measured by
Field of view	25° 30'		} A.R.L.
Exit pupil diameter	6 mm.		} Teddington.
Transmission of light	26.2%		}

A rubber eyeguard and browpad are fitted, the latter adjustable to allow the use of either eye. The eyeguard is not long or flexible enough to be an efficient light excluder. The periscope is secured in the turret roof by a rotating locking ring of similar pattern to that in the M.G. mounting, which engages with lugs on the periscope body, and two horizontal clamping screws on the mounting.

The object prism assembly is replaceable, and one spare is carried with the instrument. There is no zeroing adjustment in the instrument but adjustment for line may be made by rotating it in its mounting between two adjusting screws, and adjustment for elevation by altering the length of the connecting link to the trunnions.

(ii) Telescope T.M.F.D.

This is a straight tube moving eyepiece telescope, the object end being offset 23mm. from the axis of the body by means of a prism assembly. It has an illuminated graticule and three range scales:

Left hand (CT)	- H.E. (old type)	- 0 - 3800 (in 200m)
Centre (Δ)	- H.E. (streamlined)	- 0 - 5000 (in 200m)
Right hand (O)	- M.G.	- 0 - 1400 (in 200m)

(The zero is displaced to allow for negative jump)

Range is put on by a milled knob under the eyepiece body. Above the range scales there is a deflection scale graduated left and right from 0 - 32 in mils. Deflection adjustment is given by the knob on the left of the eyepiece body. Separate illumination of range scales and crosswires is provided.

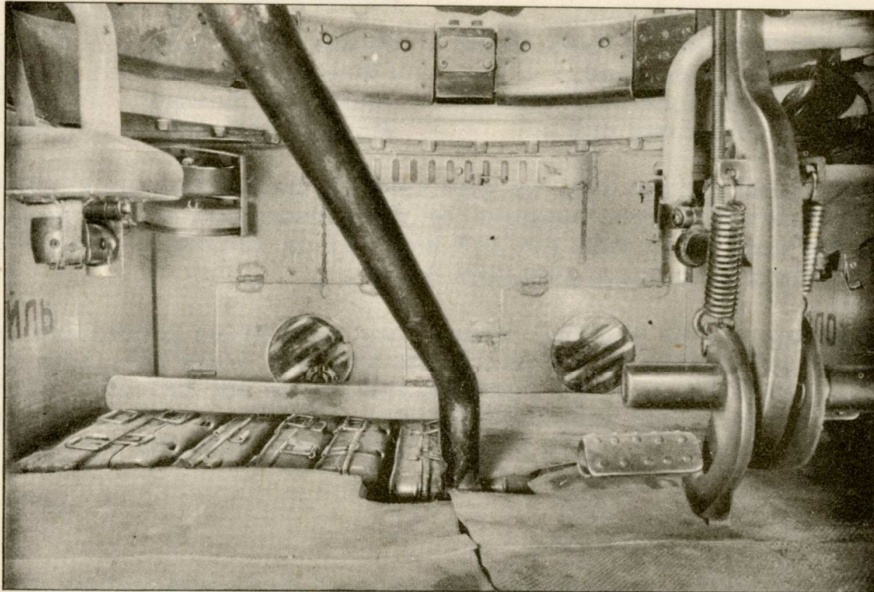
Magnification	x2.5	}	A.R.L. Teddington figures.
Field of View	14° 30'		
Exit pupil diameter	4.6mm		
Transmission of light	39.2%		

The telescope is mounted on the left of the 76.2mm gun in the left hand trunnion casting. It is held secure by a compression spring shock absorber around the telescope body. The bracket is adjustable for zeroing the telescope, laterally by means of transverse and longitudinal dovetail slides, and vertically by two adjusting nuts on a vertical thread in the mounting slide. The telescope is clamped in the mounting by a hinged strap and clamping nut. A rubber eyeguard is fitted which is not an efficient light excluder, and there is a browpad mounted on the cradle of the 76.2 mm. gun. The equipment as fitted is not specially designed for indirect fire, in spite of the fitting of a dial sight, as the scale on the sight is graduated in divisions of 6° only and there is no provision for the fitting of a clinometer though the handbook seems to indicate that a clinometer was formerly fitted.

(b) AUXILIARY M.G.

No telescopes are provided for the auxiliary M.G.'s, the open sights on the gun only being used in conjunction with the foresight nibs and apertures in the mountings. The sight for the A/A machine gun is of the cartwheel forward area type. The cartwheel is pivotally mounted on a horizontal axis in a "U" bracket. The end of the axle is squared and a pendulum is sprung to the squared portion. The pendulum may either be locked perpendicularly to the plane of sight (in which case it swings free and keeps the cartwheel horizontal) for use against high level bombing, or may be locked in the same plane, for dive-bombing attacks. The sight is not a new idea, several varieties of it having been seen before.

Tangent elevation	30'
Deflections (i)	2° 50'
(ii)	5° 28'
(iii)	8° 19'
(iv)	11° 7'

6. AMMUNITION

The ammunition sent with the tank comprised:

76.2 mm.	- 98 rounds
7.62 mm	- 43 magazines of 63 rounds
Grenades	- 20

<u>76.2 mm</u>	<u>Where Stowed</u>	<u>No. of Rounds</u>
	In rack on left wall of turret	5
	In rack on rear wall of turret	5
	In 44 bins under rubber flooring (the bins actually form the floor)	<u>88</u>
	Total	<u>98</u>

This total differs from that given in the handbook, which states that 111 rounds of 76.2 mm ammunition are carried.

All rounds are horizontally and longitudinally stowed, those in the racks being retained by metal quick release straps. Each box holds two rounds, alternately nose and base forward, held in position by metal rests, and is closed by quick release clips. The boxes are stowed in vertical pairs in racks on the superstructure floor - stowage for 48 boxes is provided, the remaining four, of identical size and shape being adapted internally to take:

- (i) 20 grenades
- (ii) grease gun
- (iii) special spanners and tools
- (iv) spare bolts, washers, clips etc.

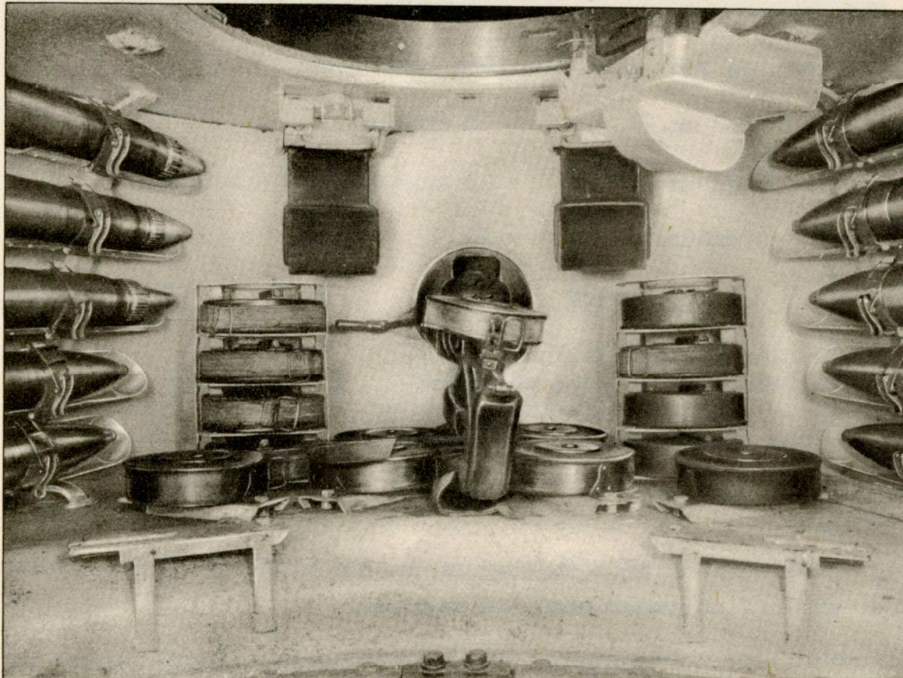
The boxes are unarmoured but dust proof, and, as they cannot be opened while stowed, access to the rounds would be difficult in action; this would apply particularly to closed down fighting owing to the necessity for disposal of the boxes as well as the empty cases.

	<u>Length of complete rounds</u>	<u>Weight of complete rounds</u>
A.P. (Tracer with M.A. 5 base fuse)	614mm. (24.2 ins)	21 lb.
H.E. (with percussion fuse)	634mm. (25.4 ins)	20 lb 6 oz.
Shrapnel (ball with 22 sec. time fuse)	702mm (27.6 ins)	20 lb 4 oz.
" (with fuse cap on)	715mm. (28.1 ins)	20 lb 10 oz.

The H.E. shell is the same as that used in the Russian Model 1936 field gun, some of which have been captured by the Germans and are being used by them under the name "7.62 F.K. 295(r)" hence it is described on Page 43 of "Handbook of Enemy Ammunition Pamphlet No. 8".

The fuse cap on the shrapnel rounds is a spun brass protective cap secured to the projectile by a knurled and threaded brass retaining collar. The A.P. projectile has a short steel ballistic cap and two deep grooves cut around the shoulder. All projectiles have been factory tested for hardness. The shrapnel is understood to be used as case shot, with the fuse set at "yД" (Strike).

7.62mm

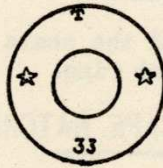


<u>Where Stowed</u>	<u>No. of Mags</u>
In racks, in bulge at rear of turret	8
In clips on floor of bulge	8
In racks, forward on offside of turret roof	5
In straps, in centre of turret roof	2
In racks forward on offside of turret wall	3
In racks, under rear nearside of turret ring	2
In racks, under forward offside of turret ring	3
In racks, on forward offside of forward compartment	12
	roof
In straps on centre of forward compartment roof	2
In clips, on 76.2 mm racks behind driver's seat	3
Total	<u>48</u> (3024 rnds)

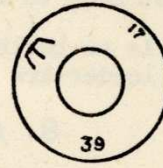
Several types of S.A.A. were found in the magazines with various colour markings, the following list is assumed to be correct but is still subject to confirmation:-

- | | | |
|-------|-------------------------------------|--------------------------|
| (i) | Plain annulus and plain bullet | - ball |
| (ii) | " " " yellow tipped bullet | - heavy ball |
| (iii) | " " " green tipped bullet | - ball with tracer |
| (iv) | Red annulus and green tipped bullet | - incendiary with tracer |
| (v) | " " red " " | - incendiary |

Typical base markings are:



Plain annulus and bullet



Green tipped bullet, red annulus

Dimensions

Overall length of all rounds	3.00 ins
Diameter of base of all rounds	0.49 ins
Diameter of rim of all rounds	0.539 ins
Diameter of neck of all rounds	0.34 ins
Overall length of red tipped bullet	38.5 mm
" " " green " "	37.5 mm
" " " yellow " "	33.0 mm
" " " plain bullet	27.5 mm

Charge - 3 grammes graphited nitro-cellulose for all rounds.

These rounds are rimmed, have gilded metal coated bullets, and coppered steel cases. The cases are not ringed or stabbed.

GRENADDES

These are egg-shaped, of time type, with segmented cast iron bodies. There is a vertical drilling down the centre to take the detonator assembly, which carries a ring attached to a split pin, and a handle for holding the striker after removal of the split pin. When not primed, the central drilling is filled by a long plastic plug, of the same length as the detonator, which screws into the thread at the top of the detonator drilling.

Diameter of grenade	2.15 ins.
Height of grenade when primed	4.75 ins
Weight " " " "	13 ozs.

