

# KASSERINE PASS BATTLES



## Doctrines and Lessons Learned Volume II, Part 3



U.S. ARMY  
CENTER OF MILITARY HISTORY

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Comparison of American and German Ordnance  
(Extract), 1945

2-11-45

# CATALOGUE OF STANDARD ORDNANCE ITEMS

## VOLUME I TANK AND AUTOMOTIVE 1 JUNE 1945

### Replacement Sheets for Tank and Automotive Section

Please insert these sheets in their proper places in the loose-leaf binder you have, destroying old sheets in accordance with provisions of AR 380-5.

Tanks and Tank Transporters	Armored Cars, Scout Cars, Carriers
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### Additional Revisions: Tanks and Tank Transporters

Pages 11-12—Light Tank M24. Change fire control designations to Periscope M10P, Telescope M71K, and Telescope M77G—OCM 27018, 15 March 1945.

Pages 16-20—Medium Tank M4 Series. Production changes authorized include: (a) use of horizontal volute spring suspensions and 23-inch tracks—OCM 23058, 2 March 1944, and OCM 23336, 30 March 1944; (b) use of Continental R-975-C4 engines—OCM 22995, 24 February 1944, and OCM 23496, 13 April 1944; (c) application of commander's vision cupola—OCM 23446, 6 April 1944; (d) substitu-

tion of Borg & Beck clutch—OCM 23660, 20 April 1944. Change fire control designations: Periscope M10C in Periscope Mount M68 replaces Periscope M4—OCM 25972, 7 December 1944, and OCM 26354, 11 January 1945.

Page 21—Medium Tanks M4 (105-mm) and M4A3 (105-mm). Present production vehicles use horizontal volute spring suspension and 23-inch center-guide tracks. A loader's hatch and an Oilgear power traverse are provided. OCM 26381, 11 January 1945.

*Continued on next page*

~~C O N F I D E N T I A L~~

# LIGHT TANK M3 SERIES

**LIGHT TANK, M3**, standardized in July, 1940, and produced in quantity beginning in March, 1941, was supplied to our Allies, under Lend-Lease, as well as to our own Army through 1941 and 1942. Nicknamed the "General Stuart" by British troops, these tanks won high praise during the Libyan campaign, and are now considered obsolete only because of the great improvements in later vehicles.

Based on Light Tank, M2A4, but using heavier armor and incorporating other improvements, Light Tank, M3, for its day, was heavily armed and armored and provided a high standard of mechanical reliability.

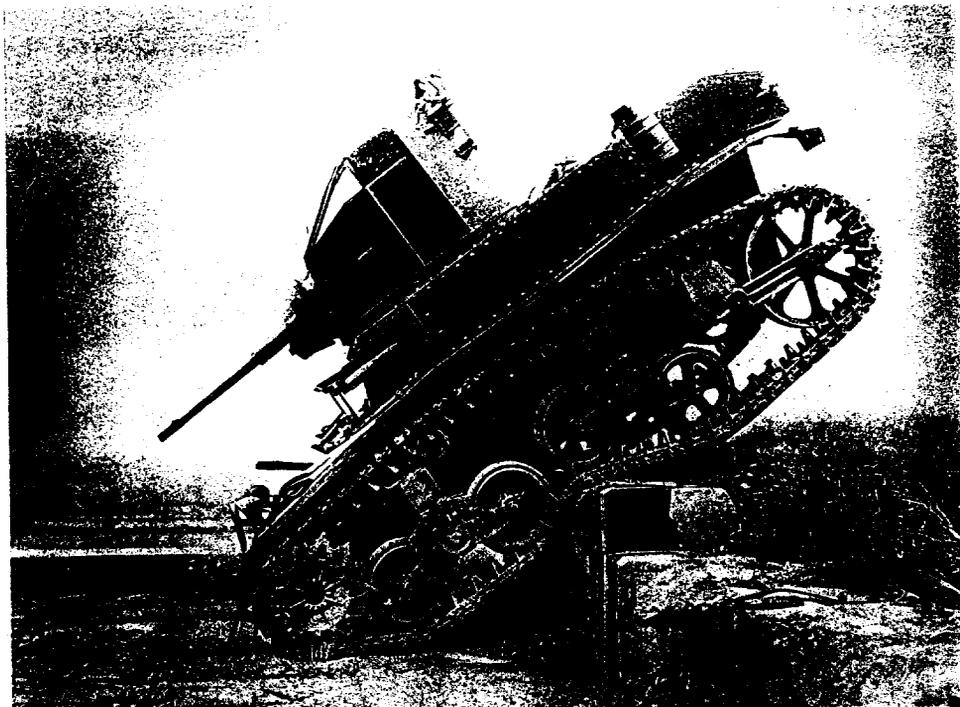
Through the production period, numerous improvements were made, so that the final M3s were vastly different from the first. First models were entirely riveted, with a seven-sided turret. Later a welded, seven-sided turret was used, and still later, a rounded, welded, homogeneous turret. The final models were entirely welded.

The volute spring suspension is used, with the rear idler "trailing" on ground level, rather than "mounted" above the ground as on Light Tank, M2A4. This lengthens the ground contact of the track, thus decreasing the pressure per square inch, and gives additional support to the rear of the tank.

Power is supplied by a 7-cylinder Continental W670-9A gasoline engine. Some models of Light Tanks, M3 and M3A1, were powered by a Guiberson T1020-4 Diesel engine. A synchromesh transmission provides five forward speeds and one reverse.

The driver and assistant driver occupy seats in the hull, with vision ahead through hatches equipped with windshields. In combat areas, the armored hatch cover may be closed, whereupon vision is possible through a protectoscope, a form of periscope.

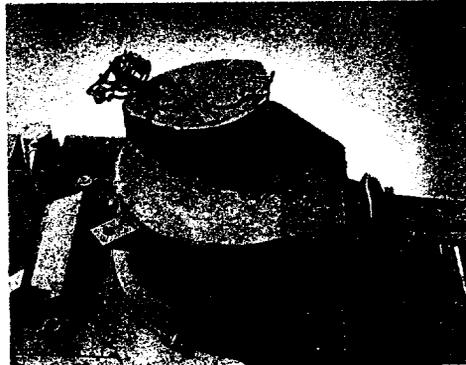
The gunner and commander-loader occupy seats in the turret, which may be traversed through 360° by a hand-operated mechanism. Entrance to the turret is through the cupola hatch, which also provides an observation post for the commander. In noncombat areas, the commander may operate with his head and



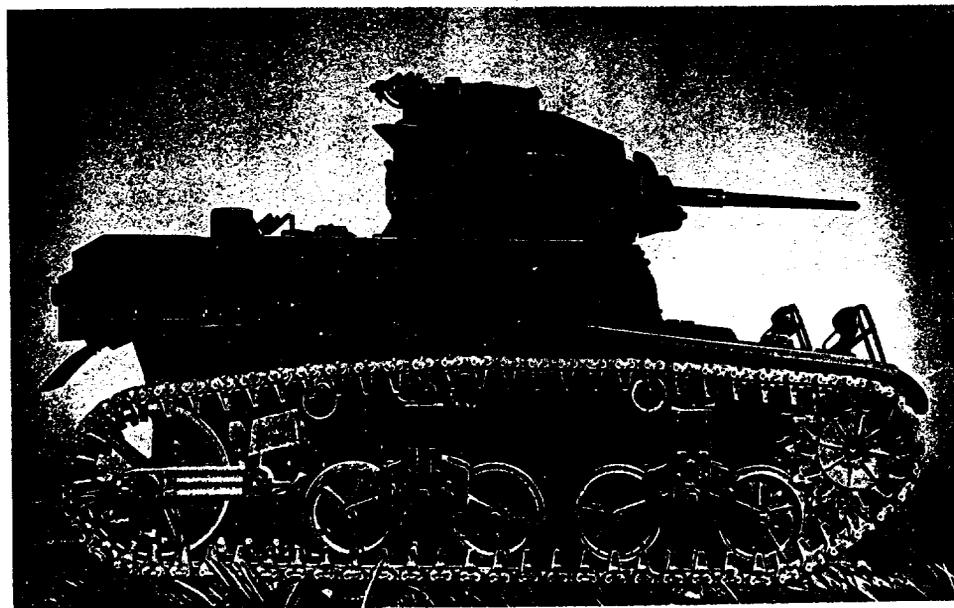
LIGHT TANK, M3, WITH SEVEN-SIDED, WELDED TURRET, RIVETED HULL



