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REPORT A.T. No. 232

PARTS I-IV

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ARMOUR BRANCH REPORT ON

Comprehensive Firing Trials against German Panther Pz.Kw.V.

DEPARTMENT OF TANK DESIGN.

MATERIALS DIVISION.

ARMOUR BRANCH.

09

Copy No. 53 SECRET

D.T.D. Experimental Report.

A.T. No.252.

Parts I-IV.

Project Nos.M.6815A/4.
Sheets 1-6.

Subject.

Comprehensive Firing Trials against German Panther. Pz.Kw.V.

Origin.

The trials were originated by the Armour Branch of the Department of Tank Design.

Remarks.

A. Three vehicles were used during the trials, all the ballistic trials being directed against a Model G. Panther.

The trial was carried out in four parts, and weapons and ammunition used were as follows:-

Part I.	.303" Rifle	Ball and A.P.
	20 mm. Hispano	A.P.
	25 pdr.	H.E. (Air-burst)
Part II.	6 pdr.	A.P.C.B.C.; A.P.D.S.
	17 pdr.	A.P.C.B.C.; A.P.D.S.; A.P.
	75 mm.	A.P.C.B.C.H.E.; H.E.
	25 pdr.	H.E. (Direct hits)
	P.I...T.	5½-lb.
	A.T. Grenade Mine	No.75. (Used as mine)
	A.T. Mine	Mk.V H.C. (Standard)
Part III.	6 pdr.	A.P.; A.P.C.
	17 pdr.	A.P.
	A.T. Grenade Mine	No.75. (Used as grenade)
Part IV.	A.T. Mines -	4-lb. (Non-detectable)
	-	Mk.V. (Reduced depth)
	-	Mk.V H.C. (Standard)
	-	5½-lb. (Asbestos cement)
	-	10-lb.
	-	15-lb.

For the attacks in Parts III and IV, and the 20 mm. attack, the vehicles used were stripped of engines and equipment.

B. Results may be summarized briefly as follows:-

1. The vehicle is virtually immune to small arms fire from ground level.
2. Small arms attack directed downward at about 30° into the inlet louvres of the engine compartment causes severe damage to radiators.
3. Even more severe damage to the radiators may result from 20 mm. attack from the air or from fragments of H.E. shell bursting in the air above the vehicle or against the turret above the engine compartment roof.

/4.

4. Projectiles of calibre 6 pdr. and upwards, whether A.P. or H.E., which strike below the horizontal centre line of the gun mantlet, are likely to penetrate or blow in the roof of the driving compartment and may jam the turret traverse.
5. Penetrations through the sides of the vehicle will very probably cause cordite or petrol fires.
6. The rolled armour proved brittle and flaky.
7. The use of interlocked joints provides a structure which has considerable stability even when the main welds are fractured.
8. The brittle nature of the roof plates makes these vulnerable to attack from H.E. grenades or shell which burst in contact with or within a few inches of the plate.
9. Frontal attack with P.I.A.T. is unprofitable, flank attack against pannier (or turret) sides is effective.
10. Mine with explosive charges between 4 and 15-lbs. are likely to break the track if detonated at the centre of its width, but may not do so if detonated by its edge. Detonations under any part of the track are unlikely to affect the floor plates or their joints with the hull side.
11. It is probable that a combination of three No.75 grenade mines will have an effect on the track similar to that produced by a single Mk.V H.C. (Standard) A.T. mine. Either will break the track when detonated below the middle third of the track.

Fuller discussion of the above conclusions will be found in the various parts of this report.

C. The trial has confirmed in general the assessment of vulnerability given in D.T.D. Report No. M.6815./3 No.1, differences between certain predicted vulnerable ranges and actual results being due to the brittle nature of the armour. Though evidence is available that many other Panther tanks damaged in battle have had armour which has shown similar defects, it should not be assumed that this form of weakness will always exist.

The design of the vehicle is such that its structural stability is considerable, the effective use of interlocking joints being chiefly responsible.

The Panther tank, judged on the results of this trial alone, remains a most formidable weapon with few weaknesses; and its value if used with adequate flank protection should not be underrated.

(A.T. Bowden)
Assistant Director (Armour)

(A.M. Durrant)
Director.

12.1.45.
M.461

/Distribution

D.T.D. Experimental Report.

A.T. No.832.

Part I.

Project No: M.6815A/4.
Trial Nos: X.789, X.816.
File No: 850/14/5.

REPORT OF FIRING TRIAL
against Pz.Kw.V. (Panther)
held at [illegible]

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D.T.D. Experimental Report.

A.T. No.232.

Part I.

Project No: M.6815A/4.
Trial Nos: X.789, X.816.
File No: 250/14/5.

REPORT OF FIRING TRIAL
against Pz.Kw.V. (Panther)
held at S. of E. Range, Shoeburyness,
on 11th, 12th and 13th October and 27th November, 1944.

Present at Trial.

Name	Representing	Date Present Oct.	Nov.
Mr. Sankey -	D.T.D. (Armour Branch)	11th and 12th.	
Mr. Cole -	" " "	12th and 13th.	
Mr. Wilde -	" " "	11th 12th and 13th.	27th
Mr. Gray -	" " "	11th 12th and 13th.	27th
Lieut. Tredinnick - Range Personnel	S. of E. Range Officer.	11th 12th and 13th.	27th

Report.

Compiled by:- Mr. G.W. Gray - D.T.D. (Armour Branch)
Mr. M.D. Wilde - " " "
Checked by:- Major G. Guthrie, R.E.M.E. - D.T.D. (Armour Branch)
Mr. J.B. Sankey - " " "

References.

Section I. - Object of Trial.
Section II. - Target Details.
Section III. - Method of Attack.
Section IV. - Small Arms Attack.
(a) .303" Ball and A.P.
(b) Conclusions from this attack.
Section V. - Air Burst H.E.
(a) 25-Pdr. H.E. attack.
(b) Conclusions from this attack.
Section VI. - Air A.P.
(a) 20 mm. A.P. Attack.
(b) Conclusions from this attack.

Appendices.

Appendix A. - Detailed Results.
Appendix B. - Photographic Record.

Note:-

SECTION I. Object of Trial.

1. To determine the degree of immunity of various fitments against .303" Ball and A.P. attack.

2. To determine the effect of 25-Pdr. H.E. Airburst against the engine cooling radiators.

3. To determine the effect of 20 mm. A.P. on the hull roof and the engine cooling radiators.

SECTION II. Target Details.

Pz.Kw.V. (Panther) Tank D.T.D. No.3040 complete, but less stowage. Vehicle in running condition. Fuel tanks were approximately half full.

SECTION III. Method of Attack.

1. Small Arms.

Various details were attacked with .303" Ball, full service charge, at angles calculated to give the least resistance to splash entry. .303" A.P. full service charge was also used for attack against certain details, to obtain a measure of their immunity to jamming.

2. Air Burst H.E.

25-Pdr. H.E. shell (charge II) T.N.T. filled, were detonated at heights of approximately 5 ft., 13 ft., and 23 ft., above the forward louvres, and in positions forward of the engine covers, as would ensure that the maximum zone of fragmentation was over the engine air louvres. Diagrams 1 and 2 in Section V show how the attack was carried out.

The means used for detonating the shell was wooden boards 3 ft. square 1" thick, slung by means of wire cables from tubular steel towers erected at a suitable distance either side of the target.

3. Air Attack, A.P.

In order to simulate attack by aircraft, the Engine Air Louvres, and engine roof, were attacked with 20 mm. A.P. full service charge from an angle of 27° above the horizontal.

SECTION IV. Small Arms Attack.

Two items were omitted from those attacked, for the following reasons.

A periscope for the Driver's position was not available.
The turret Cupola hatch was jammed in a partially open position.

(a) .303" Ball and A.P.

1. Co-Driver's M.G. Ball Mounting.

Attack by .303" Ball, disclosed only very slight marking of the witness cards and in no way affected the functioning of the mounting.

.303" A.P. attack against the mounting in an attempt to cause jamming failed.

/2.

2. 75 mm. Gun - Annulus between Barrel and Mantlet.

Splash from .303" Ball entering is not likely to cause damage to the mounting or harm to the crew.

3. 75 mm. Gun Mantlet. Clearance Between Moving and Fixed Cheeks.

.303" Ball splash entered opposite the right-hand trunnion cheeks, causing two slight perforations, and slightly marked the witness card.

.303" A.P. directed into this clearance failed to jam the mantlet.

4. Turret Escape Door.

The witness card in this case was severely torn and perforated adjacent to the edge of the aperture by .303" Ball splash which entered freely.

It was noted after this attack that the door did not fit closely and it is thought that the catch worked slightly loose.

5. Turret Fan Cowl.

Attack with .303" Ball against the rear half of the cowl did not cause any splash entry into the turret.

6. Co-Driver's Hatch.

Slight lead splash entered and marked the witness card when .303" Ball impinged on the edge of hatch cover, but this would not give any trouble.

7. Turret Race.

.303" Ball caused a very slight dusting of the witness cards, when the attack was directed at the clearance between the turret and hull roof.

.303" A.P. attack showed the turret race to be immune from jamming.

8. Hull Fan Cowl. (Intake full open).

The only effect of .303" Ball against this detail was to slightly mark the witness card.

(b) Conclusions from Small Arms Attack.

Splash (.303" Ball)

It is concluded that the extent of splash entry, with one exception, is too slight to cause any damage, or inconvenience to the crew.

This exception is the turret escape door which allowed free entry. It should be borne in mind, however, that this door was not a good fit on its seating.

A.P. (.303")

Generally, jamming of the gun mantlet, turret traverse, and the m.g. mounting, would not be likely, although core fragments may possibly enter the turret race.

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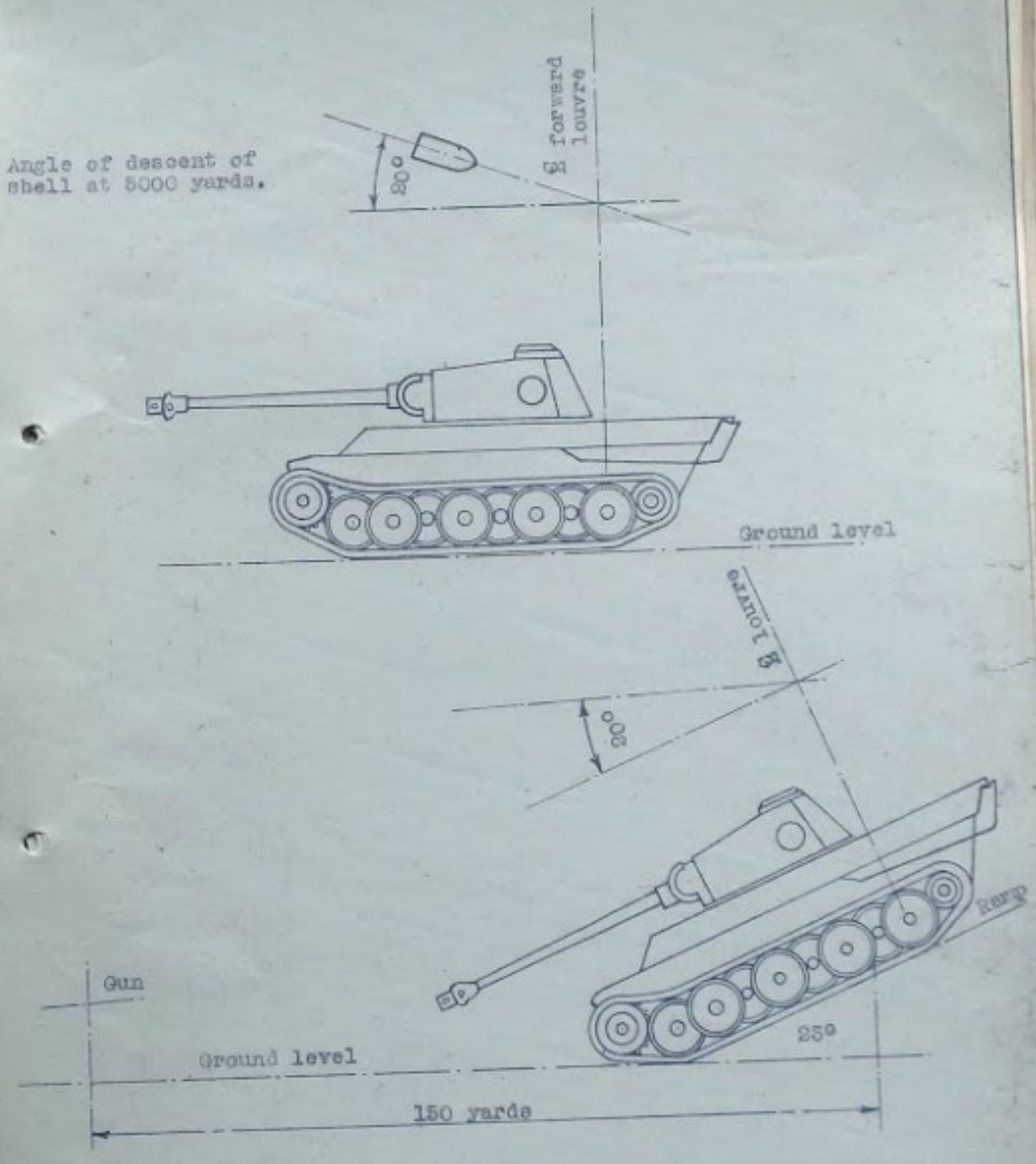
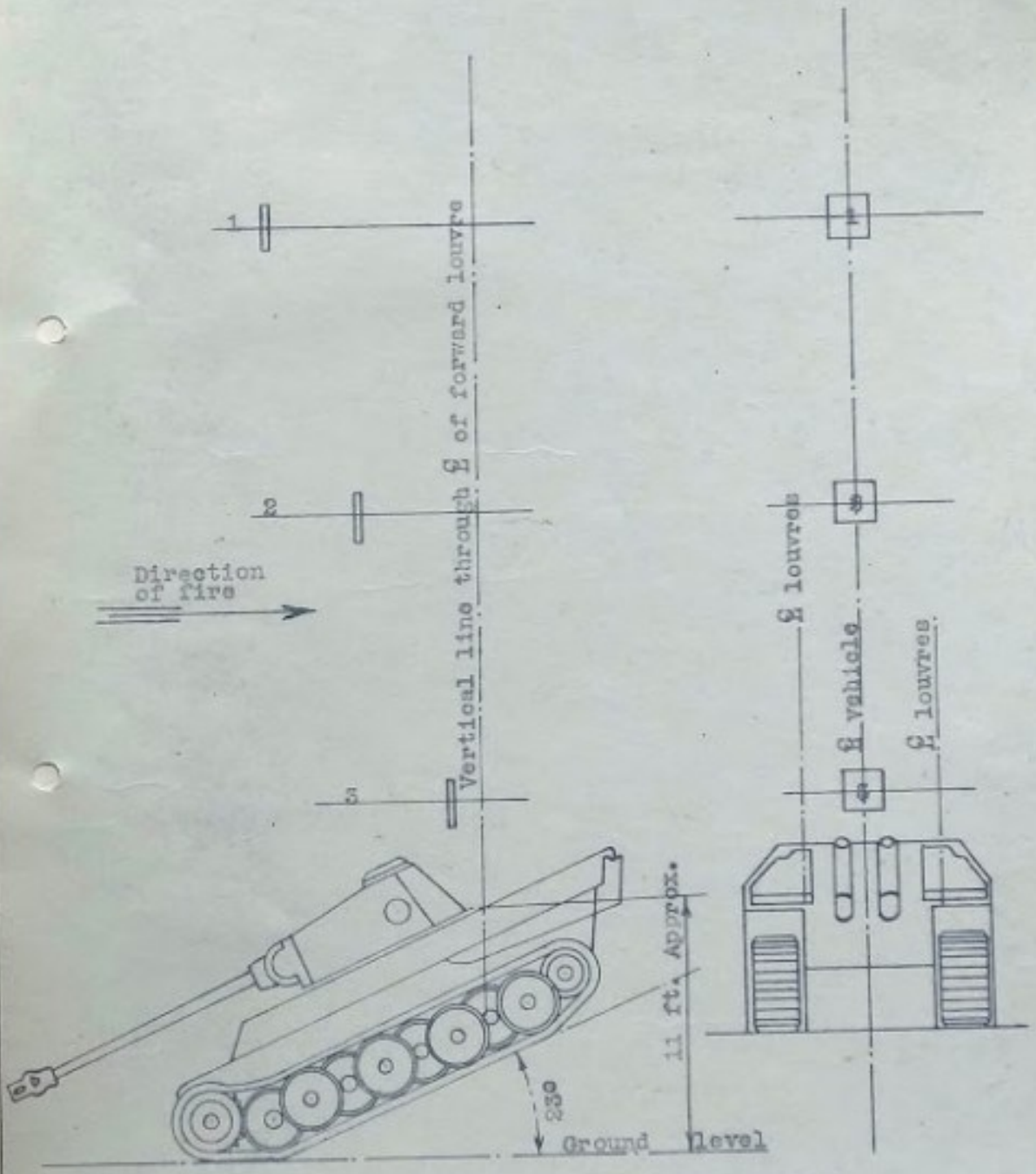
[redacted]

Diagram I indicates the angle at which the tank was set in order to simulate the angle of descent of the shell at a range of 5000 yards.



Tank set at 25°, being a mean figure to suit distance, gun to target, of 150 yards, and allowing for variation in the inclination of line of flight to suit heights of 5 ft., 13 ft. and 23 ft. above the forward louvres.

Diagram 2 indicates the points of burst in relation to the louvres. The positions of the boards in the direction of the line of fire were derived from the results obtained during Trial X.581 reported under A.T.164, Part II, and were used as a guide for this attack.



Position of Burst	Height above louvre	distance forward of louvre
1	23 ft.	10' - 0"
2	13 ft.	6' - 0"
3	5 ft.	2' - 0"

SECTION V. Air Burst H.E. Attack.

25-Pdr. H.E. (Charge II) was fired from a range of 150 yards and detonated above the tank, so that fragments would enter the air louvres.

Diagrams I and II indicate the conditions required to be met, with the tank advancing and at a range of 5000 yards.

The tank engine was not running during the attack, but an estimate of the effect on the engine from attack is given.

(a) 25-Pdr. H.E. Attack.

Position 1. Burster Board 23 ft. above louvre.

Round 1 detonating 10 ft. in front of the forward louvres failed to perforate the radiators.

Round 2 detonating 11 ft. in front caused several perforations in the forward and rear radiators. The loss of water would have caused overheating and ultimate stoppage.

Position 2. Burster Board 13 ft. above louvre.

Round 3 detonating 6 ft. in front of the forward louvres, caused extensive damage to the forward left-hand radiator, with consequent free leakage of water.

The remaining radiators were not further damaged.

Ultimate stoppage of the engine would have been caused by this attack.

Position 3. Burster Board 5 ft. above louvre.

Round 4 detonating 2 ft. in front of the forward louvre caused only one perforation of the forward right-hand radiator. Over-heating would have resulted with possible engine stoppage.

Round 5 detonating 1 ft. in front produced further perforation of both of the forward radiators causing extensive damage, with considerable water loss.

The engine would quickly have over-heated and stopped.

The results are summarized as follows:-

Summary of Results.

Tank:- On ramp - nose down, and front facing gun. Angle of tank on ramp 25° to horizontal.

Air Burst Attack:- 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yards.

Round No.	Position of burster board		Damage to louvres, Guide vanes etc.	Damage to radiators, fuel tanks, etc.	Effect on tank.
	Height above forward louvre.	Distance forward of louvre.			
1.	23 ft.	10 ft.	1 severe strike on left-hand circular outlet grille.	Nil.	Nil.
2.	23 ft.	11 ft.	2 strikes on rear left-hand inlet grille. 3 strikes on forward left-hand radiator grille. 1 large strike on left-hand circular outlet grille. Right-hand fan one blade perforated.	1 perforation in rear left-hand radiator. Five perforations in forward left-hand side cooling radiator. Water leaking from four perforations. 1 perforation in rear right-hand radiator - forward right-hand side radiator not leaking. 3 perforations in rear right-hand radiator caused by fragments entering right-hand circular outlet grille.	Engine would have overheated and ultimately stopped.
3.	13 ft.	6 ft.		2 perforations in forward left-hand radiator - largest 3" x 2½". Water leaking freely.	Engine would have overheated and eventually stopped.
4.	5 ft.	8 ft.	2 strikes on forward left-hand grille. 4 strikes on forward right-hand grille. 1 strike on rear right-hand grille. 1 strike on right-hand circular outlet grille.	1 perforation in forward right-hand radiator.	Engine would have overheated after a time and possibly stopped.

Summary of Results. (Continued from previous sheet)

Tank:- On ramp - nose down, and front facing gun. Angle of tank on ramp 23° to horizontal.

Air Burst Attack:- 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yards.

Round No.	Position of burster board		Damage to louvres, Guide vanes, etc.	Damage to radiators, fuel tanks, etc.	Effect on tank
	Height above forward louvre.	Distance forward of louvre.			
4 Contd.	5 ft.	2 ft.	1 strike on left-hand circular outlet grille. Four perforations of guide vanes - forward right-hand grille. Some strikes on left-hand forward grille guide vanes.	1 perforation in forward right-hand radiator.	Engine would have overheated after a time and possibly stopped.
5	5 ft.	1 ft.	Heavy pitting of forward intake grilles. 1 strike on each circular outlet grille. 2 strikes on rear right-hand intake grille.	Several fragments entered forward intake grilles and perforated radiators. Extensive water leakage.	Engine would have overheated and quickly stopped.

SECTION V. (Contd.)

(b) Conclusions from Air Burst Attack.

It is concluded that the water cooling system is vulnerable to 25-pdr. H.E. Air Burst, and that damage to the radiator is liable to occur from detonations occurring within the range of positions selected for this trial.

The degree of vulnerability for each height is difficult to define, but the evidence points to heights above the louvre within 15 ft. as being the most likely to cause extensive radiator perforation.

The loss of cooling water would be such that it is doubtful whether the tank could continue to run for other than a short time.

SECTION VI. Air A.P. Attack (Tank No.3041).

(a) 20 mm. A.P. Attack.

The attack was directed from an angle of 27° above the horizontal against the engine cooling system grilles and engine covers.

It should be noted that no engine radiators or fans were in position but suitable witness cards were fitted in these positions and the probable damage to the system estimated therefrom.

1. Left-hand rear intake grille.

Round 1 striking this grille sheared away two transverse cross bars. Extensive perforation of the witness card representing the rear radiator resulted. Considerable water loss would have been caused with ultimate engine stoppage.

Round 2 striking the same grille caused extensive perforation of the witness cards representing the forward and rear radiators. In the case of the forward card it is thought that with the fan in position damage may not have resulted. The results from this round would have been similar to those from round 1.

2. Left-hand front intake grille.

Round 5 striking this grille, sheared out metal and caused extensive perforation of the rear card. This damage was comparable to that caused by attack against the rear grille and confirmed the vulnerability of the system.

3. Left-hand fan grille.

Two rounds against this grille indicated that fragments are liable to perforate both the front and rear radiators but to a less degree.

4. Right-hand rear intake grille.

One round of cross fire to endeavour to obtain strikes on the petrol tank failed to cause anything greater than shallow strikes on the rear end of the right-hand tank.

5. Engine roof covers (17 mm. thick).

Five rounds directed against the roof showed the plate to be immune to 20 mm. attack at this angle and only slight local damage was caused.

/(b)

(b) Conclusions from 80 mm. A.P. attack.

It is concluded that the water cooling system is vulnerable to attack from 80 mm. A.P. directed into the system grilles from an angle of 27° above the horizontal and considerable damage to the radiators with consequent water loss would result, causing the ultimate stoppage of the engine.

Damage to petrol tanks as a result of fragments is unlikely.

This attack would not defeat the engine covers.

G. Guthrie, Major, R.E.M.E.
O. i/c. Armour Trials Section,
Armour Branch.

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Trial No.X.789.
6 Sheets.

APPENDIX A.
Sheet No.1.

Detailed Results - Small Arms.

ITEM NO.	DETAIL ATTACKED	ATTACK NO. OF ROUNDS	POSITION OF IMPACT	CONDITION OF SPLASH CARD	REMARKS
Item 1. Vehicle front at normal.	Co-Driver's machine gun ball mounting on glacis.	.303" Ball at normal. 5 Rounds. Range 30 ft.	Lower edge of mounting and right side. 4 rounds effective.	Very slight marking mostly along lower edge.	Mounting free.
		.303" Ball at normal. 5 Rounds. Range 30 ft.	Top edge of mounting and left side.	Very slight marking mostly along lower edge.	Mounting free.
Item 2. Vehicle front at normal.	Turret gun 75 mm. aperture annulus around gun. Gun horizontal.	.303" Ball at normal. 10 Rounds. Range 30 ft.	R.H. side of aperture. 7 rounds effective.	Cards clear.	Mounting free.
Item 3. Turret.	Mantlet side, right hand. Clearance between moving and fixed cheeks. Gun horizontal.	.303" Ball at normal. 10 Rounds. Range 30 ft.	Right hand side of mantlet. 7 rounds effective.	Cards slightly marked adjacent to bottom of R.H. trunnion cheek over area 4" x 2". Top right, two slight perforations, 5" from top corner, 5" in from trunnion cheek edge. Slight marking. A light lead deposit throughout length of cards.	Mounting free
Item 4. Turret.	Turret escape door at normal.	.303" Ball at normal. 20 Rounds. Range 30 ft.	Around joint 8 rounds effective.	Card severely torn and perforated around edge of aperture. Main tear 7" long. Top right hand side, four tears each approx. 1½" to 1" long. Several small perforations also considerable lead splashing.	Door free but slight gap between door and hatchway was observed.
Item 5. Turret roof.	Turret fan cowl rear side.	.303" Ball at normal. 5 Rounds Range 30 ft.	Through rear slot in cowl. 4 effective.	Clear.	

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ITEM NO.	DETAIL ATTACKED	ATTACK NO. OF ROUNDS	POSITION OF IMPACT	CONDITION OF SPLASH CARD	REMARKS
Item 6. Hull roof.	Co-driver's hatch.	.303" Ball at 6° above horizontal. Range 80 ft. 10 Rounds.	None effective.		
		5 Rounds.	2 effective.	Card perforated in twelve places over area 4" x 4". Largest ¼" dia.	Door catch loosened and door slightly raised.
Item 7. Turret and hull.	Turret race. Turret left hand side at normal.	.303" Ball at 6° above horizontal. Range 20ft. 10 Rounds.	Between turret and hull. 10 effective.	No perforations. Slight dusting of lead splash on cards only.	
		5 Rounds.			To check effect on turret ring bolts. Bolts not affected.
Item 8. Turret.	Turret race. Turret left hand side at normal.	.303" A.P. at 6° above horizontal. Range 20 ft. 10 Rounds.	Between turret and hull. 7 effective.		Turret free.
Item 9. Hull.	Machine gun ball mounting on glacis.	.303" A.P. at 6° above horizontal. 1 Round			Mounting free
		1 Round	Struck ball no result.		" "
		3 Rounds	Struck ball and housing.		" "
Item 10 Vehicle side at normal.	Hull fan cowl. Air intake open max.	.303" Ball 10° above horizontal. Range 20 ft. 5 Rounds.	5 rounds effective. Struck along lower edge of gap - right hand side.	Card slightly marked over area 5" x 4".	(Card covering fan opening)
Item 11 Turret side.	Mantlet side at 20° to normal.	.303" A.P. at 20° to normal. 5 Rounds. Range 30 ft.	5 strikes on side of mantlet.		Mantlet not jammed. Rounds scooped off.
		.303" A.P. at 20° to normal. Range 30 ft. 5 Rounds.	5 strikes on side of mantlet.		Mantlet not jammed. Rounds scooped off.
		.303" A.P. at 20° to normal. Range 30 ft. 5 Rounds.	2 strikes on fixed mantlet side.		2 rounds scooped into gap. Mantlet not jammed.