For delivery, the grenades are packed in wooden boxes of 20, and the detonators in small airtight tins of 20. A tin opener is provided, but as this takes deep bites into the metal, care must be taken when opening the tin owing to the danger of setting off the detonators.

The grenades are stowed in a 2-round 76.2 mm. ammunition box, with the ammunition position stops removed and the inside divided into ten equal compartments. Each compartment contains a canvas bag which holds two grenades and two detonators. Thus, stowage for 20 grenades is provided, and the box may be stowed in any of the racks under the fighting compartment flooring.

7. LEADING DIMENSIONS OF FIGHTING CHAMBER

Floor to bottom of turret ring	635	mm	(25.0 ins)
Depth of turret ring	158	mm	(6.25 ")
Turret ring to turret roof	704	mm	(27.7 ")
Headroom in turret	1498	mm	(59.0 ")
Trunnion axis to top of turret ring	342	mm	(13.5 ")
Trunnion axis to ground	2159	mm	(85.0 ")
Trunnion axis to centre of turret	736	mm	(29.0 ")
Distance apart of trunnions	688	mm	(27.5 ")
Axis of bore of 76.2mm gun above trunnion axis	89	mm	(3.5 ")
Internal diameter of turret ring	1562	mm	(61.5 ")
Internal diameter of turret roof hatch	499	mm	(19.6 ")
Turret ring to rear face of breech ring	605	mm	(23.8 ")
Turret ring to rear face of deflector guard	100	mm	(3.9 ")

There is no basket or rotating floor, and the seats for the commander, gunner and loader are suspended from the turret ring.

8. ACCESS DOORS AND ESCAPE HATCHES

HULL - the driver and wireless operator are provided with a common circular access hatch situated on the nearside of the hull top plate immediately above the wireless operator's seat. This hatch is fitted with a door hinged to the front. A compensating device is provided to assist the opening of the door and to retard its closure. The securing mechanism consists of a central cam operated by a square key from outside and a lever from inside, which extends four bolts, three of which secure the door. The fourth bolt engages the fixed member of the hinge and retains the door in an open position. It is worthy of note that this arrangement forms a positive safeguard against damage to the securing bolts when closing the door, since all bolts must be withdrawn before the "open" position lock is released.

This hatch must be closed before the turret is traversed, as in the "open" position it is fouled by the armoured encasement of the 76.2mm. gun.

A circular escape hatch hinged to the front is provided in the belly plate behind the driver's seat. It is secured by two screw clamps and a spring loaded catch.

TURRET - a circular hatch is provided in the turret roof. The hinged hatch cover is mounted on the upper face of a rotating ring which also carries the A/A mounting. Details of this mounting are given under "ARMAMENT". A coil spring compensating mechanism is fitted to counterbalance the weight of the door during opening or closing. The door is secured by a similar mechanism to that on the driver's access hatch.

9. OBSERVATION AND PISTOL PORTS

Commander/Loader - One episcopes rotatable about a horizontal axis through an arc of 27° mounted on the offside of the turret roof, facing outboard and rearward at approximately 5° to the lateral axis of the tank.

One vision slit, with glass block, at 3 o'clock in the turret wall.

One pistol port, below vision slit.

One PTK periscope in the forward offside of turret roof.

Gunner - One episcopes rotatable about a horizontal axis through an arc of 27° mounted on the nearside of the turret roof, facing outboard and rearward at approximately 5° to the lateral axis of the tank.

One vision slit, with glass block at 9 o'clock in the turret wall.

One pistol port, below vision slit.

One PT 4-7 periscopic sight in the forward nearside of turret roof.

One TMPD telescopic sight in cradle.

Rear Gunner - Two episcopes rotatable round a horizontal axis through an arc of 27° (25° depression and 2° elevation) mounted in the offside and nearside of the turret roof. Both face rearward and outboard at approximately 15° to the keel line of the tank.

Driver - One periscope rotatable about a horizontal axis through an arc of 27° mounted slightly to the offside of the forward compartment roof, facing forward.

One visor, with vision slit and glass block. This visor consists of two main parts, the visor and the glass block mounting which may be locked together or moved independently.

The visor is mounted on two angle brackets on a torsion bar; to give clear vision on approach marches, it may be pushed forward and upward and locked in this position by a spring loaded plunger on each side: when in action, it may be locked in the down position, vision being then through a slit measuring 133mm. x 70mm. The laminated glass block and its mounting may be locked to the visor, when the latter is closed, or dropped down under the glacis plate when the visor is open. The block and holder are similar to those in the turret vision slits, with the same arrangement for the replacement of the block. The sliding shutter on the visor has no slot however, the shutter sliding out of register with the slot for vision. The bonding material used in the laminated glass blocks is of poor quality and air has entered.

Hull Gunner/Wireless Operator - One open sight aperture in M.G. ball mounting.

EPISCOPES - The episcopes are of two piece construction, with sheet metal cases containing two mirrors, the top one of which is replaceable. The eyepiece mirror only is protected by an external glass, mounted in the rubber eyeguard, and a rubber flap is provided over the eyepiece for blackout purposes, when operating at night. A cylinder is formed in the upper part of the casing, about which the episcopes rotate - it is seated in two hollow cylindrical seatings on the mounting, one of which may be withdrawn against a spring for replacement of the episcopes top mirror. The spring loaded seating is mounted on a sliding shutter under the roof, which may be slid across the episcopes opening when the episcopes is dismantled. An armoured hood is welded to the roof over each instrument.

Overall length	306.5 mm
" width	121.0 mm
" depth	40.0 mm
Size of exit window	116 mm. x 45 mm.
" " eyepiece "	121 mm. x 56 mm.

PERISCOPE (PTK) - The periscope P T K is a version of the PT 4-7 simplified by the omission of the range scales and the graticule adjustment. It has a crosswire with a vertical scale graduated above and below horizontal from 0 - 56 in four mil divisions and a horizontal scale graduated left and right from 0 - 56 in four mil divisions. This is presumably for gauging corrections when observing fire. The cross wire, the interior of the body and the external traversing scale of the object prism are illuminated, leads being taken from a junction box on the turret roof. There is no adjustment of the intensity of illumination.

As in the PT 4-7 the prismatic head may be elevated or depressed by the arm on the right of the sight body, which is provided with a knob for operation by hand instead of the linkage to the trunnion as on the PT 4-7. The head may be traversed by a milled knob on the underside of the sight body. There is no adjustment for the cross wire. The object end of the periscope is protected by a rotating armoured hood with a vision aperture, a stud on which engages a recessed collar round the object head.

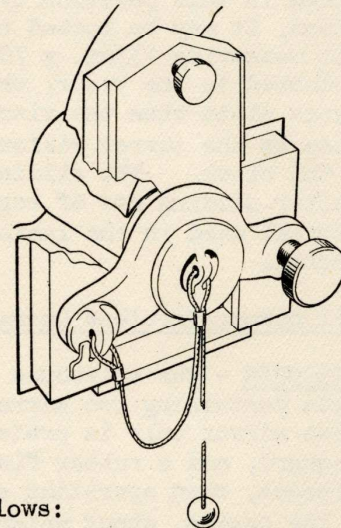
Magnification	x2.5) Measured by A. R. L. Teddington
Field	26°	
Exit pupil diameter	6.1 mm.	
Transmission of light	25.5%	

A rubber eyeguard and browpad are fitted, the latter, mounted on the periscope body, is adjustable to permit of the use of either eye in observing. The eyeguard is not a fully efficient light excluder. The periscope is mounted in the same way as the PT 4 - 7 sight.

VISION SLITS - The vision slits are of parallel type (122mm. x 30mm.) and inclined downwards at approximately 5° to the horizontal in the turret wall. Each is provided with a glass block, whose overall dimensions are 142mm. x 92mm. x 90mm., with a window 112mm. x 41mm. externally and 106mm. x 52mm. internally. They are retained by a drop flap, hinged at the bottom, carrying a rubber eyeguard. The window may be closed by a vertically sliding B.P. shutter between the block and the turret wall, which contains a vision slit measuring 100m. x 1.5mm. The slit is closed when the shutter is in the down position.

PISTOL PORTS - The pistol ports are conical apertures of 62mm. internal diameter, 94mm. external diameter and approximately 10° taper, closed by conical plugs. The plugs are attached to the inside of the turret by a wire cable with a handle. In the event of the plugs being shot away, the ports may also be blanked off by removable vertically sliding bronze shutters on the inside of the turret.

The plugs are retained in the closed position by pivoted bars which engage in annular grooves on the base of the plugs.



10. SEATING

Seats for the crew of five are arranged as follows:

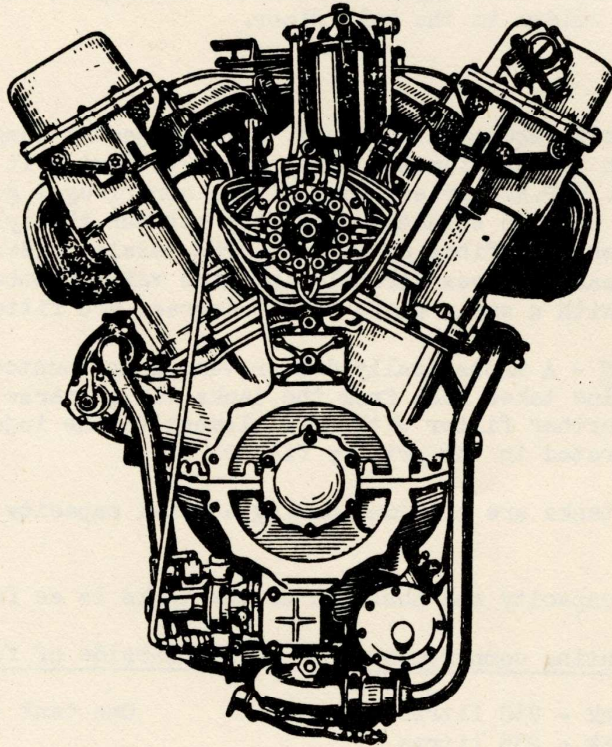
(i) Commander/Loader - the loader's seat is identical with that of the gunner, except that it is mounted on a support bolted to the offside of the turret ring. The seats and backrests of both are cushioned and are provided with removable covers.

(ii) Gunner - the gunner's seat is adjustably mounted for height on a tubular support bolted to the nearside rear of the turret ring. It may be swung out of the way to the rear, and the seat lifted and held up by means of a strap on the pillar and a buckle on the underside of the seat. A wide backrest is pivotally mounted on the support and locked in position by a spring loaded plunger.

(iii) Second Driver/Mechanic - This man is also the rear gunner, his seat may be mounted in either of two positions - one in the rear centre of the turret ring underneath the access hatch (for approach marches, or when using the A/A mounting) and one on the offside rear of the turret ring, to the right of the deflector guard (for use when the 76.2 mm. gun is in action or for firing the rear M.G.) The first position can only be used when the deflector guard is down. The seat is of simple circular padded type, non-adjustably mounted on a stout steel strip bracket. It must be removed before traversing the turret as the bracket fouls the fuel tanks.

(iv) Driver - the driver's seat has a tubular frame and padded seat and back rest. It is longitudinally adjustable and is mounted on the centre of the forward compartment floor. The backrest is pivoted to the seat and supported by two stays connected to the front of the seat. Each stay has a turnbuckle adjustment, which alters the angle of the backrest. A flat formed at one end containing two slots gives a quick two-position adjustment. The backrest may be lowered to horizontal by disconnecting the slots in the stays from the studs on the backrest.

(v) Hull Gunner/Wireless Operator - the hull gunner's seat is circular non-adjustable and mounted on the nearside of the forward compartment floor. It is padded and a protective cushion for the gunner's back is strapped to the nearside wall and the vehicle battery brackets.