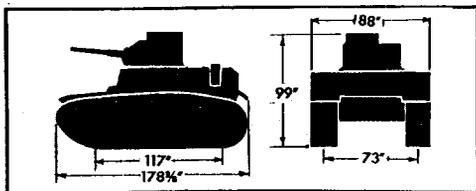
PISTOL PORT DOOR AND PROTECTOSCOPE

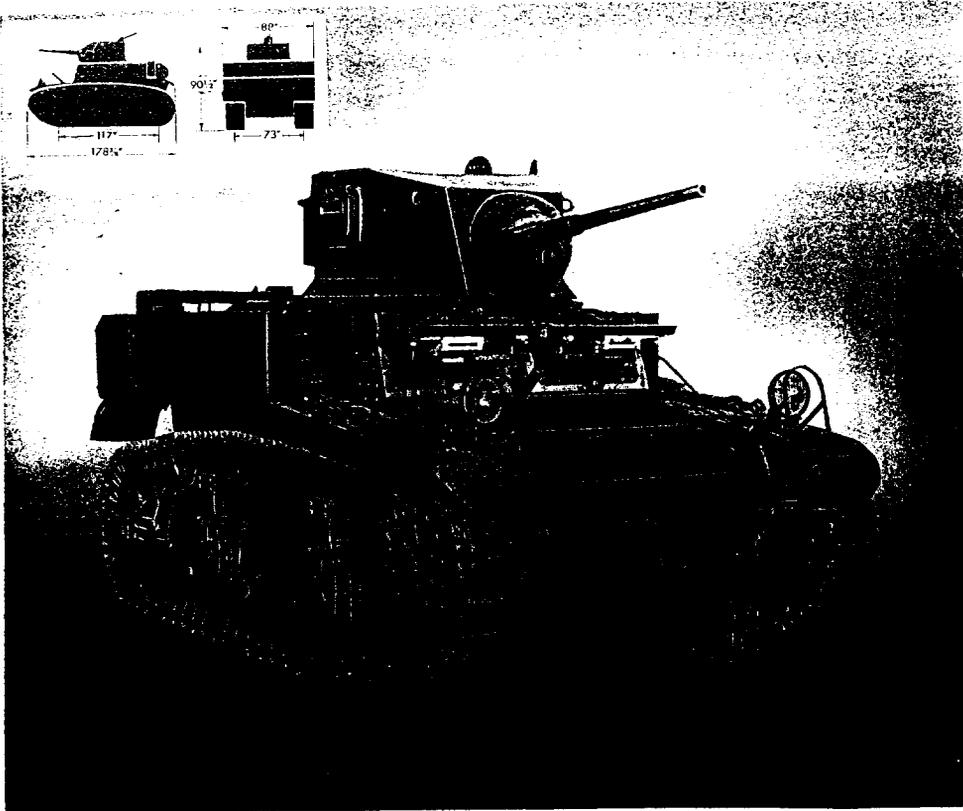


TOP OF ROUNDED, HOMOGENEOUS TURRET

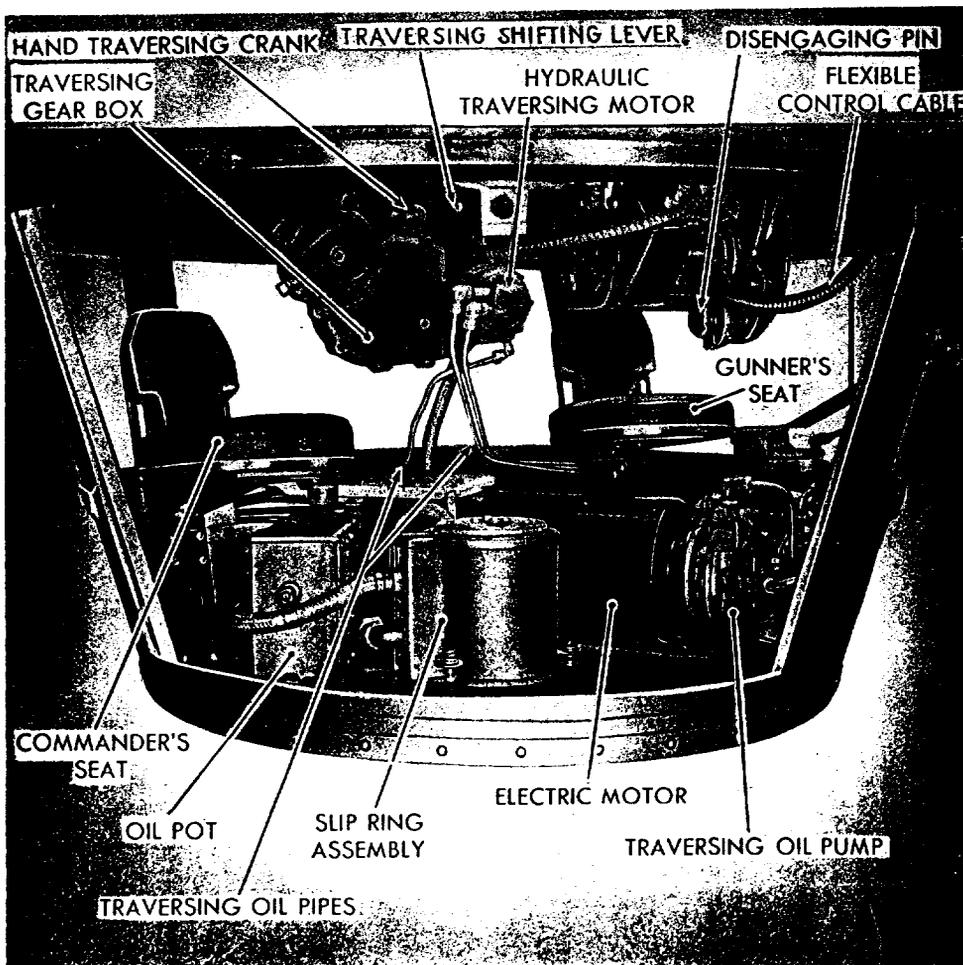


LIGHT TANK, M3, WITH ROUNDED, HOMOGENEOUS, WELDED TURRET





LIGHT TANK, M3A1. HAS POWER-TRAVERSED TURRET WITHOUT CUPOLA



LIGHT TANK, M3A1, TURRET BASKET SHOWING TRAVERSING MECHANISM

shoulders above the cupola. In danger zones, vision from the cupola is through pistol ports equipped with protectoscopes. (Early models used direct vision "peep-holes" instead.)

Principal armament is a 37 mm gun, M5 or M6, mounted with a cal. .30 machine gun in a combination mount in the turret. The turret guns have elevations from  $-10^{\circ}$  to  $+20^{\circ}$ . An A.P.C. projectile, fired from the 37 mm gun, has a muzzle velocity of 2,900 feet per second. It has a maximum range of 12,850 yards, and will penetrate 1.8-inch face-hardened armor plate at 1,000 yards.

Late models are provided with a gyro-stabilizer to increase the accuracy of aiming and firing the turret guns when the vehicle is in motion.

Other armament includes a cal. .30 machine gun, in the bow, one on the turret for anti-aircraft use, and one in each sponson.

Normal fuel capacity of 56 gallons may be increased when necessary by the use of two 25-gallon jettison fuel tanks. These can be abandoned upon entering a combat zone. The vehicle is equipped with a two-way radio.

Light Tanks, M3 and M3 (Diesel), were declared obsolete by Ordnance Committee action in July, 1943. These and later vehicles of the Light Tank, M3, Series, were built by the American Car and Foundry Co.

REFERENCES—TM 9-726; OCM 15920, 15932, 16135, 16258, 16370, 16531, 16583, 16603, 16610, 16611, 17200, 17107, 17201, 17235, 17578, 17949, 17984, 20076, 20317, 20852, 21015.

LIGHT TANK, M3A1, was standardized in August, 1941, as a modification of Light Tank, M3. It was declared obsolete in July 1944.

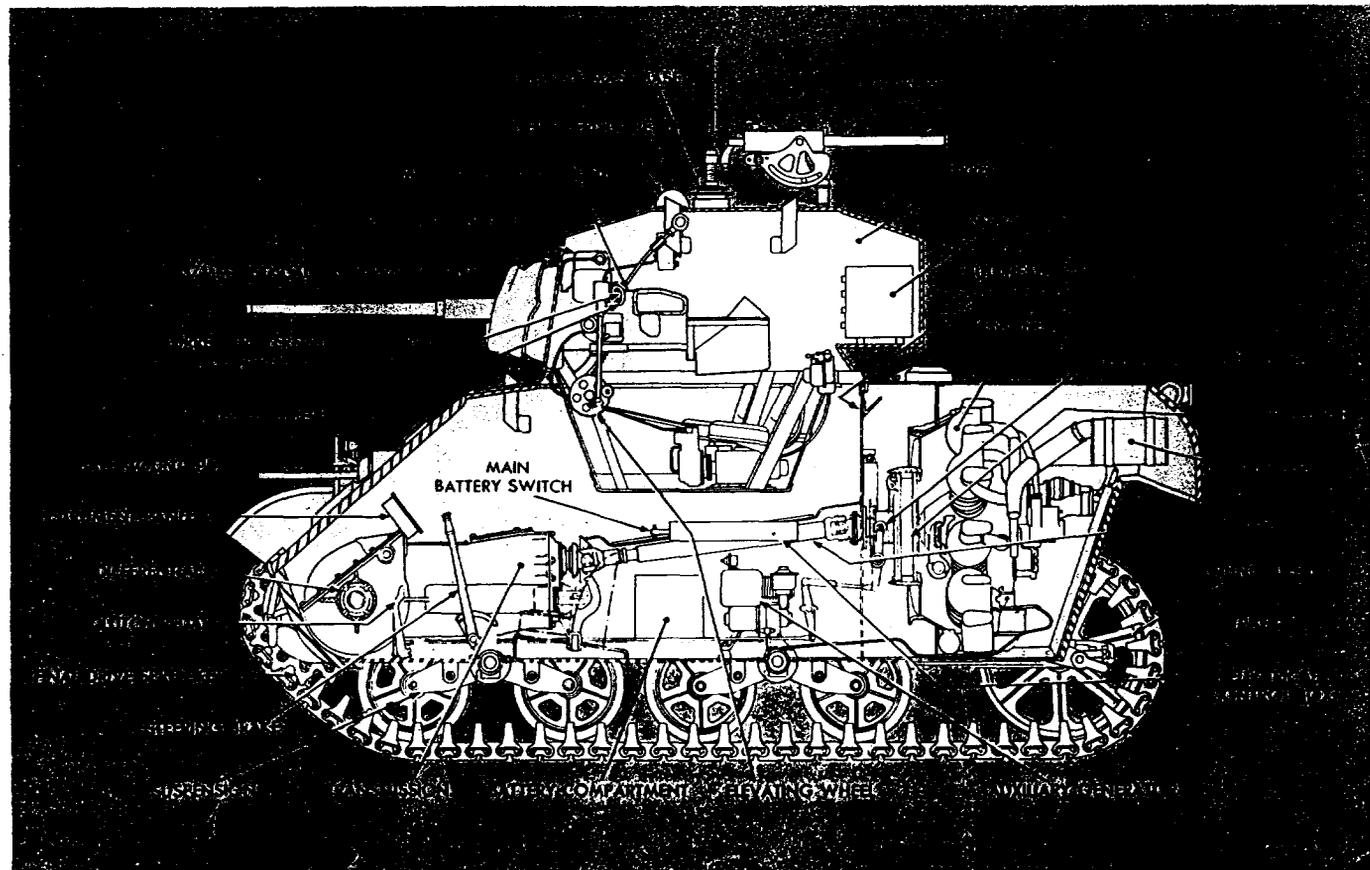
The turret is similar to that used in the final version of Light Tank, M3, but omits the cupola. A fighting compartment is integrated with the turret and is rotated with it, either by a hydraulic mechanism or by hand. This compartment contains seats for the gunner and commander-loader as well as the traversing and gyro-stabilizer mechanisms and ammunition.

An improved Combination Gun Mount, M23, for the turret guns has a periscopic sight. An additional periscope, with  $360^{\circ}$  traverse, is provided in the turret roof. Other armament is the same as on Light Tank, M3, except that the sponson guns are omitted.

The vehicle is equipped with an improved radio and with an interphone



LIGHT TANK, M3A3, HAS IMPROVED TURRET WITH RADIO BULGE. FRONT PLATE IS STRENGTHENED AND SPONSONS ARE EXTENDED FORWARD



CROSS SECTION OF LIGHT TANK, M3A3, SHOWING INTERIOR ARRANGEMENT. CHARACTERISTICS ARE GIVEN ON PAGE 4

system, with connections for each crew member.

Light Tank, M3A1 (Diesel), was declared obsolete in July, 1943.

REFERENCES—TM 9-727; OCM 17235, 17330, 17578, 17680, 17906, 17952, 17984, 18639, 19396, 20076, 20317, 20852, 21015, 21037, 24120; SNL G-103, Vol. 5.

The nomenclature, Light Tank, M3A2, was authorized in March, 1942, for a tank to be similar to Light Tank, M3A1, but with a welded hull. This model was never put into production.

REFERENCES—OCM 17984, 18639, 20076.

**LIGHT TANK, M3A3**, was standardized in August, 1942, as a modification of Light Tank, M3A1. It was reclassified as Limited Standard in April, 1943.

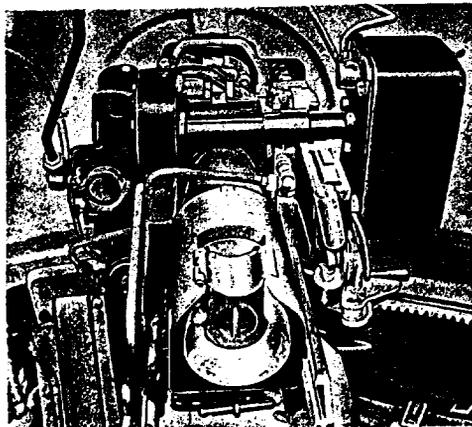
An improved turret, with a radio bulge at the rear, provides greater space in the fighting compartment. The hull is welded and streamlined in design. The front plate is extended forward and reinforced, providing more space and greater safety for the driver and assistant. The drivers' hatches, formerly in the front plate, are relocated in the top plate and equipped with periscopes to provide indirect vision in combat zones. Three additional periscopes are provided in the turret.