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Detailed Results - Air Burst H.E.

TARGET	ATTACK	OBSERVATIONS
Tank on ramp. Nose down and front facing gun. Angle of tank on ramp approx. 23°. Burster board approx. 23 ft. above centre line forward intake louvre and 10 ft. in front of forward louvre. Engine not running.	Round 1. 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yds.	One severe strike only on L.H. fan grille, several smaller strikes on turret top. No damage to cooling radiators likely. Rear R.H. grille cover blown away (bolts removed previously)
Ditto. Burster board approx. 23 ft. above centre line forward intake louvre, and 11 ft. in front of forward louvre. Engine not running.	Round 2. 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yds.	Two strikes on rear L.H. radiator grille. Three strikes in forward radiator grille. One large strike on circular outlet louvre 1" x ½". Five perforations in forward L.H. side cooling radiator. Water leaking out from four perforations. One perforation 1" x ½" in L.H. rear radiator near top. Six perforations in sheet metal guard over gun mantlet. Three strikes on turret roof. One strike on hull roof R.H. side of turret. One perforation on rear R.H. radiator. Forward R.H. side radiator intact. Three perforations in rear R.H. radiator caused by fragments entering circular outlet louvre. Fan blade perforated. Engine would ultimately have stopped.
Ditto. Burster board approx. 13 ft. above centre line forward intake louvre and 6 ft. in front of forward louvre. Engine not running.	Round 3. 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yds.	L.H. forward radiator sustained two additional perforations - largest 3" x 2½". Water leaking freely. Numerous strikes on cupola hatch, turret roof, and hull roof, 1 ft. - 2 ft. forward of louvres. No further damage to other radiator apparent. Engine would ultimately have stopped.

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Trial No.X.789.
6 Sheets.

APPENDIX ..
Sheet No.4.

Detailed Results - Air Burst H.E.

TARGET	ATTACK	OBSERVATIONS
Tank on ramp Nose down and front facing gun. Angle of tank on ramp approx. 25°. Burster board approx. 5 ft. above centre line forward intake louvre and 2 ft. in front of forward louvre. Engine not running.	Round 4. 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yds.	Rear edge of turret roof and cupola severely pitted. Forward grilles (right and left) sustained following: Two strikes on L.H. Four strikes on R.H. Rear R.H. grille, one additional strike. Circular outlet grille, one strike on each R.H. and L.H. Inlet forward R.H. grille, four fragments had perforated guide vanes largest 1" square. One perforation in forward R.H. radiator. Further strikes in rear L.H. grille guide vanes. Wading tube container on hull side and track guards severely perforated. Engine would ultimately have stopped.
Ditto. Burster board approx. 5 ft. above centre line forward intake louvre and 1 ft. in front of forward louvre.	Round 9. 25-Pdr. H.E. T.N.T. filled. Charge II adjusted. Fuse 119. Range 150 yds.	Heavy pitting on forward intake grilles. Several fragments entered and severely perforated forward radiators causing extensive water leakage. Engine would quickly have stopped. One additional strike on each circular outlet grille. Two strikes in rear R.H. intake grille. Large perforation in L.H. exhaust pipe.

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Detailed Results - 20 mm. Air Attack.

TARGET	ATTACK	OBSERVATIONS
Tank No.3041 on ramp. Rear of tank to gun. Left side air intakes and fan. Cards fitted in positions normally occupied by radiator. Rear Intake.	20 mm. Hispano A.P. Mk.II. F.S.C. At 27° above horizontal. Range 30 ft. Round 1.	Two transverse bars from grille broken away. Left hand petrol tank untouched. Shot penetrated first bar (11/16) thick and struck second bar. Both bars recovered below grille each in two pieces. 20 perforations on witness card. Largest perforation ½" x ¼" - most of which would have struck on radiator tubes. Considerable loss of water would have resulted. Engine would ultimately have stopped. Fuel tank intact.
Rear Intake.	Ditto. Round 2.	Shot struck fourth cross bar scooping out metal and carried witness card severely torn and perforated. Top right hand corner perforated over area ¼" x ⅜" max. Lower main perforation 2" x ½". Sixteen other perforations. Most would have perforated radiator and considerable loss of water would have resulted with ultimate stoppage of engine. Front card torn in two places and perforated in three places. Main perforation 1" x ½" in top right hand corner. With fan normally in position the extent to which this damage would have taken place is unknown. Fuel tank intact.
Tank No.3041 on ramp. Rear of tank to gun. Left hand front inteke.	Round 3. 20 mm. Hispano A.P. Mk.II. F.S.C. At 27° above horizontal. Range 30 ft.	Struck back bar and passed through into fighting compartment. Witness card not affected.

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Trial No.X.816.
6 Sheets.

APPENDIX A.
Sheet No.6.

Detailed Results - 20 mm. Air Attack.

TARGET	ATTACK	OBSERVATIONS
Tank No.3041 on ramp. Rear of tank to gun. Left hand front intake.	Round 4. 20 mm. Hispano A.P. Mk.II. F.S.C. At 27° above horizontal. Range 30 ft.	Struck top edge of cross bar and passed through shot hole of Rd.3.
	Round 5.	Struck third central cross bar shearing metal 3" x 1½". 18 perforations on witness card. Largest ½" x ⅜". Radiator would have been perforated resulting in considerable loss of water and ultimate stoppage of engine. Fuel tank intact.
Tank No.3041 on ramp. Rear of tank to gun. Left hand fan grille. Cards fitted in positions normally occupied by radiator.	Round 6. 20 mm. Hispano A.P. Mk.II. F.S.C. At 27° above horizontal. Range 30 ft.	Struck centre circumferential bar and perforated same and entered fan hub casting. Two strikes on rear card, one strike on front card.
	Round 7.	Both cards unmarked. Struck central circumferential bar and struck fan hub casting. Fuel tank intact.
Tank No.3041 on ramp. Rear of tank to gun. Engine roof cover (17 mm.)	Round 8. 20 mm. Hispano A.P. Mk.II. F.S.C. At 27° above horizontal. Range 30 ft.	Code B. Roof not defeated.
	Round 9.	Code B. Struck welded joint between water filler cover and hull roof. Split in throat of weld 9" long.
	Round 10.	Code B. Scoop on engine cover.
	Round 11.	Code B. Struck engine hatch lower hinge shearing out one rivet and metal from hinge block over 1" x ½".
Tank No.3041 on ramp. Rear of tank to gun. Right hand rear intake. Attack against right hand petrol tank.	Round 12. 20 mm. Hispano A.P. Mk.II. F.S.C. 27° above horizontal. Range 30 ft.	Numerous shallow strikes on rear end of petrol tank, no perforations.

Trial No.X.789.
7 Sheets.

Appendix B.
Sheet No.1.

A.T. No.232.
Part I.

Pz.Kw.V. Panther

Small Arms Attack

Print No.1.

Front three-quarter view of vehicle in position in butt before attack.

Print No.2.

Rear three-quarter view of vehicle in position in butt before attack.

Print No.3.

Item No.2.
Showing .303" Ball attack on 75 mm. gun aperture.
Seven rounds effective.
No splash entered.

A.T. No.232.
Part I.

Pz.Kw.V. Panther

Small Arms Attack

Print No.4.

Item No.4.
.303" Ball attack at normal against turret escape door, showing condition of witness card fitted behind door.
Note:-
Splash entered freely, tearing and marking card.

Print No.5.

Item No.10.
Showing .303" Ball attack against hull fan cowl.
Four rounds effective, no splash entry.

Print No.6.

Item No.11.
Showing .303" A.P. attack at 20° to normal against turret gun mantlet side.

A.T. No.232.
Part I.

Pz.Kw.V. Panther

Air Burst H.E. Attack.

Print No.7.

Showing vehicle in position on ramp.

Print No.8.

View from rear of ramp, showing vehicle on ramp and burster board in position above.

Print No.9.

Round 2. Burster board 23 ft. above and 11 ft. forward of louvre. Showing perforations in forward left-hand side radiator.

A.T. No.232.
Part I.

Pz.Kw.V. Panther

Air Burst H.E. Attack.

Print No.10.

Round 2. Burster board 23 ft. above and 11 ft. forward of louvre. Showing perforations in rear left-hand radiator and guide vanes.

Print No.11.

Round 5. Burster board 5 ft. above and 1 ft. forward of louvre. Showing strikes on forward left-hand inlet louvre and perforations in guide vanes.

Print No.12.

Round 5. Burster board 5 ft. above and 1 ft. forward of louvre. Showing strikes on forward right-hand inlet louvre.

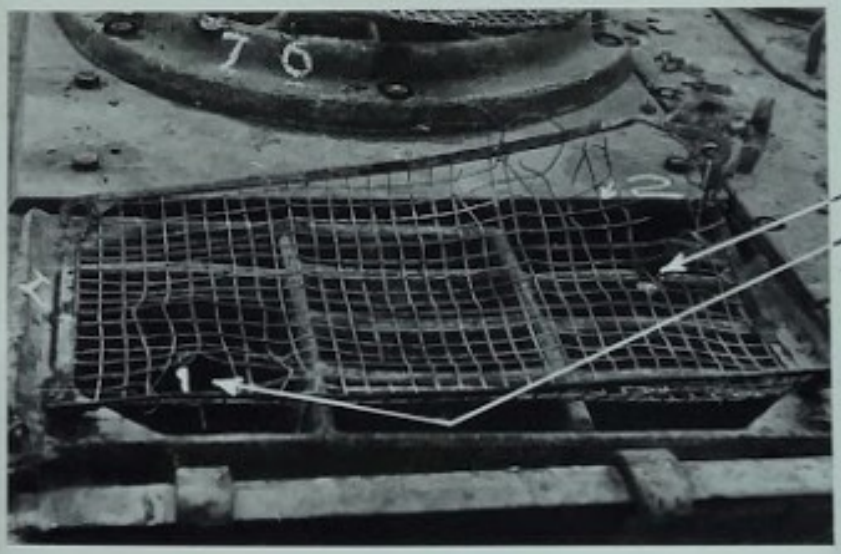
A.T. No.232.
Part I.

Pz.Kw.V. Panther

20 mm. Hispano Attack

Print No.13.

Showing engine compartment roof after attack with 20 mm. Hispano A.P. from 27° above horizontal.



Print No.14.

Showing damage to rear left-hand inlet louvre caused by Rounds 1 and 2 - 20 mm. Hispano A.P.

Print No.15.

Showing condition of rear left-hand witness card representing radiator after Round 1.

A.T. No.232.
Part I.

Pz.Kw.V. Panther

20 mm. Hispano Attack

Print No.16.

Showing condition of rear left-hand witness card representing radiator after Round 2.

Print No.17.

Showing condition of front left-hand witness card representing radiator after Round 2.

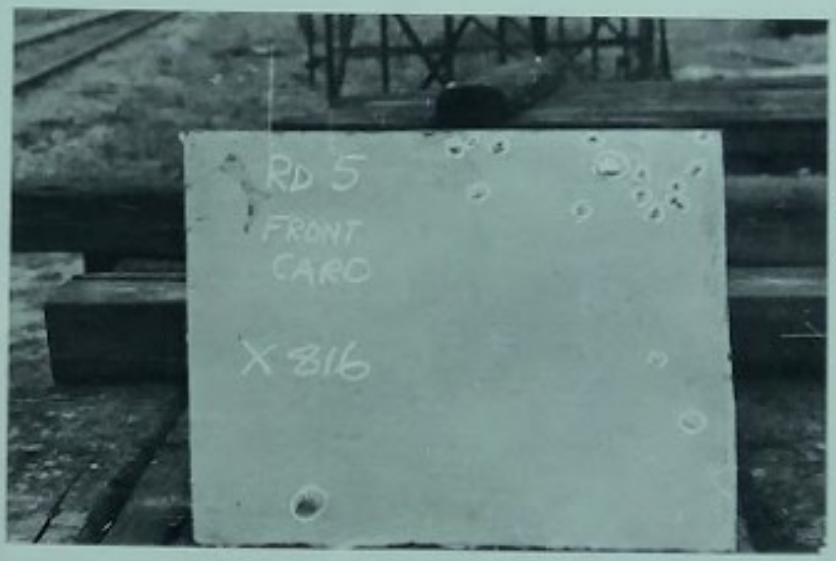
A.T. No.232.
Part I.

Pz.Kw.V. Panther

20 mm. Hispano Attack

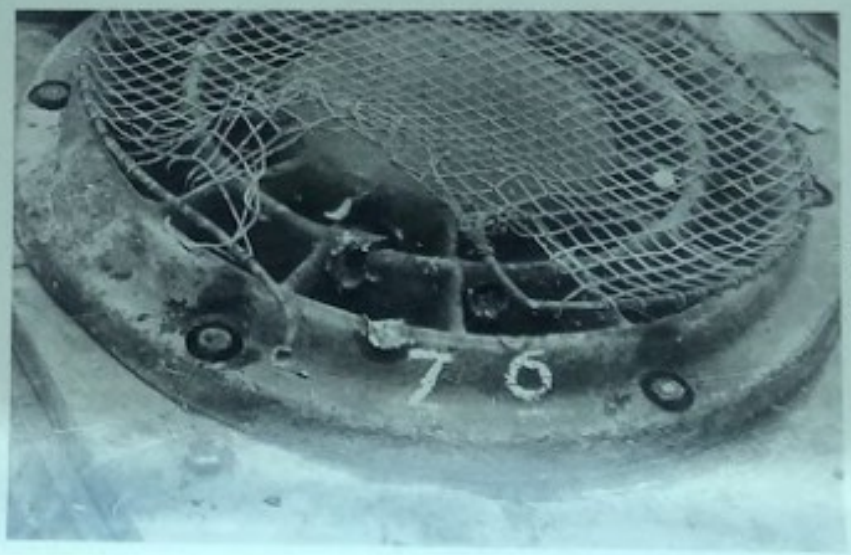
Print No.18.

Showing damage to forward left-hand louvre caused by Rounds 3, 4, and 5 20 mm. Hispano A.P.



Print No.19.

Showing condition of front left-hand witness card representing radiator after Round 5.



Print No.20.

Showing damage to left-hand circular outlet louvre caused by Rounds 6 and 7 - 20 mm. Hispano A.P. Witness cards only slightly marked.

09 04

D.T.D. Experimental Report

A.I. No.232

Part II.

Project No: M.6815A/4.
Sheet 2.
Trial No: X.794.
File No: 250/14/5.

REPORT OF FIRING TRIAL
against Pz.Kw.V (Model G.) D.T.D.No.3040
held at Shoeburyness Range
On October 17th-20th 1944.

Present at Trial	Representing	Date attended
Lt. Tredinnick	S. of E.	All dates.
Col. McNair	Ordnance Board	18.10.44.
Capt. Martin	C.E.A.D.	19.10.44.
Capt. Ryan	A.3.	19.10.44.
Mr. Service	Messrs. Wm. Beardmore & Co. Ltd.	17.10.44.
Major Fowler	D.T.D. Welding Branch.	18.10.44.
Mr. Redhead	" " "	16-19.10.44.
Mr. Snodgrass	" " "	19.10.44.
Dr. Bowden	" Armour Branch.	17.10.44.
Mr. Turner	" " "	17.10.44.
Major Martin	" " "	17-18.10.44.
Major Guthrie	" " "	17-18.10.44.
Mr. Cole	" " "	17,18,20.10.44.
Mr. Goodlad	" " "	19.10.44.
Mr. Barker	" " "	All dates.
Mr. Young	" " "	All dates.

Report.

Compiled by:-	(Mr. A. Young (Mr. F. Barker	- D.T.D. (Armour Branch)
Checked by:-	Major G. Guthrie Mr. J.B. Sankey	" " " " " "

References.

Appendices.

Note:-

09 04

SECTION I.

Objects of Trial

(i) To determine the general battleworthiness of the hull and turret of a Model G. Panther against 6 pdr. and 17 pdr. A.P.C.B.C. and D.S. shot, and against 75 mm. A.P.C.B.C. and H.E. Shell, and 25 pdr. H.E. Shell.

(ii) To determine the probable effect of frontal and flank attack from 3-lb. P.I.A.T. on stowed ammunition.

(iii) To determine what minimum combination of Grenades A.T. No.75, or of A.T. Mines (British Mk.V H.C.) is required to break the track.

SECTION II.

Target Details

The target was a German Panther Tank 135 (Pz.Kw.V. Model G. No.120404) complete with tracks and suspension units, engines and transmission, and all permanent equipment. No stowage, either internal or external, was provided. The fuel tanks were filled but as the radiators had been severely damaged during the airburst H.E. attack in Part I of the trial, the engines could not be run.

Diagrams giving the thicknesses and the angles of presentation of the various plates are to be found in Appendix C, and details of Brinell Hardness figures for various plates and castings are given hereunder.

N.B. The turret fitted to the hull at the time of capture was badly damaged and was removed at F.V.P.E. workshops. A turret from another vehicle (D.T.D. No.3041) was fitted to this hull for the purpose of the firing trial. The D.T.D. number of this hull was 3040.

	Turret Roof	Nearside of Turret	Offside of Turret	Turret Rear Plate	Mantlet
Corrected Poldi Hardness figures	319	277	315	297	237

	Hull roof front	Nearside Pannier	Offside Pannier	Vertical Hull sides	Rear plate of hull	Glacis Plate	Nose Plate
Corrected Poldi Hardness Figures	309	289	263	316	308	270	304

Photographs in Appendix B. illustrate the target.

SECTION III.

Method of Attack

The target was situated on level ground and was attacked from 100 yds. range with the following projectiles.

	No. of rounds fired	No. of strikes
6 pdr. A.P.D.S. shot	29	24
6 pdr. A.P.C.B.C. shot	17	17
75 mm. A.P.C.B.C. shell	1	1
17 pdr. A.P.D.S. shot	5	5
17 pdr. A.P.C.B.C. shot	2	2
17 pdr. A.P. shot	1	1
75 mm. H.E. shell	4	4
25 pdr. H.E. shell	3	3
3-lb. P.I.A.T. (Range 10-20 yds.)		

The front of the vehicle was attacked at normal, the nearside at angles approximating to 500 and the offside at normal, the tank being turned to give the required presentations.

The/

The attack from A.T. mines and grenades w s carried out on meadow land.

Details of presentation and conditions for each form of attack are given in Appendix A.

SECTION IV. Trial Commentary. (6 pdr. A.P.D.S. and A.P.C.B.C. attacks)

1. Turret front and mantlet

(a) 6 pdr. A.P.C.B.C.

Five rounds of 6 pdr. A.P.C.B.C. were directed at the offside half of the mantlet, the thickness of which could not be measured. Strikes at velocities above 2300 f.s. holed the mantlet at its centre line and 7½" above it, while a striko 4" below the centre line at a velocity 125 f.s. lower did not penetrate the mantlet, but was deflected downwards through the hull roof. The damage thus caused to the ammunition bin behind the hull gunner indicated that a cordite fire would probably have resulted had ammunition been stowed, and there is little doubt that the gunner would have been severely wounded by fragments of shot or roof plate.

It is thus apparent that damage likely to arrest the vehicle may be caused by head-on attack from 6 pdr. A.P.C.B.C. at a range of 1,270 yds. if hits are obtained on the mantlet, especially below the centre line, where the dangerous range is approximately 1780 yds.

(b) 6 pdr. A.P.D.S.

Ten rounds of 6 pdr. A.P.D.S. were directed at the nearside half of the mantlet and it was apparent that perforations are unlikely to be caused by this form of attack at striking velocities less than 2500 f.s., i.e. at ranges greater than 2500 yds. Chance rounds such as Rounds 7 and 14, however, which struck in the clearance round the gun barrel and on the edge of the turret front below the mantlet respectively, may wedge the gun barrel or jam the turret by pegging it to the hull roof. Rounds deflected downward from the mantlet are unlikely to perforate the hull roof, as they will probably shatter on first impact.

Lack of space prevented further data being obtained from the turret mantlet under this form of attack. (Rds.6-15.)

(N.B. The turret was released by cutting out the armour around the lodged core of Round 14 with an oxy-acetylene flame.)

2. Turret side at 50° and 60° (Thickness 47 mm.)

(a) 6 pdr. A.P.C.B.C.

Rounds 37 to 43 directed at the nearside of the turret at an angle of 50° indicated that the ballistic limit and M/R limit were 2205 f.s. and 2243 f.s. respectively. Round 43 passed through the turret wall, crossed the fighting compartment, perforated the transverse bulkhead in the offside pannier at the rear of the compartment, and entered the fuel tank behind the bulkhead. A severe fire resulted which was kept under control with some difficulty by means of water from fire hoses, and although some time elapsed before it was extinguished, the armour was not heated above 100°C. The whole round, except for the caps, was recovered from the fuel tank. (Rds. 37-43.)

(b) 6 pdr. A.P.D.S.

Eight rounds were directed at the turret side, two at 50° to normal and six at 60°. Each of those at 50° defeated the plate and indicated that perforations are likely at ranges up to 2500 yds. As it is highly improbable that hits could be made with any degree of accuracy at such ranges, the angle of presentation of the plate was increased to 60° to normal in order that striking

velocities

velocities corresponding to a shorter range might be employed. Of six rounds fired with charges reduced to give striking velocities between 2900 and 3700 f.s., only two struck the turret. These scooped harmlessly at 2977 f.s. and 3629 f.s., indicating that the plate is immune at this angle for ranges approximating to 700 yds.

For some reason the accuracy from this form of attack deteriorated during the firing of Rounds 21 to 28, possibly due to the employment of reduced charges or the fact that the cartridge cases were not crimped. (Rds.21-28).

3. Pannier side at 50° (Thickness 50 mm.)

(a) 6 pdr. A.P.C.B.C.

Five rounds were fired at the nearside pannier and revealed that the critical velocity at this angle was approximately 2360 f.s. (equivalent range 1020 yds.). The area attacked cracked very severely after each impact and the weld to the pannier floor was fractured for almost the entire length of the vehicle, although attack was confined to the front half of the plate. (Rds.44-48.)

(b) 6 pdr. A.P.D.S.

Seven rounds were directed at the rear portion of the nearside pannier, but only one strike was obtained on the plate and that was so wide of the mark that it failed to influence the velocity recording camera. In view of the extreme inaccuracy of this ammunition the attack was discontinued.

The last round fired went low and penetrated into the fuel tank behind the hull side and caused a violent outbreak of fire, which was eventually brought under control and extinguished without heating the armour enough to affect its temper. (Rds.69-75.)

4. Hull nose at 53° (Thickness 51.5 mm.)

6 pdr. A.P.D.S.

Four rounds were directed at this plate but two scooped harmlessly off the glacis plate. The others, striking on the nose plate at velocities of 3330 f.s. and 3635 f.s., caused a scoop and a perforation respectively, indicating that this plate is vulnerable at ranges under 700 yds. against this form of attack. (Rds.17-20.)

SECTION V. Trial Commentary (Contd.) 17 pdr. A.P.D.S. and A.P.C.B.C. attacks.

Glacis plate at 55°. (Thickness 80 mm.)

(a) 17 pdr. A.P.D.S.

Five rounds of 17 pdr. A.P.D.S. were directed at the glacis plate and a critical velocity of approximately 3410 f.s. was estimated from Rounds 31 and 33. The plate was shown to be brittle and flaked severely on being overmatched.

The indication is that the plate is likely to be defeated with this form of frontal attack at ranges not exceeding 1500 yds. (Rds.29-33).

(b) 17 pdr. A.P.C.B.C.

Two rounds only were fired at the glacis plate and both caused excessive cracking over wide areas. Round 35, striking at 2443 f.s., was deflected upwards but the plate was forced in 5" along a crack through the point of impact. Round 34 did not penetrate at 2673 f.s., but dislodged a flake 1'-10" x 1'-6", which however was retained about 1" behind the armour by the steering shaft and the left-hand support for the final drive housing.

The plate was so badly cracked by these two rounds that the only areas remaining whole were those covering the pannier fronts. (Rds.34 and 35.)

(c)/

(c) 17 pdr. A.P.

One round of 17 pdr. A.P. directed at the glacis plate in front of the offside pannier at a striking velocity corresponding to a range of 900-1000 yds., holed the plate and dislodged in pieces a flake 13" x 11" x 2". Further severe cracking resulted and attack against this plate was discontinued. (Rd.56.)

SECTION VI. Trial Commentary (Contd.) 75 mm. M.61, H.E. and 25 pdr. H.E. attacks.

1. Turret mantlet. 75 mm. A.P.C.B.C. shell.

One round of American M.61 A.P.C.B.C. shell was directed at the lower half of the turret mantlet at the near side. The round detonated, scooped downward, shattered the roof plate behind the driver's hatch, and passed into the hull with large pieces of roof plate. Considerable internal damage was caused, and it is probable that severe injury would have incapacitated the driver even if a cordite fire did not occur in the damaged bin behind his back. (Rd.16.)

2. Turret 75 mm. H.E. attack.

(a) Mantlet

One round, directed at the cupola, detonated on the mantlet which it struck at normal on its centre line to the left of the gun. As the turret was traversed approximately 40° left, no appreciable damage resulted. The mantlet was not attacked with the whole tank facing the gun as the damage already caused to the hull roof by Rounds 5 and 16 made it impossible to determine the resistance of the portion over the driving compartment to H.E. attack. The brittleness of the roof plate suggests, however, that a round of 75 mm. or 25 pdr. H.E. detonated low on the mantlet would probably blow a hole in the roof and displace the hatches.

(b) Cupola

One round of 75 mm. H.E. was detonated on the front of the cupola at a point 4" above the hull roof. The roof plate was severely cracked over an area 2'-9" x 2'-6" and forced inward 2½" at a point 4" in front of the cupola. Blast would have entered the turret, and fittings attached to the roof below the deformed area were dislodged, and would have caused injuries to members of the crew. No periscopes were fitted in the cupola; it was, therefore, impossible to determine whether they would have been dislodged by this type of attack. (Rd.60.)

(c) Rear escape door

The detonation of Round 61 at the centre of the rear escape door on the turret caused negligible damage inside the turret. The door catch was bent but could still be operated and the door was not jammed. The forward radiators were damaged by fragments of the shell which passed through the grills, and the roof of the engine compartment was forced down ¾" adjacent to the front edge of the main hatch. (Rd.61.)

25 pdr. H.E. attack

(d) Turret rear plate.

A round of 25 pdr. H.E. was detonated on the turret rear plate towards the near side. The escape door was jammed due to the distortion of the catch, which could not be withdrawn, and damage to the hinge attachments also resulted. As for the previous round, damage to the forward radiators was increased by shell fragments; otherwise the round appeared to have little further effect on the engine compartment roof and fittings. (Rd.62.)

(e) Turret side

The turret was traversed left to expose the butt-weld in the hull roof at the offside and a round of 25 pdr. H.E. was detonated on the turret side 12"

above/

above the roof plate. The roof plate was cracked and set downward beneath the point of impact, but no appreciable damage was caused inside the turret. The displacement of the roof plate at the time of detonation caused the top guide rail for the ammunition rack cover to be dislodged from the roof, together with the sheet steel cover. (Rd.63.)

3. Hull

(a) Hull side 75 mm. H.E.

One round of 75 mm. H.E. struck 6" below the pannier floor on the offside of the hull at a point immediately below the central bulkhead between the ammunition racks. The detonation cracked the weld to the lower armour for 38", but the presence of the bulkheads and a stiffening rib running over the joint prevented any severe distortion of the pannier floor plate. Damage to the track was slight. (Rd.64.)