II. POWER PLANT

ENGINE

TYPE V-2K 60 degrees 12 cylinder water cooled C.I.

BORE 150 mm.

STROKE 180 mm. (master rods) - 186.7 mm. (articulated rods)

CAPACITY 38.88 litres

COMPRESSION RATIO 15 : 1 (master rods) - 15.8 : 1 (articulated rods)

RATED MAXIMUM POWER 600 B.H.P. at 2000 R.P.M.

The engine is situated in a separate compartment at the rear with a radiator on each side.

The design of the engine in general follows established principles embodied in certain well known in line aero engines and there seems very little doubt that it is basically an aero engine, converted to C.I. and modified for use in A.F.V.'s.

It is of very light construction, the cylinder heads, blocks and crankcase being of aluminium alloy. The blocks are detachable and fitted with wet liners. The combustion chamber is of open type with the injector nozzle situated centrally in the head. To gain access to the injectors it is necessary to remove the valve covers. Four vertical valves per cylinder are operated directly by the camshafts. The pistons are of hot-pressed aluminium alloy and the connecting rods are articulated, of "H" section and machined all over. Copper lead bearings are used in the big ends and mains, and a ball thrust race is located on the driving end of the crankshaft. The crankshaft is supported in eight bearings and is fully machined. No torsional vibration damper is fitted. The crankcase is split along the crankshaft centre line but extends below this level to support side thrust on the main bearings. A bevel on the free end of the crankshaft drives up to the camshafts, injector pump and governor, air distribution valve and dynamo.

Driven also from this bevel and located on the sump are the water pump, oil pump and fuel feed pump. The engine is mounted rigidly at four points on longitudinal bearers welded to the hull floor.

INJECTOR EQUIPMENT

Bosch type injector equipment is used. The injector pump is a 12 cylinder in-line with 10 mm. diameter plungers. In design it is basically similar to the C.A.V. B.P.E. series pumps with a centrifugal governor incorporated at the rear. It is situated centrally between the cylinder banks and driven through a Bosch type fibre coupling. The nozzle holders have a very long reach and the leak off goes directly into the valve chamber. Seven hole closed type nozzles with a spray angle of 170 degrees are fitted.

FUEL PUMP AND FILTERS - A mechanically driven vane pump mounted centrally at the front of the engine takes fuel from the tanks via a coarse filter and delivers through a further filter with silk element to the injector pump. A stop cock is incorporated in the primary filter.

FUEL SYSTEM - Three tanks are provided having a total capacity of 600 litres (131.25 gallons).

The respective capacity and position of the tanks is as follows:

On offside of fighting compartment

Forward - one tank - 230 litres
Rear - one tank - 235 litres

On nearside of fighting compartment

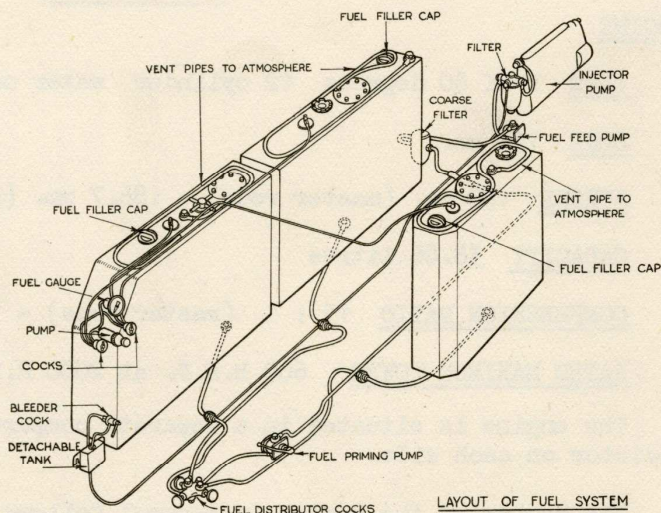
One tank - 135 litres.

Filler plugs are fitted to each tank and are accessible upon removal of B.P. covers on the hull top plate. Each tank is also provided with a remote cock, operated by a handwheel at the top of the tank. These cocks enable the supply from the respective tank to be isolated. Detachable plates are fitted to the top of each tank for cleaning purposes. Vertical anti-splash partitions are fitted across the width of each tank. Hydrostatic fuel gauges are provided on a panel on the right hand wall in the driving compartment. These gauges indicate the

quantity of fuel in each of the three tanks. They are plunger operated and two way cocks are provided to give readings from each individual tank.

A central fuel valve is situated near the floor in front of the driver's seat - this comprises three needle valves, one for each fuel tank, each operated by a separate handwheel and passing fuel to a common outlet. In the delivery line from this outlet is a manually operated semi-rotary vane pump, which is operated before starting the engine to prime the fuel system. A pipe taken from the top of the fuel filter bleeds from a cock in the driving compartment into a small removable tank.

LUBRICATION SYSTEM - The triple gear oil pump is mounted adjacent to the water pump. Two scavenge pumps draw oil from each end of the sump and deliver it to the oil tank, which is rectangular and mounted at the nearside rear of the fighting compartment.



The pressure pump delivers oil into the free end of the crankshaft after it has passed through a clearance type filter incorporating a by-pass valve.

Oil radiator units are mounted at each side of the engine. Each assembly comprises two units, referred to in the handbook respectively as the "oil radiator" and the "additional oil radiator". The "oil radiator" units are mounted vertically at each side of the engine compartment between the hull side and the water radiator. They each consist of two dimpled light metal sheets welded together around their edges and spot welded at each dimple. The "additional oil radiators" are tubular units and are mounted longitudinally across the water radiators on each side of the engine. A control cock, situated low down on the nearside, is accessible through a door in the bulkhead. Manipulation of this cock permits the isolation of the "additional radiators". A further cock, also accessible from the fighting compartment, may be used to isolate the whole cooling system.

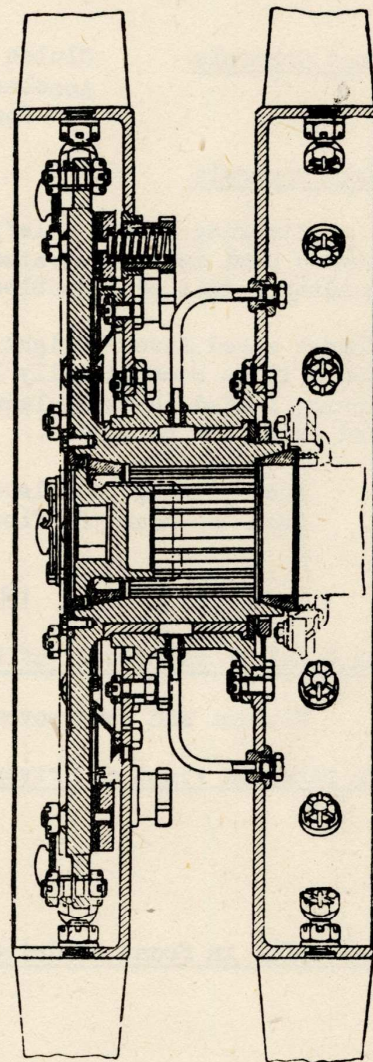
COOLING SYSTEM - The centrifugal water pump is situated on the engine sump. Water is drawn from the bottom of each radiator and delivered to each bank, after circulation through the jackets it is returned to the radiators via return pipes at the flywheel end. The water pump spindle is lubricated from a manually operated greaser on the engine bulkhead.

The greaser is accessible from the fighting compartment. A gilled tube radiator is mounted at each side of the engine compartment. They are inclined towards the top of the engine at an angle of 30 degrees. A shallow circular header tank is mounted centrally over the engine and is connected to each radiator. A filler incorporating a pressure relief valve is accessible on removal of a threaded plug in the engine cover plate.

The cooling fan assembly is driven by the main engine clutch and runs in a cowl in the bulkhead between the engine and transmission compartments. The fan is a composite unit comprising two drums to each of which are bolted sixteen blades. The guide vanes, eleven in number, are set at opposite angles to the fan blades and thus maintain an axial flow of air to the rear fan assembly. Air exhausted by the fan is directed through a further set of fixed radial vanes and then distributed over the gearbox and steering units. A slipping clutch is incorporated in the hub of the fan.

The fan assembly draws air from openings at each side of the engine compartment top plate. The air is directed over the water and oil radiators by a light metal deflector mounted in the mouth of each intake. These plates are constructed around an armoured segment by which they are secured to the fore and aft engine compartment bulkheads. The air is finally expelled through the tail plate.

AIR CLEANERS - Two oil bath type air cleaners are fitted, one for each bank. They are mounted at each side of the engine compartment immediately in front of the rear engine bulkhead. In order to obtain access to the cleaners, it is necessary first to remove the top plate of the rear (transmission) compartment. The cleaners are then exposed by the opening of access plates in the rear bulkhead.



EXHAUST SYSTEM - The exhaust gases from each bank are conveyed via separate manifolds to cast outlets bolted to each side of the engine compartment top plate.

STARTING EQUIPMENT - The engine may be started either by a solenoid operated electric starter, or by compressed air. The electric starter is described in Electrical Section, Para. 17 of this report.

The compressed air system is provided for emergency should the electric starter fail. It comprises two steel cylinders each of 5 litres capacity installed forward to the right of the driver. From the cylinders air is supplied to a distributor mounted centrally on the front of the engine, from which the air is directed to each cylinder through valves in the cylinder head. Two pressure gauges are incorporated, one indicating the pressure in the bottles, the other registering the pressure of air passing to the starter valve. The gauges are mounted at either side of the starter valve to the left of the driver. Independent cocks are fitted to the top of each cylinder. The handbook states that the maximum permissible pressure to be admitted to the engine is 90 Kg./cm². A union is provided for the purpose of charging the bottles from an independent compressor. There is no installation in the vehicle for this purpose.

12. DRIVER'S CONTROLS

Foot Controls

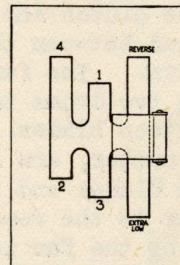
Clutch Pedal - left
Accelerator - right
(No footbrake is fitted)

Hand Controls

Steering levers - left and right hand. A plunger operated, spring loaded pawl is incorporated in each lever. By engagement with a toothed quadrant, this pawl enables steering brakes to be used as vehicle brakes.

Change speed lever - right hand. This lever moves in an exceptionally large gate - A spring loaded hinged plate isolates the reverse and extra low positions.

Fuel priming pump lever - left hand
(Mounted near the floor beside driver's seat).