Sponsons are lengthened to the rear of the vehicle and contain additional gasoline tanks as well as additional ammunition storage. Sand shields are provided over the suspensions. A storage box is located at the rear.

Other improvements include easier steering, improved fire protection and ventilation, relocation of battery, switch and instruments and provision of detachable head lamps and a detachable windshield and weather cover.

The redesigned Combination Gun Mount, M44, includes a telescope which may be used through all degrees of gun elevation.

REFERENCES—TM 9-726C; OCM 18639, 19119, 19182, 19396, 20076, 20153, 20317; SNL G-103, Vol. 7.



COMBINATION GUN MOUNT, M44

## TYPICAL CHARACTERISTICS

### LIGHT TANK, M3

<b>Crew</b> .....	4	Rated hp. . . . .	250 at 2,400 r.p.m.
<b>Physical Characteristics</b>			220 at 2,200 r.p.m.
Weight (gross).....	27,400 lb.	Max. torque . . . . .	584 lb.-ft. 580 lb.-ft.
Length (hull).....	14 ft., 10 <sup>3</sup> / <sub>8</sub> ins.	at 1,800 r.p.m.	at 1,400 r.p.m.
Width.....	7 ft., 4 ins.		
Height.....	8 ft., 3 ins.		
Turret ring diameter.....	46 <sup>3</sup> / <sub>4</sub> ins.		
Ground clearance.....	16 <sup>1</sup> / <sub>2</sub> ins.		
Tread (center to center of tracks).....	73 ins.		
Ground contact length.....	117 ins.		
Ground pressure.....	10.47 lb./sq. in.		
<b>Armor</b>	<b>Actual</b>	<b>Basis</b>	
Hull, Front, Upper.....	1 <sup>1</sup> / <sub>2</sub> ins.	1 <sup>3</sup> / <sub>4</sub> ins.	
Lower.....	9 <sup>5</sup> / <sub>8</sub> -1 <sup>3</sup> / <sub>4</sub> ins.	1 <sup>3</sup> / <sub>4</sub> -3 ins.	
Sides and rear.....	1 in.	1 in.	
Top.....	3 <sup>3</sup> / <sub>8</sub> in.		
Bottom.....	3 <sup>3</sup> / <sub>8</sub> -1 <sup>1</sup> / <sub>2</sub> in.		
Turret, Front.....	1 <sup>1</sup> / <sub>2</sub> ins.	1 <sup>3</sup> / <sub>4</sub> ins.	
Sides and rear.....	1 <sup>1</sup> / <sub>4</sub> ins.	1 <sup>1</sup> / <sub>4</sub> ins.	
Top.....	1 <sup>1</sup> / <sub>2</sub> in.		
<b>Performance</b>			
Maximum speed on level.....	36 m.p.h.		
Maximum grade ability.....	60%		
Trench crossing ability.....	6 ft.		
Vertical obstacle ability.....	24 ins.		
Fording depth (slowest forward speed).....	36 ins.		
Turning radius.....	21 ft.		
Fuel capacity—without jettison tanks.....	56 gal.		
with jettison tanks.....	106 gal.		
Maximum drawbar pull.....	14,800 lb.		
Cruising range (approx.).....	70 miles		
<b>Engine,</b>			
Make.....	Continental	Guiberson	
Model.....	W670-9A	T1020-4	
Type.....	Radial A.C.	Radial A.C.	
Cylinders.....	7	9	
Fuel.....	Gasoline (80 octane)	Diesel (50 cetane)	
Max. gov-erned speed . . . . .	2,400 r.p.m.	2,200 r.p.m.	

(See additional engine characteristics on page 27)

### Vision and Fire Control

Protectors.....	2
Direct vision slots.....	2

### Communications—Radio

SCR-245	12
---------	----

### Battery, Voltage, Total

12	
----	--

### Fire Protection and Decontamination

Fire Extinguisher, CO <sub>2</sub> -10 lb. (fixed).....	1
CO <sub>2</sub> -4 lb. (hand).....	1
Decontaminating Apparatus, M2, 1 <sup>1</sup> / <sub>2</sub> qts.....	1

### Transmission, Type

Manual shift	
--------------	--

### Gear ratios

First speed.....	5.37:1
Second speed.....	2.82:1
Third speed.....	1.72:1
Fourth speed.....	1.09:1
Fifth speed.....	1.738:1
Reverse speed.....	6.19:1

### Differential, Controlled, Gear Ratio

2.62:1	
--------	--

### Steering Ratio

1.845:1	
---------	--

### Final Drive, Type

Herringbone	
-------------	--

### Gear Ratio

2.41:1	
--------	--

### Sprocket, no. of Teeth

14	
----	--

### Pitch diameter

24.56	
-------	--

### Suspension, Type

Volute spring	
---------------	--

### Wheel or tire size

20x6	
------	--

### Wheel construction

Welded	
--------	--

### Idle, Trailing, Type

Ind. vol. spring	
------------------	--

### Wheel or tire size

30x6	
------	--

### Wheel construction

Welded	
--------	--

### Track, Type

Rubber block	
--------------	--

### Width

11 <sup>1</sup> / <sub>2</sub> ins.	
-------------------------------------	--

### Pitch

5 <sup>1</sup> / <sub>2</sub> ins.	
------------------------------------	--

### No. of shoes per vehicle

132 or 134	
------------	--

### LIGHT TANK, M3A1

Characteristics same as for Light Tank, M3, except as noted:

#### Physical Characteristics

Weight.....	28,500 lb.
Height.....	7 ft., 6 <sup>1</sup> / <sub>2</sub> ins.
Ground pressure.....	10.56 lb./sq. in.

#### Vision—Protectors

5	
---	--

#### Periscopes

2	
---	--

#### Direct vision slots

2	
---	--

#### Communications—Radio

SCR-508	
---------	--

#### Interphone stations

4	
---	--

### LIGHT TANK, M3A3

Characteristics same as for Light Tank, M3A1, except as noted:

#### Physical Characteristics

Weight (gross) (with Track, T16).....	31,752 lb.
Length (with bustle box).....	16 ft., 6 ins.
Width.....	8 ft., 3 ins.
Height.....	7 ft., 6 <sup>1</sup> / <sub>2</sub> ins.

#### Fuel Capacity

102 gals.	
-----------	--

#### Vision and Fire Control

Periscopes.....	5
-----------------	---

#### Protectors

Omitted	
---------	--

#### Direct vision slots

Omitted	
---------	--

#### Telescope, M54

1	
---	--

### Armament—Light Tanks, M3, M3A1, M3A3

37 mm Gun, M5 or M6, and.....	} In Combination Mount, M22, M23 or M44, in turret
1 cal. .30 Browning machine gun.....	
1 cal. .30 Browning machine gun.....	} In ball mount in bow
1 cal. .30 Browning machine gun.....	
2 cal. .30 Browning machine guns.....	} On turret, anti-aircraft
1 Tripod Mount, cal. .30, M2	
Provision for 1 cal. .45 submachine gun	Sponsons: on M3 only

### Ammunition Stowage

37 mm (A.P.C., M51B1, A.P.C., M51B2, H.E., M63, Can., M2).....	M3	M3A1	M3A3
	103 rds.	116 rds.	174 rds.
Cal. .30.....	8,270 rds.	6,400 rds.	7,500 rds.
Cal. .45.....	500 rds.	510 rds.	540 rds.
Grenades, Hand (Fragmentation, Mk. II, 4; Offensive, Mk. IIIA2, w/Fuze, Detonating, M6, 2; Smoke, W.P., M15, 4; Thermite, Incendiary, 2).....	12	12	12

# LIGHT TANKS M5 LIMITED STANDARD—M5A1 SUBSTITUTE STANDARD



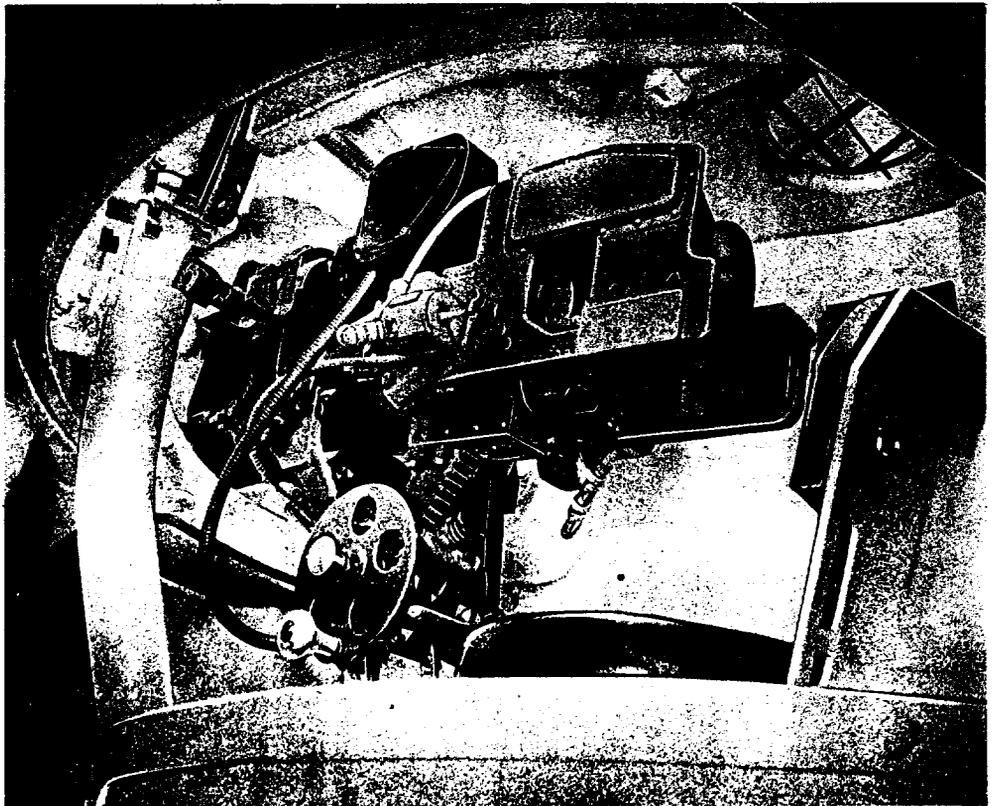
LIGHT TANK, M5, WITH PISTOL PORTS AND HATCHES CLOSED; HULL AND TURRET PERISCOPE UP; GROUSERS ON SIDE OF TURRET

LIGHT TANK, M5, standardized in February, 1942, was designed as a modification of Light Tank, M3A1, to use twin Cadillac engines and Hydra-Matic transmissions, providing automatic gear shifting. It was reclassified as Limited Standard in April, 1943.