(b) Hull side 25 pdr. H.E.

Severe damage to the pannier floor resulted when a round of 25 pdr. H.E. was detonated against the hull side opposite the hull-gunner's position. The joint to the lower armour was torn open for more than 7 ft. and blast and fragments entered the hull through the gap which was 2" wide nearest to the point of impact. This round struck 14" below the pannier floor, very close to the track and destroyed the inner third of one track link. Damage to the track and bumper bracket might have resulted in the severing of the track had the vehicle been moving. There is little doubt but that the hull-gunner and the driver would have been injured. (Rd.65.)

N.B. No skirting plates were fitted to the hull side.

SECTION VII. Trial Commentary (Contd.) 3-lb. P.I.A.T. Attack.

1. Pannier Side

Two rounds were directed at the pannier side opposite the driver's position and struck at 30° to normal, the tank being broadside on to the attack. Both rounds detonated, but the first failed to pierce the armour and had apparently been affected by the presence of external fittings for securing stowage. The second round caused a perforation ½" in diameter and dislodged a flake 1½" in diameter. Fragments damaged the casing over the gearbox, and pitted the back of the offside armour. (It was not possible to stow 75 mm. ammunition for this attack as the bins and racks had been severely damaged by previous shooting.) Had ammunition been stowed in the pannier racks, it is probable that a cordite fire would have resulted. (Rds.49-50.)

2. Glacis Plate

Three rounds struck on the glacis plate and all failed to detonate on impact. One detonated after scooping upward and striking a thin plate which had been laid to project forward from the hull roof, but caused no damage to the hull. Attack against this plate was discontinued. (Rds.51-53.)

3. Cupola

Five rounds were directed at the front of the cupola and of these, three failed to detonate. The two which detonated struck on the front edge of a periscope protector and on the protector around the hinge pillar for the hatch. The second caused no internal damage. The first caused fragment entry downwards through the periscope aperture into the turret. Whether this would have occurred had a periscope been fitted is not known, but it is probable that the periscope would have been driven in by blast. (Rds.54-58.)

As 60% of the projectiles used failed to detonate on impact, further attack was considered unprofitable.

SECTION VIII/

SECTION VIII. Attack from A.T. Grenades and Mines

1. Offside Track A.T. Grenades No.75.

(a) Two grenades placed one above the other with detonating plates in contact were statically detonated beneath the leading road-wheel with their centres 8" from the outer edge of the track. The track was not severed and would probably have continued to give service unless subjected to excessive strain if the tank encountered heavy going. (Rd.66.)

(b) Three grenades, arranged as described in Appendix A (Rd.67), were detonated statically under the last pair of road-wheels which corresponded in type to the leading pair. The centre of the arrangement of grenades was 8" from the outer edge of the track. The detonation severed the track completely by fracturing one link through all its webs. Three links immediately above the grenades were less severely damaged, the broken link was below the road wheels behind those attacked, and another link (fourth from that fractured) situated under the wheels forward of the attack was broken half way across. At least five new links would have been required to repair the track. (Rd.67.)

SECTION IX. Summary

1. 6 pdr. Attack

The following table gives details of critical velocities of the plates attacked.

The equivalent ranges are approximate and refer to 6 pdr. 7 cwt. Mks.IV and V.

Plate	Thick-ness	Presenta-tion	Angle of strike	A.P.C.B.C. f.s.	Equiv.Range yds.	A.P.D.S. f.s.	Equiv.Range yds.
Mantlet	110mm.*	Front of turret at normal.	Various	2300 on centre line	1280	2500	2500+
Turret side	47mm.	Side of turret at 45°	50°	2243 (2290)	1500	2258-	2500+
		56°	60°	-	-	3629+ Immune	675-
Hull Nose	51.5mm.	Front of hull at normal.	53°	-	-	3600	725
Pannier side	50mm.*	Side of hull at 42°	50°	2360 (2410)	1040	-	-

*Nominal thicknesses.
(Velocities in brackets are average ballistic limit figures obtained under similar conditions of attack from British machineable quality armour.)

2. 17 pdr. Attack

The following table summarizes the results obtained during this trial. Critical velocities are quoted.

Plate	Thickness	Presentation	Angle of strike	A.P.C.B.C. f.s.	Equiv. Range yds.	A.P.D.S. f.s.	Equiv. Range yds.
Glacis plate	80 mm.	Front of tank at normal	57°	2670	800	3410	1500

The/

The plate was holed by 17 pdr. A.P. at a striking velocity corresponding to a range of 900-1000 yds.

3. 75 mm. A.P.C.B.C. shell

A shot striking low on the mantlet penetrated the hull roof and caused considerable internal damage.

4. H.E. attack

Detonations of 75 mm. or 25 pdr. H.E. within 12" of the roof plates of hull or turret, or below the panniers (without skirting plates fitted), caused severe cracking of roof plates and entry of blast into the vehicle. Detonations within 6" of the thin plates may drive portions of the plates into the vehicle. Internal fittings are liable to be dislodged from the thin plates by this form of attack.

The most vulnerable area is that below the mantlet where detonations will cause severe damage to the hatches and frame of the driving compartment roof.

Detonations above the roof of the engine compartment, e.g. from strikes on the back of the turret, will cause fragmentation damage to the radiators.

It is improbable that attack from either type of shell will sever a track unless the detonation occurs, from head-on attack, between the driving sprocket and the ground when the fragments will probably cut the track or damage it sufficiently to cause it to break when moved.

5. 3-lb. P.I.A.T.

The pannier side, the glacis plate, and the cupola were attacked. Results from head-on suggest that this form of frontal attack is likely to be unprofitable. Flank attack against the pannier side will be very effective, provided that the projectile is not deflected by external stowage or fittings.

6. A.T. Grenades No.75 and A.T. Mines Mk.V.

Two No.75 grenades laid one above the other and detonated simultaneously failed to break the track. Three No.75 detonated simultaneously completely severed the track, and a single Mk.V. H.C. mine gave a similar result.

7. Incidence of Fire.

(a) Fuel

Two serious fuel fires occurred during the trial. The first was caused by the penetration of a 6 pdr. A.P.C.B.C. round (Rd.43) through the turret nearside at 50°. The whole round passed across the interior of the fighting compartment holing the transverse bulkhead at the offside, and entering the pannier tank behind it. The CO2 apparatus did not operate automatically and the turret could not be approached, so that manual operation was impossible. A portable CO2 extinguisher also failed to operate, as did a foam extinguisher attached to a fire hose supplied by trailer pump from a static water tank. The fire was controlled by means of water from two fire hoses and eventually extinguished.

The drain valve from the fuel system was opened in order to run off the remaining fuel, but as none drained out it was assumed that the remaining undamaged tanks were empty.

The second fire was caused by Round 75 (6 pdr. A.P.D.S.) which missed its intended target and penetrated through the lower armour into a fuel tank below the nearside radiators. Again fire spread throughout the engine and fighting compartments, and was eventually controlled and extinguished.

When the vehicle was stripped after the trial, it was found that the control rod to the petrol tap would not operate the tap. This explained why no fuel had drained out when the drain valve was opened. The fuel tank damaged by Round 75

was cut to ribbons by fragments of the broken core, and fuel had flooded the fuel compartment and gushed through the bulkhead (also torn open by this round) into the engine compartment.

The lower offside tank still held 25 gallons of petrol when stripped out.

Cordite

No ammunition was stowed during the trial, but there was ample evidence from damage caused to racks and bins that cordite fires would be probable as the result of successful attack in the following areas:-

1. Pannier sides; from perforations of any type of A.P., and from P.I.A.T.

2. Front of turret below mantlet; from A.P. shot deflected downward through the hull roof, causing damage to bins behind driver and hull machine gunner, or from H.E. which may drive pieces of the roof plate into the same bins.

SECTION X. Conclusions

1. Vulnerability and quality of Armour.

The results of this trial (Part II) have shown that the estimates of the vulnerability of the Panther, given in the D.T.D. Armour Branch Report M.6815A/3 No.1 (Armour Quality and Vulnerability of Pz.Kw.V Panther), which was prepared after preliminary examination of vehicle No.213101, are substantially correct. Where differences between the estimates and the proved results do occur, in each case the resistance of the vehicle fell short of expectations. Thus, for instance, where it was stated that the glacis plate was nominally immune to 17 pdr. A.P.C.B.C. frontal attack, the assumption was made that the quality of the German armour would be equal to that of British machineable quality rolled armour; in fact the trial against this particular vehicle showed that all the plates tended to flake and that all but one of those attacked cracked extensively under A.P. or A.P.C.B.C. attack, from 6 pdr. or 17 pdr., and that, therefore, the protection given by the armour was less than that expected. The glacis plate was defeated by 17 pdr. A.P.C.B.C. at a range of 800 yds. and by 17 pdr. A.P. at a range of over 900 yds.

Examination of other vehicles damaged in action, and reports of battle damage to Panther tanks indicate that brittleness of the armour is not peculiar to the vehicle used in this trial. (For details of attack on other plates of this vehicle, see Part III of this report.)

Ample confirmation of the weakness of the design of the area between the centre of the mantlet and hull roof was afforded, both 6 pdr. A.P.C.B.C. shot and 75 mm. A.P.C.B.C. shell (M.61) caused extensive damage in the driving compartment by breaking through the hull roof after being deflected from the lower half of the mantlet.

The plates forming the roofs of hull and turret were found to be very brittle, and liable to fracture under the effects of H.E. detonations occurring within 12" of the surface. Detonations within 6" of the plate will probably cause severe ruptures or even dislodge portions of the fractured plate into the vehicle.

2. Structure.

The welds of the main structure revealed extensive junction cracking during the trial, and it was apparent that many of the fractures had existed prior to the trial, as their surfaces were rusted. The presence of the anti-magnetic coating made earlier detection of cracks almost impossible. As a result of repeated attack, the welds around the glacis plate failed almost completely, but the interlocked joints prevented a general collapse of the front of the vehicle, even when the armour was itself broken into many pieces. It is evident that the interlocked type of joint does give the structure considerable stability, and deficiencies of welding which occur in production would be less likely to lead to serious consequences in battle.

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3. Effect of A.T. Mines

The trial has shown that the Panther track is more easily broken than experience with Churchill tracks had suggested was likely. This trial confirmed a report from Western Europe that a single Mk.V (H.C.) A.T. Mine will in fact sever the track even if not detonated centrally beneath it; and showed that a similar effect may be obtained by a combination of three No.75 A.T. grenades. Two such grenades will probably fail to achieve the desired effect. Members of the crew are not likely to be affected by either type of mine if detonated by the track.

For details of subsequent mine trials see Part IV of this report.

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TARGET	ATTACK	OBSERVATIONS
Front of turret mantlet.	Round 1. 6-Pr. A.P.C.B.C. at normal. S.V.2321 f.s. Range 280 ft.	Code W. Struck 7½" above centre line of mantlet and 17" to right of centre line of 75 mm. gun. Shot passed between top edge of inner mantlet and roof, injuring loader. Struck right side of recoil guard, motor of roof fan unit dislodged. Rear door in turret struck by fragments.
Ditto	Round 2 6-Pr. A.P.C.B.C. at normal. S.V.2034 f.s. Range 280 ft.	Code D. Struck 4¼" below centre line of mantlet and 15" right centre of 75 mm. gun.
Ditto	Round 3 6-Pr. A.P.C.B.C. at normal. S.V.2171 f.s. Range 280 ft.	Back damage not visible. Nose lodged. Struck 2" above centre line and 9½" to right of centre line of 75 mm. gun.
Ditto	Round 4 6-pdr. A.P.C.B.C. at normal. S.V. 2313 f.s. Range 280 ft.	Code W. Base lodged. Struck 4" above centre line and 28" from centre line of 75 mm. gun and 4½" from right hand edge. Base of shot 3½" below face. Five of eight bolts behind off-side trunnion holding outer casting on to turret front, fractured at reduced section for threads. Shot retained between mantlet and turret front. Elevation free.
Ditto	Round 5. 6-pdr. A.P.C.B.C. at normal. S.V. 2175 f.s. Range 280 ft.	Shot shattered. Back damage not visible. Struck 4" below centre line of mantlet and 8" from edge of mantlet. Shot scooped down breaking hole 8" x 9½" through roof plate behind hull gunner's hatch. Roof plate fractured for 38" from right hand side, along back edge, from point 8" forward of right rear corner of hatch frame. Roof plate brittle, (thickness 17 mm. approx.). Fragments of plate and shot penetrated through top of ammunition bin behind hull gunner and severely distorted all sides of ammunition bin. One bolt securing frame plate of roof hatch assembly dislodged ad[illegible] to point of impact.

Contd.

TARGET	ATTACK	OBSERVATIONS
Front of turret mantlet.	Round 5 continued. 6-pdr. A.P.C.B.C. at normal. S.V. 2175 f.s. Range 280 ft.	Hull gunner's roof hatch lifted 2" bodily due to displacing of locking clamp below hinges. Fragmentation marks over roof stiffener behind driving compartment, ammunition bin in front right hand corner of fighting compartment dented by fragments but not penetrated. In all probability, hull machine gunner would receive serious injury and cordite fire would have occurred in bin behind him.
Front of turret mantlet.	Round 6. 6-pdr. A.P. D.S. at normal. S.V. 2556 f.s. Range 280 ft.	Code W. Plug out 1" diameter. Struck 10⅜" to left of centre line of 75 mm. gun and 4" above centre line of gun. Shot entered through telescope aperture, and passed through dummy gunner's head, and dummy commander's thigh.
Ditto.	Round 7, 6-pdr. A.P.D.S. at normal. S.V. 2238 f.s. Range 280 ft.	Back damage not visible. Core broke up. Struck gun jacket 1" below centre line on clearance between gun and jacket at left hand side.
Ditto.	Round 8. 6-pdr. A.P.D.S. at normal. S.V.2228 f.s. Range 280 ft.	Back damage not visible. Nose lodged. Struck 3½" up above centre line of mantlet and 16½" from centre line of gun.
Ditto.	Round 9. 6-pdr. A.P.D.S. at normal. S.V.2415 f.s. Range 280 ft.	Back damage not visible. Struck 7" down below centre line of mantlet and 13" left of centre line of 75 mm. gun and scooped downwards and shattered on hull roof.
Ditto.	Round 10. 6-pdr. A.P.D.S. at normal. S.V. 2389 f.s. Range 280 ft.	Code D. Glanced off left hand end of mantlet and struck turret front in weld to turret side, and shattered within the armour. Centre portion of interlocking joint fractured 9½" (i.e. full length). Weld on turret side cracked from front edge for 4" above and below centre section. Turret side forced out 3/16" at point of impact. Inner weld between front and side broken in junction to side plate from point 1½" above floor for 15½".

TARGET	ATTACK	OBSERVATIONS
Front of turret mantlet.	Round 11. 6-pdr. A.P. D.S. at normal. S.V. 2405 f.s. Range 280 ft.	Back damage not visible. Nose lodged. Struck 22½" from centre line of 75 mm. gun and on centre line of mantlet.
Ditto.	Round 12. 6-pdr. A.P. D.S. at normal. S.V. 2468 f.s. Range 280 ft.	Code C. Struck 16" from centre line of 75 mm. gun and on centre of mantlet 3" below point of strike of Round 8.
Ditto.	Round 13. 6-pdr. A.P. D.S. at normal. S.V. 2380 f.s. Range 280 ft.	N.F.H. Struck 3" below top edge of glacis plate and 19" from edge of nearside of glacis plate.
Ditto.	Round 14. 6-pdr. A.P. D.S. at normal. S.V. 2478 f.s. Range 280 ft.	Code B. Struck face of turret below mantlet, 19" from nearside bottom corner of turret, 1½" above bottom edge of turret. Bottom edge forced down and together with nose of shot jammed turret. (Nose of core lodged in turret and in hull roof)
Ditto.	Round 15. 6-pdr. A.P. D.S. at normal. S.V. 2485 f.s. Range 280 ft.	Code D or E. Whole shot lodged. Bulge 2" dia. x ½" high. Five star cracks ¾" long, max. opening 5/16". Struck 5" below centre line of mantlet and 16½" to left of centre line of 75 mm. gun.
Ditto.	Round 16. 75 mm. A.P.C.B.C. Shell (American M61) Filled and fused. Range 280 ft.	Struck 7" below centre line of mantlet and 16" left of centre of 75 mm. gun, detonated, scooped downwards and forced portion of roof 15½" x 8" into hull, caused transverse crack in roof plate 48" long and linking up to damage caused by Round 5. Driver's hatch removed and deposited clear of vehicle. Clamp of hull-gunner's hatch hinge displaced allowing hatch to lift out of roof plate. Main portion of roof between hatches forced down 1". Lid of ammunition bin behind driver torn at corner with probable damage to one round. Considerable damage to fittings on gear box, electrical fittings, and light gauge air duct caused by fragments of roof plate and projectile.

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TARGET	ATTACK	OBSERVATIONS
Front of turret mantlet	Round 16 continued. 75 mm. A.P.C.B.C. Shell (American) (M.61). Filled and fuzed. Range 280 ft.	Probable that vehicle no longer a runner. Existing crack in weld junction between glacis and top edge of roof plate now visible, extending from nearside to driver's periscope.
Nose plate.	Round 17. 6-pdr. A.P. D.S. at 53°. S.V. 3330 f.s. Range 280 ft.	Code C. Scoop. Struck 8½" above bottom edge of nose plate and deflected down. Outer weld, nose to side plate, cracked intermittently. Weld length 31" fractured about 50%.
Ditto.	Round 18. 6-pdr. A.P. D.S. at 53°. S.V. 3599 f.s. Range 280 ft.	Code B. Struck glacis plate at 55° 25" from front edge and 22" from left hand side.
Ditto.	Round 19. 6-pdr. A.P.D.S. at 53°. S.V. 3628 f.s. Range 280 ft.	Code B. Struck 7" from front edge of glacis plate at 55° and scooped up. 75 mm. barrel has numerous small scoops. Crack in weld junction to nose plate 7" long immediately below scoop.
Ditto.	Round 20. 6-pdr. A.P. D.S. at 53°. S.V. 3635 f.s. Range 280 ft.	Code R. Shot shattered. Struck 6½" down from edge of nose plate. Weld fracture between nose and glacis now 10".
Near side wall of turret.	Round 21. 6-pdr. A.P. D.S. at 50° compound. S.V. 2967 f.s. Range 280 ft.	Code W. Shot shattered. Struck 7" below top edge of turret and 18" from front edge. Flake off 3" x 2½" x ⅜". Left side of recoil guard and compressed air feed torn by fragments. Area 18" x 12" on offside wall pitted. Dummy commander wounded in thigh and abdomen. Dummy loader's head and shoulders removed.

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TARGET	ATTACK	OBSERVATIONS
Nearside wall of turret.	Round 22. 6-pdr. A.P. D.S. at 50° compound. S.V. 2558 f.s. Range 280 ft.	Code W. Struck 19½" down from top edge of turret and 10½" from front edge.
Ditto.	Round 23. 6-pdr. A.P. D.S. at 60° compound. S.V. 2977 f.s. Range 280 ft.	Code C. Scoop. Bulge ⅛" high. Struck 3¾" down from top edge and 25" from front edge. Plate cracked across scoop in two places.
Ditto.	Round 24. 6-pdr. A.P. D.S. at 60° compound. S.V. N.O. Range 280 ft.	Missed target.
Ditto.	Round 25. 6-pdr. A.P. D.S. at 60° compound. S.V. 3292 f.s. Range 280 ft.	Missed target.
Ditto.	Round 26. 6-pdr. A.P. D.S. at 60° compound. S.V. 3539 f.s. Range 280 ft.	Code C slight. Struck glacis plate at 55° 7" below top edge near centre line.
Ditto.	Round 27. 6-pdr. A.P. D.S. at 60° compound. S.V. 3400 f.s. Range 280 ft.	Missed target.
Ditto.	Round 28. 6-pdr. A.P. D.S. at 60° compound. S.V. 3629 f.s. Range 280 ft.	Code C. Bulge ¼" high. Struck turret wall 10" from front edge and 16" down. Weld to front split further 3½" in side plate.
Glacis plate. Front of tank at normal to gun.	Round 29. 17-pdr. A.P. D.S. at 55°. S.V. 3226 f.s. Range 280 ft.	Code C. Struck 7" above bottom edge of glacis plate. Crack in plate below scoop 5" long, adjacent to plate edge. Old junction crack to nose plate opened to 1/16" max, 24" long (full length between interlocking section at centre).

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TARGET	ATTACK	OBSERVATIONS
Glacis plate. Front of tank at normal to gun.	Round 30. 17-pdr. A.P. D.S. at 55°. S.V. 3501 f.s. Range 280 ft.	Code W, hole 1¾" x 1½". Struck 17" above bottom edge and 20" from inner edge of offside side plate. Crack in glacis plate 6" towards top offside corner from shot hole. Internal:- Casting for final drive housing fractured, fragments probably entered drive housing.
Ditto.	Round 31. 17-pdr. A.P. D.S. at 55°. S.V. 3374 f.s. Range 280 ft.	Code C. Shot shattered. Scoop 5½" x 5¾" x 1⅜" deep. Struck 10½" above bottom edge of glacis plate and 3½" from offside inner edge of side plate. Crack across scoop 5" long. Weld between glacis and side plate fractured full length of joint, i.e. for 2' 7". Glacis plate forced down 5/16" adjacent to point of impact. Weld of tenon on offside side plate fractured full perimeter (about 2 ft.). Crack in glacis from centre of scoop 5½" long running left towards hull nose (at about 45°).
Ditto.	Round 32. 17-pdr. A.P. D.S. at 55°. S.V. 3348 f.s. Range 280 ft.	Code C. Scoop 7" x 4⅜" x 2" deep. Struck 2' 4" above bottom edge of glacis and 1' 10" from inner edge of side plate. Crack across scoop 3½" long. Weld attaching machine gun mtg. now cracked for whole circumference. Weld attaching roof to glacis plate cracked from near side to within 18" of offside (approx. 7'). Most cracks in this joint are old junction cracks adjacent to the roof plate but around driver's periscope a new crack runs for approx. 8" in the junction to the glacis plate. A crack in the glacis plate from point of impact to aperture for ball mounting ran 3½" long.

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TARGET	ATTACK	OBSERVATIONS
Glacis plate. Front of tank at normal to gun.	Round 33. 17-pdr. A.P. D.S. at 55°. S.V. 3449 f.s. Range 280 ft.	Code W. Front flake 5½" x 6½" x 1" dislodged immediately above point of impact. Round struck 1'9" from top edge of glacis plate. Back damage: Flake off in pieces 6" x 5½" x ¾", hole 3¼" x 1¾". Switch box fitting removed and badly torn by fragments of shot and plate. Centre portion of shaft connecting steering controls dented by fragments. Ammunition bin behind driver penetrated in several places. Cover over gear box severely torn by fragments. The driver would have been killed, and several fragments caused injury to the turret gunner's legs.
Glacis plate.	Round 34. 17-pdr. A.P.C.B.C. at 55°. S.V.2673 f.s. Range 280 ft.	Code R. Shot deflected upwards. Flake off 1'10" dia. but retained by internal fittings. Hole 9¾" x 4½". Struck 14" from bottom edge. Cracks from point of impact to Round 19, 12" long, to nearside edge 15" and to Rd. 18 5" long. Roof plate lifted 3/16".
Ditto.	Round 35. 17-pdr. A.P.C.B.C. at 55°. S.V. 2443 f.s. Range 280 ft.	Code D. Bulge 3/8" high. Scoop 8" x 3½". Struck 9" below top edge of glacis plate. Extensive cracks in glacis plate. Portion of plate 15" x 16" forced down ¾" at bottom edge and hinged about roof joint. Joint between roof and glacis now open ½" adjacent driver's periscope. Joint between roof and nearside pannier broken 19". Joint glacis to nearside pannier cracked in junction to side plate 16". Three radial cracks in glacis plate 15" long from broken piece. Circum. crack on inside face 18" long, 13" from top edge.

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TARGET	ATTACK	OBSERVATIONS
Glacis plate.	Round 36. 17-pdr. A.P. at 55°. S.V. N.C. Approximate equivalent range 900 - 1000 yds.	Code W. Hole 3" x 2¾". Struck 8" below top edge 12" from outside. Three radial cracks in plate, 10", 12" and 8" long. Joint between glacis and roof now fractured full length. Joint to offside pannier fractured 12" from front edge. Flake off in pieces 13" x 11" x 2".
Nearside wall of turret.	Round 37. 6-pdr. A.P.C.B.C. at 50° compound. S.V. 2227 f.s. Range 280 ft.	Code R. Flake off 4¾" x 4½" x ¾". Hole 2" x 1½". Struck 13" up and 1' 11" from front of turret.
Ditto.	Round 38. 6-pdr. A.P.C.B.C. at 50° compound. S.V. 2041 f.s. Range 280 ft.	Code C. Bulge 5/16" high 6" x 4½". Scoop 5" x 2½" x ⅜". Struck 13" above turret bottom edge.
Ditto.	Round 39. 6-pdr. A.P.C.B.C. at 50° compound. S.V. 2140 f.s. Range 280 ft.	Code C. Scoop 6½" x 2¾" x 1⅛". Struck 4" down below top edge of turret. Bulge 6½" x 4" x ⅜".
Ditto.	Round 40. 6-pdr. A.P.C.B.C. at 50° compound. S.V. 2183 f.s. Range 280 ft.	Code C. Struck 1'5" from top edge of turret. Bulge 6½" x 4½" x ⅜".
Ditto.	Round 41. 6-pdr. A.P.C.B.C. at 50° compound. S.V. 2221 f.s. Range 280 ft.	Not fair hit. Bulge now ⅜" high. Double hit on Rd. 39. Struck 5½" down.
Ditto.	Round 42. 6-pdr. A.P.C.B.C. at 50° compound. S.V. 2230 f.s. Range 280 ft.	Code S. Scoop 7" x 2½" x 2". Struck 11½" up above bottom edge of turret. Flake 5½" x 4¼" lifted ⅛".

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TARGET	ATTACK	OBSERVATIONS
Nearside wall of turret.	Round 43. 6-Pr. A.P.C.B.C. at 50° compound. S.V. 2259 f.s. Range 280 ft.	Code W. Struck on nearside turret 11½" below top ends and 22" from front edge of nearside of turret. Vehicle caught fire. Round passed downwards across turret and penetrated engine compartment, bulkhead and front of offside pannier fuel tank. Round recovered whole from offside fuel tank. Flake off 5½"x4"x⅝".
Nearside pannier.	Round 44 6-Pr. A.P.C.B.C. at 50° compound. S.V. 2353 f.s. Range 280 ft.	Code D. Shatter scoop 4⅛"x2⅜"x⅞" Horizontal crack in plate 6½" across scoop. Weld joint pannier to floor plate sheared for 43" in junction to pannier. Pannier side dished 9/32" at point of impact. Rear. Crack extending from points 25" apart on joint to pannier floor through an arc reaching at its centre a point 6" from the joint.
Ditto	Round 45 Ditto S.V. 2341 f.s. Range 280 ft.	Code W. N.F.H. Struck 6" from Round 44. External weld between pannier side and pannier floor now fractured 7'10". Plate cracks extended forming three star cracks, two 20" long and one 10" long.
Ditto	Round 46 Ditto S.V. 2373 f.s. Range 280 ft.	Code W. Struck 13" above bottom edge of pannier. Flake off 6"x4½" in pieces. Rear supports for ammunition racks torn away and distributed about turret. Rim of gun elevating hand wheel broken.
Ditto	Round 47 Ditto S.V. 2297 f.s. Range 280 ft.	Code C. Scoop Struck 7" above bottom edge of pannier. Short irregular cracks now apparent in weld hull roof plate to pannier side.