13. DRIVER'S INSTRUMENTS

On Panel on right wall of hull

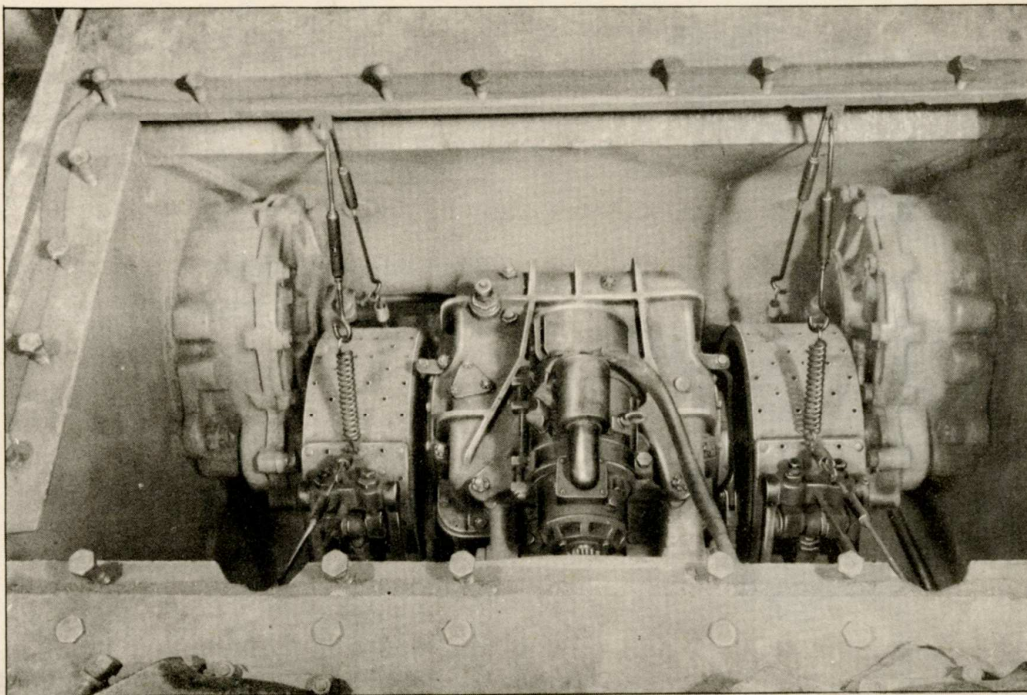
Plunger and changeover cocks for hydrostatic fuel gauges.

On panel on right of driver

Starter switch
Lighting switches
Ammeter

On panel in front of driver

Water temperature gauge
Oil pressure gauge
Oil temperature gauge.



14. TRANSMISSION

CLUTCH

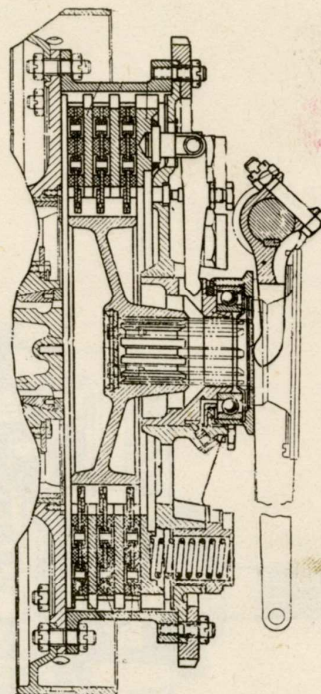
From the engine the drive is transmitted through a dry multi-plate clutch. Clutch operation is by simple mechanical linkage. The driving plates are steel and the driven plates fabric lined.

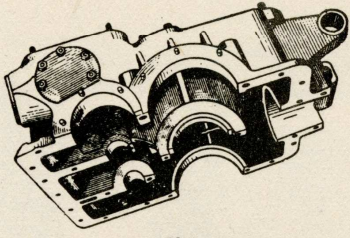
GEARBOX

The gearbox is of sliding mesh type giving four normal speeds, one extra low and one reverse. The bevel is contained within the gearbox, the drive being first taken to a main shaft. Between the main shaft and the output shaft is an intermediate shaft, and this design no doubt contributes to the moderate overall width. The casing is an aluminium casting in two halves, and has liberal external webs to ensure rigidity. Lubrication is by splash, the lubricant being introduced through a filler in the top of the casing. The filler is accessible through a circular hatch in the rear hull top plate and a breather valve is incorporated.

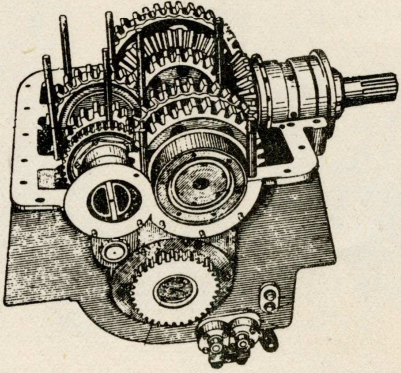
A device to prevent the gears jumping out of engagement is incorporated in the gearbox. The lock is operated through a linkage from the engine clutch withdrawal mechanism, and ensures that no gear can be engaged or disengaged unless the clutch pedal is operated.

When the clutch pedal is depressed the selector shafts are rotated. The selector shafts have annular grooves in which are located studs fixed to each selector, and along its axis each shaft has a slot intersecting the annular grooves. Rotation of the shafts causes the longitudinal slots to register with the studs and permit movement of the appropriate selector.

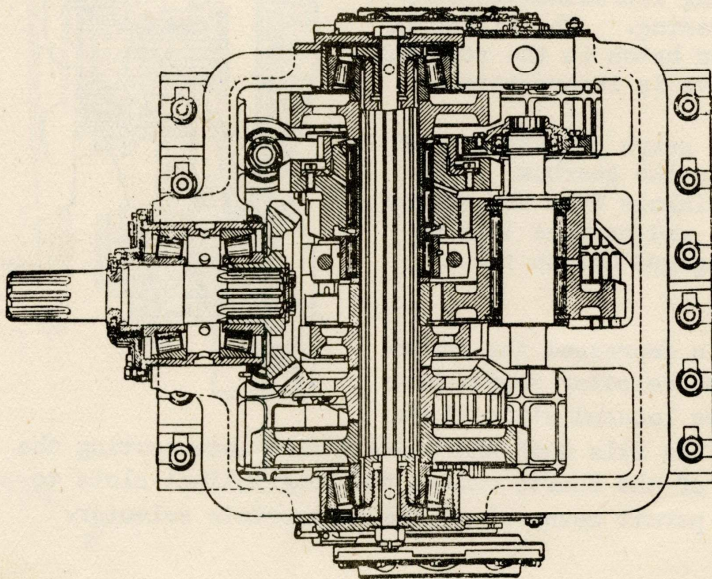
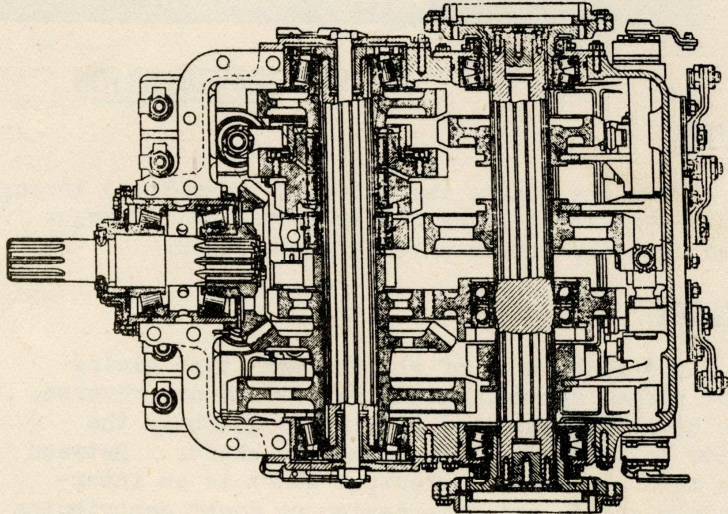




*Gear Box with Upper
half casing removed.*



*Section through
Bevel Gear,
Intermediate &
Main Shafts.*



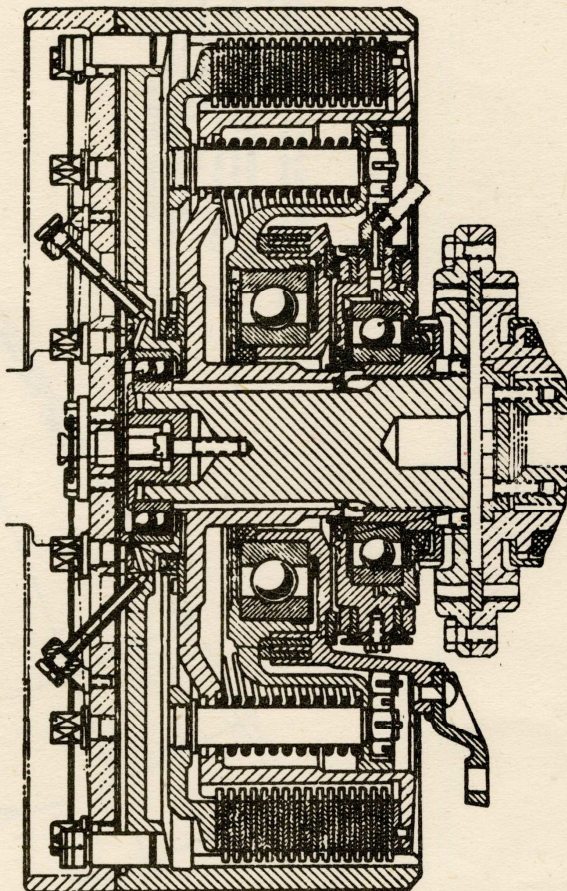
*Section through Bevel
Gear of Driving Shaft.
Axis of intermediate
Shaft & Axis of Reverse
Gear train.*

In addition to the above positive lock, normal interlocking is provided by spring loaded balls engaging the annular grooves in the selector shafts. A "lost motion" device is incorporated in the connection to the clutch pedal so that the clutch can be engaged although the sliding gears may not have been slid right home.

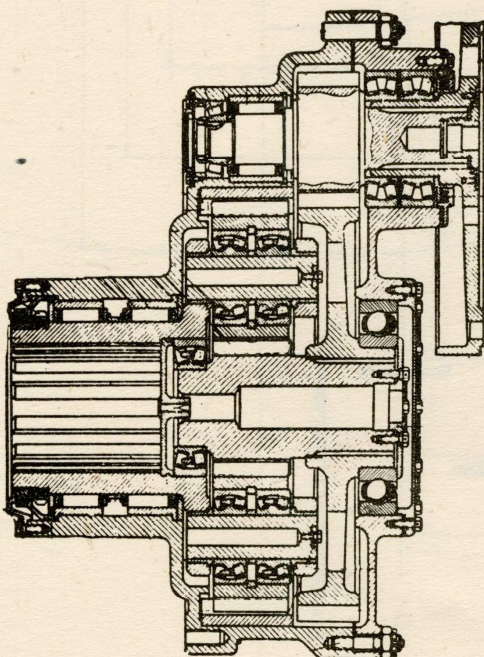
STEERING

Steering is effected by the clutch/brake system - A clutch/brake assembly is mounted at each side of the gearbox and the drive is transmitted from the gearbox mainshaft through a splined coupling to the driving drums of the clutches. Clutch operation is by straight-forward mechanical linkage from the steering levers to the withdrawal mechanism, which is of the cam face and roller type. The driven drums of the clutch are splined to shafts carrying the spur gears of the final reduction. External contracting brake bands with fabric linings act on the driven drums.

Adjustment of the brakes is effected from the transmission compartment, and it is necessary to remove the top rear plate to carry out this operation. A mechanical lifting appliance would be required by reason of the weight of the plate.