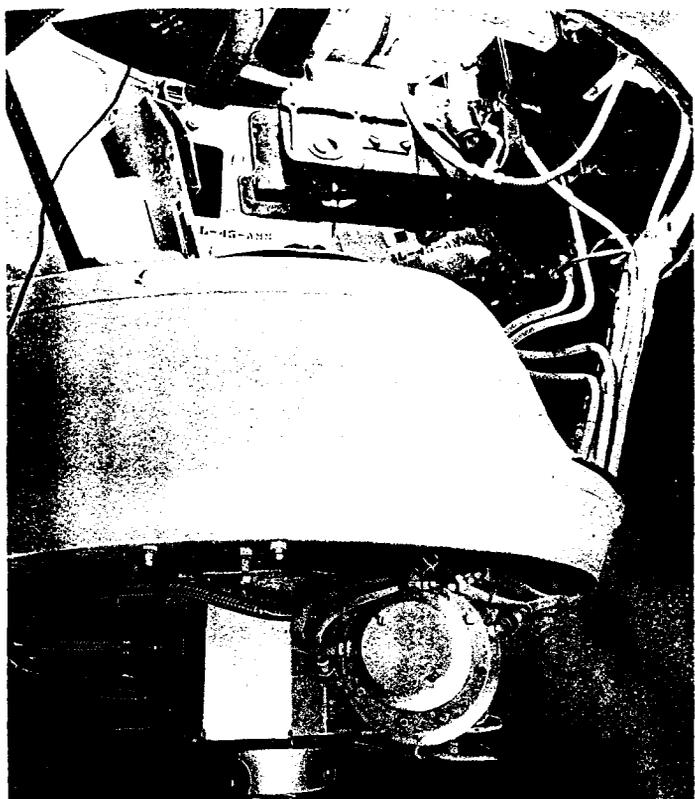
The hull is fabricated of welded, homogeneous armor plate with the reinforced front plate, extended sponsons, and streamlined effect subsequently adopted for Light Tank, M3A3. Elimination of bolts and rivets reduced the danger of having these parts driven inside the tank by the impact of projectiles on the exterior.

The welded, power-operated turret and integrated turret basket are similar to those used on Light Tank, M3A1. However, because of the lower driveshaft tunnel required by the use of the Cadillac engines and Hydra-Matic transmissions, it was possible to relocate the turret-traversing mechanism and portions of the gun stabilizer under the turret basket, thus providing more space in the fighting compartment.

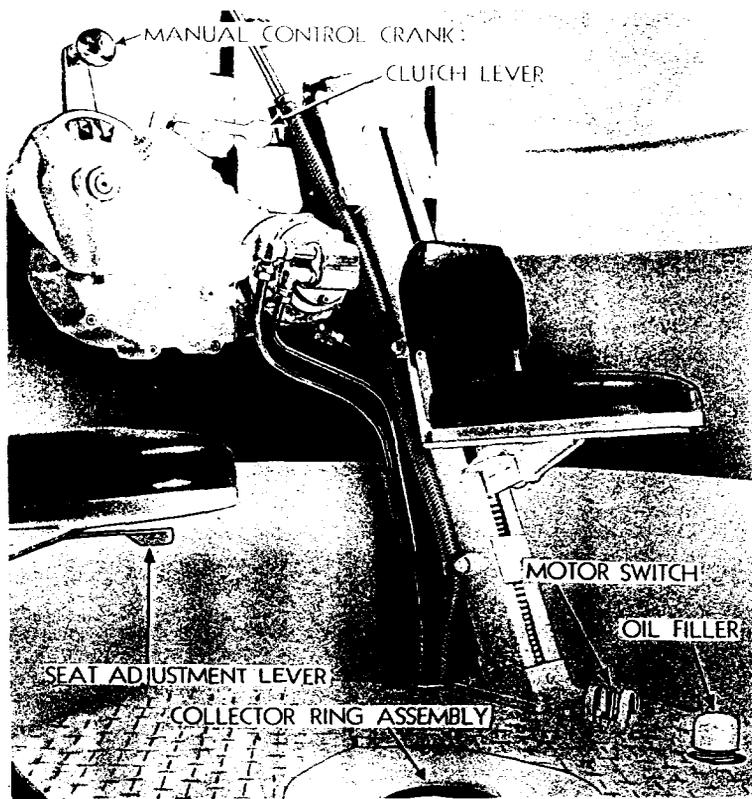
The turret, of welded, curved-plate armor plate, is covered on the front by a



LEFT SIDE OF COMBINATION GUN MOUNT, INCLUDING 37 mm GUN, M6



TRaversing MECHANISM BENEATH TURRET BASKET



ADJUSTABLE SEATS AND CONTROLS IN TURRET BASKET

heavy armor-plate casting which serves as a base for the combination gun mount. The turret can be rotated through a traverse of 360° either by a hydraulic mechanism or by hand.

Principal armament is a 37 mm Gun, M6, mounted with a cal. .30 Browning machine gun, in the turret. Elevation is from -10° to +20°. An A.P.C. projectile, when fired from the 37 mm gun, has a muzzle velocity of 2,900 feet per second. It has a maximum range of 12,850 yards, and will penetrate 1.8 inches of face-hardened armor plate at 1,000 yards.

A gyrostabilizer is provided to keep the turret gun sufficiently close to a fixed elevation while the tank is in motion over normal terrain so that the gunner can accurately aim and fire the gun.

The two 8-cylinder, 90°, V-type, liquid-cooled Cadillac engines are located in the rear of the hull. The flywheel end of each engine is connected to a Hydra-Matic transmission. These transmissions, plus a two-speed stepdown in the transfer unit, provide six forward speeds and one reverse speed.

An auxiliary power plant consisting of a generating set powered by a single-cylinder gasoline engine supplements the engine generators for charging the battery.

Seats for the driver and assistant driver are adjustable horizontally or vertically. Seats go up under spring pressure and

down under body weight and can be locked in any position.

The vehicle is provided with dual controls and has four escape hatches, one for each member of the crew. It is equipped with 360° periscopes for the driver, assistant driver, and commander and a periscopic gun sight, as well as with three protectoscopes in the turret ports. Two knockout plugs cover ports in the front armor plate. The tank is wired for radio and for an interphone system.

REFERENCES—TM 9-732, 9-1732A; OCM 15959, 16135, 17428, 17451, 17471, 17578, 17680, 17827, 17906, 17952, 17984, 18544, 18639, 19119, 20076, 20317; SNL E-103, Vol. II.

**LIGHT TANK, M5A1**, was standardized in September, 1942, and replaced Light Tank, M5, in production. It was reclassified as Substitute Standard in July, 1944.

Principal change was in the use of an improved turret with a radio bulge at the rear, similar to the turret of Light Tank, M3A3. The improved turret provides more room for turret crew members and permits desirable rearrangements in stowage. A radio antenna bracket is mounted above the bulge. A removable plate in the rear of the bulge permits removal of the 37 mm gun.

The antiaircraft gun mount is improved

and repositioned to the right side of the turret. Dual traverse is incorporated, permitting the commander to traverse the turret while firing the antiaircraft gun.

Larger escape hatches, with improved positive water-sealing door latches, are provided, and there is an additional escape hatch for emergency use in the floor of the hull.

The improved Combination Gun Mount, M44, for the turret guns, incorporates a direct-sighting 3-power telescope. The breech guard permits hinging upward, facilitating travel from one seat to another by personnel. A new mount for the commander's periscope permits 360° traverse. An additional periscope in the turret facilitates rear vision for the commander.

Pistol port doors are redesigned and relocated, and equipped with locking devices. A direction finder fastened to the turret roof ahead of the commander's periscope indicates the straight ahead position. A spotlight is provided.

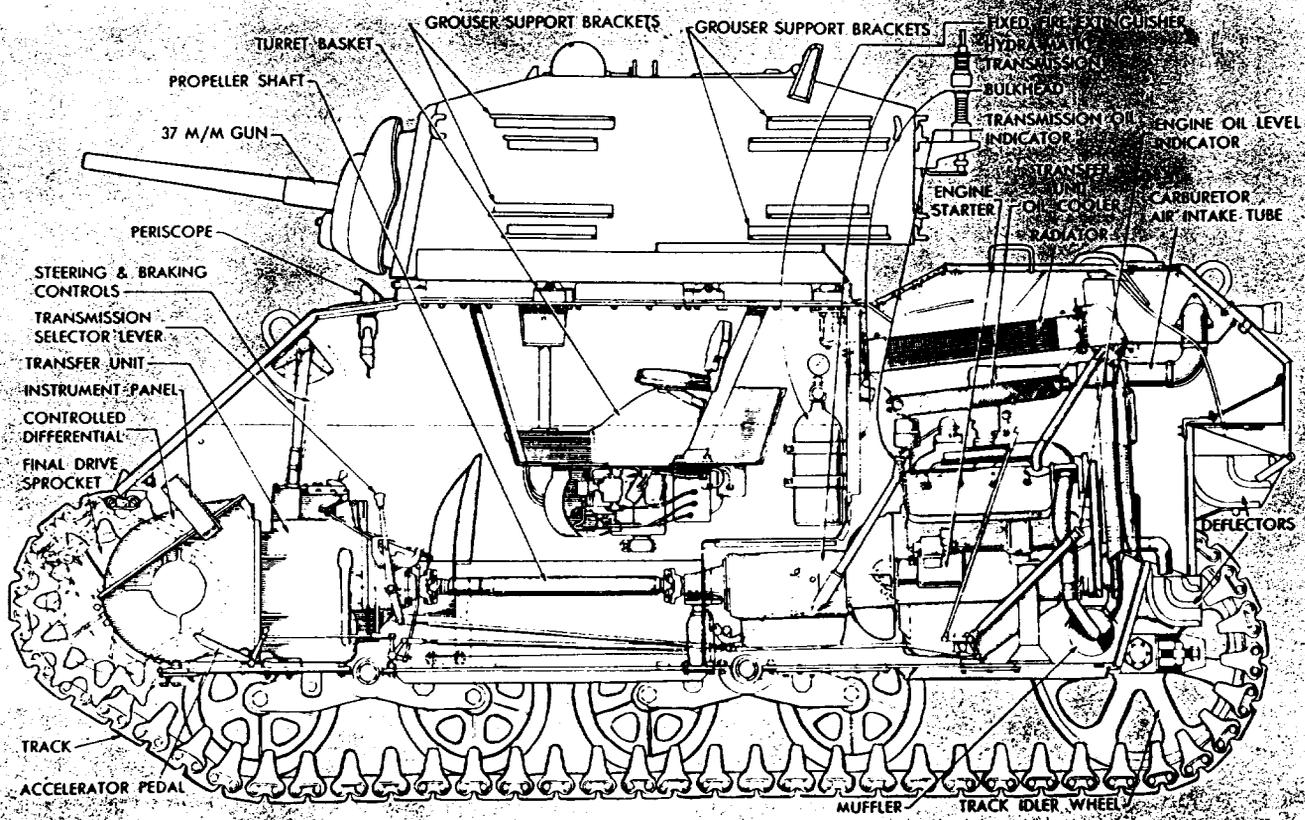
Sand shields, which extend down from the sponsons and cover the top portion of the track, are supplied when required.

Pilot models for Light Tanks, M5 and M5A1, were manufactured by the Cadillac Motor Car Division, General Motors Corp.