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TARGET	ATTACK	OBSERVATIONS
Nearside pannier	Round 48 6-Pdr. A.P.C.B.C. at 50° compound. S.V. 2335 f.s. Range 280 ft.	Code D. Shatter scoop. Struck 7" below top edge of pannier. Flake 8"x5½" lifted 1½" for three quarters of circumference. Weld pannier side to floor now fractured full length except 12" at rear and 9" at front end
Pannier side. Nearside of hull at normal to projector.	Round 49 3lb PLAT. at 30° Range 60ft.	Struck 6" below top edge of pannier and detonated. Slight pitting on strip welded to pannier for external stowage.
Ditto	Round 50 Ditto Range 60 ft.	Pannier holed. Struck 5⅛" below top edge of pannier. Numerous strikes on pannier at 7" radius. Hole ⅜" dia. with flake off 1¼" dia. on inside face. Inner face of offside armour marked and pitted. Driver probably killed. Strikes on some of roof fittings from fragments.
Front of tank at normal to projector.	Round 51 Ditto at 55° Range 30ft.	Struck on glacis plate at front of nearside pannier. Blind.
Ditto	Round 52 Ditto	Blind on glacis plate. Scooped upwards and detonated on overhanging plate laid on hull roof. Glacis plate slightly pitted by fragments of bomb casing.
Ditto	Round 53 Ditto	Struck glacis plate and failed to detonate.
Commander's Cupola.	Round 54 Ditto at normal Range 30 ft.	Struck between periscope protectors and failed to detonate.
Ditto	Round 55 Ditto	Ditto
Ditto	Round 56 Ditto	Ditto.
Ditto	Round 57 Ditto	Detonated on top of periscope protector. Bracket securing machine gun guide rail dislodged from top of protector. Fragments penetrated inside through periscope aperture and made strikes on recoil guard. Presence of periscope might have kept fragments out.

TARGET	ATTACK	OBSERVATIONS
Commander's Cupola	Round 58 3-lb.P.I.A.T. at normal Range 30ft.	Detonated between periscope and boss for hinge pillar. Hole through boss. Jet would have gone upwards and impinged on cupola hatch hinge arm. No damage caused inside turret.
Commander's Cupola	Round 59 75.mm. H.E.shell filled T.N.T. at normal. Instantaneous fuse. Reduced charge.	Missed Cupola. Detonated on mantlet at centre line.
Ditto	Round 60 Ditto	Detonated on front of cupola 4" above roof. Roof plate cracked severly over area 2'9"x2'6" and forced down 2¾" at a point 4" forward of cupola. Guide rail for machine gun dislodged. Cupola hatch previously screwed down now raised 2". Fittings attached to roof driven off into turret. Bolts securing circular blanking off plate at offside rear of turret roof dislodged.
Rear wall of turret rear of tank presented to attack	Round 61 75mm. H.A. filled T.N.T at 20° Instantaneous fuse. Reduced charge. Range 280 ft.	Struck rear wall of turret on centre of escape door and detonated. Offside radiator marked by fragments. Cast grille on nearside has strikes on vertical division bars. Roof plate forward of engine hatch set down ¾" max. over 2'4". catch for holding escape door in open position now useless. Door remained shut but welds attaching locking device to door sheared for most of length. Dove tailed tongue forced back slightly. Upper lip of catch bent on rebound of door. Seven bolts, attaching centre plate of engine compartment roof to scallop welded landing edge along back edge of main hull roof plate, dislodged 21" of forward portion of landing strip for engine hatch dislodged.

TARGET	ATTACK	OBSERVATIONS
Rear wall of turret. Rear of tank presented to attack.	Round 62 25-Pr.H.E. at 20° Filled T.N.T. Fuse 119 Cap off. Charge III.	Struck on rear wall of turret 9" from nearside and 12" above roof plate. Nearside radiator severely pitted. Nearside vertical weld joint of turret fractured for 19" from bottom in weld junction to rear plate. Internal weld fracture 3" in junction to rear plate from bottom. Upper lug for hinge boss fractured half through. Upper engaging lip for catch broken off. Door jammed in closed position. Bottom bolt of three securing hinge bracket to turret wall now loose due to fracture and removal of internal castellated nut. Head removed from central bolt. Handle for raising cupola hatch dislodged from crank.
Offside wall of turret	Round 63 25-Pr.H.E.at 23° filled T.N.T. Fuse 119 Cap off. Charge III.	Struck 12" above hull roof and detonated. Crack in forward plate 2'4" long parallel to line of turret base. Crack in butt weld between roof plates 4" long. Roof plate set down $\frac{3}{8}$" below point of impact. Outer portion of roof plate set down $\frac{1}{8}$" on inside at fracture. Crack extends along rear of roof beam. Sheet steel cover of ammunition bins dislodged. Top guide for cover dislodged from hull roof. Welds attaching protector over loader's periscope to turret roof, fractured completely at right side and nearly so at left hand side.
Offside Hull side below pannier.	Round 64 75.mm.H.E.at normal filled T.N.T. Instantaneous fuse. Reduced charge.	Detonated on hull side 6" below pannier floor. Weld pannier floor to hull side fractured 38". Three inner webs of one track link fractured 6" below point of impact. Pannier floor bulged up $\frac{3}{8}$". Max. Weld pannier side to pannier floor fractured 7" in junction to floor. The pannier floor was reinforced internally at this point by a box section stiffener welded to the pannier floor and lower side armour and also by two bulkheads attached

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TARGET	ATTACK	OBSERVATION
Offside hull side below pannier.	Rd.64 Contd. 25-pdr. H.E. at normal. Filled T.N.T. Fuse 119 - Cap off. Charge III.	to this member between the ammunition racks in the pannier Stiffener fractured halfway across (about 1½") at bend opposite junction of pannier floor and lower side armour.
Offside hull side below pannier	Round 65 25-Pr.H.E.at normal filled T.N.T. Fuse 119 Cap off. Charge III.	Detonated on hull side 14" below pannier floor. Shell passed between tread bars of track. Inner third of track fractured. Portion of track 9"x6" forced down crack in pannier side to floor 7' 7"long. Pannier floor lifted 2" max. over 6' 0". Inner weld between pannier floor and side of hull fractured from glacis plate to roof stiffener below turret. Contd.

TARGET	ATTACK	OBSERVATIONS
Offside hull side below pannier.	Round 65 continued. 25-pdr. H.E. at normal. Filled T.N.T. Fuse 119. Cap off. Charge III.	Tyre of road wheel below point of impact severed. Outer flange of this road wheel distorted. Bumper pad for suspension arm forced from side armour ½", one nut dislodged.
Front of offside track, beneath outer half of leading road wheel.	Round 66. Two grenades A.T. No. 75 placed one above the other with detonating plates in contact. Top of upper grenade in contact with track. Both grenades fitted with No. 33 detonators wired in parallel. Longitudinal axes of grenades parallel to hull side, centres 8" from outer edge of track under leading offside road wheel.	Detonation. Track not severed. One pin sheared. Small portion of centre of track broken out. Outer guide lug removed from one link. One tread fractured. Rim of first road wheel distorted on outer flange. Bumper bracket dislodged due to bolts shearing (previously stressed by detonation of Rd. 65). Track would probably hold for a time but very liable to snap under heavy strain.
Rear of offside track, beneath outer half of penultimate pair of road wheels.	Round 67. Three grenades A.T. No. 75. Lower one set transversely with centre 8" from outer edge of track. Upper pair set end to end longitudinally. All three detonated in parallel.	Detonation. Track severed due to fracture of link and not pin. One link broken and fourth one away from this fractured half way across. Five links would be required to repair track. Rim of road wheel above point of detonation distorted. Vehicle immobilised.
Front end of near-side track. Centre of mine beneath outer edge of first road wheel.	Round 68. One Mk. V.H.C. A.T. mine.	Detonation. Track severed. Bumper bracket dislodged. Portion of flanges of road wheel at point of detonation dislodged for 14". One rubber tyre removed from this road wheel. Link above mine was destroyed and pin behind this point was sheared. Centre portion of adjacent link cracked to rear of this damage. Land of lower bumper forced under hull side due to arm of road wheel having been forced against it.

SECRET

Trial No. X.794

APPENDIX A
Sheet No.15

TARGET	ATTACK	OBSERVATIONS
Nearside pannier.	Round 69. 6-pdr. A.P. D.S. at 50° compound. S.V. 3432 f.s. Range 280 ft.	Struck edge of track and shattered. Slight pitting of pannier floor. Three track links scooped.
Ditto.	Round 70. Ditto. S.V. N.O. Range 280 ft.	Code W. Back damage not visible. Shot shattered. Hole 3½" x 1½" into fuel compartment. Struck lower side armour, immediately inside end plate and ¾" below floor plate of pannier. (Side armour 41.5 mm. thick) Crack from point of impact for 9" to centre of tenon from rear plate and cracked for 6" to lifting hole. Weld to pannier floor cracked for 13" from rear.
Ditto.	Round 71. Ditto. S.V. 4127 f.s. Range 280 ft.	Missed target.
Ditto.	Round 72. Ditto. S.V. 3457 f.s. Range 280 ft.	Missed target.
Ditto.	Round 73. Ditto. S.V. N.C. Range 280 ft.	Code C. Scoop 6¾" x 1¾" x 11/16". Struck pannier side 5½" above bottom edge.
Ditto.	Round 74. Ditto. S.V. N.C. Range 280 ft.	Struck rim of second outer road wheel removing portion of rim and tyre. Penetrated disc immediately above hub of inner wheel breaking flange of hub. No other apparent damage.
Ditto.	Round 75. Ditto. S.V. 4054 f.s. Range 280 ft.	Code W. Back damage not visible. Struck 3" below pannier floor. Petrol fire in engine compartment, spreading to fighting compartment.

After stripping the hull and turret, examination of the engine compartment showed that the shot had broken up and had ricocheted a fuel tank. The nearside longitudinal bulkhead in the engine compartment opposite this fuel tank was burst open for an area of 18" x 12", no metal being dislodged. The dynamo on the engine was also damaged.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.1.

Mantlet after attack by 6 pdr. A.P.C.B.C., Rounds 1 to 5.
Round 5 scooped downwards and shattered the roof plate below. The hull gunner's hatch was dislodged due to the internal locking clamp being displaced.
Note:-
These doors are jettisonable.

Print No.2.

Front view of damage caused by Round 5.

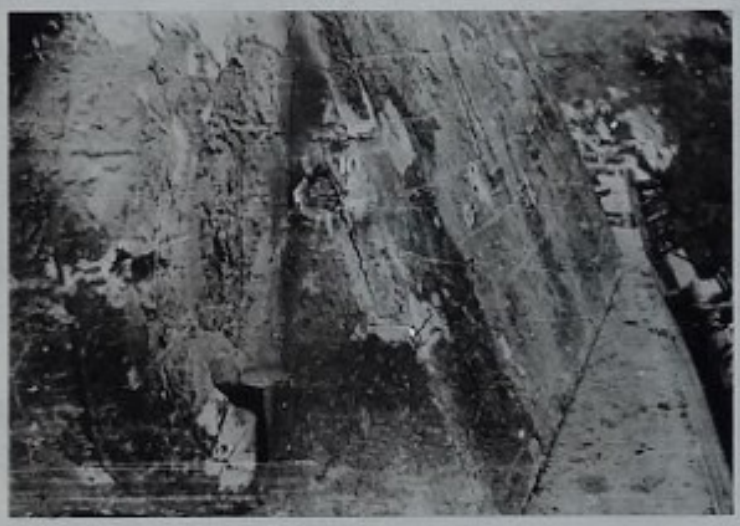
Print No.3.

Nearside of mantlet after attack by 6 pdr. A.P.D.S., Rounds 6 to 15.
Round 7 would have interfered with the recoil of the gun.
Round 14 struck the turret below the mantlet, the nose of the shot lodged in roof plate and turret, thus jamming the turret.

A.T. No.232.
Part II.

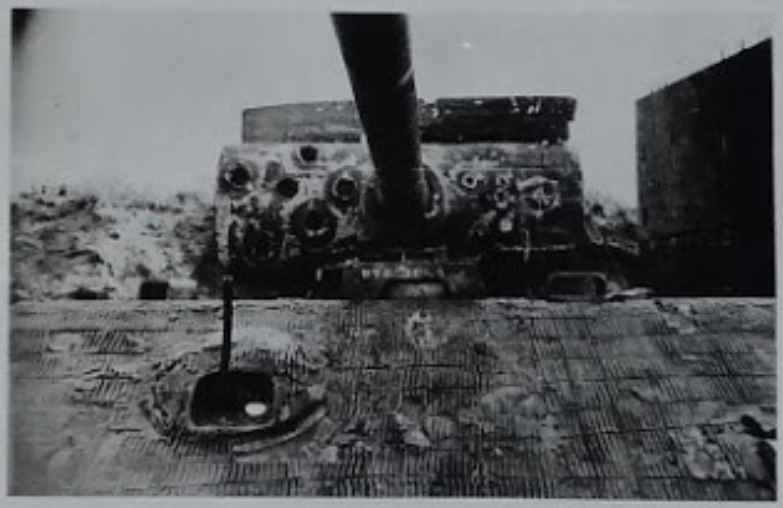
Pz.Kw.V Panther

A.P. Attack



Print No.4.

Showing damage to interlocking joint between nearside and turret front casting, caused by Round 10, 6 pdr. A.P.D.S., which scooped off the edge of the mantlet.



Print No.5.

General view of mantlet after Rounds 1 to 5, 6 pdr. A.P.C.B.C., and Rounds 6 to 15, 6 pdr. A.P.D.S.

Print No.6.

Showing damage to roof plate caused by Round 16 75 mm. A.P.C.B.C. Shell, after scooping off mantlet and penetrating roof.
The damage to the roof plate links up to that caused by Round 5, 6 pdr. A.P.C.B.C., which also scooped off the mantlet.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.7.

View looking into hull gunner's compartment after Round 5, 6 pdr. A.P.C.B.C., and Round 16, 75 mm. A.P.C.B.C. Shell, had scooped down off the mantlet and penetrated the roof plate.

Print No.8.

Showing damage to ammunition bin behind hull gunner's station after Round 5 had scooped down through roof plate.
Similar damage was caused by Round 16 to the ammunition bin behind the driver's position.
Cordite fires would probably have occurred in both cases.
See also Print No.7.

Print No.9.

Glacis and nose plates after attack by 6 pdr. A.P.D.S., Rounds 17 to 2[illegible] Arrows near the front edge indicate the extent of the weld failures.

A.T. No.252.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.10.

Nearside of turret after attack by 6 pdr. A.P.D.S. at 50°, Rounds 21 and 22, and at 60°, Rounds 23 and 28.

Print No.11.

Glacis plate after attack by 17 pdr. A.P.D.S. at 55°, Rounds 29 to 33.
Rounds 13, 18, 19 and 26 on the glacis plate, and Rounds 17 and 20 on the nose plate, were 6 pdr. A.P.D.S.

Print No.12.

Showing point of strike of Round 34, 17 pdr. A.P.C.B.C.
The huge flake off the rear face of the armour was held in position by the final drive support members. See Print No.13.
The 17 pdr. attack caused excessive cracking of the glacis plate.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.13.

Showing flake dislodged from rear face of glacis plate by 17 pdr. A.P.C.B.C. at 55°, Round 34.
The flake was recovered at the end of the trial after the final drive and its support had been removed.

Print No.14.

Round 35, 17 pdr. A.P.C.B.C. at 53°, was practically a double hit on Round 13, 6 pdr. A.P.D.S.
Note the extent of the cracks in the glacis plate and the failure of the weld to the roof. In many cases the fractured welds proved to be old junction cracks which opened up progressively during the trial.

Print No.15.

General view of front of vehicle after attack by 6 pdr. A.P.D.S., Rounds 13, 17 to 20, and 26, 17 pdr. A.P.D.S., Rounds 30 to 33, and 17 pdr. A.P.C.B.C., Rounds 34 and 35.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.16.

Showing extensive cracks (lined in white) which developed on the glacis plate.
Some of these cracks appeared at points of impact only after the following round had struck the glacis plate.

Print No.17.

Round 36, 17 pdr. A.P. at 55°, holed the glacis plate at a velocity equivalent to a range of 900 yds.

Print No.18.

Nearside wall of turret after attack by 6 pdr. A.P.D.S. at 50°, Rounds 21 and 22, at 60°, Rounds 23 and 28, and from 6 pdr. A.P.C.B.C. at 50°, Rounds 37 to 43.
Round 43 holed the turret and passed across the fighting compartment, through the engine compartment bulkhead, and was held in a fuel tank on the offside.
An extensive fire was caused.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.19.

View of vehicle at commencement of fire caused by Round 43, 6 pdr. A.P.C.B.C. at 50°, against nearside wall of turret.

Print No.20.

Front view of vehicle towards end of fire.

Print No.21.

Inner face of nearside wall of turret after attack by 6 pdr. A.P.D.S. at 50°, Rounds 21 and 22, at 60°, Rounds 23 and 28, and from 6 pdr. A.P.C.B.C. at 50°, Rounds 37, 38, 41 and 43. Round 10 was 6 pdr. A.P.D.S on the front face of the turret.
Note typical flaking where plate was overmatched.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.P. Attack

Print No.22.

Nearside pannier after attack by 6 pdr. A.P.C.B.C. at 50°, Rounds 44 and 45. Round 45 struck 6" from Round 44 and is therefore not a fair strike.

Print No.23.

View showing extent of fracture in pannier side from Rounds 44 and 45.
The horizontal crack measured 40" and the vertical one 10".

Print No.24.

Internal face of nearside pannier after attack by 6 pdr. A.P.C.B.C. at 50°, Rounds 44 and 45.

A.T. No.232.
Part II.

Pz.Kw.V Panther

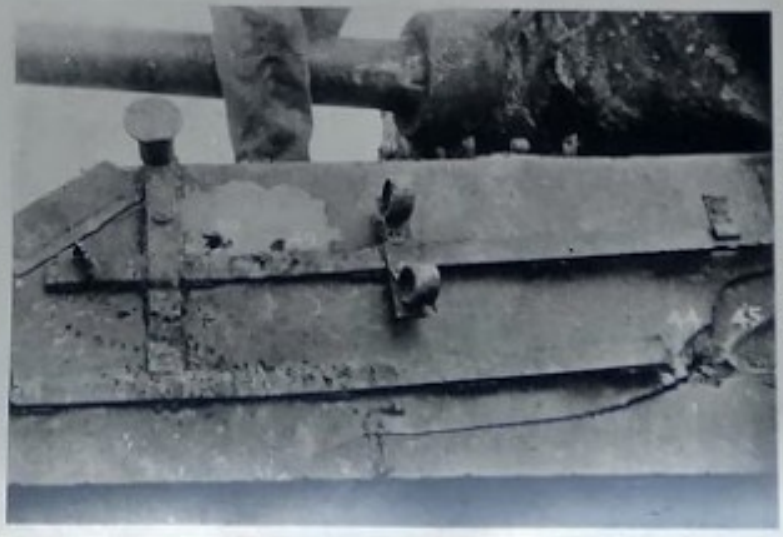
A.P. and P.I.A.T. Attack

Print No.25.

Nearside of tank before attack by 6 pdr. A.P.C.B.C., Rounds 46 to 48.

Print No.26.

Nearside pannier after attack by 6 pdr. A.P.C.B.C. at 50°, Rounds 46 to 48. Round 46 holed the armour at S.V.2373 f.s.



Print No.27.

Forward end of nearside pannier after attack by 3-lb. P.I.A.T. at 30°. Round 49 did not hole the armour. Round 50 made a hole 1" diameter and the offside pannier was marked by fragments.

A.T. No.232.
Part II.

Pz.Kw.V Panther

P.I.A.T. Attack

Print No.28.

Glacis and nearside pannier inside faces.
6 pdr. A.P.D.S., Round 13.
17 pdr. A.P.C.B.C., Rounds 34 and 35.
3-lb. P.I.A.T., Round 50
Three P.I.A.T. aimed at the glacis plate failed to detonate. (Rounds 51 to 53.)

Print No.29.

Commander's cupola after attack by 3-lb. P.I.A.T., Rounds 57 and 58.
Round 57 struck the top edge of the periscope protector.
If periscopes had been fitted it is possible that fragments would not have entered turret, unless periscope was dislodged.
Note lodged tail of Round 58.

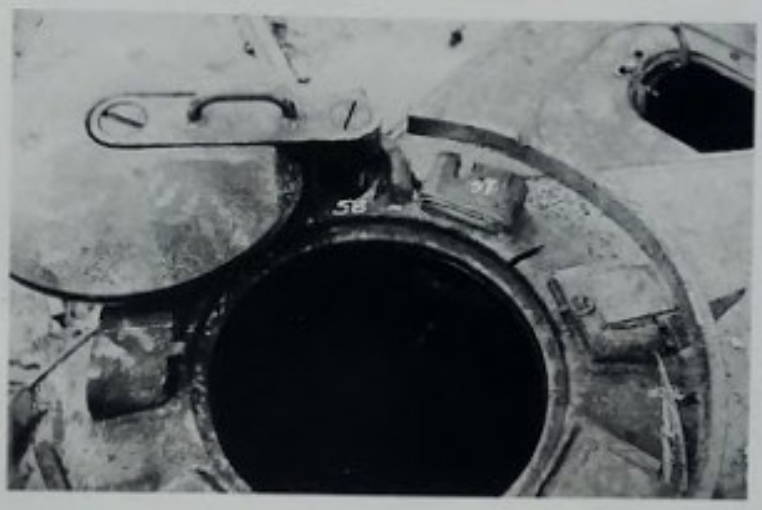
Print No.30.

Cupola after removing lodged tail of 3-lb. P.I.A.T., Round 58.
The boss for the hinge pillar was penetrated and had the hatch been closed, the jet would have struck the hinge arm without causing casualties.

A.T. No.232.
Part II.

Pz.Kw.V Panther

P.I.A.T. and H.E. Attack



Print No.31.

Cupola after attack by 3-lb. P.I.A.T., Rounds 57 and 58.
Note bracket dislodged from machine-gun guide rail by Round 57.
See also Prints 29 and 30.

Print No.32.

Cupola after detonation of 75 mm. H.E., Round 60.
Note extensive cracks in roof plate.
Rail guide for machine-gun now dislodged.

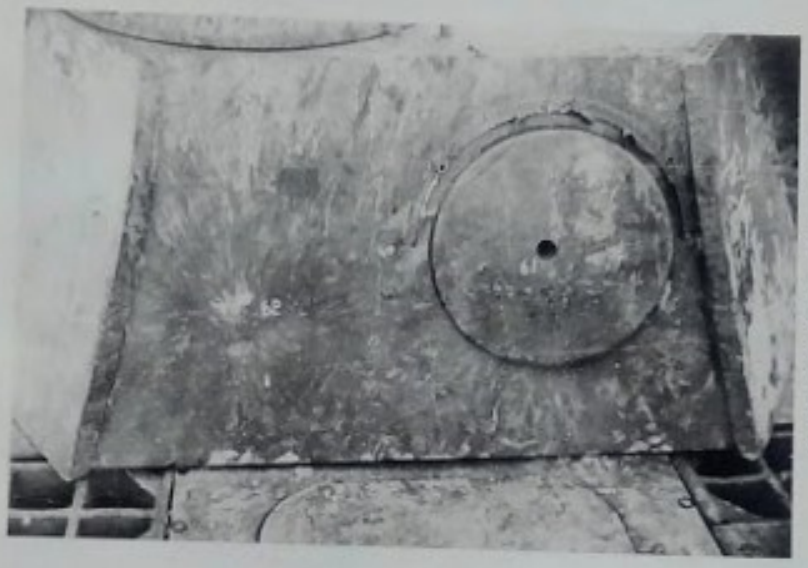
Print No.33.

Inside view of roof plate after detonation of 75 mm. H.E., Round 60 on cupola.
Note bolts dislodged from segments holding cupola to roof, and displacement of welded straps.

A.T. No.232.
Part II.

Pz.Kw.V Panther

H.E. Attack

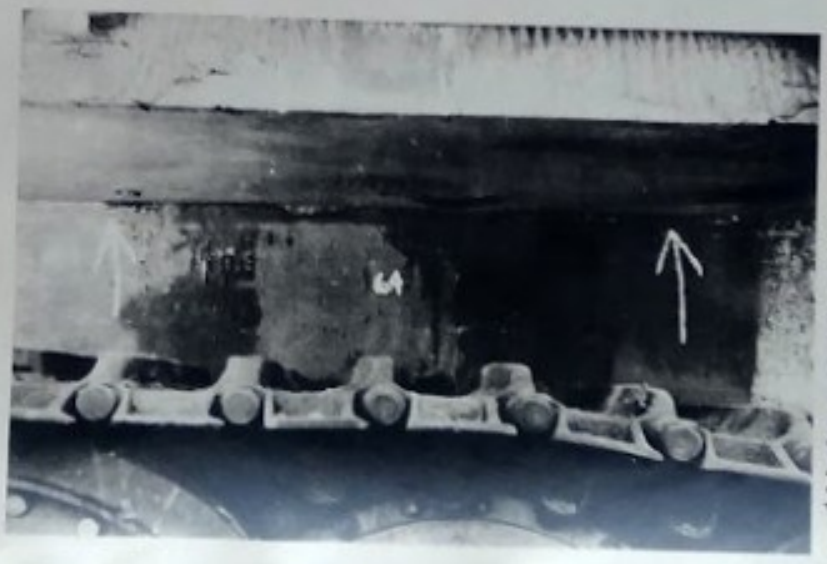


Print No.34.

Rear wall of turret after detonation of 75 mm. H.E., Round 61, and 25 pdr. H.E., Round 62.
Fragments from both rounds cut into the radiator matrix at nearside and offside.
The circular escape door was jammed after Round 62.

Print No.35.

Offside wall of turret after detonation of 25 pdr. H.E., Round 63.
The roof plate was set down $\frac{3}{8}$" below point of impact.
The crack extended from the butt joint between the roof plates and ran along the rear of the internal roof stiffener



Print No.36.

Offside lower side armour after detonation of 75 mm. H.E., Round 64, 6" below pannier floor.
Weld between pannier floor and side armour fractured for 38".
Note:-
The floor is stiffened at this point by a box section bea
No skirting pla
were fitted.

A.T. No.232.
Part II.

Pz.Kw.V Panther

H.E. Attack

Print No.37.

Showing damage caused to track by 75 mm. H.E., Round 64, detonating on side armour.
Three webs of one link were fractured.
See also Print No.36.

Print No.38.

Offside lower side armour after detonation of 25 pdr. H.E., Round 65.
Weld joint between pannier floor and side armour was fractured for 7'-7" and open 2".

Print No.39.

Damage to track from 25 pdr. H.E., Round 65, which detonated immediately above track.
Track was not severed but displaced portion, which was forced downwards, would probably have caused a stoppage by fouling the driving sprocket.

A.T. No.232.
Part II.

Pz.Kw.V Panther

H.E. and A.T. Mine Attack

Print No.40.

Internal view of offside pannier after 25 pdr. H.E., Round 65, had detonated against the lower armour.

Print No.41.

View of forward portion of fractured joint between pannier floor and lower side armour after attack with 25 pdr. H.E., Round 65.

Print No.42.

Forward end of offside track after detonation of two No.75 Grenades placed one above the other, and 8" from outer edge of track. The track was not severed.

A.T. No.232.
Part II.