15. FINAL DRIVE

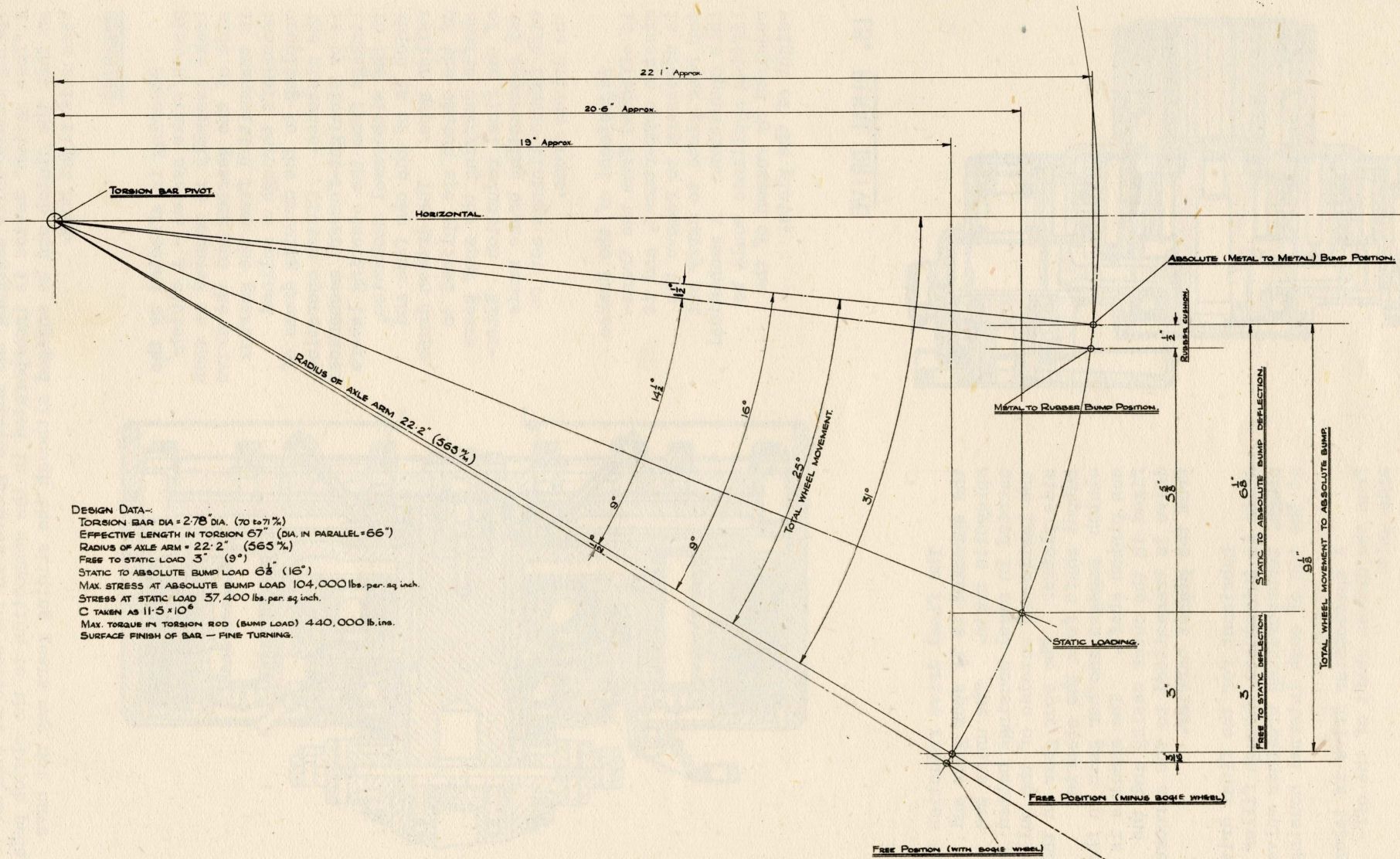


The final drive reduction to the sprocket is by spur gear and epicyclic train. The units are carried in steel housings bolted to the inside and outside of the hull side plates. The spur gear on the output shaft from the steering clutch engages another gear on the sun pinion shaft. The annulus is fixed in the outer casing and the drive is transmitted to the sprockets from the planet carrier.

Lubricant for the final drive units is introduced through filler plugs, incorporating breather valves at the top of each internal housing.

A speedometer drive is taken from the driven shaft of the off-side unit.

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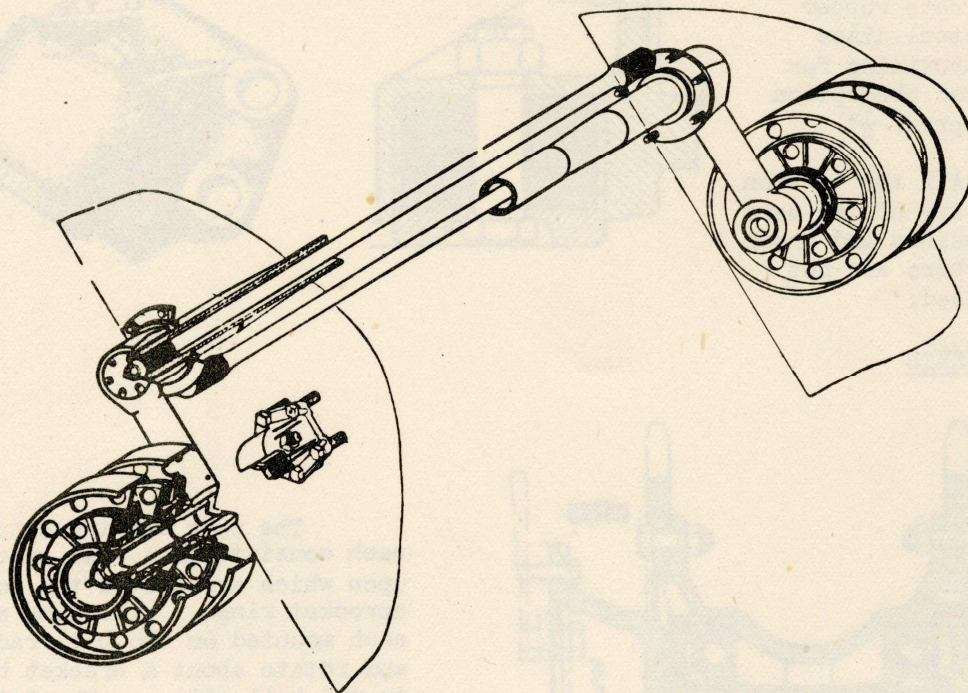


DESIGN DATA:-
 TORSION BAR DIA = 2.78" DIA. (70 to 71%)
 EFFECTIVE LENGTH IN TORSION 67" (DIA. IN PARALLEL = 66")
 RADIUS OF AXLE ARM = 22.2" (563%)
 FREE TO STATIC LOAD 3" (9°)
 STATIC TO ABSOLUTE BUMP LOAD 6.8" (16°)
 MAX STRESS AT ABSOLUTE BUMP LOAD 104,000 lbs. per sq. inch.
 STRESS AT STATIC LOAD 37,400 lbs. per sq. inch.
 C TAKEN AS 11.5×10^6
 MAX. TORQUE IN TORSION ROD (BUMP LOAD) 440,000 lb. ins.
 SURFACE FINISH OF BAR - FINE TURNING.

TORSION BAR SUSPENSION GEOMETRY

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16. SUSPENSION AND TRACKS

The suspension is similar to that on the German Pz. Kw. III and is characterised by its robust appearance.

There are six twin steel bogies on each side. These are sprung through torsion bars lying transversely across the hull immediately above the belly plate. The bogies are of cast steel, and they are supported on the wheel spindles by taper roller bearings. Rubber tyres are not used.

All the axle arms are trailing both on the near and offside. Although a very wide track is employed, no provision has been made in the bogie wheel assembly to take care of transverse articulation such as is encountered on a heavily cambered road or in hard rough country.

The pivotal sleeves are mounted in the hull in plain bronze bearings and in order to attain a high standard of rigidity the inboard and outboard bearings are widely spaced.

Simple grouped lubrication is provided, resulting in only three points per station.

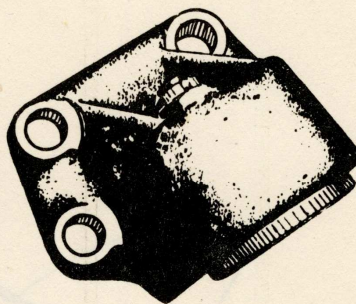
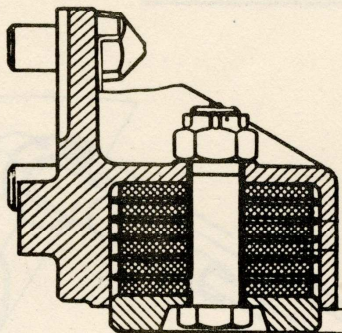
No particular surface finish is employed on the torsion bars which are of simple straight-forward design employing Vee type serrations, with provision for axle arm adjustment through differential splining. There are 62 serrations on the fixed end and 66 on the moving end.

The fixed end of the torsion bar is accommodated in a simple bracket without any adjustment for discrepancies in alignment.

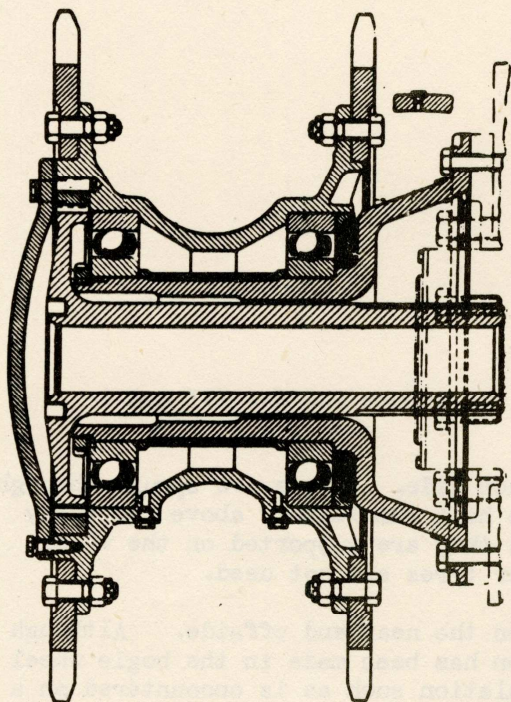
The geometry of a suspension unit and the stressing data are given in the accompanying drawing. This shows a free to static movement of 3" and a static to rubber bump position of $5\frac{5}{8}$ " increasing to approx. $6\frac{1}{8}$ " when metal to metal contact is made with the bump stop.

The bump stop is of simple design comprising a steel casting, housing alternate rubber and steel discs and providing for a total absorption of approx. $\frac{1}{2}$ ".

All the torsion bars are of the same dimensions and shock absorbers are not provided.



SPROCKETS

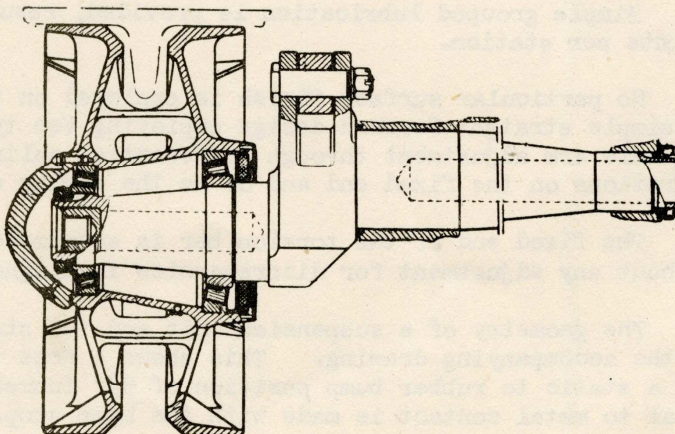


The rear driving sprockets each consist of a cast steel hub upon which are bolted two toothed sprocket rings. The hubs are each mounted on two ball races and rotate about a bracket bolted to the hull side. The drive is transmitted to the hub by a semi-floating shaft to the outer end of which is splined a toothed ring which engages annular teeth in the hub.