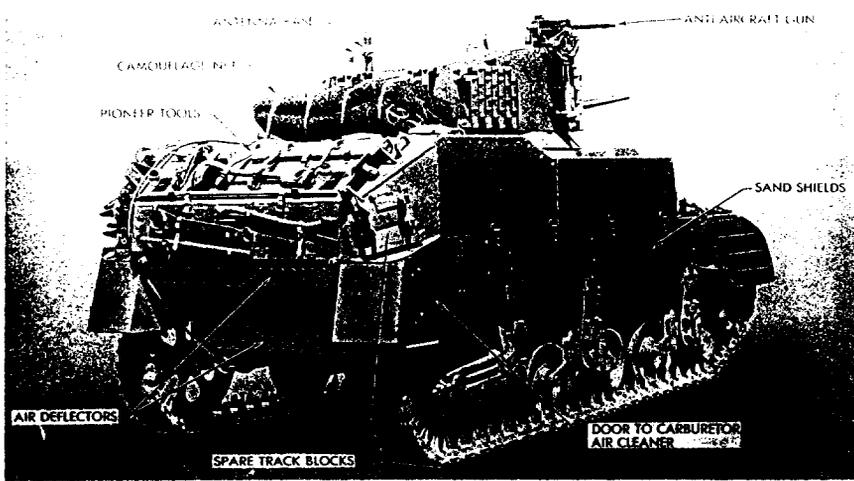
REFERENCES—TM 9-732; OCM 17471, 17827, 18639, 18925, 19182, 19396, 20153, 24175; SNL G-103, Vol. VIII.



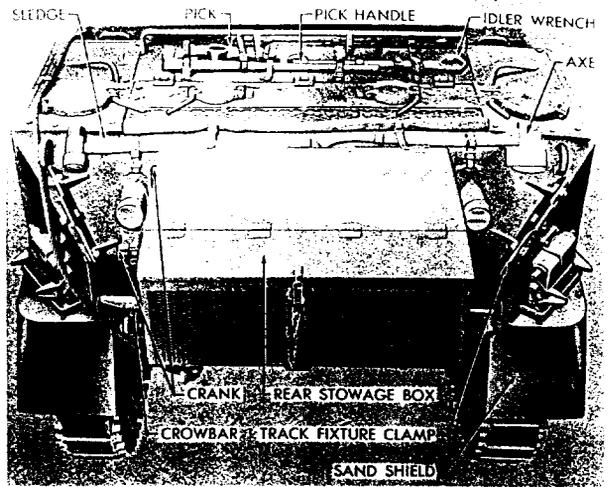
LIGHT TANK, M5A1, SHOWING REDESIGNED TURRET WITH SHIELD FOR ANTI-AIRCRAFT GUN MOUNT; SAND SHIELDS OVER SUSPENSIONS



CROSS SECTION DIAGRAM OF LIGHT TANK, M5A1, SHOWING INTERIOR ARRANGEMENT. CHARACTERISTICS ARE GIVEN ON PAGE 8



**LIGHT TANK, M5A1, REAR VIEW SHOWING EXTERIOR STORAGE**



**REAR VIEW SHOWING USE OF STORAGE BOX**

**TYPICAL CHARACTERISTICS**

**LIGHT TANK, M5**

**Crew** ..... 4

**Physical Characteristics**

Weight (gross)..... 33,000 lb.  
 Length..... 14 ft., 2<sup>3</sup>/<sub>4</sub> ins.  
 Width..... 7 ft., 4<sup>1</sup>/<sub>4</sub> ins.  
 Height..... 7 ft., 6<sup>1</sup>/<sub>2</sub> ins.  
 Height—to center line of bore... 6 ft., 5<sup>3</sup>/<sub>8</sub> ins.  
 Turret ring diameter..... 46<sup>3</sup>/<sub>4</sub> ins.  
 Ground clearance..... 13<sup>3</sup>/<sub>4</sub> ins.  
 Center of gravity—above ground..... 33<sup>1</sup>/<sub>2</sub> ins.  
 rear of sprocket..... 79<sup>1</sup>/<sub>2</sub> ins.  
 Tread (center to center of tracks)..... 73<sup>1</sup>/<sub>2</sub> ins.  
 Ground contact length..... 117 ins.  
 Ground pressure..... 12.4 lb./sq. in.

**Armor**

	Actual	Basis
Hull, Front, Upper.....	1 <sup>1</sup> / <sub>8</sub> ins.	2 <sup>1</sup> / <sub>2</sub> ins.
Lower.....	2-2 <sup>1</sup> / <sub>2</sub> ins.	2-2 <sup>1</sup> / <sub>2</sub> ins.
Sides and rear.....	1-1 <sup>1</sup> / <sub>8</sub> ins.	1-1 <sup>1</sup> / <sub>8</sub> ins.
Top.....	1/2 in.	
Bottom.....	3/8-1/2 in.	
Turret, Front.....	1 <sup>3</sup> / <sub>4</sub> ins.	2 ins.
Sides and rear.....	1 <sup>1</sup> / <sub>4</sub> ins.	1 <sup>1</sup> / <sub>4</sub> ins.
Top.....	1/2 in.	

**Performance**

Maximum speed on level..... 36 m.p.h.  
 Maximum grade ability..... 60%  
 Trench crossing ability..... 5 ft., 4 ins.  
 Vertical obstacle ability..... 18 ins.  
 Fording depth (slowest forward speed)..... 36 ins.  
 Fuel capacity..... 89 gals.  
 Cruising range..... 100 miles  
 Turning radius..... 21 ft.

**Vision and Fire Control**

Periscopes (M6, 3; M4, 1)..... 4  
 Protectoscopes (in pistol ports)..... 3

**Communications**

Radio..... SCR-508, 528 or 538  
 Command tank..... SCR-506  
 Interphone stations..... 4  
 Flag Set, M238..... 1

**Battery, Voltage**..... 12

**Fire Protection and Decontamination**

Fire Extinguisher, CO<sub>2</sub>-10 lb. (fixed)..... 1  
 CO<sub>2</sub>-4 lb. (hand)..... 1  
 Decontaminating Apparatus, M2, 1<sup>1</sup>/<sub>2</sub> qts. ... 1

**Engine, Make and Model**... Cadillac, Series 42  
 Type..... Dual, V-8, L.C.  
 No. of cylinders..... 16  
 Displacement..... 346 cu. ins.  
 Fuel (gasoline)..... 70 and 80 octane  
 Max. governed speed..... 4,000 r.p.m.  
 Net h.p..... 220 at 4,000 r.p.m.  
 Max. torque..... 488 lb.-ft. at 1,200 r.p.m.\*  
 (Additional engine characteristics on page 27)

**Transmission, Type**..... Hydra-Matic  
**Gear ratios**

First speed..... 3.26:1  
 Second speed..... 2.26:1  
 Third speed..... 1.44:1  
 Fourth speed..... 1.00:1  
 Reverse..... 3.81:1

**Transfer Case, Type**..... Hydraulic  
**No. of speeds**..... 2  
**Gear ratios**..... 2.37:1, 1.00:1

**Differential, Controlled, Gear Ratio**... 2.62:1  
**Steering ratio**..... 1.845:1

**Final Drive, Type**..... Herringbone  
 Sprocket, No. of teeth..... 13  
 Pitch diameter..... 22.8  
 Gear ratio..... 2.57:1

**Suspension, Type**..... Vertical volute spring  
 Wheel or tire size..... 20x6 ins.

No. of wheels per vehicle..... 8  
 Wheel construction Rubber tired, spoked or disk  
**Idler, Type**..... Trailing  
 Wheel or tire size..... 30x6 ins.  
**Track, Type**..... T16, T55E1, or T36E6  
 Width..... 11<sup>5</sup>/<sub>8</sub> ins.  
 Pitch..... 5<sup>1</sup>/<sub>2</sub> ins.  
 No. of shoes per vehicle..... 132  
 \*Transmission output in direct drive.

**LIGHT TANK, M5A1**

Characteristics same as for Light Tank, M5, except as noted.

**Physical Characteristics**

Weight (gross) (with T16 tracks)..... 33,907 lb.  
 Length—over stowage box..... 15 ft., 10<sup>1</sup>/<sub>2</sub> ins.  
 Width—with sand shields..... 90 ins.  
 Height—over gun mount..... 7 ft., 10<sup>1</sup>/<sub>2</sub> ins.  
 Ground clearance..... 13<sup>3</sup>/<sub>4</sub> ins.  
 Ground pressure..... 12.5 lb./sq. in.

**Vision and Fire Control**

Periscope, M4, w/Telescope, M40, or Periscope, M4A1, with Telescope, M40, and Instrument Light, M30..... 1  
 Periscopes, M6..... 4  
 Protectoscopes..... Omitted  
 Telescope, M70D, with Instrument Light, M39C..... 1

**Armament—Light Tanks, M5 and M5A1**

1 37 mm Gun, M6, and.....	} In Combination Mount, M23, in turret
1 cal. .30 Browning Machine Gun, M1919A5 (fixed).....	
1 cal. .30 Browning Machine Gun, M1919A4 (flexible).....	In bow
1 cal. .30 Browning Machine Gun, M1919A4 (flexible).....	On turret, antiaircraft
1 Tripod Mount, cal. .30, M2	
Provision for:	
1 cal. .45 submachine gun.....	Equipment of crew

**Ammunition, Stowage**

	M5	M5A1
37 mm (A.P.C., M51B1, A.P.C., M51B2, H.E., M63, Can., M2).....	123 rounds	147 rounds
Cal. .30.....	6,250 rounds	6,500 rounds
Cal. .45.....	420 rounds	540 rounds
Grenades, Hand (Fragmentation, Mk. II, 4; Offensive, Mk. III (w/Fuze, M6), 2; Smoke, H.C., M8, 4; Thermite, Incendiary, 2) ...	12	12

# MEDIUM TANK M3 SERIES

These were the first American medium tanks produced in quantity under the defense program prior to the entry of the United States into World War II. Supplied to the British and Russians as Lend-Lease materiel, they compared favorably with other medium tanks at that time.

They were the first of our tanks to employ 75-mm guns, gyrostabilizers, and power-traversed turrets with integral fighting compartments. Their armor was thicker than that of our earlier tanks.

Battle experience in Africa and Russia suggested improvements, some of which were introduced as production continued. Most of the improvements, however, were incorporated in the design of Medium Tank M4. When the latter was standardized in October 1941, tanks of the M3 series were designated Substitute Standard. In April 1943 they were reclassified as Limited Standard, and in April 1944 they were declared obsolete.

**MEDIUM TANK M3**—This was the original vehicle of the series. It had a riveted hull and was powered by a Continental (Wright) R-975-EC2 or R-975-C1 gasoline engine.

**MEDIUM TANK M3A1**—This was similar to Medium Tank M3 but had a cast hull.

**MEDIUM TANK M3A2**—This was similar to Medium Tank M3 but had a welded hull.

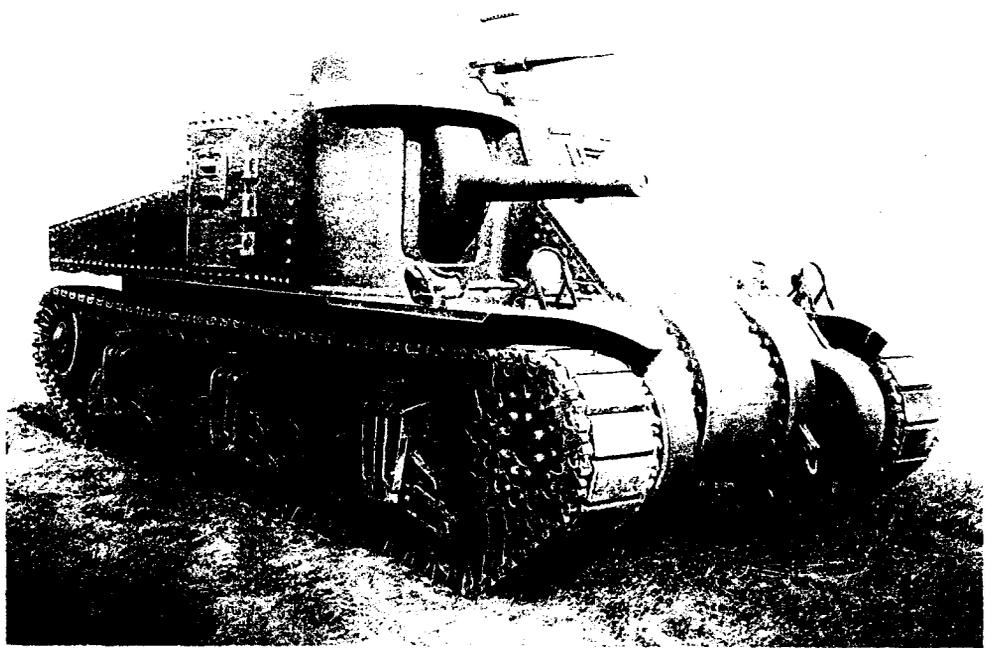
**MEDIUM TANK M3A3**—This was similar to Medium Tank M3A2, with a welded hull, but was powered by twin General Motors 6-71 Diesel engines.