Pz.Kw.V Panther

A.T. Mine Attack

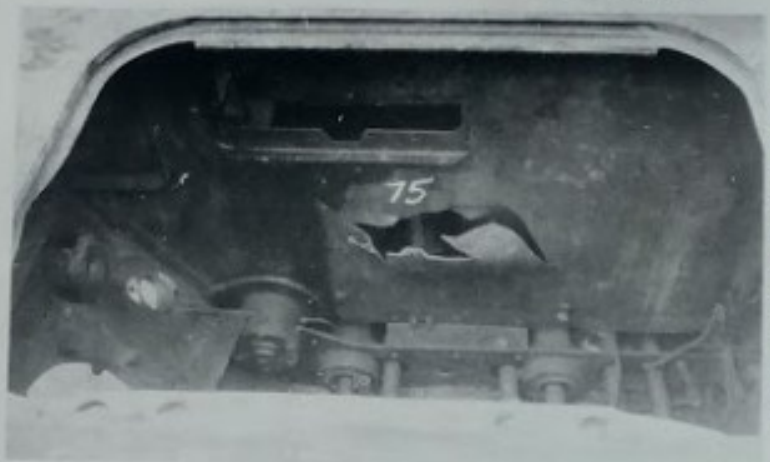
Print No.43.

Rear end of offside track after detonation of three No.75 grenades, Round 67.
The track was fractured completely across at one point and half-way across at a point four links away.

Print No.44.

Front end of nearside track after detonation of one Mk.V H.C. A.T. Mine, Round 68.
Track severed.
Note damage to rim of first road wheel.

Views obtained after removal of engine



Print No.45.

Damage to longitudinal bulkhead on nearside of engine compartment from 6 pdr. A.P.D.S. at 50°, Round 75, which perforated the lower side armour.
The shot ripped open a fuel tank before striking this bulkhead.
A very severe fuel fire broke out.

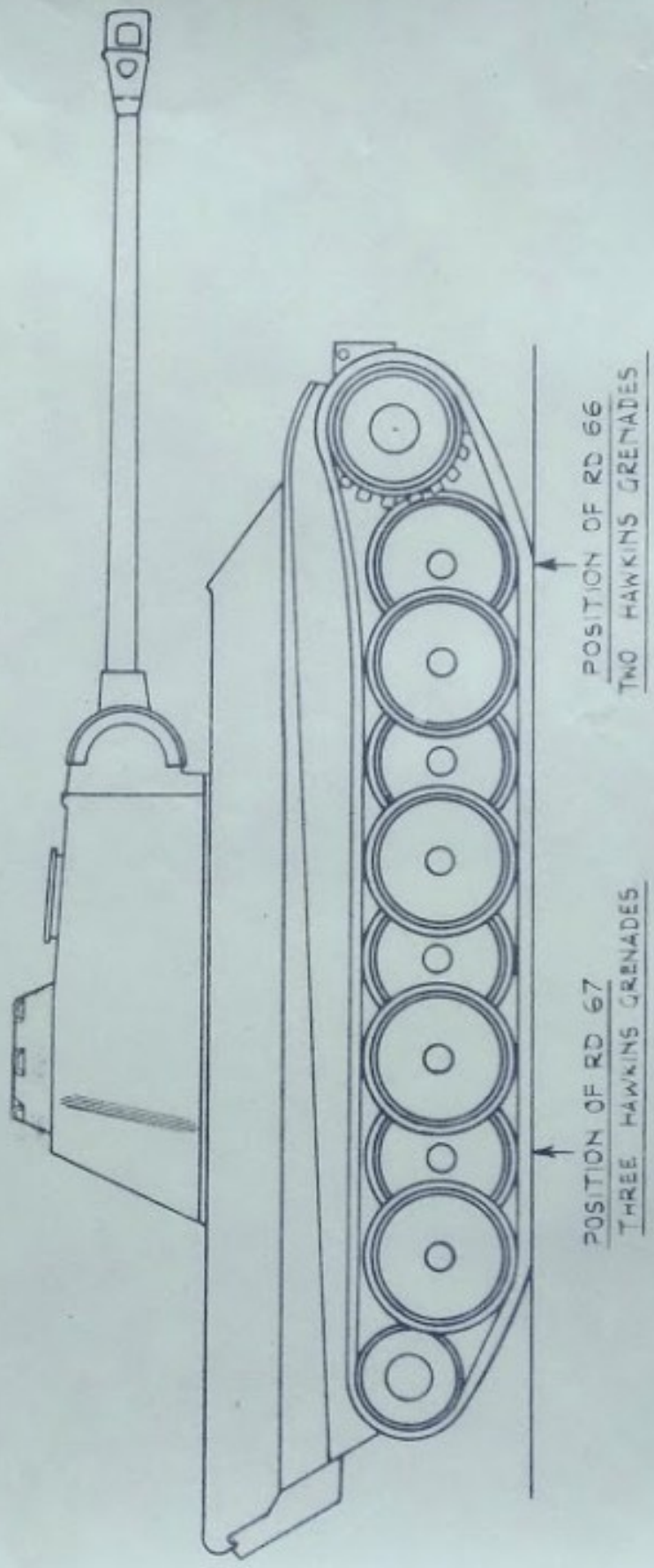
Print No.46.

Fuel tank which was penetrated by Round 75, 6 pdr. A.P.D.S. The core evidently broke up on passing through the armour and the fr[illegible] caused this damage to the tank [illegible] then to the bulkhead seen above.

TRIAL Nº X794
(4 SHEETS)

A T Nº 232
PART II
PZ KW MK. V PANTHER

APPENDIX C
SHEET Nº 1

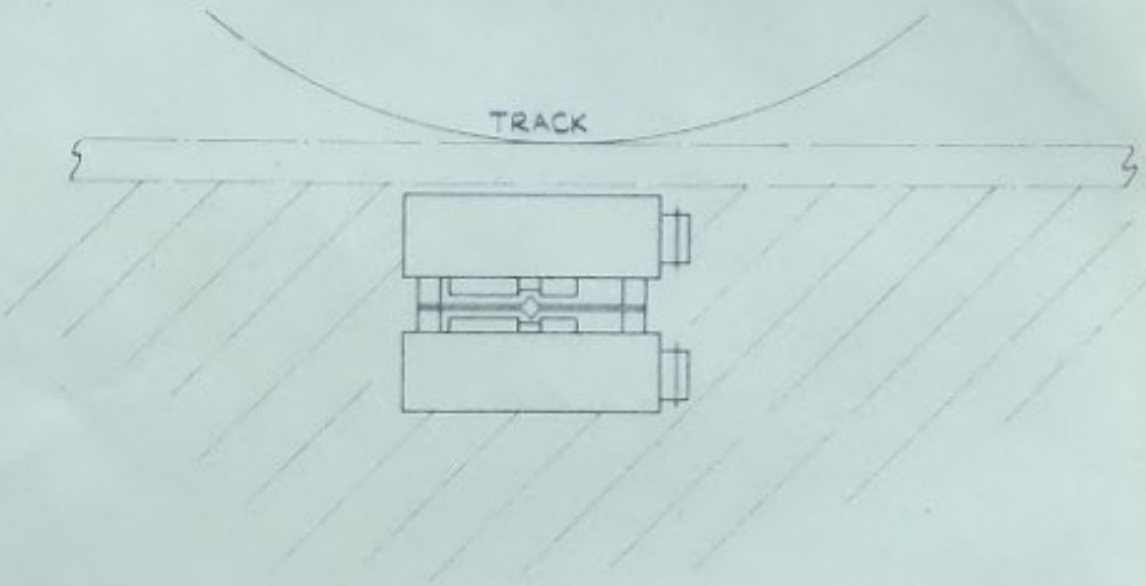


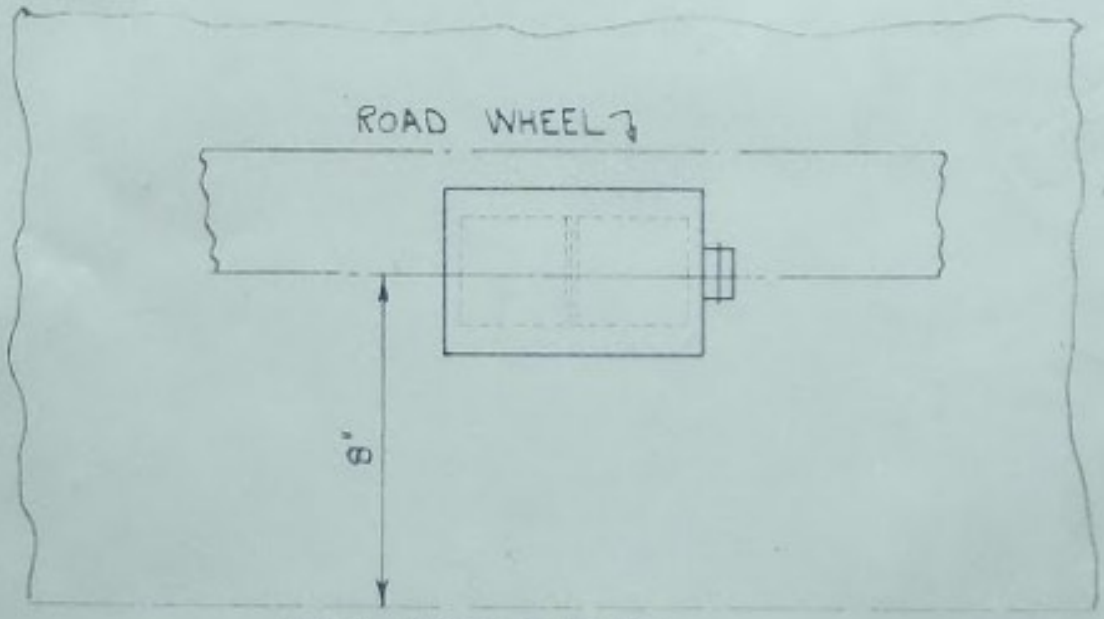
TRIAL Nº X794
(4 SHEETS)

A. T. Nº 232
PART II

APPENDIX C.
SHEET. Nº 2.

PZ KW MK V (PANTHER) MODEL G.





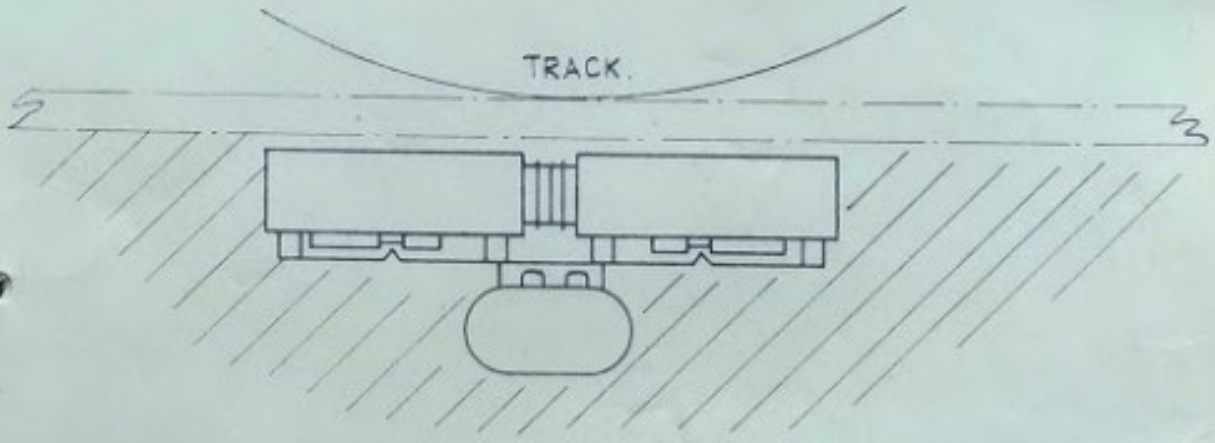
SHOWING METHOD OF LAYING TWO HAWKINS GRENADES BENEATH TRACK OF PANTHER.

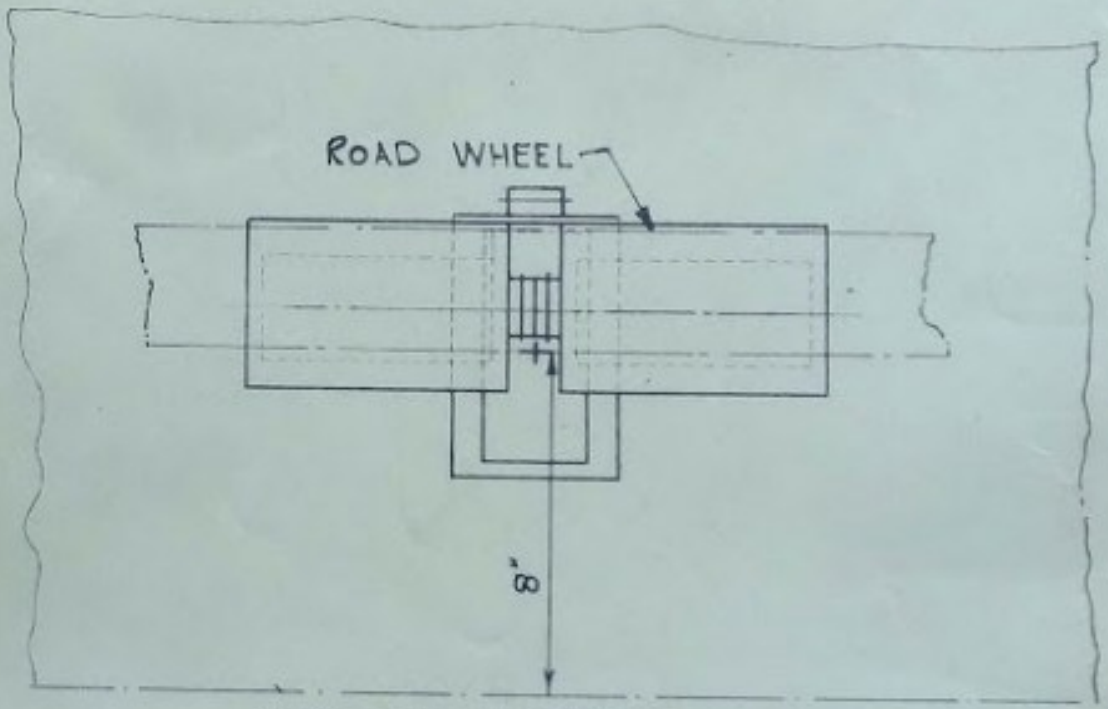
TRIAL Nº X 794
(4 SHEETS)

A. T. Nº 232.
PART II

APPENDIX C.
SHEET Nº 3

PZ. KW MK V (PANTHER) MODEL G.





SHOWING METHOD OF LAYING THREE HAWKINS GRENADES BENEATH TRACK OF PANTHER

09 0

APPENDIX D

Trial No. X.794

A.T. No. 232
Part II.

Results of metallurgical investigation of sample from Glacis Plate.

Hull No. 120404. D.T.D. No. 3040.

A front flake from the glacis plate, removed by Round 33 (17-pdr. A.P.D.S.) was sent for metallurgical investigation to Messrs. Wm. Beardmore & Co. Ltd. The following extracts are from the report issued by the firm's Research Department.

"The appearance of the flake suggested that the armour might have surface flame hardened. It was therefore cut through its thickness and a section polished and etched, observation then showed that the material was homogeneous and had not been either carburized or flame hardened. This was confirmed by Vickers Pyramid hardness readings which gave values between 286 and 311, with an average of 293 roughly equivalent to a Brinell hardness of 272."

(N.B. The table in Section II gives a corrected Poldi hardness of 270).

"A small tensometer test was cut parallel to the face of the plate and gave the following results:-

Yield Point	Ult. Stress	Elongation	Reduction of Area
55.0 tons sq. in. (approx.)	62.5 tons sq. in.	24% O.M.H.	58%

These results confirm the hardness readings already taken since the tensometer test can usually be expected to give slightly higher values for the maximum stress than the normal tensile test. The figures for the elongation and reduction are good considering the ultimate stress obtained.

A micro section was cut through the thickness of the material and examination showed that it was clean, containing only a few small well distributed inclusions both slag and manganese sulphide. The etched structure was very fine grained, the rolling structure having been almost completely removed.

Drillings were taken for chemical analysis with the following results:-

C	Si	S	P	Mn	Ni	Cr	V	Mo
0.40	0.420	0.019	0.016	0.72	0.09	2.12	0.03	0.01

This material appears to be either Electric Furnace or Basic Open-Hearth Steel."

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SH.

D.T.D. Experimental Report.

A.T. No.232.

Part III.

Project No: M.6815A/4
Sheet 3
Trial No: X.795.
File No: 250/14/5.

REPORT OF BALLISTIC TRIAL against Pz.Kw. V Model G. (D.T.D. No.3040) held at Shoeburyness Range on October 24th-26th, 1944.

Present at Trial	Representing	Date Attended
Lt. Tredinnick	S. of E.	24,26.10.44.
Capt. Gibbs	" "	25.10.44.
Major Durrenberger	U.S. Embassy	24.10.44.
Capt. Burke	" "	24.10.44.
Dr. Harris	Messrs. Babcock & Wilcox	24.10.44.
Mr. Dunn	Vickers-Armstrongs Ltd.	24,25.10.44.
Capt. Harber, R.C.A.C.	D.T.D. E.W. Lulworth	26.10.44.
Major Steane	D.T.D. (General Design Branch)	24.10.44.
Major Denaro	" (Welding Branch)	24.10.44.
Major Guthrie	" (Armour Branch)	25,26.10.44.
Mr. Cole	" " "	25.10.44.
Mr. Young	" " "	All dates.
Mr. Barker	" " "	" "

Report.

Compiled by:- (Mr. A. Young) D.T.D. (Armour Branch)
(Mr. N. Barker)

Checked by:- Maj. G. Guthrie R.E.M.E. D.T.D. (Armour Branch)
Mr. J.B. Sankey " " "

References.

Section I.	-	Objects of Trial.
Section II.	-	Target Details.
Section III.	-	Method of Attack.
Section IV.	-	Trial Commentary. (6 pdr. A.P. & A.P.C.)
Section V.	-	Trial Commentary. (17 pdr. A.P.)
Section VI.	-	Trial Commentary. (A.T. Grenades)
Section VII.	-	Summary.
Section VIII.	-	Conclusions.

Appendices.

Appendix A.	-	Details of Damage.
Appendix B.	-	Photographic Record.
Appendix C.	-	Sketch of Armour Disposition.

Note:-

M.461(a).
BS.

SECTION I. Objects of Trial.

(i) To obtain additional ballistic data from the hull and turret of a Model G Panther, when subject to heavy A.P. attack, and to test the various joints of the structure.

(ii) To determine the effect upon the hull and turret roofs of the detonation of No. 75 grenades placed in contact with these roof plates.

SECTION II. Target Details.

The target was a German Panther Tank 135 (Pz.Kw.Mk.V Model G) No. 120404, which had been the subject of a firing trial reported in A.T. No. 232, Part II. The engine, radiators, fuel tanks, transmission and other internal equipment had been removed to enable the damage to the rear faces of the armour to be inspected. Diagrams giving the plate thicknesses and angles of presentation, together with the Brinell Hardness figures, will be found in Part II of this report.

SECTION III. Method of Attack.

The target was attacked from a range of 40 yds. with 17 pdr. A.P., 6 pdr. A.P. and 6 pdr. A.P.C., the plates attacked were as follows:-

Nose plate v 17 pdr. A.P. at 55°.
Hull N.S. v " " " "
Offside pannier v 6 pdr. A.P. at 50° and 6 pdr. A.P.C. at 50°.
Offside lower side armour v 6 pdr. A.P. at 50° and 6 pdr. A.P.C. at 50°.
Mantlet nearside edge v 6 pdr. A.P. at 30°
Front face of turret v 17 pdr. A.P. at normal.
Offside walls of turret v 6 pdr. A.P. at 50° and 6 pdr. A.P.C. at 50°.
Rear wall of turret v 6 pdr. A.P. at 50°.
Turret cupola v 6 pdr. A.P.

The angles of tilt to the vertical of the various plates were read by means of a clinometer, and the target was turned to present azimuth angles to suit the compound angles of strike required. Azimuth angles were read by means of a sighting protractor.

Hawkins Grenades (No. 75) were laid on the hull and turret roofs, and initiated electrically.

SECTION IV. Trial Commentary. (6 pdr. A.P. and A.P.C.)

(i) Offside Pannier

With the side of the tank at 42° to the gun, making a compound angle of attack of 50°, six rounds of A.P. at velocities lying between 2760 f.s. and 2366 f.s. were directed at the pannier side. From these rounds the ballistic limit was found to be 2458 f.s., equivalent to a range of 680 yds., and the W/R limit 2700 f.s., indicating that the pannier should be holed at a range of 370 yds. (Rds. 108-113.)

With similar conditions to those above, twelve rounds of 6 pdr. A.P.C. shot were fired at the pannier. At velocities of 2432 f.s. and 2418 f.s. the damage code was W and C respectively, the other ten rounds, all at higher velocities than these two, showed that at this obtuse angle of attack consistent results cannot be obtained; this is shown below:-

Rd.	118	119	117	120	122	121	116	115	123	124
Vel.	2785	2735	2659	2658	2603	2599	2533	2474	2441	2438
Code	W	W	C	W	C	R	C	D	R	W

All these rounds were fair hits, the shots shattered on impact and either scooped or holed the armour, an estimate of the ballistic limit shows this to be about 2425 f.s. (Rds. 114-125)

(ii) Offside Lower Side Armour.

This plate was attacked at 50° to normal by five rounds of 6 pdr. A.P. shot at velocities between 1827 f.s. and 1874 f.s., the ballistic limit was found to be 1843 f.s. and therefore the plate would be immune if attacked at this angle at ranges greater than 1520 yds. (Rds. 126-130)

For the attack by A.P.C. shot at 50°, ten rounds were fired. A severe failure occurred at Round 132, striking velocity 1928 f.s., when a flake was dislodged, but no confirmatory failure was obtained. A ballistic limit which disregards Round 132 was assessed at 2009 f.s., the discrepancy evidently being due to the steep angle and the variable quality of the armour. (Rds. 131-140).

(iii) Turret Mantlet.

The nearside edge of the mantlet was attacked by two rounds of 6 pdr. A.P. at 30° in an attempt either to peg the mantlet to the turret, or to force the mantlet into contact with the turret and so prevent elevation or depression of the mounting. Both rounds scooped off without jamming the mantlet, but it was seen that the two castings were rubbing at certain points, the normal clearance was $\frac{3}{8}$" to $\frac{1}{2}$". The striking velocity of the rounds was 2290 f.s. corresponding to a range of 900 yds. (Rds. 106-107.)

(iv) Offside Walls of Turret.

The side walls of the turret are formed from bent plates, the forward offside wall was attacked with seven rounds of 6 pdr. A.P. and one round of 6 pdr. A.P.C. shot at 50° (Rds. 76-82, 105), and the rear offside wall was attacked with one round of 6 pdr. A.P. and three rounds of 6 pdr. A.P.C. shot at 50°, (Rds. 83-86.) The ballistic limit of the forward wall under 6 pdr. A.P. attack was 2160 f.s. equivalent to a range of 1070 yds. The rear wall under A.P.C. attack at 50° was immune at 2607 f.s. confirming the inferiority of the capped shot.

(v) Rear Wall of Turret.

Nine rounds of 6 pdr. A.P. shot at 50° were directed against the rear wall of the turret; these gave a ballistic limit of 2257 f.s. and a W/R limit of 2579f.s. These correspond to ranges of 940 yds. and 530 yds. respectively. (Rds. 87-89, 98-103).

(vi) Turret Cupola.

One round of 6 pdr. A.P. at 50° was aimed at the junction between the cupola and turret roof at a velocity of 2276 f.s. The interior of the cupola was undamaged, one bolt was dislodged from a retaining segment. (Rd. 104.)

SECTION V. Trial Commentary, (17 pdr. A.P.)

1. Hull nose at 53°. (Thickness 51.5 mm.)

Reports of vehicles previously examined gave the thickness of the nose plate as 60 mm. or 75 mm. The perforations caused by 17 pdr. A.P. rounds 90 and 91, made either thickness appear excessive and the actual thickness of the plate on this hull was measured and found to be 51.5 mm. Three rounds at lower velocities indicated that the ballistic limit was approximately 1800 f.s. and that flakes were liable to be dislodged by impacts at velocities above this limit. (Equivalent range 2200 yds.) The plate was also found to be very brittle. (Rds. 90-94.)

2. Hull machine-gun mounting. (Glacis plate at 55°)

One round striking on the joint between the main housing, over the machine-gun mounting, and the glacis plate scooped upwards without causing appreciable damage. Although the weld attaching the housing to the glacis plate had been fractured all round by previous attack against the glacis plate, the crack was only opened $\frac{1}{8}$".

/A second round ....

A second round at a similar striking velocity struck directly on the ball, which it broke in pieces and conveyed into the hull, together with the lower part of the housing. Equivalent range for these two rounds was approximately 1940 yds. (Rds. 95-96.)

3. Turret front.

One round at a velocity similar to those used against the ball mounting was directed at the turret front adjacent to the joint with the offside plate. The round carried away parts of front and side armour and penetrated into the turret where damage from fragments was widespread. (Rd. 97.)

SECTION VI. Trial Commentary. (A.T. Grenades - Hawkins No. 75)

1. Hull roof at nearside of turret.

A grenade was laid on the roof plate across the butt joint at the nearside of the turret. Its detonation blew in a piece of the plate above the ammunition racks, damage which would have caused a cordite fire had live rounds been stowed. The roof plate was 17 mm. thick. (Rd. 141.)

2. Engine compartment roof.

The detonation of a grenade towards the rear edge of the main hatch over the engine, drove a piece of the hatch 9" x 5" into the engine compartment, where it would undoubtedly have interfered with the efficiency of the engines, probably by breaking the rear carburettor and causing a fire. (Rd. 142.)

3. Turret roof.

The turret roof had been severely cracked by Round 60 (75 mm. H.E.) against the cupola and successive 6 pdr. attack on the turret walls had extended the cracks. The front portion of the roof plate at the offside was, however, undamaged and it was therefore attacked with a grenade. Again the 17 mm. roof plate was holed by the detonation and considerable internal damage to the machine-gun, the offside buffer cylinder of the main piece, and to the loader would have resulted.

N.B. 14 mm. of I.T. 100 is normally sufficient to keep out a Hawkins No. 75 Grenade. The fact that the 17 mm. German plate fails so completely, is due to its excessive brittleness.

SECTION VII. Summary.

1. 6 pdr. Attack.

The following table summarises the information obtained during the attack on various plates of the hull and turret, with 6 pdr. A.P. and A.P.C. ammunition. Ballistic limits and W/R limits are given where possible, and equivalent ranges are based on 6 pdr. 7 cwt. Mks. IV and V.

/Plate ....

				A.P.			A.P.C.		
Plate	Thick-ness	Presenta-tion	Angle of strike	R.L. f.s.	W/R f.s.	Equiv. Range yds.	R.L. f.s.	W/R f.s.	Equiv. Range yds.
Turret side	47 mm.	Side of turret at 44°	50°	2160 (2250)	2200+	1070 1020-	Immune at 2600		500
Turret rear	47 mm.	Rear of turret at 44°	50°	2257 (2250)	2579	940 530			
End of Gauntlet	?	Front of turret at 30°	60°	Immune 2290		900			
Pannier side	52 mm.	Side of hull at 42°	50°	2458 (2420)	2700	680 370	2425 approx.		730
Lower side armour	41.5 mm.	Side of hull at 50°	50°	1843 (2070)	1900+	1520 1430	2000 approx.		1290

(Velocities in brackets are average ballistic limit figures obtained under similar conditions of attack against British machineable quality armour.)

It was found in general that A.P. shot gave more consistent results than A.P.C., and, with the exception of the attack on the pannier side, was more successful at a given striking velocity.

All the plates attacked showed flaking tendencies, and, with the exception of that forming the turret rear, proved brittle and cracked extensively under attack.