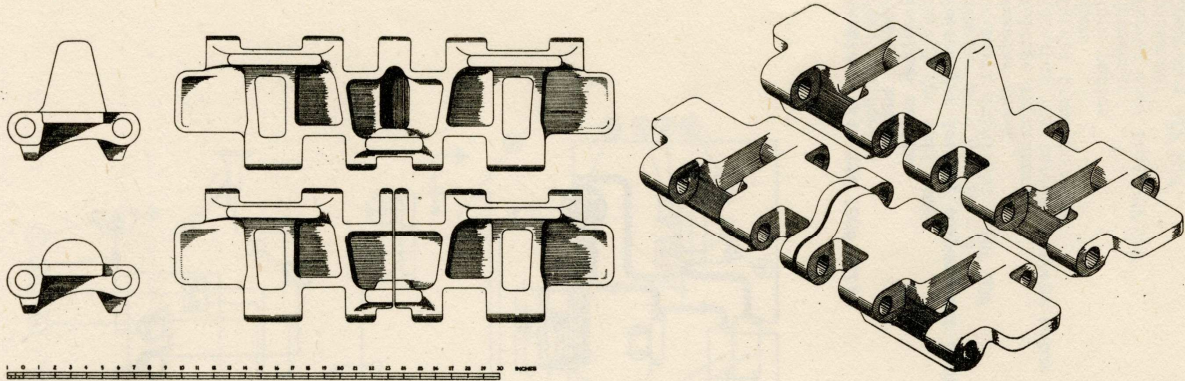
P.C.D. of sprocket	2' 10"
Width from tooth centres of outer and inner rings	1' $\frac{3}{2}$ "
No. of teeth	16

IDLERS

The front idler wheels are steel castings. The hub and rims are a single casting, the guide horn of the track running between the double rims.



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TRACKS

The tracks are manganese chromium steel stampings. Two types of link are employed, one with a guide horn and one plain. The plain link is formed in two halves. The two types of link are generally alternately disposed in the track assembly, but in several sections of the track the interposition is irregular, there being three or four horned links fitted consecutively.

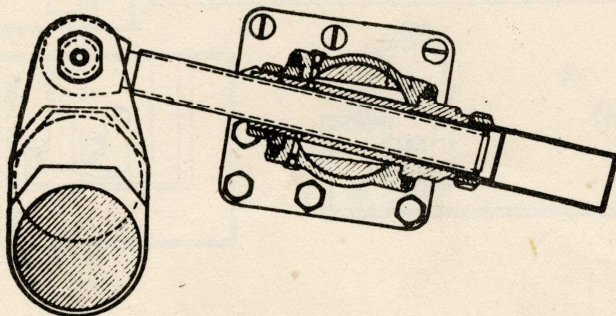
The track pins are retained by circlips locating in annular grooves in the pins, plain washers are fitted between the circlips and the track lugs.

Width of track	27 $\frac{1}{2}$ "
Pitch " "	6 $\frac{1}{4}$ "
Length of Pin	25"
Diameter of Pin	1 $\frac{1}{8}$ "
No. of lugs	5/4
Weight of horned link	48 lbs. 14 oz.
" " plain "	48 lbs.
" " pin	7 lbs. 8 oz.

A sample horned track link from a K.V. I was submitted for metallurgical examination by the Department of Tank Design and the results are given in D.T.D. Report No. M. 6597 M/2 No. 1 dated January 1943.

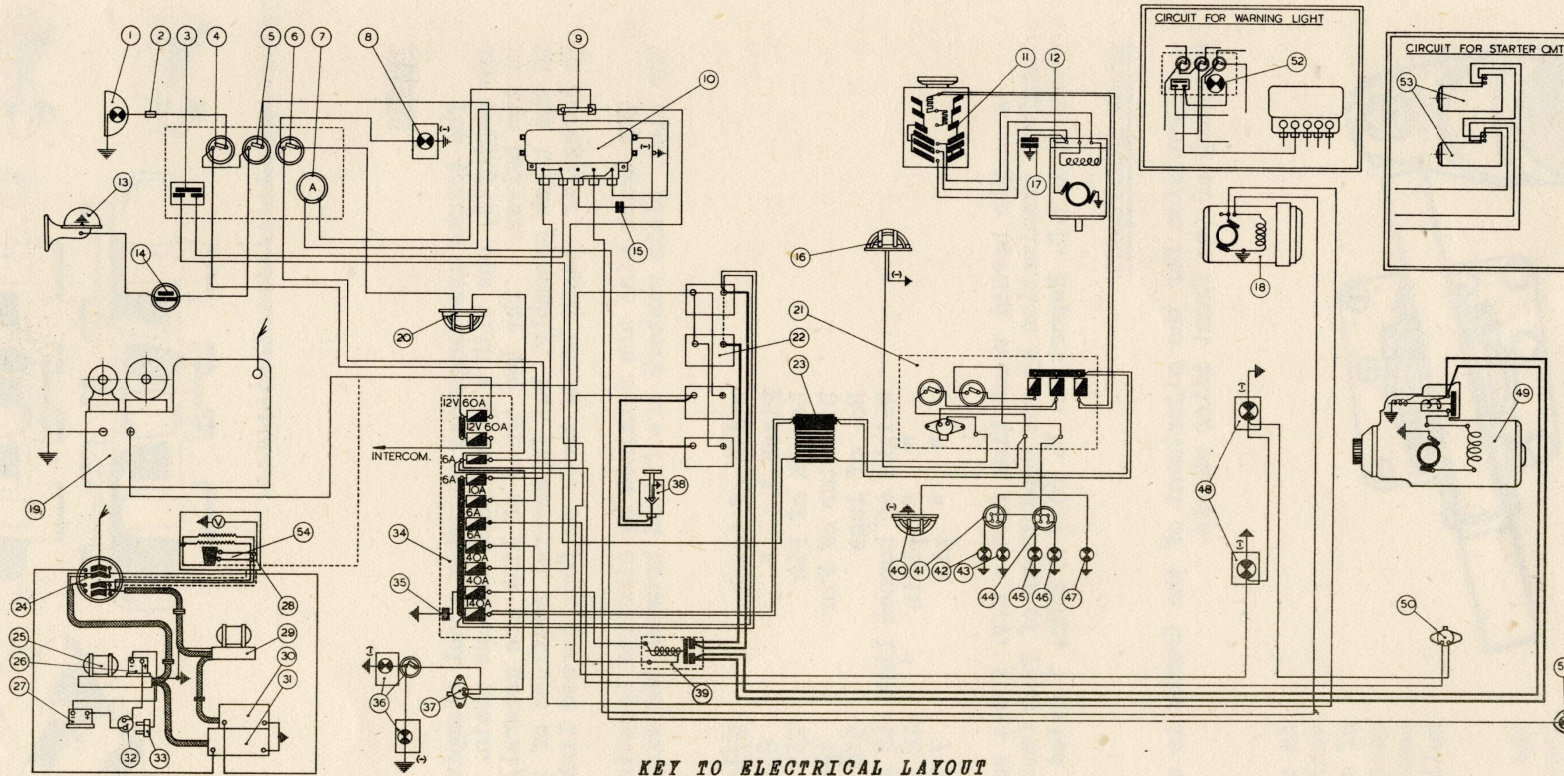
Track Adjustment

Provision for the adjustment of the tracks is made through the cranked mounting of the front idler wheels.



Movement of the cranks is effected from outside the vehicle through the medium of a drawbolt carried in a mounting, with a pivotal bearing for the bolt on the hull side.

An eye is formed at the head of the bolt for insertion of a tommy bar. Both the drawbolt and its bearing are capped to exclude dirt.



KEY TO ELECTRICAL LAYOUT

- | | | |
|---|---|---|
| 1. Headlamp with 25V 100W bulb | 19. Radio Set 10-R(10 - P) | 37. Socket |
| 2. Plug and Socket | 20. Roof lamp 26V 10W illuminating driver's compartment | 38. Earth switch |
| 3. Starter button | 21. Turret panel | 39. Starter relay |
| 4. Headlamp switch | 22. Batteries 12V | 40. Turret roof lamp 26V 10W |
| 5. Switch for tail lamp | 23. Rotary base junction | 41. Distribution box for periscope |
| 6. Switch for driving compartment light | 24. "Receiver-Transmit" switch | 42. Lamp 26V 0.15W illuminating graticules of periscope |
| 7. Ammeter 50 - 0 - 50 - A | 25. Transformer for the receiver | 43. Lamp 26V 0.15W illuminating cross wires of periscope |
| 8. Driver's dashlight - 26V 10W | 26. Indicator lamp - operating | 44. Distribution box for Commander's periscope |
| 9. Ammeter shunt | 27. Indicator lamp - spare | 45. Lamp 26V 0.15W illuminating graticules of Commander's periscope |
| 10. Voltage regulator | 28. Hand voltage regulator | 46. Lamp 26V 0.15W illuminating graticules of Commander's periscope |
| 11. Rheostat for turret traverse motor | 29. Transformer for the transmitter | 47. Lamp 26V 10W illuminating telescope |
| 12. Turret traverse motor | 30. Transmitting set 71 TK-3 | 48. Lamp 26V 10W illuminating engine compartment |
| 13. Horn | 31. Receiver set 71 TK-3 | 49. Starter |
| 14. Horn button | 32. Indicator lamp socket | 50. Socket in transmission compartment |
| 15. Condenser | 33. Two-pin plug | 51. Tail lamp 26V 10W |
| 16. Turret roof lamp 26V 10W | 34. Fuse panel | 52. Inspection lamp 26V 5W |
| 17. Condenser | 35. Condenser | 53. Starter motor |
| 18. Generator 1KW 24V | 36. Lamp 26V 10W illuminating wireless set | 54. Receiver |

17. ELECTRICAL EQUIPMENT

The whole of the electrical equipment on the K.V.I. operates on a 24 volt earth return system, with the exception of the wireless and intercommunication systems which are 12 volts and are connected across one bank of accumulators and earth.

Accumulators

Four lead acid 12 volt accumulators of about 180 amp/hours capacity are connected in series parallel to give the necessary 24 volts. The accumulators are carried in tiers behind the front gunner's seat and the negative leads are earthed through a single pole plunger type switch mounted between the front gunner and the driver. The individual cell terminals are connected by bus-bars which are brought out to the main terminals at the end of the accumulator case. The cells are mounted in a wooden crate and are completely covered with pitch, only the filler orifices and cell terminals projecting. The accumulators must be removed from their mounting for topping up.

Generator

The accumulators are charged by a 24 volt, 4 pole, shunt wound, totally enclosed generator of 1000 watt output mounted on the left hand side of the engine and driven through a slipping clutch. The negative pole of the generator is earthed.

Voltage Regulator

Voltage regulation is by a vibrating type regulator of the constant voltage, current limiting pattern. The regulator is carried under the glacis plate on the right hand hull wall and is mounted in a pressed steel case with the cut-out. The cut-out is of normal design having two sets of contacts. The regulator consists of two units; one controlling the voltage, the other limiting the current. The two units are identical in mechanical construction.

STARTER

The starter motor is a 24 volt, 4 pole, series wound, totally enclosed machine with negative pole earthed, and is mounted in a cradle carried on top of the gearbox. The motor is controlled through two solenoid operated switches. The main switch is operated by a push button on the instrument panel to the driver's right, and the switch itself is mounted on the floor forward of the front gunner's seat. This switch completes the circuit to the solenoid switch mounted on the starter motor body. This second solenoid when energised, engages the starter pinion with the flywheel ring, then by means of a bridge piece on the solenoid core, completes the circuit to the starter motor armature.