**MEDIUM TANK M3A4**—This was similar to Medium Tank M3, with a riveted hull, but was powered by a Chrysler multibank engine.

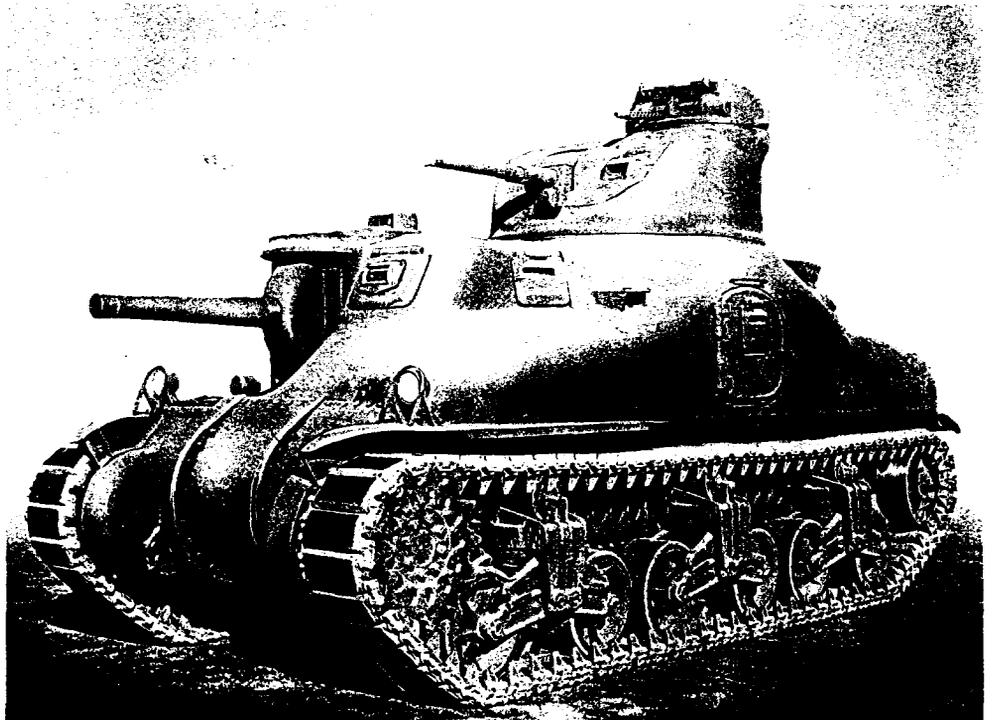
**MEDIUM TANK M3A5**—This was similar to Medium Tank M3, with a riveted hull, but was powered by twin General Motors 6-71 Diesel engines.

Principal armament was a 75-mm Gun M3, in a rotor mount in the right front of the crew compartment. This gun had an elevation from  $-9^{\circ}$  to  $+20^{\circ}$  and could be traversed  $15^{\circ}$  in each direction. The gun could be fired manually or electrically. The A.P.C. projectile M61, fired from this gun with a muzzle velocity of 1,920 feet per second, has a maximum range of 13,090 yards and will penetrate 2.9 inches of face-hardened armor plate at 1,000 yards.

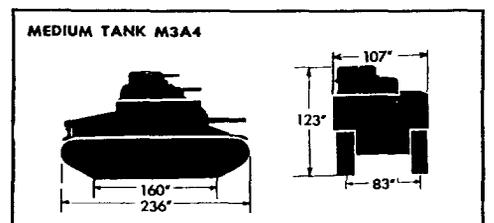
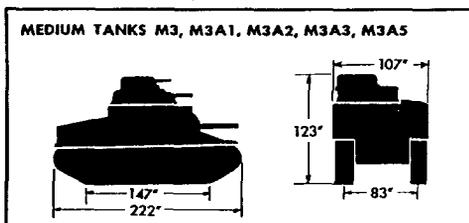
A 37-mm Gun M6 and a Cal. .30 Machine Gun M1919A4 were mounted in a Combination Gun Mount M24, in the turret, which had a traverse of  $360^{\circ}$ . The turret guns were fired electrically and had elevations from  $-7^{\circ}$  to  $+60^{\circ}$ . The



MEDIUM TANK M3 HAD RIVETED HULL AND CAST TURRET WITH  $360^{\circ}$  TRAVERSE



MEDIUM TANK M3A1 HAD CAST HULL AND CAST TURRET, GIVING STREAMLINED EFFECT



**MEDIUM TANK M3 SERIES** (Continued)

A. P. C. projectile, fired from the 37-mm gun with a muzzle velocity of 2,900 feet per second, has a maximum range of 12,850 yards and will penetrate 1.8 inches of face-hardened armor plate at 1,000 yards.

A cal. .30 machine gun for antiaircraft use was mounted on the cupola, and two cal. .30 machine guns were in the bow. Provision was made for carrying one cal. .45 submachine gun.

The turret and integrated fighting compartment could be traversed by a hydraulic mechanism or by hand. The cupola normally rotated with the turret but could be rotated by hand.

The crew consisted of six men. The driver and radio operator occupied seats forward in the hull. The 75-mm gunner sat on the left side of the gun mount. The 37-mm gunner and gun loader and the commander were seated in the turret.

Both the 75-mm gun and the 37-mm gun were provided with gyrostabilizers, which aided in keeping the guns aimed at their targets while the tank was in motion.

Periscopic sights were provided for the 75-mm and 37-mm guns. The driver's door and the pistol port doors were provided with protectoscopes for indirect vision.

The armor of the front upper section,

cupola, and turret sides was 2 inches thick, and that on the sides of the hull and the front lower section was 1½ inches thick.

The tank was wired for radio installation and for an interphone system.

An auxiliary generating set provided additional electric power when required.

The vehicle had five forward speeds and one reverse.

REFERENCES—TM 9-750; OCM 16052, 16111, 16258, 16610, 16728, 16935, 16699, 16911, 16860, 17090, 17159, 17293, 17201, 17301, 17316, 17503, 17440, 17503, 17578, 17591, 17613, 17677, 17722, 17723, 17799, 17800, 17906, 23185, 23495; SNL G-104, Vols. 1, 3, 5, 10, 12.

**TYPICAL CHARACTERISTICS**

	M3 (riveted)	M3A1 (cast)	M3A2 (welded)	M3A3 (welded)	M3A4 (riveted)	M3A5 (riveted)
<b>Crew</b> .....	6	6	6	6	6	6
<b>Physical Characteristics</b>						
Weight (gross).....	60,000 lb.	60,000 lb.	60,000 lb.	63,000 lb.	64,000 lb.	64,000 lb.
Length.....	18 ft., 6 in.	18 ft., 6 in.	18 ft., 6 in.	18 ft., 6 in.	19 ft., 8 in.	18 ft., 6 in.
Width.....	8 ft., 11 in.	8 ft., 11 in.	8 ft., 11 in.	8 ft., 11 in.	8 ft., 11 in.	8 ft., 11 in.
Height.....	10 ft., 3 in.	10 ft., 3 in.	10 ft., 3 in.	10 ft., 3 in.	10 ft., 3 in.	10 ft., 3 in.
Turret ring diameter (inside).....	57 in.	57 in.	57 in.	57 in.	57 in.	57 in.
Ground clearance.....	17½ in.	17½ in.	17½ in.	17½ in.	17½ in.	17½ in.
Tread (center to center of track).....	83 in.	83 in.	83 in.	83 in.	83 in.	83 in.
Ground contact length at 0 penetration.....	147 in.	147 in.	147 in.	147 in.	160 in.	147 in.
Ground pressure per sq. in.....	13.36 lb.	13.36 lb.	13.36 lb.	13.36 lb.	12.9 lb.	13.36 lb.
<b>Performance</b>						
Maximum speed.....	26 m.p.h.	26 m.p.h.	26 m.p.h.	29 m.p.h.	26 m.p.h.	29 m.p.h.
Maximum grade ability.....	60%	60%	60%	60%	60%	60%
Trench crossing ability.....	6.2 ft.	6.2 ft.	6.2 ft.	6.2 ft.	6.2 ft.	6.2 ft.
Vertical obstacle ability.....	24 in.	24 in.	24 in.	24 in.	24 in.	24 in.
Fording depth (slowest forward speed).....	40 in.	40 in.	40 in.	36 in.	40 in.	40 in.
Fuel capacity.....	175 gal.	175 gal.	175 gal.	150 gal.	160 gal.	175 gal.
Cruising range.....	120 miles	120 miles	120 miles	160 miles	120 miles	160 miles
Turning radius.....	37 ft.	37 ft.	37 ft.	37 ft.	39 ft.	37 ft.
<b>Engine, Make</b> .....						
Model.....	Continental R-975-EC2 or C1	Continental R-975-EC2 or C1	Continental R-975-EC2 or C1	G.M. 6-71 6046	Chrysler A-57	G.M. 6-71 6046
Type.....	Radial A.C.	Radial A.C.	Radial A.C.	Twin, In-Line, L.C.	Multibank, L.C.	Twin, In-Line, L.C.
No. of cylinders.....	9	9	9	12	30	12
Fuel, Octane or cetane.....	92 or 80	92 or 80	92 or 80	50	80	50
Type.....	Gasoline	Gasoline	Gasoline	Diesel	Gasoline	Diesel
Max. governed speed.....	2,400 r.p.m.	2,400 r.p.m.	2,400 r.p.m.	2,100 r.p.m.	2,400 r.p.m.	2,100 r.p.m.
Net hp. at r.p.m.....	340 at 2,400	340 at 2,400	340 at 2,400	375 at 2,100	370 at 2,400	375 at 2,100
Max. torque, lb.-ft. at r.p.m.....	800 at 1,800	800 at 1,800	800 at 1,800	1,000 at 1,400	1,020 at 1,200	1,000 at 1,400

(See additional engine characteristics on page 28.)