2. 17 pdr. A.P. attack.

This form of attack against the hull nose revealed that on this hull the nose plate was only 51.5 mm. thick, and could be penetrated sufficiently to cause lethal damage at ranges up to 2200 yds. A ballistic limit of 1800 f.s. was estimated; and the plate proved brittle and flaky.

The hull machine-gun mounting and the turret front plate can both be defeated by 17 pdr. A.P. at a range of 1940 yds.

3. A.T. Grenades (No. 75.)

Attack from No. 75 grenades on the roofs of hull, turret, and engine compartment, defeated the 17 mm. armour in each case by blowing a hole in the plate.

SECTION VIII. Conclusions.

1. Armour.

All the plates on this vehicle which were attacked with A.P. shot of either 6 pdr. or 17 pdr. calibre showed pronounced flaking tendencies, and, with the exception of the turret rear plate, cracked extensively.

Where ballistic limits against 6 pdr. attack at 50° to normal were assessed on the 40-50 mm. plates, they were in general slightly lower than the average of those obtained from machineable quality plates in the United Kingdom. It should be appreciated, however, that they are well within the spread of such results, a spread which is fairly wide at this oblique angle of attack, and is partially due to variations in the quality of the shot used.

/Results ....

Results obtained from a 51.5 mm. plate against 17 pdr. A.P. shot at 50° also suggest that the ballistic limit against this form of attack obtained on the Panther hull nose, which was the same thickness, was lower than might have been expected.

Thin plates forming the roofs of hull, turret, and engine compartment, all approximately 17 mm. thick, are more brittle than I.T.100 14 mm. plates and fail to withstand the detonation of a No.75 A.T. grenade.

2. Welds and structure.

As previously noted in Part II of this report, extensive junction cracking, much of which had existed before the trial, was revealed when various plates were attacked. In general the welds showed little ductility, particularly on the hull. The welds which showed least tendency to fail were those securing the turret roof to the turret sides, and those between the hull roof and pannier sides.

Welds between glacis plate and roof plate, and between glacis plate and nose plate failed completely during the attack on the glacis and hull nose plates.

The structure of the vehicle proved most satisfactory in general, the design of the joints at the front being such that even when welds failed completely no collapse of the hull could occur. The weakest joints were those between lower side armour and pannier floors, but as these are normally protected by skirting plates the weakness is not serious. Another weakness is apparent at the joints between the turret front and sides where frontal attack from A.P. is likely to force out the side plate by penetrating into the joint at the side of the tenon from the side plate. The target area is, however, small.

3. Hull machine-gun mounting.

While direct hits on the mounting from 17 pdr. A.P. at ranges up to 2000 yds. are likely to defeat the protection, it is noticeable that the area around the mounting shows no weakness comparable with that around the ball mountings fitted in British tanks. The vulnerable area is therefore very small, chiefly due to the fact that the aperture required for the machine-gun is so very much smaller than that required for the Besa.

4. Cupola.

The method of attaching the cupola to the turret roof proved very effective against H.E. and A.P. attack. The heads of bolts in the locking segments may however be violently dislodged by either attack, thus providing a potential danger to members of the turret crew.

5. Impacts from A.P. shot or shell, of calibre greater than 20 mm., which occur within one calibre of the bottom edge of the turret walls, will almost certainly jam the traversing movement.

G. Guthrie

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Trial No. M.795
(12 Sheets)

APPENDIX
Sheet No.1

TARGET	ATTACK	OBSERVATIONS
Offside wall of turret	Round 76 6-Pr. A.P. at 50° compound. S.V. 2076 f.s. Range 120 ft.	Code D. Scoop 5" x2½"x1" deep. Struck 14" below top edge of turret. Bulge 6"x3½"x½" high. Crack to top edge 13" vertically and one diagonal to bottom 28" long.
Ditto	Round 77 Ditto S.V.2154 f.s. Range 120 ft.	Code D severe. Shatter scoop 3½"x2½"x⅜" deep. Struck 8" above bottom edge of turret. Bulge 3½"x2½"x⅜" high. Two vertical cracks across bulge 2½" and 1½" long. Plate sheared horizontally along edge of weld to floor 2½". Weld fractured half in throat and half in junction to floor for 3½".
Ditto	Round 78 Ditto S.V.2159 f.s. Range 120 ft.	Code B. Hole 1½"x1½". Struck 10" below top edge of turret. Flake off 5½"x4"x⅜".
Ditto	Round 79 Ditto S.V.2127 f.s. Range 120 ft.	Code C. Dent 5⅜"x2½"x⅝". Bulge 5½"x3½"x½". Crack extends from Rd.76 to 77. Turret floor fractured from bend of offside plate for 8½" towards ring. Weld between floor and make up piece at bend of turret fractured for 6" in junction to make up piece.
Ditto	Round 80 Ditto S.V.2174 f.s. Range 120 ft.	Code C. Shatter scoop. Dent 1" deep. Struck 12" below top edge of turret. Bulge 3½"x3½"x⅜". Floor plate set down 3/16"
Ditto	Round 81 Ditto S.V.2190 f.s. Range 120 ft.	Code B. Hole 1½"x1½" Struck 9" below top edge of turret. Weld to front cracked 9½" from top adjacent to side plate junction 5" from front top of interlock.

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Trial No. X.795

APPENDIX A
Sheet No.2

TARGET	ATTACK	OBSERVATIONS
Offside Wall of Turret	Round 81 Cont 6-Pr A.P. at 50° compound. S.V.2190 f.s. Range 120 ft.	Two cracks in junction to side plate on front face 5¼" and 1". Two cracks in plate 7" long from Round 80. One from Rd. 76 across point of impact 41" long approx. Flake off 7"x5"x1⅛". Flake lifted around previous round 1' on 4½" radius. Crack from Rd.80 through 81 for 18" to junction with front plate. Fragments of shot inside turret.
Offside wall of turret	Round 82 6-Pr.A.P.C. at 50° S.V.2143 f.s. Range 120 ft.	Code C. Shatter scoop. 3½"x2½"x⅞" Struck 7" below top edge. Bulge 4½"x3½"x½".
Rear of offside wall of turret.	Round 83 6-Pr.A.P.C. at 50° compound. S.V.2174 f.s. Range 120 ft.	Code C. Shatter scoop 2½"x2½"x⅝". Bulge 4½"x3½"x½" high. Old junction crack in tenon 2¾" long.
Ditto	Round 84 6-Pr.A.P.C. at 50° compound. S.V.2214 f.s. Range 120 ft.	Code C. Scoop 5"x2½"x⅞". Triangular portion of turret 12"x8" fell out of bottom corner of turret below point of impact of Rd.77. Struck 15" below top edge of turret and 8" to rear of bend of turret wall. Horizontal crack across Rd.83. 14" long.
Ditto	Round 85 Ditto S.V.2607 f.s. Range 120 ft.	Code D. Scoop 7"x2½"x1½". Struck 6" from top edge and 6" from bend. Bulge 7½"x4½"x⅝". Crack across bulge 6" continued to top rear corner for 9".
Ditto	Round 86 6-Pr.A.P. at 50° compound. S.V.2181 f.s. Range 120 ft.	Code D. Scoop 6½"x2½"x1". Struck top edge of tenon 4" from rear edge of turret. Rear edge of side plate fractured in line with tenon and also at point 6" above tenon. Portion 16½" long forced sideways ⅝" at point of impact.

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Trial No. X.795

APPENDIX A.
Sheet No. 3

TARGET	ATTACK	OBSERVATIONS
Rear of offside wall of turret	Round 86 Cont 6-Pr.A.P. at 50° compound S.V.2181 f.s. Range 120 ft	External fillet between side and rear fractured 19" in junction to rear plate and 1½" in throat. Bulge on side plate 2"x4"x1⅛". Horizontal crack 1⅛" across bulge. Metal forced back 3/16". Vertical crack in rear plate 2" long.
Rear wall of turret	Round 87 6-Pr.A.P. at 50° compound. S.V.2134 f.s. Range 120 ft.	Code C. Scoop 5"x2¼"x1". External weld to nearside wall fractured 19½" in weld metal. Struck 5½" below top edge and 4" from nearside edge. Bulge 5½"x3⅛"x½". Weld to turret side plate broken in junction to side plate 10" from top. (Plate 45 mm. thick).
Ditto	Round 88 Ditto S.V.2172 f.s. Range 120 ft.	Code C. Shatter scoop 4"x2⅜"x1.3/16". Bulge 4½"x4½"x½". Tenon between rear plate and near side wall has existing crack down front edge of tenon. New crack opened in rear edge 7" long in junction to tenon. Old crack 6" long between and on rear of junction to side plate.
Ditto	Round 89 Ditto S.V.2246 f.s. Range 120 ft.	Code C. Shatter scoop 4"x2_"x1⅛". Struck 4" from nearside edge. Bulge 3½"x3½"x½".
Nose plate. Front of Tank at normal to gun.	Round 90 17-Pr...P. at 53°. S.V.2233 f.s. Range 120 ft.	Code R. Hole 3⅛"x2½". Struck 11" below edge of nose plate. Flake off 7"x6¼"x½". Offside support for final drive gear box forced away from hull nose 1½" at top edge and welds to nose plate cracked for 18" on offside and 16" on nearside.
Ditto	Round 91 17-Pr...P. at 53° S.V.2046 f.s. Range 120 ft.	Code R. Hole 3"x2½". Flake off 6"x5"x½". (Thickness 51-52 mm.) Struck 6" below top edge of nose plate. Crack 5" long now runs from [illegible] to offside.

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Trial No. X.795

APPENDIX A
Sheet No. 4

TARGET	ATTACK	OBSERVATIONS
Nose plate at normal to gun.	Round 92 17-Pr.A.P. at 53°. S.V. 1759 f.s. Range 120.ft.	Code C. Scoop 5½"x3"x½". Struck 14½" below top edge of nose plate. Crack noted after Rd.91 now open 3/32" and extended 4" on opposite side of Rd.90. Radial cracks 2" and 1¼" long at Rd.91. Bulge 5½"x3½"x⅝" high. Fractured weld between nose and glacis now open 3/16" at centre.
Ditto	Round 93 Ditto S.V. 1915 f.s. Range 120 ft.	Code R. Hole 3½"x2⅝". Struck 17" below top edge of nose plate. Flake off 8"x6½" average thickness 1½". Nearside support for final drive forced away from armour. Crack 7" running radially below hole.
Ditto	Round 94 Ditto S.V. 1838 f.s. Range 120 ft.	Code E. Scoop 6"x3"x1". Plate set back 1" at point of impact. Flake off 4"x6"x1". Cracks running towards Rd.93 6" " " " " 92 8" and one running towards bottom 6". Extensive cracking of nose plate from previous rounds. Air ducts to clutch and final drive dislodged.
Hull machine gun.	Round 95 17-Pr. A.P. S.V. 1906 f.s. Range 120 ft.	Code D. Struck junction of machine gun housing on glacis plate on offside and scooped upwards removing 4½" of external fillet and portions of adjacent armour. Crack between housing and weld now open ⅛". below point of impact. Crack running to point of impact of Rd.36 13" long.
Ditto	Round 96 Ditto S.V. 1922 f.s. Range 120 ft.	Code W. Struck top inner corner of aperture and broke off portion 7"x11" for full thickness. Ball unit dislodged in fragments and floor ribs below turret distorted by impact of these fragments.

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APPENDIX A
Sheet No.5.

TARGET	ATTACK	OBSERVATIONS
Offside front face of turret	Round 97 17-Pr.A.P. at normal S.V. 1915 f.s. Range 120 ft.	Code W. Struck 2" from side at bottom of tongue of side plate. 4"x1 $\frac{3}{4}$"x4" removed from front plate. 9"x9" from side plate for full thickness (47.mm). Crack 24" long running to rear to point of impact of Rd.63. Internal: Hole $3\frac{1}{2}$"x$4\frac{1}{2}$". Internal weld to front plate split in throat for 9". Nose of shot struck edge of turret floor below rear escape door removing 5"x1"x1" from edge. Teeth of turret traversing rack at both sides of turret marked by fragments.
Rear wall of turret	Round 98 6-Pr.A.P. at 50° compound.. S.V. 2579 f.s. Range 120 ft.	Code W. Hole $2\frac{3}{4}$"x$2\frac{3}{8}$". Struck 13" below top edge of turret. Flake off 2"x3"x$\frac{3}{4}$". Four teeth of traverse rack damaged by fragments.
Ditto	Round 99 Ditto S.V. 2579 f.s. Range 120 ft.	Code R. Hole $2\frac{1}{2}$"x2". Struck 12" above bottom edge of turret. Metal broke off $2\frac{3}{4}$"x2".
Ditto	Round 100 Ditto S.V. 2506 f.s. Range 120 ft.	Code D severe. Shatter scoop $3\frac{3}{4}$"x$2\frac{1}{2}$"x$\frac{1}{8}$". Bulge $3\frac{1}{2}$" dia x $\frac{3}{4}$" high. Struck 10" above bottom edge of turret. Three star crack 2"x$1\frac{1}{2}$"x1".
Ditto	Round 101 Ditto S.V. 2349 f.s. Range 120 ft.	Code R. Shatter scoop $4\frac{1}{4}$"x$2\frac{1}{4}$". Hole 2"x$1\frac{3}{4}$". Part of base lodged. Petal off 2"x2". Struck $9\frac{1}{4}$" above bottom edge of turret.

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Trial No. X.795

APPENDIX A
Sheet No.5.

TARGET	ATTACK	OBSERVATIONS
Rear wall of turret	Round 102 6-Pr.A.P. at 50° compound. S.V. 2269 f.s. Range 120 ft.	Code R. Shatter scoop 4"x2⅜". Hole 2⅛"x1½". Struck 11" below top edge of turret. Metal off 2⅛"x2¾". Crack in turret floor 10" from inner edge near escape door adjacent to damage caused by Round 97.
Ditto	Round 103 Ditto S.V. 2253 f.s. Range 120 ft.	Code W. Struck 2" below top edge and 8" from escape door opening. Hole 6"x3". 2" of outer fillet removed. Roof plate cracked 9" perpendicular to edge. Flake off 13½"x6⅛"x1".
Cupola	Round 104 6-Pr.A.P. at 50° compound. S.V. 2276 f.s. Range 120 ft.	Code D. Scoop 9"x3" in junction of cupola to roof. One bolt dislodged from segment adjacent to impact. Edge of aperture lifted ¼". Roof plate cracked from edge to cupola opening. 4½" of weld metal broken from roof in junction with ½" of side plate still attached. Roof plate forced down 2" at one end. Interior of cupola undamaged.
Offside wall of turret	Round 105 6-Pr.A.P. at 50° compound. S.V. 2265 f.s. Range 120 ft.	Code R(L) Struck 2½" above bottom edge of turret and 3½" from front edge of side plate (i.e.centre of joint). Bottom edge of turret plate forced down jamming turret.
Front of turret at 30° to gun.	Round 106 6-Pr.A.P. at 60° S.V. 2290 f.s. Range 120 ft.	Struck nearside edge of mantlet. Scoop full width of edge 6"x2"x⅛". Mantlet not jammed.
Ditto	Round 107 Ditto S.V. 2294 f.s. Range 120 ft.	Struck nearside edge of mantlet. Scoop 5½"x2¼"x⅛". Mantlet not jammed.. Slight rubbing of mantlet against turret.

Trial No. X.795

TARGET	ATTACK	OBSERVATIONS
Offside pannier	Round 108 6-Pr.A.P. at 50° compound. S.V. 2366 f.s. Range 120 ft.	Code C. Scoop 6"x2⅜"x1¼". Struck 10" below top edge of pannier. Bulge 6"x4"x½".
Ditto	Round 109 Ditto S.V. 2760 f.s. Range 120 ft.	Code W. Hole 2¾"x2⅜". Struck 10" below top edge of pannier. Flake off 5"x4½"x½". Fracture of weld to roof plate extended by 3½".
Ditto	Round 110 Ditto S.V. 2676 f.s. Range 120 ft.	Code R. Base lodged. Struck 12" below top edge of pannier. Flake off 6"x4⅜"x⅜".
Ditto	Round 111 Ditto S.V. 2476 f.s. Range 120 ft.	Code R. Part of base lodged. Struck 6½" below top edge of pannier. Flake off 4¾"x4⅛"x¾".
Ditto	Round 112 Ditto S.V. 2441 f.s. Range 120 ft.	Code C. Shatter scoop 4⅛"x2⅜"x1½". Struck 13" below top edge of pannier. Bulge hidden by straps.
Ditto	Round 113 Ditto S.V. 2419 f.s. Range 120 ft.	Code C. Shatter scoop 5"x2⅜"x1¼". Struck 5½" below top edge of pannier. Bulge 5½"x4½"x¾"
Ditto	Round 114 6-Pr. A.P.C. at 50° compound. S.V. 2418 f.s. Range 120 ft.	Code C. Shatter scoop 4¾"x2½"x1⅛". Struck 13" below top edge of pannier. Bulge 5"x3¼"x½".
Ditto	Round 115 Ditto S.V. 2474 f.s. Range 120 ft.	Code D. Shatter scoop 5"x2⅜"x1¼". Struck 5½" below top edge of pannier. Bulge 6"x4½"x¾". Vertical crack ½"x1/16" open. Horizontal crack to rear 6" from point of impact of Rd.110 on external face. Plate dished inwards ½".

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APPENDIX A
Sheet No.8.

TARGET	ATTACK	OBSERVATIONS
Offside pannier	Round 116 6-Pr. A.P.C. at 50° compound. S.V. 2533 f.s. Range 120 ft.	Code C. Scoop 6½"x2⅝"x1¼". Struck 4½" below top edge of pannier. Crack in plate immediately above point of impact 6" forward and 9" to rear. Inner weld split in throat 17" from top edge of glacis plate then for 13" in junction to roof plate then for 4" in throat total length 34". Bottom weld pannier side to floor cracked 25" mostly in junction to floor plate. Crack starts 16" from front of pannier bottom. Bulge 7"x4"x¾".
Ditto	Round 117 Ditto S.V.2659 f.s. Range 120 ft.	Code C. Scoop 6½"x2½"x1⅛". Struck 6½" below top edge of pannier. Two bulkheads welded to pannier side and floor opposite point of impact - welds fractured. Flange of bulkhead to roof fractured. Bulkhead forced sideways 1" and severely buckled.
Ditto	Round 118 Ditto S.V. 2785 f.s. Range 120 ft.	Code W. Shatter area 6"x3⅜". Hole 2¼"x2¼". Struck 11" below top edge of pannier. Flake off 5¼"x3¾"x¾".
Ditto	Round 119 Ditto S.V. 2735 f.s. Range 120 ft.	Code W. Shatter area 4¾"x3". Hole 2¼"x2¼". Struck 13½" below top edge of pannier. Flake off 7"x5¾"x1".
Ditto	Round 120 Ditto S.V. 2658 f.s. Range 120 ft.	Code W. Struck 3½" below top edge of pannier. Hole 4"x2½". Shatter area 5¼"x3". Flake off 8½"x5¾"x1".
Ditto	Round 121 Ditto S.V. 2599 f.s. Range 120 ft.	Code R. Struck 10½" below top edge of pannier. Hole 2⅜"x2". Shatter area 4"x2¾". Flake off 9"x5½"x¾".

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APPENDIX A
Sheet No.9

TARGET	ATTACK	OBSERVATIONS
Offside pannier	Round 122 6-Pr.A.P.C. at 50° compound. S.V. 2603 f.s. Range 120 ft.	Code C. Bulge 6½"x4"x3¾". Struck 7" above bottom edge of pannier. Shatter scoop 6"x2½"x1½".
Ditto	Round 123 Ditto S.V. 2441 f.s. Range 120 ft.	Code R. Struck 5½" above bottom edge of pannier and 3½" behind joint to glacis plate. Shatter scoop 4½"x2½". Petal off 2½"x2¼".
Ditto	Round 124 Ditto S.V. 2438 f.s. Range 120 ft.	Code W. Struck 3" above bottom edge of pannier. Circum.crack 15" on 6" radius from bottom edge of plate. Bottom edge of plate forced down 2¼" and cracked in two places. Pannier floor plate cracked for 9" from edge. Weld, pannier side to floor fractured 10". Bottom corner of roof stiffening bulkhead forced forward 4" and torn from welds to pannier side an and floor. Flake off 4½"x3½"x¾".
Ditto	Round 125 Ditto S.V. 2432 f.s. Range 120 ft.	Code W. Struck 1¾" from top edge of pannier. 2¾"x3" removed from pannier side 4½"x4" removed from roof plate. Roof plate cracked to crack caused by H.E. Round 63., for distance of 10" from hole in roof plate, 14" from edge of roof. Top weld split in junction to roof plate 4" forward and 2" to rear, total 10". Flake off 7"x4⅜"x1". Weld to roof fractured in junction to roof for 11" including gap 6½" of internal fillet removed with flake.
Offside lower side armour.	Round 126 6-Pr. A.P. at 50° S.V. N.O. f.s. Range 120 ft.	Code R. Hole 1¼"x1⅝". Struck 11" below pannier floor. Petal off 2"x1⅝".

TARGET	ATTACK	OBSERVATIONS
Offside Lower side armour.	Round 127 6-Pr.A.P. at 50° S.V. 1834 f.s. Range 120 ft.	Code D. Shatter scoop 2⅜"x2"x⅜". Struck 8½" below pannier floor Struck opposite web of forward roof gusset and gusset plate removed. Crack in armour 6" long diagonally across bulge also radial crack 6" long. Flake lifted ¼" about 5"x4". 2" of 10" weld remaining intact before this round now broken away with this gusset plate.
Ditto	Round 128 Ditto S.V.1839 f.s. Range 120.ft.	Code D slight. Scoop 2½"x2"x½". Struck 12" below pannier floor Bulge 4½"x3½"x⅜".
Ditto	Round 129 Ditto S.V.1874 f.s. Range 120 ft.	Code R. Hole 1½"x1¾". Struck 6½" below pannier floor Petal off 2"x1⅜".
Ditto	Round 130 Ditto S.V.1827 f.s. approx. Range 120.ft.	Code R. Hole 1½"x1⅝". Struck 14" below pannier floor Petal off 1¾"x1⅜".
Ditto	Round 131 6-Pr.APC at 50° S.V.1851 f.s. Range 120 ft.	Code C. Shatter 2¾" x 2" x ⅜" Struck 7" below pannier floor Bulge 2½" x 2½" x 5/16".
Ditto	Round 132 Ditto S.V. 1928 f.s. Range 120 ft.	Code R. Struck 14" below pannier floor Flake off 3¼"x3⅞"x½". Half of flake 2½"x3" forced back ⅛". Hole 1⅝"x1⅜".
Ditto	Round 133 Ditto S.V.1888 f.s. Range 120 ft.	Code C. Scoop 2¾"x2"x⅜" Struck 13" below pannier floor Bulge 2½"x2½"x⅜".
Ditto	Round 134 Ditto S.V.1917 f.s. Range 120.ft.	Code D. Struck 8½" below pannier floor Bulge 3½" dia x ⅜" high. Circum. crack 1⅜" on 1⅛" Radius
Ditto	Round 135 Ditto S.V.1935 f.s. Range 120 ft.	Code C. Scoop 2½"x2"x⅜". Struck 9½" below pannier floor Bulge 4"x4"x⅜" high.

SECRET

Trial No. X.795

APPENDIX A
Sheet No.11.

TARGET	ATTACK	OBSERVATIONS
Offside lower side armour.	Round 136 6-Pr. A.P.C. at 50° S.V. 1959 f.s. Range 120 ft.	Code C. Shatter 3¼"x2½". Struck 8" below pannier floor. Struck 5" from Rd.128. Flake off 3"x3"x⅜". Hole 2"x1¼".
Ditto	Round 137 Ditto S.V. 1963 f.s. Range 120 ft.	Code C. Scoop 2½"x2¼"x⅜". Struck 8½" below pannier floor. Bulge 3½"x3½"x7/16".
Ditto	Round 138 Ditto S.V. 2016 f.s. Range 120 ft.	Code E severe. Shatter 3½"x2½" x ⅜". Struck 11" below pannier floor. Metal off 2½"x2"x½".
Ditto	Round 139 Ditto S.V. 2003 f.s. Range 120 ft.	Code C. Scoop 2½"x2"x⅜". Struck 12½" below pannier floor. Bulge 3½"x2¼"x½".
Ditto	Round 140 Ditto S.V. 2037 f.s. Range 120 ft.	Code R(L) Struck 8½" below pannier floor. Flake off 4½"x3¼".
Nearside hull roof at butt weld in plate.	Round 141 No.75 Grenade Filled 704 B. Detonated electrically.	Detonation. Hole 4"x4". Plate forced in 1¼" max. over area 10½"x9". Weld to pannier side fracture 3' 3" mostly in junction to pannier side. Metal off 4½"x5". Three radial cracks 6" long in roof plate. Pannier floor and remnants of ammunition rack severely dented by fragments of roof plate.
Engine compartment roof. Rear end of central door. (Door 16.mm. thick) (Roof plate 17.mm. thick).	Round 142 No.75 Grenade. Filled 704 B. Detonated electrically.	Detonation. Portion of plate 9"x5" driven into engine compartment. Adjacent area 8"x5" forced down 1¼" maximum. Lifting handle removed. External rim of locking spindles fractured. Landing strip around rear end forced down at right and left hand sides. 8½"x7" removed from inside of door.

Trial No. X.795

TARGET	ATTACK	OBSERVATIONS
Front of turret roof plate.	Round 143 No.75 Grenade. Filled 704 B. Detonated electrically. "	Detonation. Hole 6"x5". Area 16"x7" forced downwards max. of $\frac{1}{2}$". Lifting eye at offside fractured.. Weld attaching inner end of eye broken. Cracks in junction adjacent roof plate (weld to turret front) 8"x1$\frac{1}{2}$" long. Weld to protector around ventilator cover fractured 5" in junction to protector. Flake off 9"x6$\frac{1}{2}$". Back edge of turret front forced down $\frac{3}{8}$". Weld between turret front and roof cracked 6". Fragments of roof caused damage to offside buffer casing and would have seriously damaged machine gun mounting if in position.

A.T. No.232.
Part III

Pz.Kw.V Panther

6 pdr. Attack

Print No.1.

Offside wall of turret after attack by:-
6 pdr. A.P. at 50°,
Rounds 76 to 81, and 86.
6 pdr. A.P.C. at 50°,
Rounds 82 to 85.
Round 63 was 25 pdr. H.E. fired during Part II of the trial.

Print No.2.

Offside wall of turret at bend after attack by:-
6 pdr. A.P. at 50°,
Rounds 76 to 79, and 86.
6 pdr. A.P.C. at 50°,
Rounds 83 and 84.
The triangular portion of the armour below Round 77 was dislodged by Round 84.
Round 77 struck on the level of the turret floor plate.

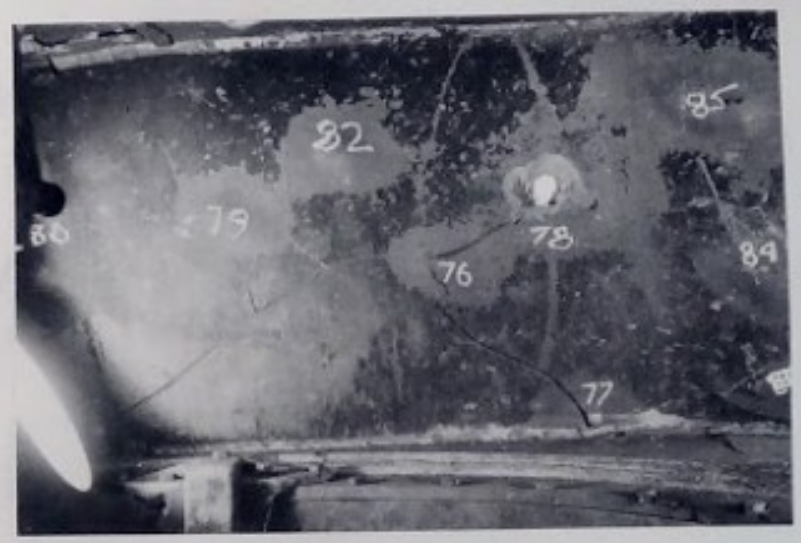
Print No.3.