LIGHTING

External

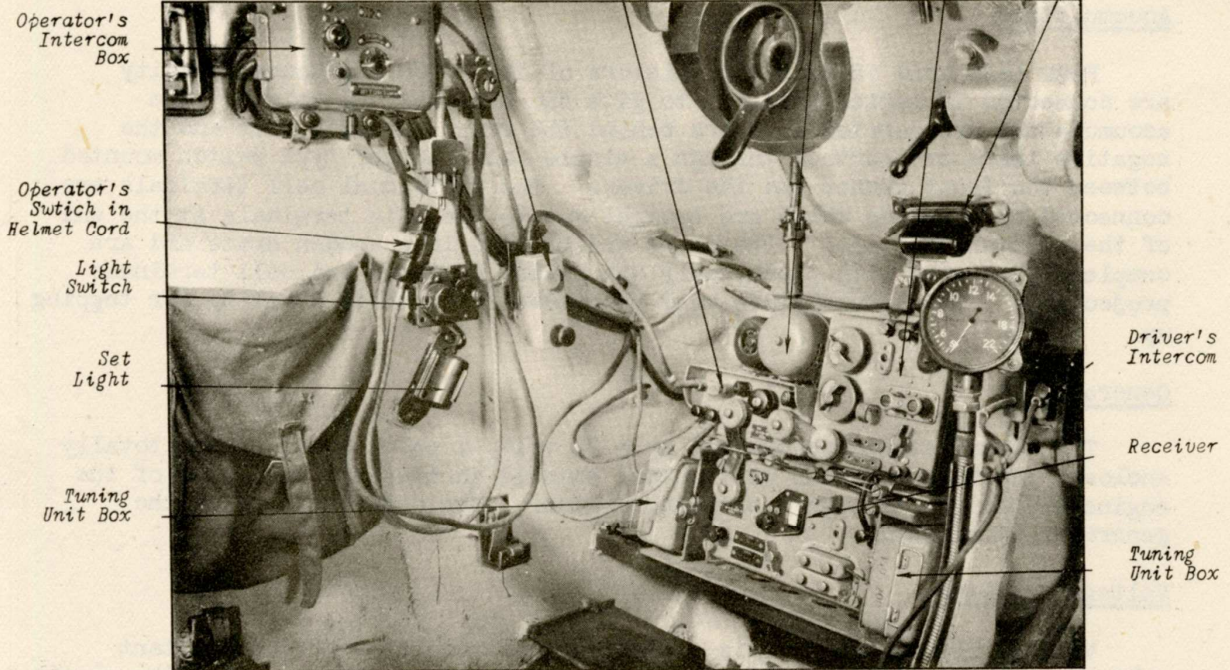
One unshielded head lamp is fitted on the right front of the glacis plate and carries a 23V 100W bulb. A combined tail and stop lamp is carried in a cast armour cylinder to the left of the tank at the rear. The tail lamp bulb is 26 volt 10 watt. The orifice in the end of the cylinder is fitted with a removable armour plate cover.

Internal

Festoon lamps are fitted to illuminate all instrument panels in the driver's compartment and the wireless sets in front of the hull gunner. The lamps are controlled by tumbler switches and cannot be switched on unless the earth switch is closed. A screened bulkhead type lamp is mounted on the roof plate between the driver and hull gunner. This lamp is also controlled by a tumbler switch but is independent of the earthing switch.

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Sending Key Control Panel Dynamotors Sender Light



RECEIVER

SENDER

B.F.O.
"on-off"
Switch

Socket for
Control
Panel lead

Volume

Slow
Motion
Drive

Phone
Sockets

Plick Frequency
Switch

Socket for
Control Panel

Plick Frequency
Tuning Units

Microphone

Sidetone

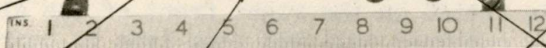
Aerial

Tuning
Lamp

Inductance
Tuner

Plick
Frequency
Switch

Aerial
to
Receiver



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Two bulkhead lamps are carried on the rear of the turret roof, one each side of the main armament breech. The lamps are controlled by tumbler switches on the switchboard to the right of the gunner on the turret wall. Sockets are provided in the turret roof for connecting up the telescope and periscope lamps, which are also controlled by tumbler switches on the turret switchboard.

Circuit Protection

All circuits except the starter motor circuits are protected by fuses. A ten-way fuse box on the hull wall and to the left of the hull gunner protects all lighting and wireless supply circuits, whilst the turret circuits are protected by two fuses carried in a box on the turret switchboard. Fuses up to 60 amp. capacity are of the glass enclosed cartridge type, whilst the two in the powered traverse circuit are the open type of 150 amp. capacity, located one in each of the fuse boxes.

General

All internal lamps are flexibly mounted. The fuse holders are marked with the circuit protected and the capacity of the fuse to be used. All cables carry a metal tag identifying the circuit. Cables are run in flexible conduits.

18. INTERCOMMUNICATION & WIRELESS

The tank is equipped with wireless receiver and transmitter and all members of the crew are on the intercommunication system.

The two wireless sets are mounted under the glacis plate in front of the hull gunner, with the intercommunication amplifier on the hull wall to his left.

The two wireless sets with their associated rotary transformers are mounted in a welded steel frame removable as a complete unit. The intercommunication rotary convertor is mounted separately beneath the wireless sets.

Both sets operate on pre-set frequencies. The frequencies are determined by plug-in condenser units plugged into the front of the sets and the flick carried out by a changeover switch on each set. In addition the receiver has a normal tuning control brought into operation when the selector switch is turned to a third position. Twelve pre-set devices are carried for each set in boxes adjacent to the sets.

The sets are connected to the amplifier unit from which the operator's headset and throat microphone are taken. The unit comprises a red signal lamp, signal push, intercomm, volume control and a three position switch giving "Sets to Self", "Intercomm" and "Sets to No. 3".

The driver's intercomm connecting box carries sockets for the headset and microphone and a signal push. Two stations are provided in the turret, the connecting box for the gunner being identical with that for the driver. The commander's connection box consists of a signal lamp, signal push and two way switch with positions "Sets to No. 3" and "Intercomm".

The commander's and operator's head set and microphone are connected to three respective boxes through a selector switch by means of which the transmitter can be brought into operation as required.

The earphones and throat microphones are built into a crash helmet making a comfortable head-dress and leaving the hands free. The receive-send switch is clipped on to the front of the tunic.

The aerial, of the fishing rod type, is carried in a flexible mounting on the left of the glacis plate, but is not capable of being dipped. The aerial is built up to about 16 ft. in length by five sections and an aerial spreader is carried which can be fitted when only two sections of the aerial are in use.

19. STOWAGE

Stowage fittings are not provided for all the items of kit on the tank. Therefore, this list is in two parts - (i) a list of fittings (ii) a complete kit list for the tank. The items not stowed appear to be carried loose on the floor of the forward compartment.

(i)	Item	No.	Where Stowed.
<u>External</u>			
	Towing shackles	2.	Superstructure rear plate.
	Track links	2	Nearside, rear of track guard
	Towrope	1	" centre of track guard (held by turn-buckle).
	3-section 76.2 mm. gun cleaning rod)	Nearside centre of track guard in bin.
	Roll of gun tools and spares		
	Projectile ejector		
	Cleaning brush		
	3 oil tins)	Nearside front of track guard in strap.
	Tarpaulin		
	Jacking block	1	" " " " " "
	Towing shackles	2	Superstructure nose plate.
	Headlamp	1	Superstructure front plate.
	Horn	1	Superstructure front plate.
	Towrope	1	Offside, centre of trackguard (held by turn-buckle).
	1 Strap		Offside, centre of trackguard.
	Track links	2	Offside, rear of track guard.
<u>Internal - Turret</u>			
	Canvas lidded box	1	Nearside turret wall, beside gunner.
	First aid box	1	Offside turret wall, behind loader.
	Hand fire extinguisher	1	Offside turret wall, behind loader
	W/T set junction box	1	Forward " " " "
	Box for 2 sets of periscopic sight spares	1	Forward nearside of turret ring.
<u>Forward Compartment</u>			
	Saw, bedding etc.,		In 2 straps, offside wall under M.G. magazines.
	Bucket (?)	1	In circular stand, with strap, offside floor.

STOWAGEForward Compartment (continued)

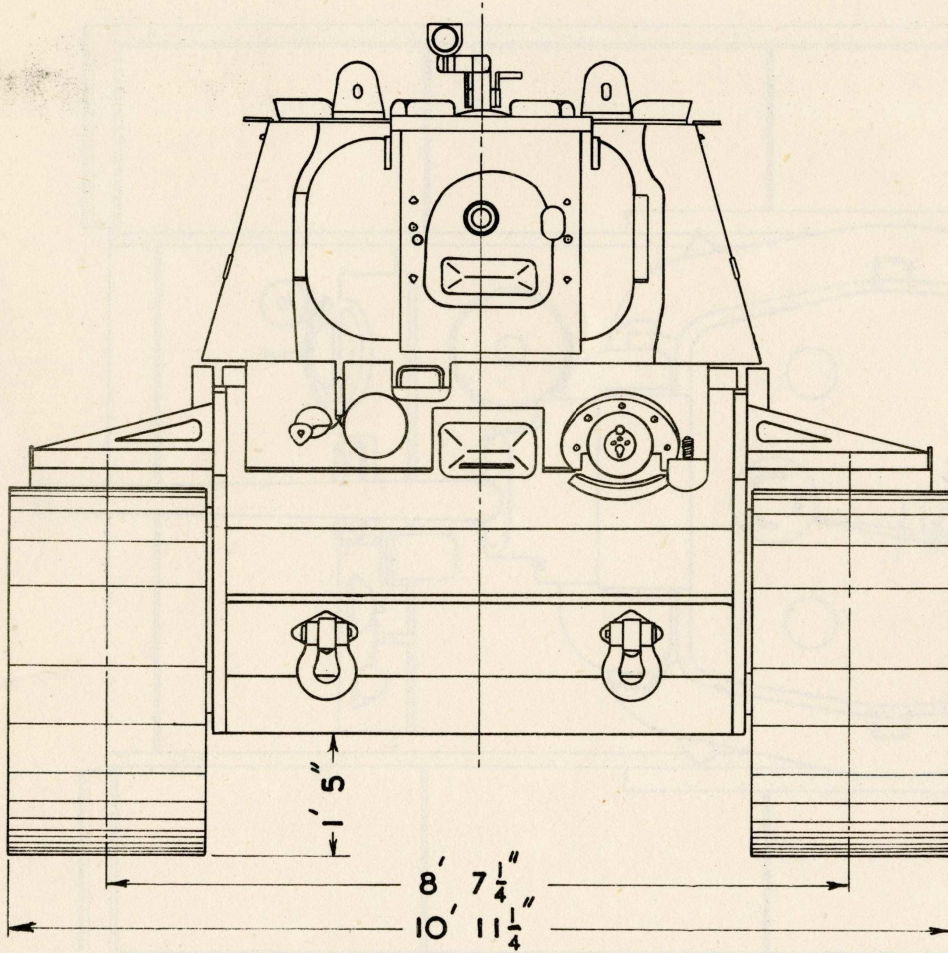
Item	No.	Where Stowed
Glass blocks	2	Centre of nose plate
Entrenching tool	1	Nearside, 76.2mm. ammunition bins, behind hull gunner.
W/T Set	1	Nearside, under glacis plate
(?) Satchel for Machine Carbine magazines	1	Nearside wall.
Machine Carbine	1	" " in 2 clips below magazine satchel.
W/T junction box	1	Nearside wall above magazine satchel.
<u>(ii) Kit list</u>		
L.M.G. Bipods	4	
Sets of L.M.G. spares and cleaning rods, in bags.	4	
L.M.G. muzzle covers	4	
L.M.G. breech covers	4	
L.M.G. deflector bags	4	
L.M.G. A.A. sights, in case	1	
76.2 mm. gun breech covers	2	
Large shovels	2	
Hand axe	1	
3' 6" crowbar	1	
Aerial rods (13 - 2' sections and spreader) in case	1	
Box of spare W/T set valves	1	
Inspection lamps	2	
Fuel funnels	2	
Spare episcopes heads (in box)	7	
Aluminium drinking mugs	2	
Aluminium water can	1	
Length of rubber tubing	1	
Triplex blocks	5	
Pistol holder (on episcopes head box)	1	