- Armament**
- 1 75-mm Gun M2 or M3..... In Mount M1
  - 1 37-mm Gun M5 or M6 and 1 Cal. .30 Browning Machine Gun M1919A4 (flexible) } In Combination Mount M24 in turret
  - 1 Cal. .30 Browning Machine Gun M1919A4 (flexible)..... On cupola, antiaircraft
  - 1 Cal. .30 Browning Machine Gun M1919A4..... In bow

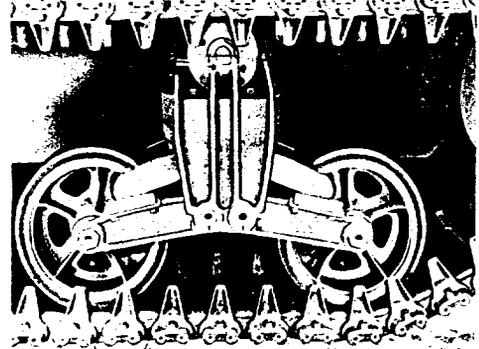
- Provision for:
- 1 Cal. .45 submachine gun. Equipment of crew

- Ammunition, Stowage**
- 75-mm..... 46 rounds
  - 37-mm..... 178 rounds
  - Cal. .45..... 1,200 rounds
  - Cal. .30..... 9,200 rounds
  - Hand Grenades..... 12

Armor	Actual	Basis
Hull, Front, Upper.....	2 in.	4¾ in.
Lower.....	1½ in.	2¾ in.
Sides.....	1½ in.	1½ in.
Rear.....	1½ in.	1½ in.
Top.....	½ in.	1½ in.
Bottom.....	½ in.-1 in.	
Turret, Front.....	2¼ in.	6½ in.
Sides and rear.....	2¼ in.	2 in.
Top.....	7/8 in.	

- Vision and Fire Control**
- Periscope M1..... 1
  - Periscope M3..... 1
  - Protectoscopes..... 7

- Communications**
- Radio (with interphone)..... SCR-508
  - Command tank..... SCR-506



DETAIL OF SUSPENSION BOGIE AND TRACKS

- Battery, Voltage, total..... 24

- Fire Protection**
- Fire Extinguisher, CO<sub>2</sub>-10 lb. (fixed)..... 2
  - CO<sub>2</sub>-4 lb. (hand)..... 2

- Transmission, Type**..... Synchromesh

- Gear ratios**
- First speed..... 7.56:1
  - Second speed..... 3.11:1
  - Third speed..... 1.78:1
  - Fourth speed..... 1.11:1
  - Fifth speed..... 0.73:1
  - Reverse..... 5.65:1

- Differential, Controlled, Gear ratio**..... 3.53:1

- Steering ratio**..... 1.515:1

- Final Drive, Type**..... Herringbone

- Gear ratio**..... 2.84:1
- Sprocket, No. of teeth..... 13
  - Pitch diameter..... 25.038

- Suspension, Type**..... Volute spring

- Wheel or tire size**..... 20x9

- Idler, Type**..... Adjustable eccentric

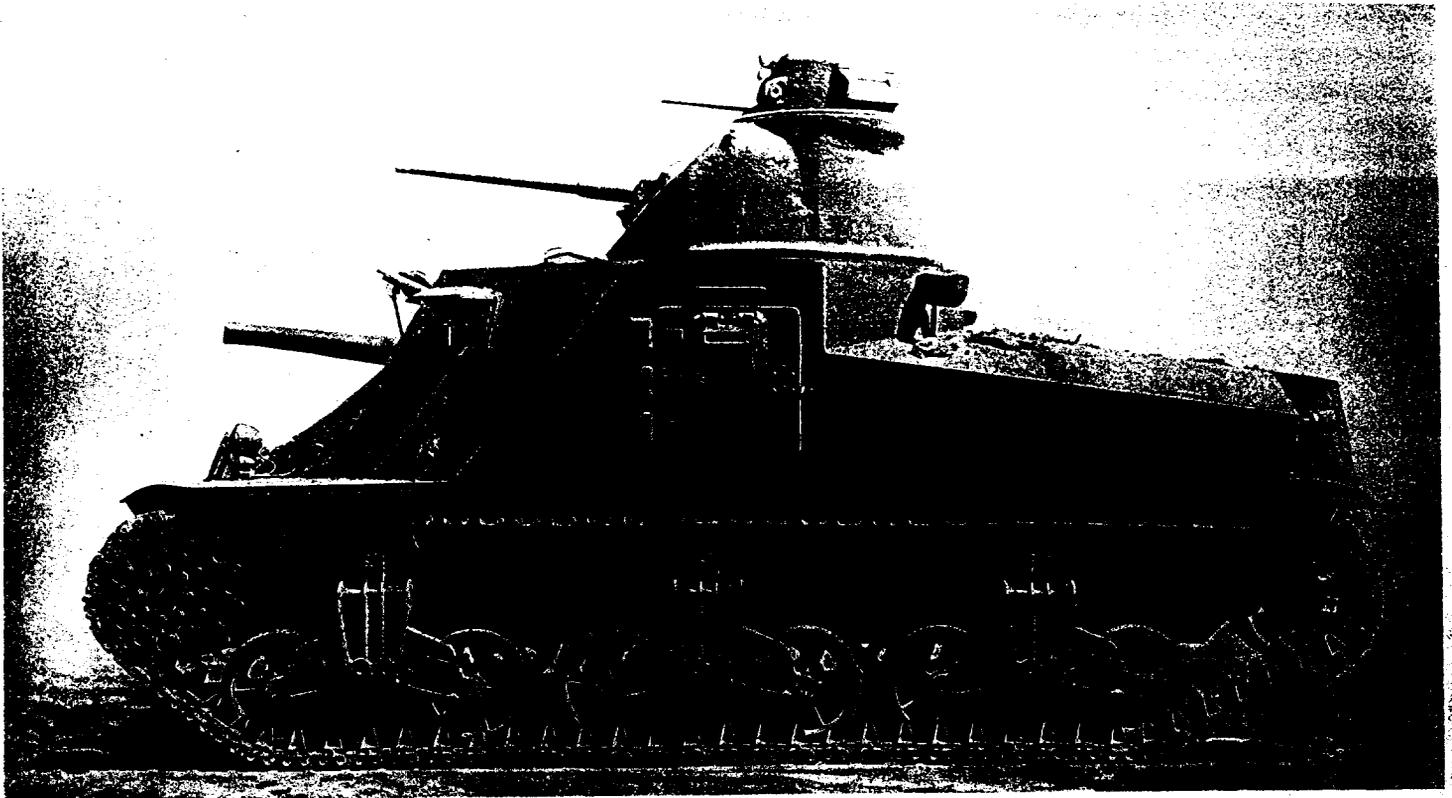
- Wheel or tire size**..... 22x9

- Track, Type**..... Rubber block

- Width**..... 16¾ in.

- Pitch**..... 6 in.

- No. of shoes per tank**..... 158 (166 on M3A4)



MEDIUM TANK, M3A3, HAS WELDED HULL, CAST TURRET. M3 SERIES MEDIUM TANKS MOUNT 75 mm GUN IN RIGHT ROTOR, 37 mm GUN IN TURRET

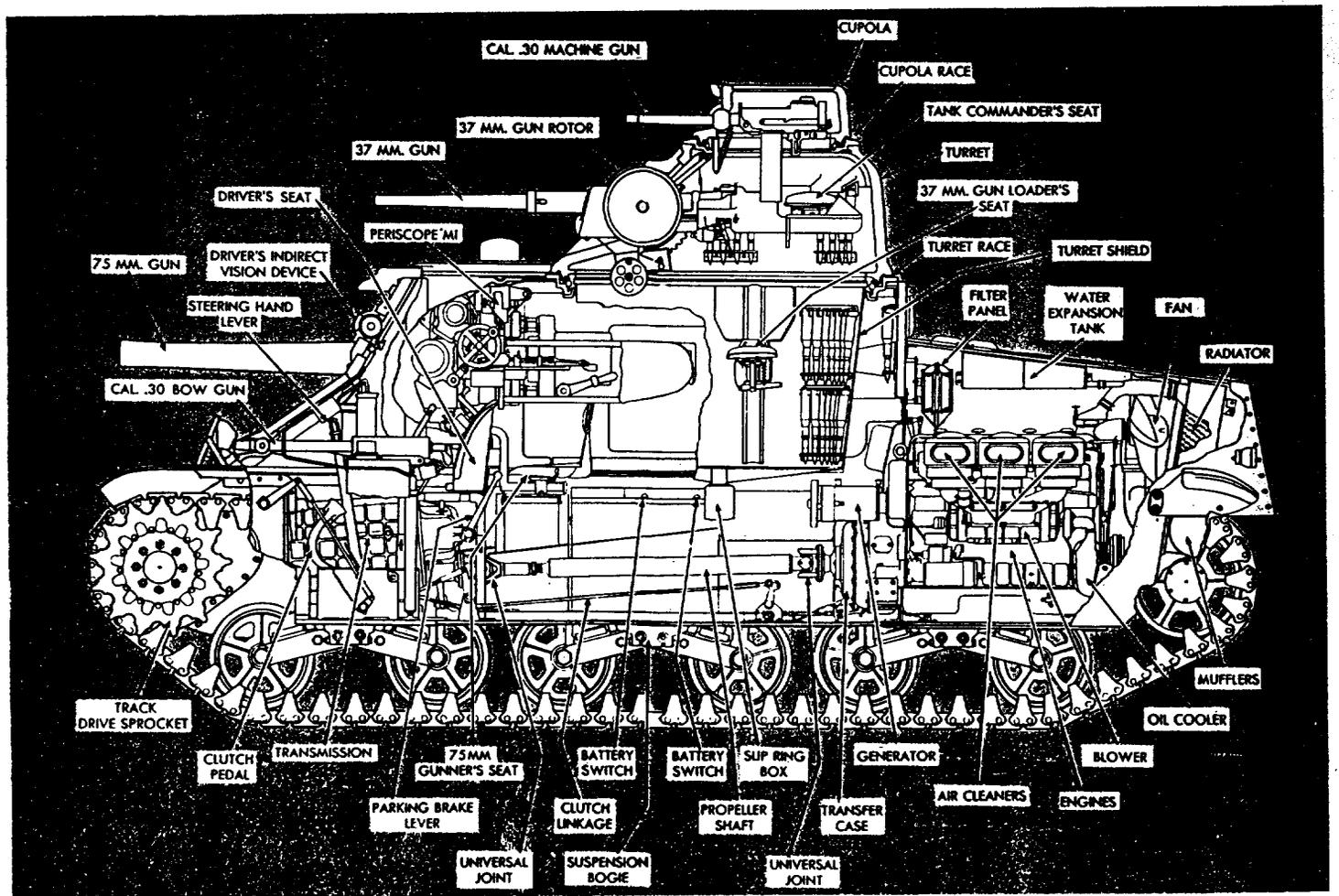
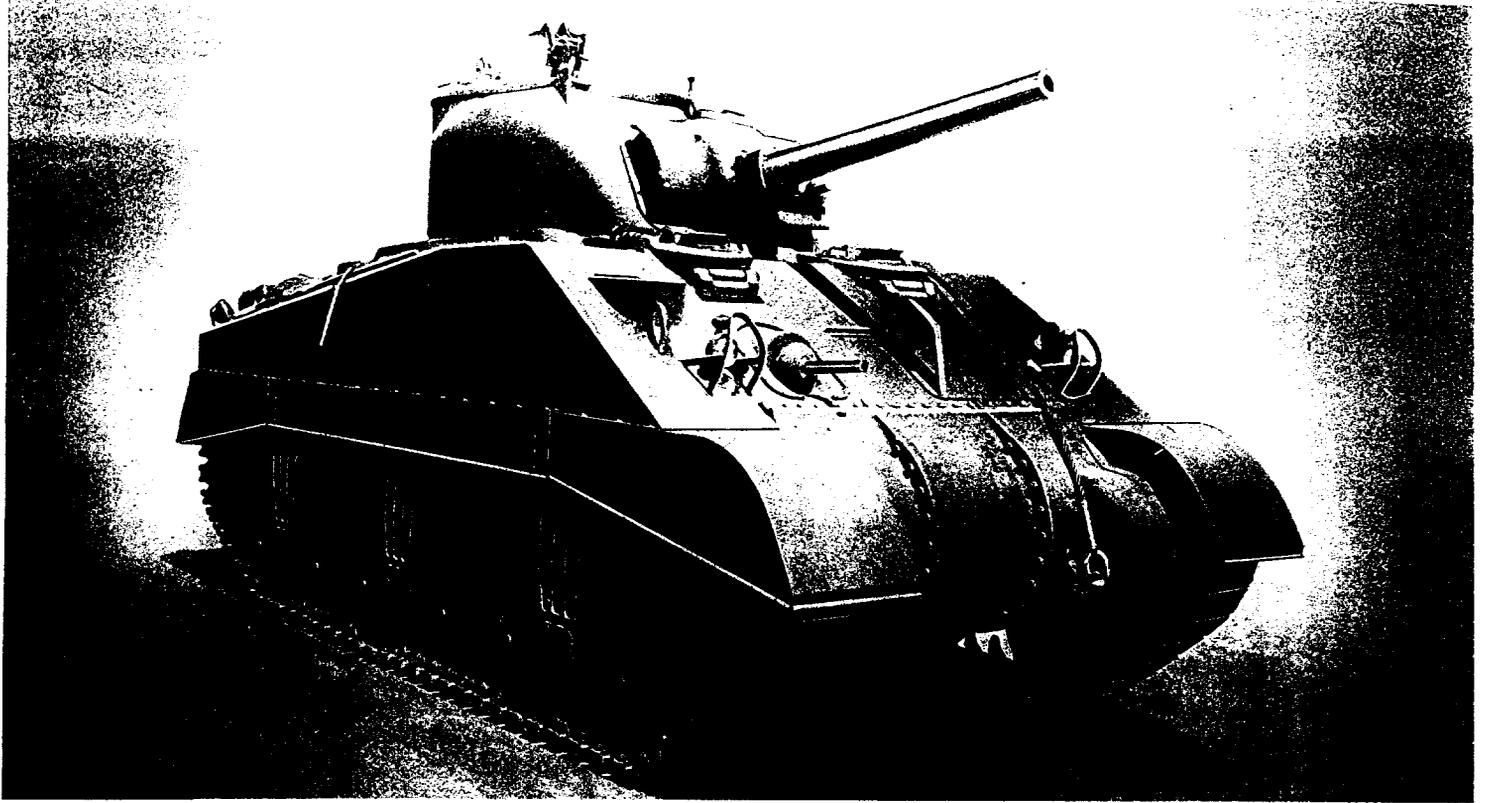