Rear offside wall of turret after attack by:-
6 pdr. A.P. at 50°,
Round 86.
6 pdr. A.P.C. at 50°,
Rounds 83 to 85.
Round 86 struck on the tenon of the interlocking joint formed by the rear plate.

A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. Attack



Print No.4.

Inside face of offside wall of turret.
6 pdr. A.P. at 50°, Rounds 76 to 80.
6 pdr. A.P.C. at 50°, Rounds 82 to 85.
Note extensive cracking.

Print No.5.

Showing inner face of offside wall of turret after attack by:-
6 pdr. A.P. at 50°, Rounds 79 to 81.
6 pdr. A.P.C. at 50°, Round 82.
17 pdr. A.P. at normal on the front face of the turret, Round 97.

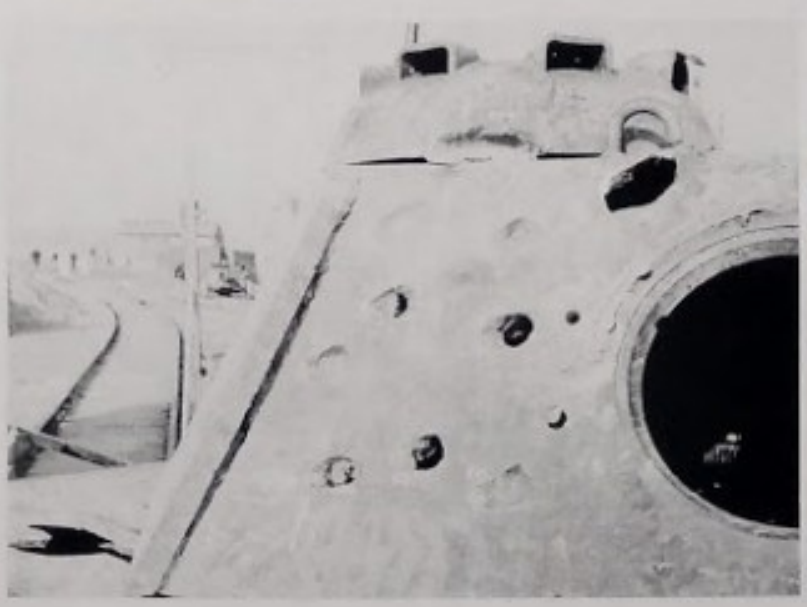
Print No.6.

Inner face of offside turret wall after attack by:-
6 pdr. A.P. at 50°, Rounds 76 to 78, and 86.
6 pdr. A.P.C. at 50°, Rounds 82 to 85.

A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. Attack

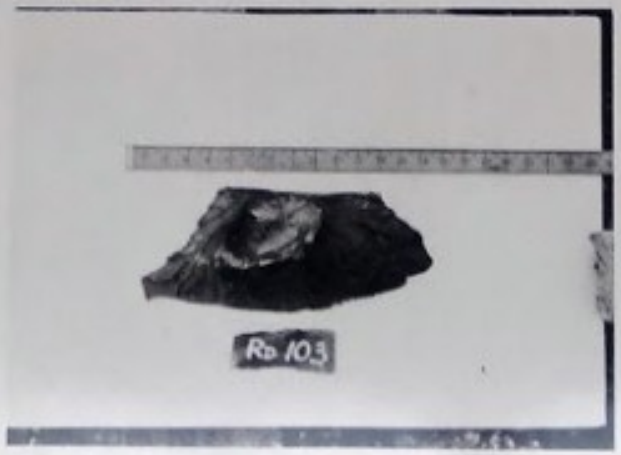


Print No.7.

Rear wall of turret after attack by:-
6 pdr. A.P. at 50°,
Rounds 87 to 89, and 98 to 103.
The cupola was attacked by one round of 6 pdr. A.P. at 50°, Round 104.

Print No.8.

Inner face of rear wall of turret after attack by:-
6 pdr. A.P. at 50°,
Rounds 87 to 89, and 98 to 103.
This plate had flakes dislodged from the inner face, as had all the other plates of the vehicle, but the extensive cracks which developed in the other plates did not occur in this plate.



Print No.9.

Flake off rear wall of turret caused by 6 pdr. A.P. at 50°, Round 103.

A.T. No.232.
Part III

Pz.Kw.V Panther

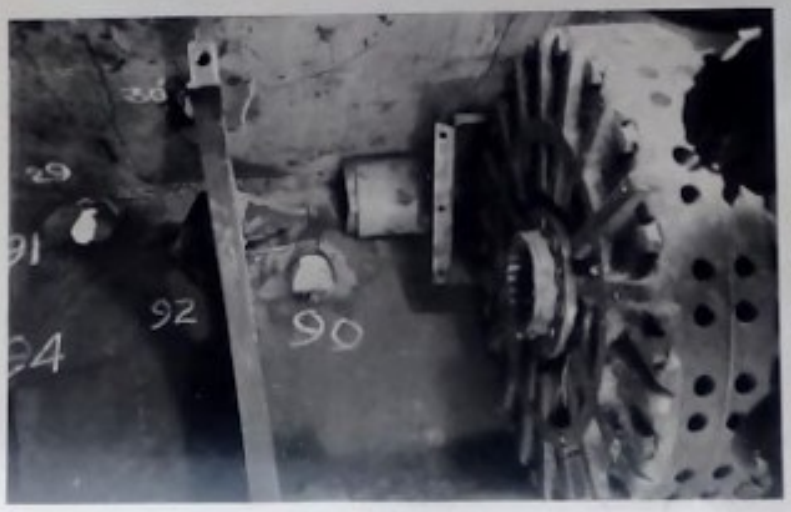
17 pdr. Attack

Print No.10.

Nose plate after attack by 17 pdr. A.P. at 53°, Rounds 90 to 94.
Note extensive cracking.

Print No.11.

Nose plate after attack by:-
6 pdr. A.P.D.S. at 53°, Round 17.
17 pdr. A.P. at 53°, Rounds 90 to 94.
Glacis plate after attack by:-
6 pdr. A.P.D.S. at 55°, Rounds 18 and 19.
17 pdr. A.P.D.S. at 55°, Rounds 29, 30, 32 and 33.
17 pdr. A.P.C.B.C. at 55°, Rounds 34 and 35.
The left-hand transmission bracket was flame-cut to permit removal of flake dislodged by Round 34.



Print No.12.

Nose plate after attack by:-
17 pdr. A.P. at 53°, Rounds 90 to 92, and 94.
Glacis plate after attack by:-
17 pdr. A.P.D.S. at 55°, Rounds 29 and 30.

A.T. No.232.
Part III.

Pz.Kw.V Panther

17 pdr. Attack

Print No.13.

Hull machine-gun after attack by 17 pdr. A.P. Round 95 - S.V. 1906 f.s. Round 96 - S.V. 1922 f.s. Round 96 dislodged the ball unit into the hull.

Print No.14.

Rear face of hull machine-gun ball mounting after attack by 17 pdr. A.P., Rounds 95 and 96. Glacis plate after attack by 17 pdr. A.P.D.S. at 55°, Rounds 29, 30 and 32, 17 pdr. A.P. at 55°, Round 36. Note extensive cracking of glacis plate.

Print No.15.

Fragments of ball mounting recovered from inside hull, mounting projected into hull by Round 96, 17 pdr. A.P. The large portion, top left, was found outside and is part of the domed upper housing.

A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. and 17 pdr. Attack

Print No.16.

Front face of turret after attack by 17 pdr. A.P. at normal, Round 97.
Offside turret wall after attack by 6 pdr. A.P. at 50°, Round 105.
Round 97 holed the turret.
Round 105 forced down the edge of the plate and jammed the turret.

Print No.17.

Showing nearside edge of turret mantlet after attack by:-
6 pdr. A.P. at 60°, Rounds 106 and 107.
The mantlet was not jammed by this attack, but rubbing between the mantlet and turret front occurred in places.

Print No.18.

Offside pannier after attack by:-
6 pdr. A.P. at 50°, Rounds 108 to 113.
6 pdr. A.P.C. at 50°, Rounds 114 to 118, and 122 to 125.
See also Print No.19.

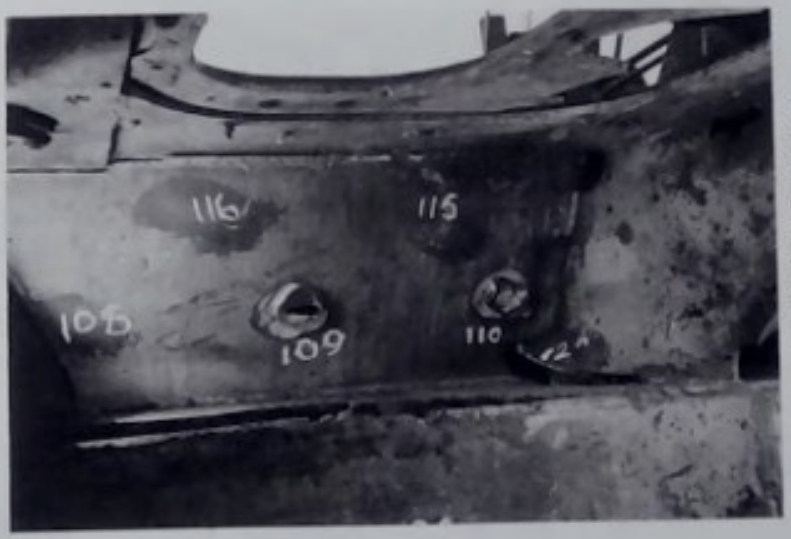
A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. Attack

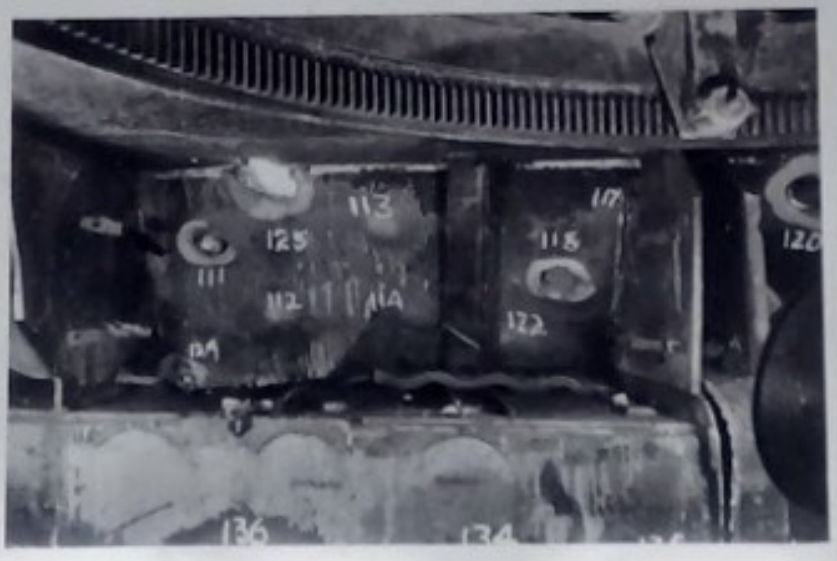
Print No.19.

Offside pannier after attack by:-
6 pdr. A.P. at 50°,
Rounds 110 to 113.
6 pdr. A.P.C. at 50°,
Rounds 114, 115, 117 to 122, 124 and 125.
Note "edge effect" on the impact of Rounds 123 and 124.



Print No.20.

Interior of offside pannier after attack by:-
6 pdr. A.P. at 50°,
Rounds 108 to 110.
6 pdr. A.P.C. at 50°,
Rounds 115 and 116.
The bottom corner of the bulkhead was forced forward by Round 124.



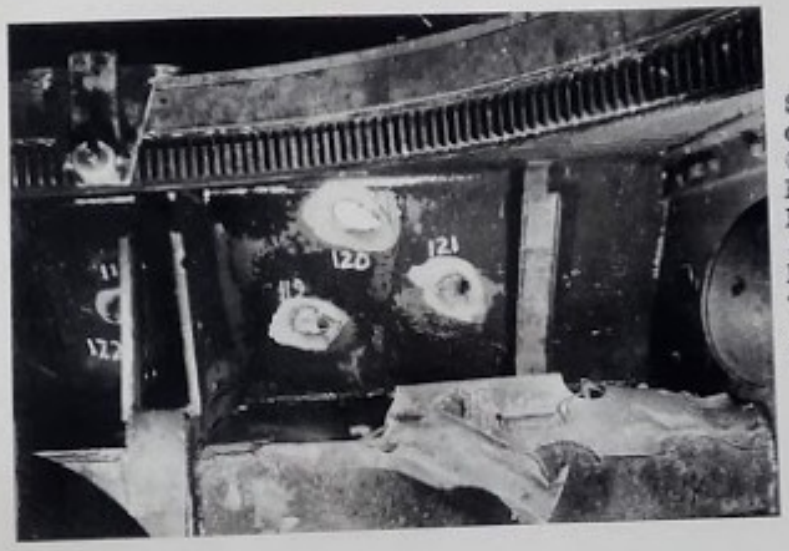
Print No.21.

Offside pannier showing back damage from:-
6 pdr. A.P. at 50°,
Rounds 111 to 113.
6 pdr. A.P.C. at 50°,
Rounds 114, 117, 118, 120, 122, 124 and 125.

A.T. No.232.
Part III.

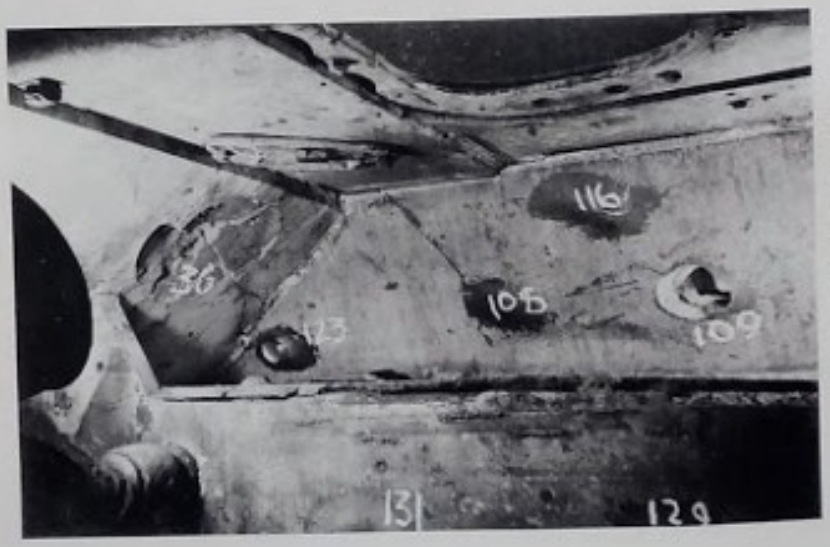
Pz.Kw.V Panther

6 pdr. Attack



Print No.22.

Showing back damage to offside pannier from 6 pdr. A.P.C. at 50°, Rounds 119 to 122. Note excessive flaking and compare damage at Round 123 on Print 23 where similar attack dislodged a plug from the same plate.



Print No.23.

Back damage to front end of offside pannier from attack by:-
6 pdr. A.P. at 50°, Rounds 108 and 109.
6 pdr. A.P.C. at 50°, Rounds 116 and 123.
Round 36 on the glacis plate was 17 pdr. A.P. at 55°.

Print No.24.

Offside lower armour after attack by:-
6 pdr. A.P. at 50°, Rounds 126 to 128.
6 pdr. A.P.C. at 50°, Rounds 134 to 136.
(Round 64 was 75 mm. H.E. fired during Part II of this trial.)

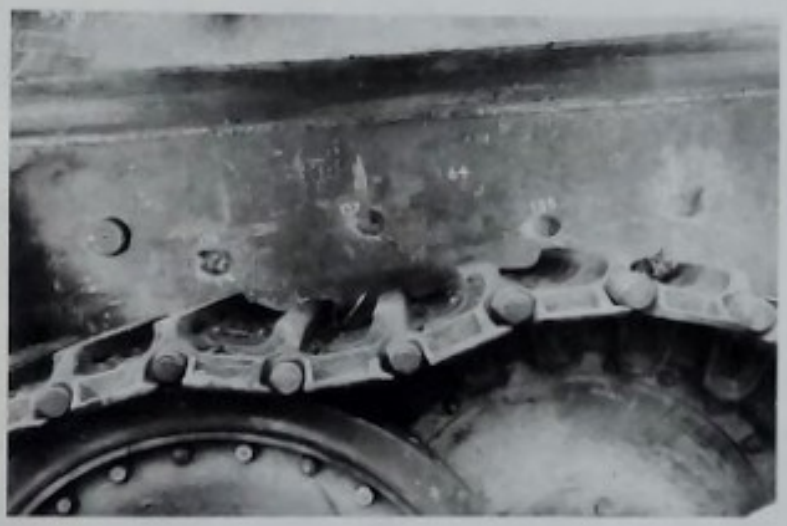
A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. Attack

Print No.25.

Offside lower armour after attack by:-
6 pdr. A.P. at 50°,
Rounds 126, 129 and 130.
6 pdr. A.P.C. at 50°,
Rounds 131 to 133, and 139.
The weld to the pannier floor was split by the blast from Round 65, 25 pdr. H.E. fired during Part II of the trial.



Print No.26.

Offside lower armour.
Rounds 134 to 138 were 6 pdr. A.P.C. at 50°.
Round 64 was 75 mm. H.E. fired during Part II of the trial.

Print No.27.

Back damage of lower armour at offside after 6 pdr. A.P. and A.P.C. attacks.
Note tendency to form plugs at Rounds 126, 129, 130; and flake lifted at Round 127.
See also Print No.28.

09

A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. Attack

Print No.28.

Forward end of offside lower armour, showing variable back damage.
Rounds 129, 126, and 130 forced out plugs, while Rounds 127 and 132 lifted or dislodged flakes.

Print No.29.

Central portion of offside lower armour, showing back damage caused during 6 pdr. attack.
The stiffening member was first damaged by Round 64 (75 mm. H.E.) and weld failures developed during 6 pdr. attack.

Print No.30.

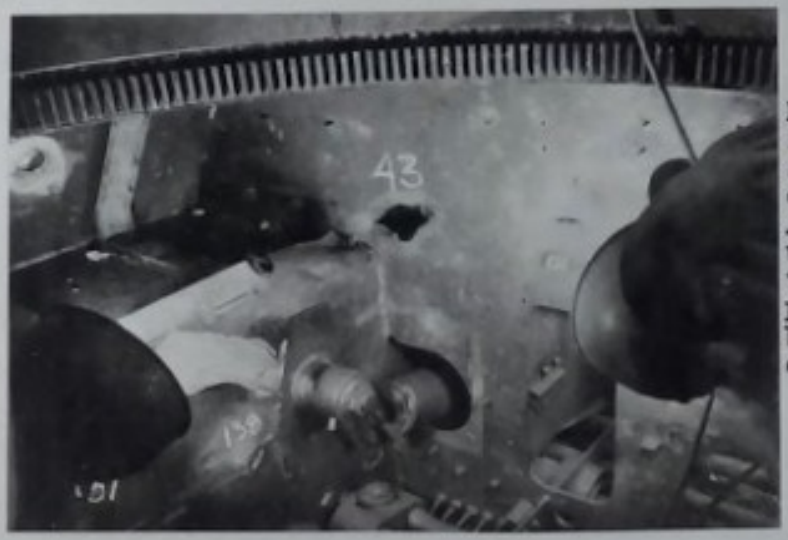
Another view of damaged stiffening device below bulkheads in pannier. Note that piston rod of the rear suspension system is fractured, possibly as a result of the detonation of three A.T. grenades (Round 67) beneath the track.

09

A.T. No.232.
Part III.

Pz.Kw.V Panther

6 pdr. Attack



Print No.31.

Right rear corner of fighting compartment, showing hole in bulkhead caused by 6 pdr. A.P.C.B.C., Round 43, which defeated the turret side at 50° and penetrated the fuel tank behind the bulkhead and caused a severe fire.

Print No.32.

6 pdr. A.P.C., Round 140, defeated the lower armour at 50° at a velocity equivalent to a range of 2300 yds.

Print No.33.

Position of No.75 grenade across butt joint in hull roof at nearside before detonation.

A.T. No.232.
Part III.

Pz.Kw.V Panther

No.75 Grenade Attack

Print No.34.

Hole blown in hull roof by No.75 grenade detonated in contact. Ammunition for the 75 mm. gun is stowed below this point.
Roof plate was 17 mm. thick.

Print No.35.

Location of No.75 grenade used to attack the cover over the engine compartment.

Print No.36.

Result of detonation of No.75 grenade on hatch over engine compartment. Hatch was 17 mm. thick.

A.T. No.232.
Part III.

Pz.Kw.V Panther

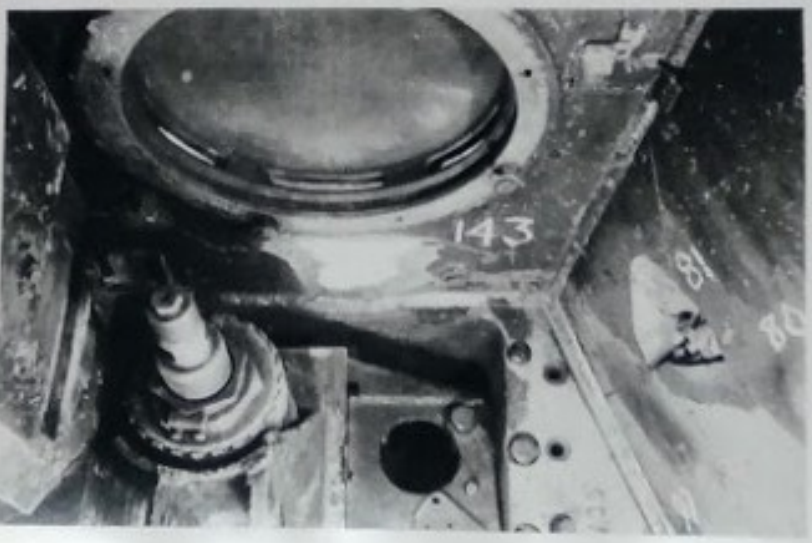
No.75 Grenade Attack

Print No.37.

Location of A.T. grenade No.75 near joint between turret roof and front casting.

Print No.38.

Result of detonation of No.75 grenade on turret roof (17 mm. thick).



Print No.39.

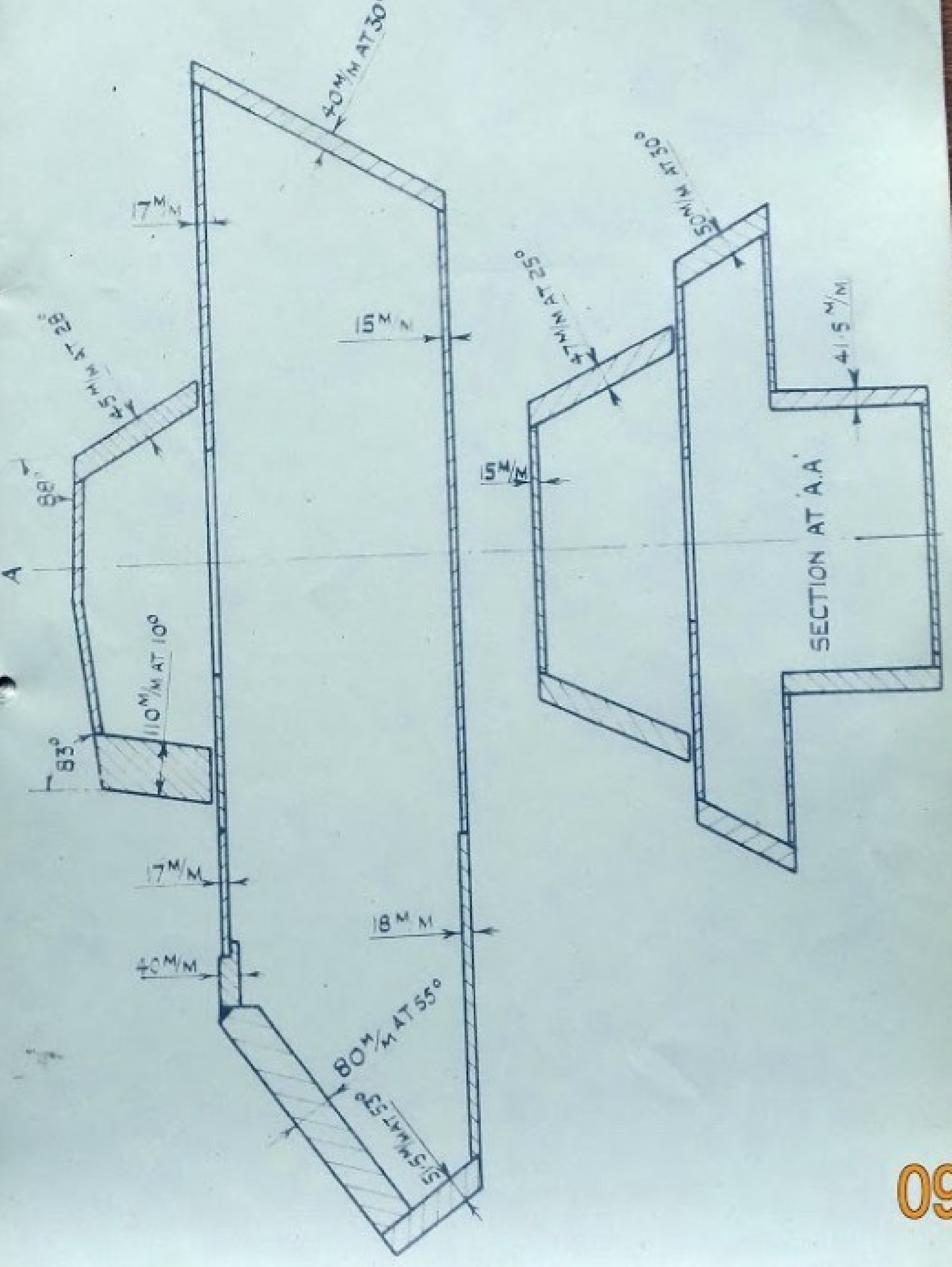
Interior of turret roof after detonation of Round 143.
The hole measured 6" x 5" and the area from which the flake was removed 9" x 6½".

TRIAL No X794
1 SHEET

AT No 232 PART III
PANTHER V MODEL G

APPENDIX C.
SHEET No 1.

DIAGRAMMATIC SKETCH SHOWING ARMOUR DISPOSITION.



D.T.D. Experimental Report.

A.T. No. 232.

Part IV.

Project No: M.6815A/4
Trial No: X.826.
File Ref: 250/188

REPORT OF MINE TRIAL
against Pz.Kw. V (Panthers)
held at S. of E. Range, Shoeburyness.
on 28th, 29th, 30th November and 1st December, 1944.

Present at Trial.

Name	Representing	Date Present Nov.	Dec.
Col. Speechly	C.E.A.D.	30th	
Major Edwards	A.2.	29th	
Capt. Martin	C.E.A.D.	28th, 30th	
Mr. Day	C.S.A.R.	28th, 29th, 30th	
Mr. Stout	C.E.A.D.	30th	
Lt. Tredinnick	S. of E. (Range Officer)	28th, 29th, 30th,	1st
Mr. Gray	D.T.D. (Armour Branch)	28th, 29th, 30th,	1st
Mr. Wilde	" " "	30th.	
Range Personnel			

Report.