STOWAGE

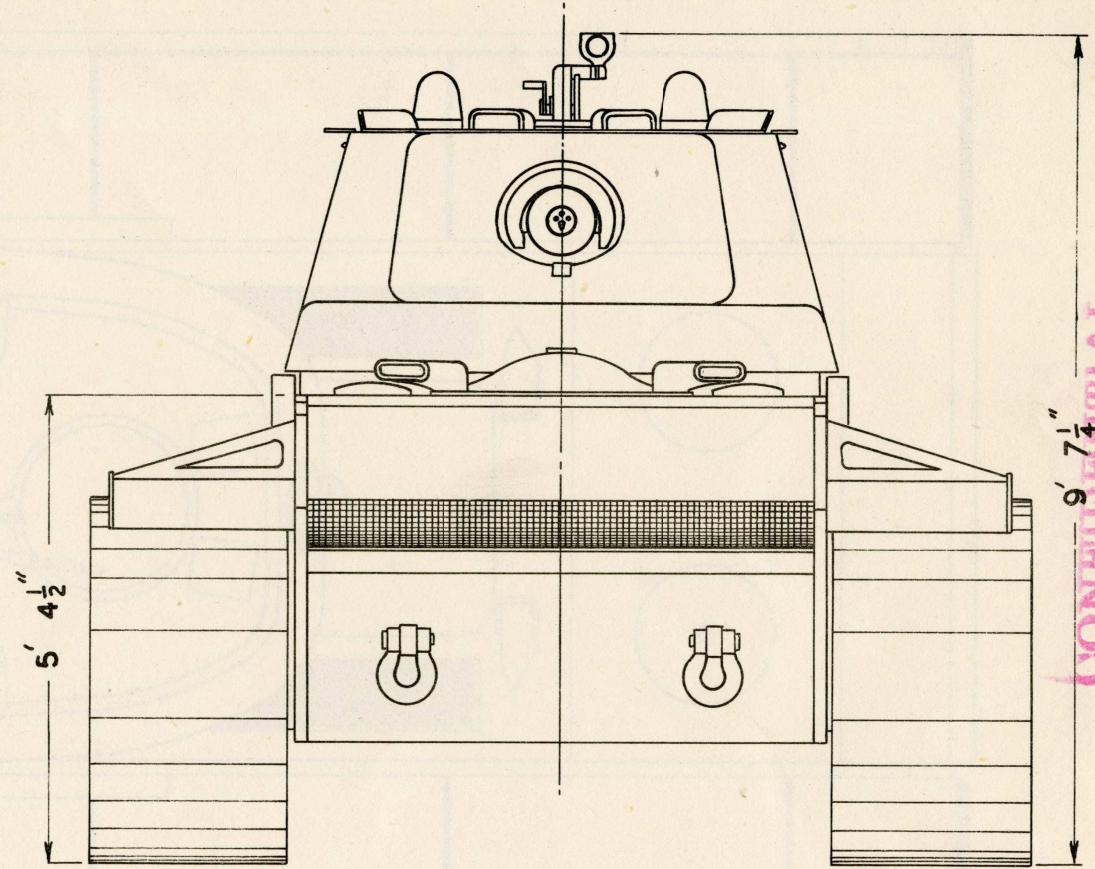
Forward Compartment (continued)

Item	No.
W/T helmets (in canvas satchels)	3
Length of wire rope	1
Canvas satchels	4
Canvas tool roll	2
Padded leather satchel	1
Box for spare bulbs	1
Tool box (empty)	1
100 cm. rule (folding)	1
Grease gun in metal box	1
Metal boxes with spares and tools	2
Entrenching tool	1
Sledge hammer	1
Metal box containing 3 kgs. Potassium dichromate Crystals in 10 paper packets	1
2' Crowbar	1
Two-man cross cut saw	1

RUSSIAN KV.I.



FRONT VIEW



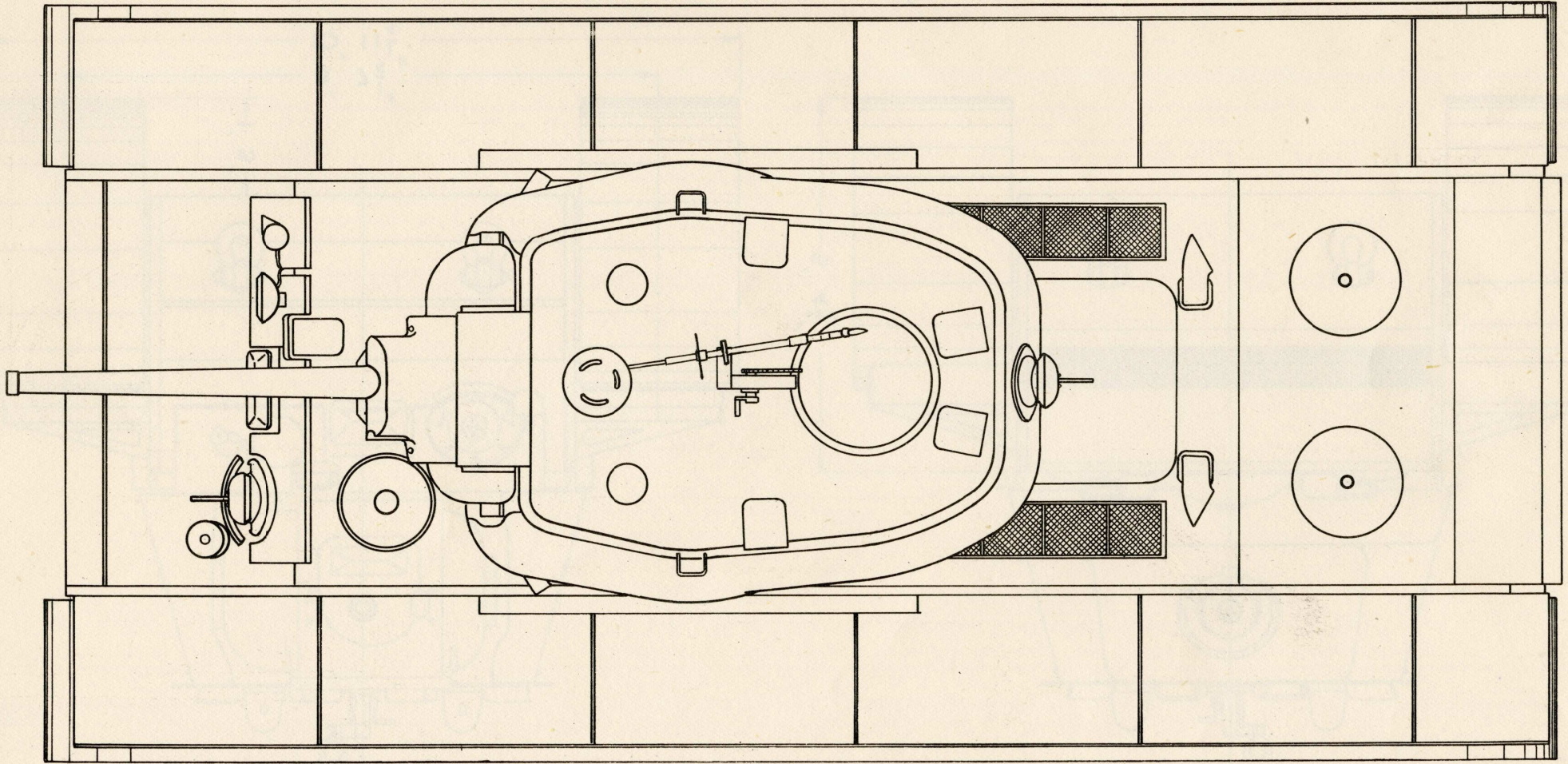
REAR VIEW

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1099644

RUSSIAN KV.I.



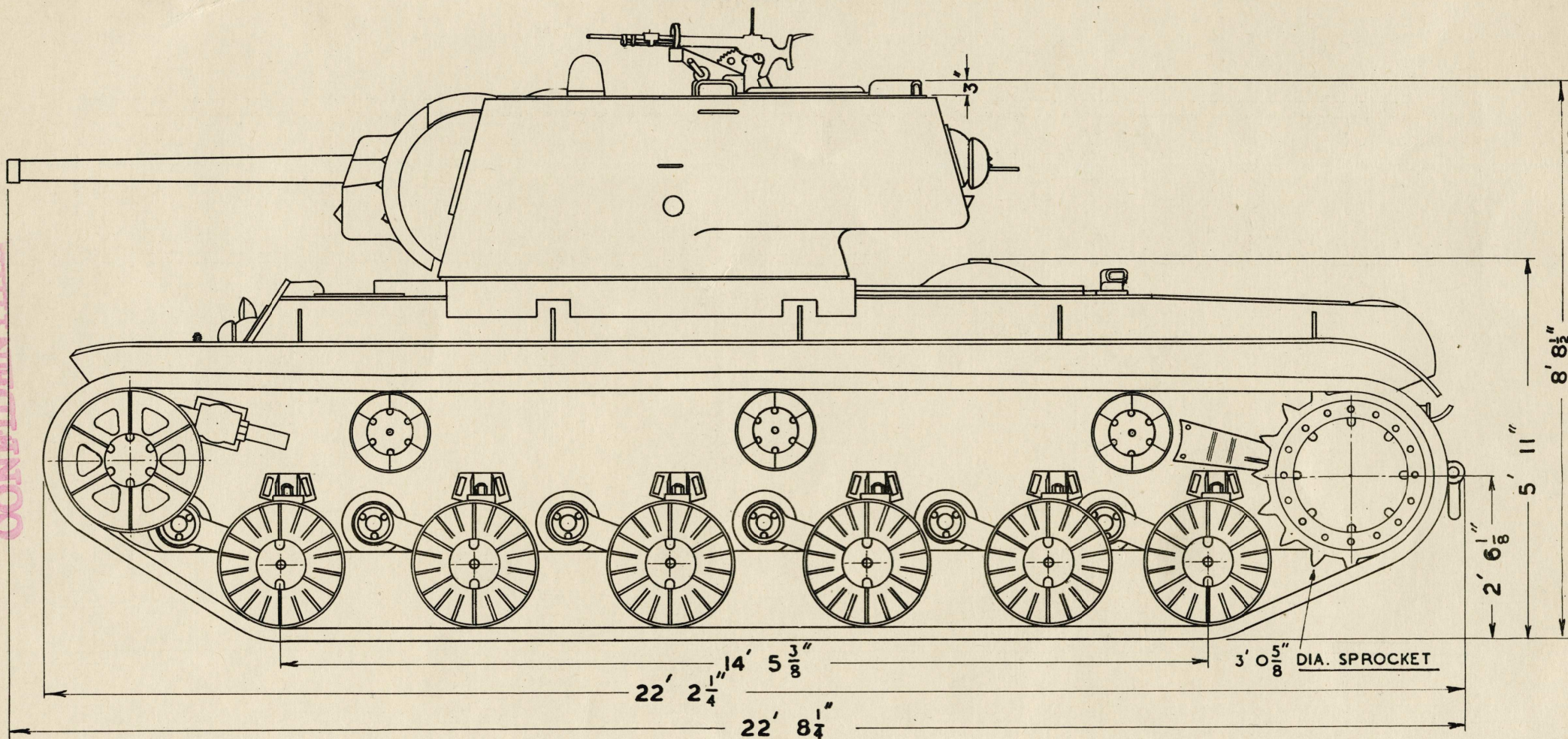
PLAN

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RUSSIAN KV.I.



SIDE ELEVATION

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1099846

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R6319
Recds of the Army Staff
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