Compiled by:- Mr. G.W. Gray - D.T.D. (Armour Branch)

Checked by:- Maj. G. Guthrie R.E.M.E. D.T.D. (Armour Branch)

" " "

Mr. J.B. Sankey

References.

Section I.	-	Object of Trial.
Section II.	-	Target Details.
Section III.	-	Method of Attack.
Section IV.	-	Trial Commentary.
Section V.	-	Summary of Results.
Section VI.	-	Conclusions.

Appendices.

Appendix A.	-	Detailed Results.
Appendix B.	-	Photographic Record.
Appendix C.	-	Sketch.

M.461(s).
BS.

09

SECTION I. Object of Trial.

To determine the degree of resistance of the tracks, suspensions and hull side to floor plate structure of Panther Tanks to attack from various Anti-tank Mines.

SECTION II. Target Details.

These consisted of three Pz.Kw.V (Panther) Tanks as follows:-

D.T.D. No.3040 - Hull and turret with part tracks and suspensions.

D.T.D. No.3041 - Hull and turret with tracks and suspensions, less certain bogies.

D.T.D. No.3031 - Hull and turret with one track and suspensions.

SECTION III. Method of Attack.

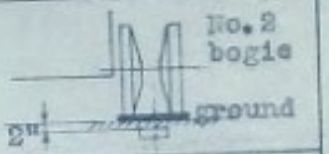
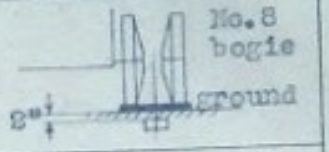
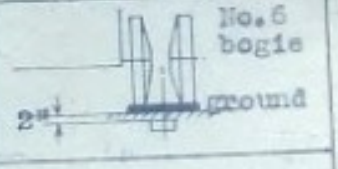
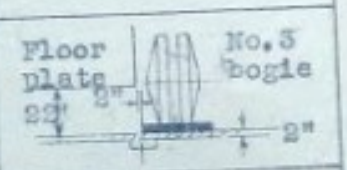
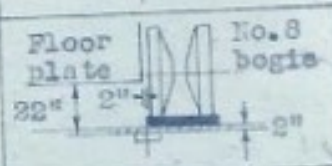
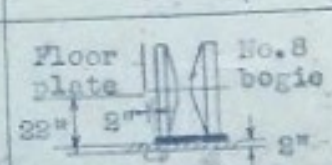
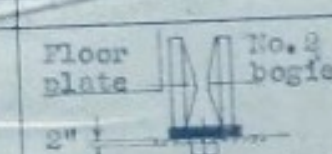
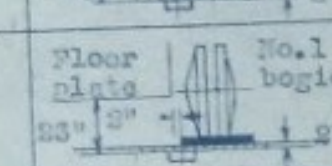
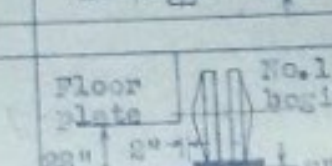
The attack against the tracks and suspensions was carried out by burying the mine in meadowland, with the top of the mine ½" below the underside, and central with the track width. In every case spaced flange wheels were selected under which the mines were placed.

When attacking the hull side to floor plate structure, the mines were buried a similar amount but with the centre of the mine under the inner edge of the track. In this case both spaced and closed flange wheels were selected under which the mines were placed.

Throughout the trial every effort was made to maintain the same dimensions, mine to target, for reasons of comparison. Such differences as did occur were due to the water-logged condition of the site. These slight differences where they occur were not considered sufficient to influence the result. Confirmation of all types of mines was not possible owing to limitation of targets.

Reference to Table A following, shows the attack for each item.

TABLE A.

Item No.	Details of Mine	Target attacked	Position of Mine
Tank No. 3031 1	1-4-lb. Non-detectable mine. Filled T.N.T. (4-lb.)	Track and suspensions	
2	1-Mk.V reduced depth A.T. mine. Filled T.N.T. (5-lb.)	Tracks and suspensions	
3	1-4-lb. Non-detectable mine. Filled T.N.T. (4-lb.)	Track and suspensions	
Tank No. 3041 4	1-Mk.V Standard A.T. Mine. Filled T.N.T. (8-lb.)	Hull side to floor plate structure and suspensions.	
5	1-Mk.V Standard A.T. Mine. Filled T.N.T. (8-lb.)	Hull side to floor plate structure and suspensions.	
6	1-Mk.V Standard A.T. Mine. Filled T.N.T. (8-lb.)	Hull side to floor plate structure and suspensions.	
7	1-Mk.V Standard A.T. Mine. Filled T.N.T. (8-lb.)	Hull side to floor plate structure and suspensions.	
Tank No. 3040 8	1-5½-lb. Asbestos-cement mine. Filled T.N.T. (5½-lb.)	Track and suspensions	
9	1-5½-lb. Asbestos-cement mine. Filled T.N.T. (5½-lb.)	Hull side to floor plate structure and suspensions.	
10	1-10-lb. Mine filled T.N.T. (10-lb.)	Hull side to floor plate structure and suspensions.	
Tank No. 3041 11	1-18-lb. Mine filled T.N.T. (18-lb.)	Hull side to floor plate structure and suspensions.	
12	1-15-lb. Mine filled T.N.T. (15-lb.)	Hull side to floor plate structure and suspensions.	

SECTION IV. Trial Commentary

Tank No. 3031 - To test track and suspensions.

Item 1. Mine under centre of track detonated in line with No. 2. bogie.

One 4 lb. non-detectable mine (4 lb. T.N.T.) failed to detonate and inspection revealed the casing broken and the charge exposed. The mine was therefore destroyed with a 1 lb. slab of gun cotton. Only minor damage was caused to the track, due, it is considered, to the loss of power owing to the filling being unconfined.

The damage was slight and the vehicle would still be a runner.

Item 2. Mine under centre of track detonated in line with No. 8. bogie.

One Mk. V reduced depth mine (5 lb T.N.T.) broke the track, and No. 8. bogie outer disc was blown away.

A field repair to track would be possible.

Item 3. Mine under centre of track detonated in line with No. 6. bogie.

One 4 lb. non-detectable mine (4 lb. T.N.T.) broke the track, confirming the view that a similar mine (Item 1) did not develop its full power.

The track in this case could be repaired in the field.

Tank No. 3041. - To test hull to floor plate structure.

The hull to floor plate was constructed on the interlocking joint principle secured by inner and outer fillet welds. The hull side was 40 mm. thick, the forward floor 25 mm, and rear floor 15 mm thick. Reference to sketch Appendix C shows a detail of this joint.

It was intended to test the forward floor by detonating mines under the first road bogies but as the first and second bogies were missing on the right and left hand sides respectively, it was decided to use the third bogies. Since our object was to compare the behaviour of the hull structure where the forward floor plate was 25 mm, and the rear floor plate was 15 mm, the change of position of mine from the first to third road bogie was considered to be immaterial.

Item 4. Mine under inner edge of track detonated in line with No. 3. bogie (Floor plate 25 mm)

One Mk. V standard mine (8 lb. T.N.T.) broke the track, and split No. 3. bogie in several places.

The hull floor to side plate structure was not affected.

Field repairs to track would have been possible.

Item 5. Mine under inner edge of track detonated in line with No. 8. bogie. L.H. side (Floor plate 15 mm)

One Mk. V standard mine (8 lb. T.N.T.) failed to break the track, but sheared out metal over an area 18" long X 6" wide from the inner edge, and severely buckled and perforated No. 8. bogie.

Apart from some pitting of the floor plate the structure was not affected.
The tank would continue to run.

Item 6 was a repeat of item 5 but on the opposite side of the vehicle. The track inner edge damage, was less severe than for item 5 and the hull to floor plate structure remained intact.

The vehicle would continue to run.

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Item 7. was a further test similar to item 4 but with the mine in line with No. 3. bogie R.H. side. The track damage was comparable to item 4. The hull structure was unaffected.

Tank No. 3040.
To test track and suspensions.

The hull to floor plate structure, was not interlocked. The floor plate was secured to the hull side by inner and outer fillet welds.

Reference to sketch Appendix C shows a detail of this joint.

Item 8 Mine under centre of track detonated in line with No. 2. R.H. bogie.

One asbestos cement type mine (5½ lb. T.N.T.) broke the track. No. 2. bogie outer disc was completely blown away and the inner disc severely buckled.

Item 9. To test hull to floor plate structure. Mine under inner edge of track detonated in line with No. 2. L.H. bogie.

One asbestos cement type mine (5½ lb. T.N.T.) sheared a portion of track away over area 6" long X 4" wide from the inner edge.

No damage was caused to the hull to floor plate structure.

Item 10. Mine under inner edge of track detonated in line with No. 1. bogie.

One experimental 10 lb. mine (10 lbs. T.N.T.) broke the track. No. 1. bogie outer disc was blown away, the front sprocket severely buckled and many teeth sheared out.

Apart from an area of pitting on the floor plate, this structure remained intact.

It is doubtful whether a field repair would have been possible in this case.

Tank No. 3041.
To test Hull to floor plate structure.

Item 11. Mine under inner edge of track detonated in line with No. 1. bogie.

One experimental 15 lb. mine (15 lb. T.N.T.) failed to detonate and was destroyed by a slab of gun cotton. The track was broken, and the leading bogie and shaft forced out of position approximately 9".

The final drive sprocket with a length of track, damaged severely in a previous trial was completely forced off and thrown clear of the vehicle.

Slight pitting of the floor plate only was caused and the hull and floor plate structure remained intact.

Allowing for the fact that the driving sprocket would probably not have been forced off had it not been previously damaged, it is considered that a field repair would not have been possible.

Item 12 Mine under inner edge of track, detonated in line with No. 8 bogie.

Owing to failure of the mine, in item 11, to detonate, it was decided to repeat the test.

This mine failed to break the track, but sheared out track metal from the inner edge 12" long x 6" wide. No. 8 bogie inner flange was partially blown away and the outer flange buckled. The bogie shaft was also forced outwards 4".

The hull to floor plate structure remained relatively intact.

A field repair in this instance was considered doubtful.

This ended the trial.

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SECTION V. Summary of Results.

The following table gives briefly a summary of the results obtained.

Item No.	Position of mine	Details of Mine	Summary of Damage	Effect on Tank
Tank No. 3031				
1	Under centre of track	1-4lb. Non-detectable mine.	Track dished locally.	Capable of running.
2	Under centre of track.	1-Mk. V Reduced depth mine.	Track sheared for full width. Outer flange No. 8 bogie blown away.	Temporarily immobilised. Field repair to track possible.
3	Under centre of track.	1-4lb. Non-detectable mine.	Track sheared across full width. No. 7 bogie outer flange now completely removed.	Temporarily immobilised. Field repair to track possible.
Tank No. 3041				
4	Under inner edge of track.	1-Mk. V Standard A/T Mine.	Track sheared across full width. Outer flange No. 3 bogie split. Hull intact.	Temporarily immobilised. Field repair to track possible.
5	Under inner edge of track.	1-Mk. V Standard A/T Mine.	Track partially severed. Hull intact.	Tank would continue to run.
6	Under inner edge of track.	1-Mk. V Standard A/T Mine.	Track partially severed. Hull intact.	Tank would continue to run.
7	Under inner edge of track.	1-Mk. V Standard A/T Mine.	Track partially severed. Hull intact.	Tank would continue to run.
Tank No. 3040				
8	Under centre of track.	1-5½lb. asbestos cement mine.	Track completely sheared. Outer disc No. 2 bogie blown away.	Temporarily immobilised. Field track repair possible.
9	Under inner edge of track.	1-5½lb. asbestos cement mine.	Track partially severed. No. 2 bogie disc severely buckled.	Would probably continue to run after freeing jammed bogie.
10	Under inner edge of track.	1-10lb. mine	Track completely severed. Front sprocket severely buckled and many teeth broken off. No1 bogie outer disc blown off. Hull intact.	Vehicle immobilised. Field repairs improbable.
Tank No. 3041				
11	Under inner edge of track.	1-15lb. mine.	Mine failed to detonate. Destroyed with 14½ ozs. of gun cotton. Track completely severed. Final drive housing damaged in previous trial completely blown off. Hull intact.	(Disregarding damage to final drive housing.) Field repairs improbable.
12	Under inner edge of track.	1-15 lb mine.	Track partially severed. No. 8 bogie - inner flange partially blown away Minor damage to hull floor locally.	Field repairs improbable.

SECTION VI. Conclusions.

From the results of this trial it is concluded that:-

(a) Test against track and suspensions.

Any of the mines used to test the "Panther" track and suspensions will break the track if detonated under the centre, which is the most favourable position for the mine.

When mines are detonated somewhat off centre, but within the track width, the higher charge contained in the standard Mk. V, it is considered, would be necessary to ensure breaking the track.

Damage to the suspensions and bogies only caused temporary immobilisation and field repairs would have been possible.

(b) Test against hull to floor plate structure.

None of the mines used for this test, i.e. against the heavy floor plates, succeeded in causing any measurable damage to this structure.

These mines also gave conflicting results in their effect on the tracks, the same type of mine producing complete breakage, and also only partial breakage. It should be noted that for this test the mine was placed under the track inner edge.

Mines containing up to 8-lbs. T.N.T. only temporarily immobilised the vehicle and in some instances the vehicle would continue to run.

It would appear, however, that suspensions, driving sprockets, and bogie damage was sufficient in the case of the 10-lb. and 15-lb. mines to preclude the possibility of field repairs.

It is emphasised that owing to the soft nature of the ground throughout this trial, the ground was completely water-logged, it is thought that less damage was done to tracks etc. than would normally be the case.

Finally it is considered that the standard Mk.V mine produced results which indicated this as being the best general purpose A/T mine.

G. Guthrie, Major, R.E.M.E.
Officer i/c. Armour Trials Section,
(Armour Branch.)

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M.461(a).
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APPENDIX A
Sheet No. 1

Trial No.X.826
(5 Sheets)

Mine Trials
Detailed Results

TARGET	ATTACK	OBSERVATIONS
Tank No.3031 Item No.1. Under centre of L.H. track in line with No.2 bogie. (Spaced flange wheels).	One 4-lb. Non-detectable mine placed with top of mine 2" below lower edge of track. Mine filled T.N.T.(4 lb) with C.E. exploder pellet and No.33 electric detonator inserted into a side orifice.	Mine failed to detonate. On inspection the casing was found to be broken open and filling exposed. One lb. of gun cotton was placed alongside to detonate the mine. This caused mine to explode. Crater area 4' dia x 18" deep. The outer bogie disc No.2 was severely buckled and tyre thrown off. Two track guide lugs immediately behind the outer disc were fractured and the track bulged inward approx. 2" over an area 6" x 4", centrally across the width of the track. One link broken Owing to the splitting of the mine casing the filling was unconfined and therefore unlikely to develop its full power. It is considered that the vehicle would still be capable of running.
Item No.2 Under centre of L.H. track in line with No.8 bogie (Spaced flange wheels).	One Mk.V reduced depth mine placed with top of mine 2" below lower edge of track. Mine filled T.N.T.(5-lb) Fitted with C.E. one oz. field primer and No.33 electric detonator C.E. field primer was wedged against one side of exploder cavity.	Mine detonated. Crater area 5' dia. x 2' 6" deep. No.8 outer bogie disc was blown away together with tyre. The track immediately above detonation was sheared across for its full width. No.7 tyre partially blown away and the outer flange of outer bogie was split.

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TARGET	ATTACK	OBSERVATIONS
Item No.3. Under centre of L.H. track in line with No.6 bogie (Spaced flange wheels).	One 4-lb. non-detectable mine placed with top of mine 2" below lower edge of track. Mine filled T.N.T. with C.E. exploder pellet and No.33 electric detonator and one C.E. 1 oz. field primer, placed near the centre and in contract with mine base, to ensure detonation after removal of detector cover.	Mine detonated. Crater 4' dia x 2' 6" deep. Inner and outer wheel discs slightly buckled. track severed for full width. No.7 outer flange previously fractured now completely removed together with tyre. Field repairs to track would be possible.
Tank No.3041 Item No.4 Under inner edge of L.H. track in line with No.3 bogie, (closed flange wheels) Distance from top of mine to underside belly plate 22". Hull side wall 2" away from inner edge track.	One Mk.V Standard A.T. Mine placed with centre of mine 2" below and in line with inner edge of track. Mine filled T.N.T. (6-lb) with No.33 electric detonator and two C.E. (1-oz) field primer.	Crater 3' dia. 2' deep. Track sheared across full width. Outer flange of No.3 bogie split in several places. Field repairs to track would be possible. Hull floor and side plate intact.

Trial No.X.826

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Mine Trials
Detailed Results

APPENDIX 'A'
Sheet No.3

TARGET	ATTACK	OBSERVATIONS
Tank No.3041 Item No.5 Under inner edge of L.H. track in line with No.8 bogie (spaced flange wheels) Distance from top of mine to underside belly plate 22" Hull side wall 2" away from inner edge track.	One Mk.V Standard A.T. Mine placed with centre of mine 2" below and in line with inner edge of track. Mine filled with 8-lb T.N.T. and initiated by a No.33 electric detonator and two 1-oz. standard C.E. primers.	Inner edge of track sheared over an area 18" long by 6" (wide) Crater 3' 6" dia x 2' deep No.8 bogie severely buckled and tyre split. Several perforations in bogie disc, largest 1" x ¾". Some slight pitting on outer edge of belly plate. max. depth approx. 1/8". Tank would continue to run.
Tank No.3041 Item No.6 Under inner edge of R.H. track in line with No.8 bogie (spaced flange wheels). Distance from top of mine to underside belly plate 22" Hull side wall 2" away from inner edge track.	One Mk.V Standard A.T. Mine placed with centre of mine 2" below and in line with inner edge of track. Mine filled with 8-lb. T.N.T. and initiated by a No.33 electric detonator and two 1-oz. standard C.E. primers.	Crater 5' x 4' x 2' deep with main area towards centre of vehicle. Track link sheared over area 6" x 3" wide. Inner disc of No.8 bogie severely buckled. Further inspection of vehicle after Item 6 indicated no appreciable damage or pitting to belly plate or hull sides.
Tank No.3041 Item No.7. Under inner edge of R.H. track in line with No.3 bogie (closed flange wheels) Distance from top of mine to underside belly plate 23". Hull side wall 2" away from inner edge track.	One Mk.V Standard A.T. Mine placed with centre of mine 2" below and in line with inner edge of track. Mine filled T.N.T. (8-lb) with No.33 electric detonator and two C.E. (1-oz) field primers.	Crater 4' x 3' 6" x18" deep with main area towards centre of vehicle. Track link sheared over area 12" x 6" wide. Field repairs to track would be possible. Hull floor and side plate intact.

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Trial No.X.826

Mine Trials
Detailed Results

APPENDIX A
Sheet No. 4

TARGET	ATTACK	OBSERVATIONS
Tank No.3040 Item No.8. Under centre of R.H. track in line with No.2 bogie (spaced flange wheels).	One 5½-lb asbestos cement mine 2" below lower edge of track. Mine filled T.N.T. with No.33 electric detonator and 2 C.E. 1.oz. field primers	Crater size 5'6" dia. x 2'6" deep. No.2. bogie outer disc completely blown away. Inner disc severely buckled. Outer disc of No.1. bogie buckled. Track sheared across full width.
Item No.9. Under inner edge of L.H. track in line with No.2 bogie (spaced flange wheels). Distance from top of mine to underside of belly plate 23". Hull side wall 2" away from inner edge of track.	One 5½-lb asbestos cement mine 2" below and in line with inner edge of track. Filled T.N.T. with No. 33 electric detonator and 2 C.E.1.oz.field primers.	Crater size 4'6"x5'0"x2' deep. Portion of track link 6"x¼" removed from inner edge under No.2. bogie. No.2. bogie inner disc severely buckled. Tyre partially stripped off. No.1. bogie forced up and jammed by sprocket teeth. Hull belly and side wall intact
Tank No.3040 Item No.10 Under inner edge of R.H. track in line with leading bogie. (closed flange wheels). Distance from top of mine to underside of belly plate 23". Hull side wall 2" away from inner edge of track.	One 10-lb. Mine filled T.N.T. with one C.E. exploder pellet cast in. Initiated with No.33 electric detonator and 2 drams of plastic explosive around detonator. Mine 2" below and in line with inner edge of track.	Dimensions of Mine 10" dia x 2½" deep, in a thin tinned iron casing. Crater size 8'x6'x3'6" deep. Track sheared across full width. Front sprocket severely buckled and many teeth broken away. No.1 bogie outer disc blown off. Inner disc still in position, severely buckled. Hull floor and side plate intact. Area of pitting approx. 12"x10" max.depth 1/8" approx.
Tank No.3041 Item No.11. Under inner edge of R.H. track in line with leading bogie. (closed flange wheels) Distance from top of mine to underside of belly plate 22" Hull side wall 2" away from inner edge of track.	One 15-lb mine filled T.N.T. with one C.E. exploder pellet cast in. Initiated with No.33 electric detonator and 2 drams of plastic explosive around detonator. Mine 2" below and in line with inner edge of track.	Dimensions of Mine 12" dia x 2½" deep. in a thin tinned iron casing. Failed to detonate. 14½ oz gun cotton placed on mine to destroy same. Crater size 9'x7'x3'6" deep. Leading bogie and shaft forced out of position sideways approx. 9". Inner tyre flange and inner and outer flanges severely buckled. Final drive sprocket complete with length of track, previously damaged, forced away and thrown 20ft. clear of vehicle to right flank. Track sheared for full width. Area of pitting approx. 12"x10" Max.depth 1/8" approx. Hull floor and side plate intact

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Trial No.X.826

APPENDIX A
Sheet No.5

Mine Trials
Detailed Results

TARGET	ATTACK	OBSERVATIONS
Tank No.304.1 Item No.12 Under inner edge of R.H. track in line with No.8 bogie (spaced flange wheels). Distance from top of mine to underside of belly plate 22½". Hull side wall 2" away from inner edge of track.	One 15-lb mine filled T.N.T., with one C.E. exploder pellet cast in. Initiated with No.33 electric detonator and 2 drams of plastic explosive around detonator. Mine 2" below and in line with inner edge of track.	Crater 8'x6'x3' deep. No.8 bogie inner flange partially blown away. Tyre destroyed. Outer flange severely buckled. No.7 bogie inner flange buckled. Track link inner edge sheared out over area 12"x6" under bogie. Floor plate split in one place parallel with side 3" long, split runs into fabricated hole in base plate. No.8 bogie shaft forced out-wards, approx. 4". Pitting over area approx. 24"x 9" max. depth 1/8". Hull floor and side plate generally intact.

A.T. No.232.
Part IV.

Mine Trials.

Pz.Kw.V. (Panthers)

Print No.1.

Item No.1.
Result from 1-4 lb. non-detectable mine plus 1 lb. of gun cotton under centre of left-hand track and beneath No.2 bogie.
Note:-
Track dished locally.

Print No.2.

Item No.2.
Result from 1-Mk.V reduced depth A.T. mine under centre of left-hand track and in line with No.8 bogie.
Note:-
Track completely broken.

Print No.3.

Item No.3.
Result from 1-4 lb. non-detectable mine under centre of left-hand track and in line with No.6 bogie.
Track completely broken.

A.T. No.232.
Part IV.

Mine Trials.

Pz.Kw.V. (Panthers)

Print No.4.

Item No.4.
Result from 1-Mk.V standard A.T. mine under inner edge of left-hand track and in line with No.3 bogie.
Note:-
Track completely broken. Hull intact.

Print No.5.

Item No.5.
Showing 1-Mk.V standard A.T. mine in position under inner edge of left-hand track and in line with No.8 bogie.

Print No.6.

Item No.5.
Result from 1-Mk.V standard A.T. mine shown in Print No.5.
Note:-
Track metal sheared out. Hull intact.

A.T. No.232.
Part IV.

Mine Trials.

Pz.Kw.V. (Panthers)

Print No.7.

Item No.6.
Result from 1-Mk.V standard A.T. mine under inner edge of right-hand track and in line with No.8 bogie.
Note:-
Small area of track removed. Hull intact.

Print No.8.

Item No.7.
Result from 1-Mk.V standard A.T. mine under inner edge of right-hand track and in line with No.3 bogie.
Note:-
Track metal sheared out. Hull intact.

Print No.9.

Item No.8.
Result from 1-5½ lb. asbestos cement mine under centre of left-hand track and in line with No.2 bogie.
Note:-
Broken track and other debris lying in crater.

A.T. No.232.
Part IV.

Mine Trials.

Pz.Kw.V (Panthers)

Print No.10.

Further view of Item 8.
Picture taken after tank was placed on fresh site.

Print No.11.

Item No.9.
Result from 1-5½ lb. asbestos cement mine under inner edge of left-hand track and in line with No.2 bogie.
Note:-
Small area of track removed. Hull intact.

Print No.12.

Item No.10.
Result from 1-10 lb. mine under inner edge of right-hand track and in line with No.1 bogie.
Note:-
Track completely broken. Hull intact.

A.T. No.232.
Part IV.

Mine Trials.

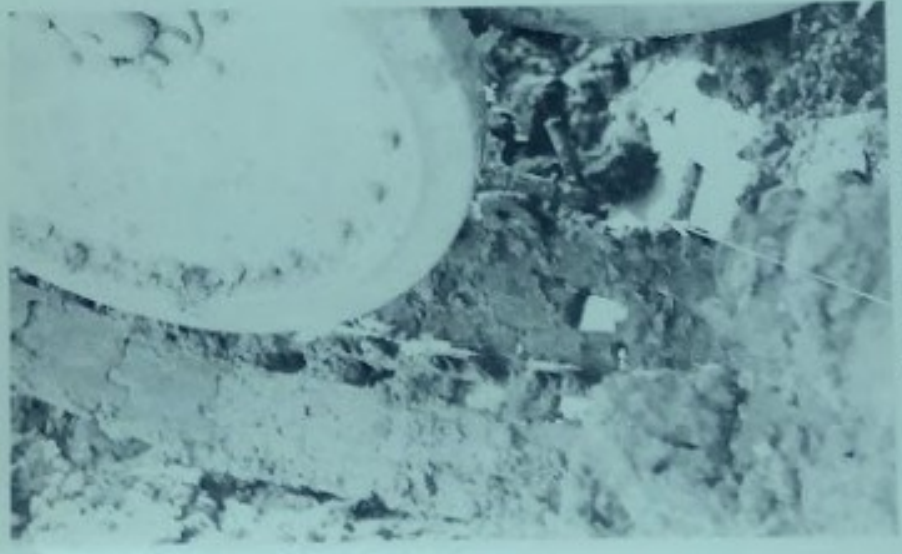
Pz.Kw.V. (Panthers)

Print No.13.

Item No.11.
Result from 1-15 lb. mine under inner edge of right-hand track and in line with No.1 bogie.
Note:-
Track completely broken. Hull intact.

Print No.14.

Showing right-hand sprocket and spindle, together with length of track, removed by 15 lb. mine (Item 11).
Note:-
The final drive casting had been very severely cracked during a previous trial.



Print No.15.

Item No.12.
Result from 1-15 lb. mine under inner edge of right-hand track and in line with No.3 bogie.
Note:-
Only partial shearing of track. Hull intact.

TRIAL. Nº X 826
(1 SHEET)

A. T. Nº 232 PART. IV
PANTHER PZ.KW V
DETAILS OF "SIDE WALL TO FLOOR" WELDED JOINT.

APPENDIX. C.
SHEET. Nº 1