DIAGRAM OF MEDIUM TANK, M3A3, SHOWING INTERIOR ARRANGEMENT. ARRANGEMENT OF OTHER M3 SERIES MEDIUM TANKS IS GENERALLY SIMILAR

# MEDIUM TANK M4\* SERIES—STANDARD



MEDIUM TANK, M4, WITH WELDED HULL AND SAND SHIELDS. 75 MM AND CAL. .30 GUNS ARE IN COMBINATION GUN MOUNT, M34A1

These medium tanks, nicknamed "General Shermans" by British troops, have played an important part in Allied victories in Africa, Sicily and Russia ever since they first helped rout Marshal Rommel's troops at El Alamein.

Standardized in October, 1941, they introduced a number of improvements over the Medium Tank, M3, Series, which they replaced in production.

The 75 mm gun was relocated in the turret, providing 360° traverse and

greater elevation and depression than was possible in Medium Tank, M3. The silhouette was lowered by the elimination of the cupola, thus making the tank a less conspicuous target and also resulting in a lowered center of gravity, making the tank more stable. The 37 mm gun was eliminated. The crew was decreased to five, including an assistant driver.

The 75 mm gun breech was turned 90° from the vertical, allowing for easy right-hand loading. The radio was relocated in

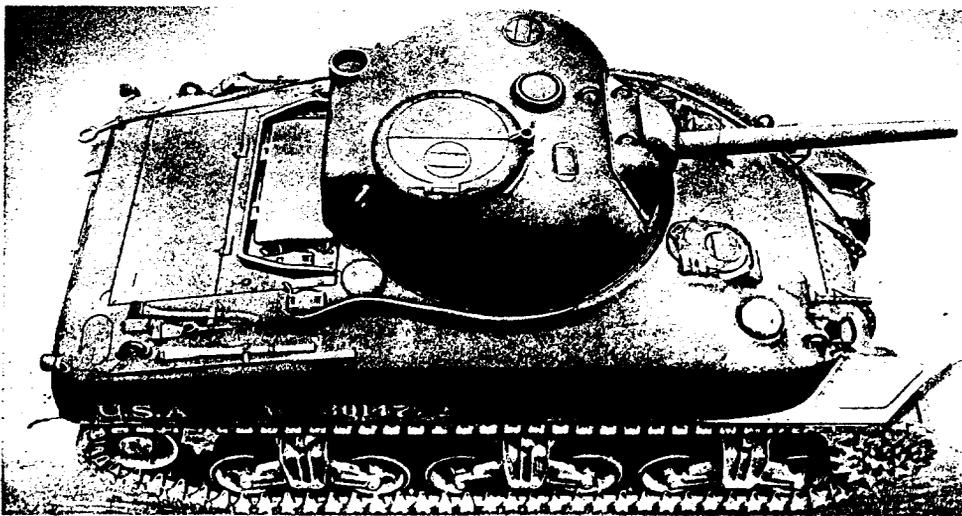
a turret "bulge." Greater comfort and safety were provided for all crew members.

Produced simultaneously by different manufacturers, the various models differ from each other principally in their engines. A further difference is that the M4A1 has a cast hull, whereas the others have welded hulls. In addition, the M4A5, produced in Canada, embodies differences requested by the Canadian government. All have cast turrets.

Principal armament (except for the M4A5) is a 75 mm Gun, M3, mounted with a cal. .30 machine gun in a combination gun mount in the turret. The turret guns may be elevated from  $-10^{\circ}$  to  $+25^{\circ}$ . They are fired electrically by means of foot and hand switches. A gyro-stabilizer is provided.

An A.P.C. projectile, fired from the 75 mm gun, has a muzzle velocity of 2,030 feet per second, and will penetrate 3.1 inches of face-hardened armor plate at 1,000 yards.

Other armament includes a cal. .30 machine gun in the bow, operated by the assistant driver; a cal. .50 machine gun, mounted at the top of the turret, operated by the commander for anti-aircraft use, and a 2-inch smoke mortar. A clip is



OVERHEAD VIEW OF MEDIUM TANK, M4A1, SHOWING ENTRANCE HATCHES

\*See also Medium Tanks, M4 (105 mm), and M4A3 (105 mm), page 21, and Medium Tanks, M4 (76 mm), Series, page 22.

mounted in the turret to carry a cal. .45 submachine gun, which can be used through the pistol port in the side of the turret.

The turret is a one-piece casting of armor which rotates on a ball bearing race recessed and protected against direct hits and lead splash from enemy fire. The turret basket is rigidly fastened to the turret by means of a ring of bolts around its circumference. The turret hatch ring acts as anti-aircraft gun mount.

The driver sits at the left bow of the tank. The assistant driver sits at the right bow. The loader sits in the turret, to the left of the 75 mm gun, and the gunner to its right. The tank commander sits in the rear of the turret, behind the gunner. Adjustable seats, allowing 12 inches of movement up and down and 5 inches fore and aft, are provided for the gunner, driver and assistant driver.

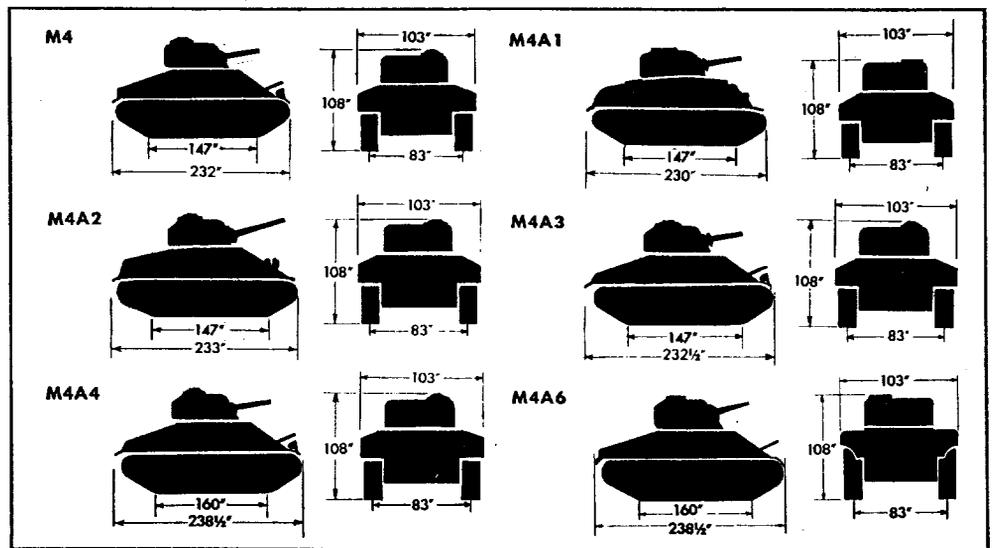
Access to the tank is through two hatches in the bow and a revolving hatch in the turret. An emergency escape hatch is located in the tank floor, behind the assistant driver.

Indirect vision is provided for each member of the crew by means of periscopes. The gunner's periscope is synchronized with the gun, contains a telescopic sight, and changes its line of sight only if the gun is elevated or depressed or the turret rotated. All other periscopes are mounted so that they can be tilted up or down and rotated through 360°. Early models had direct vision slots, protected by thick glass plates and hinged covers, for the driver and assistant driver. Because of their vulnerability to bullet splash, these were eliminated in later production, and additional periscopes were provided.

The transmission has five forward speeds and one reverse speed. A parking brake is built into the transmission. The



**MEDIUM TANK, M4A1, HAS CAST HULL. PHOTO SHOWS EARLY PRODUCTION GUN MOUNT, M34**



**MEDIUM TANK, M4A3, WELDED, WITH CAST LOWER FRONT HULL**



**MEDIUM TANK, M4A4, WELDED, WITH THREE-PIECE LOWER FRONT HULL**



**MEDIUM TANK, M4A2**, standardized in December, 1941, has a welded hull and a cast turret and is generally similar to Medium Tank, M4, except that it is powered by twin General Motors 6 71 Diesel engines, which are assembled as a single unit known as the G.M. 6046 power unit. Either engine may be operated independently of the other, if necessary.

These vehicles are manufactured by the Fisher Tank Division, General Motors Corp.; Pullman Standard Car Mfg. Co., and the Federal Machine and Welding Co.

REFERENCES — TM 9-731B; OCM 17578, 19456, 19724, 19725, 19983.

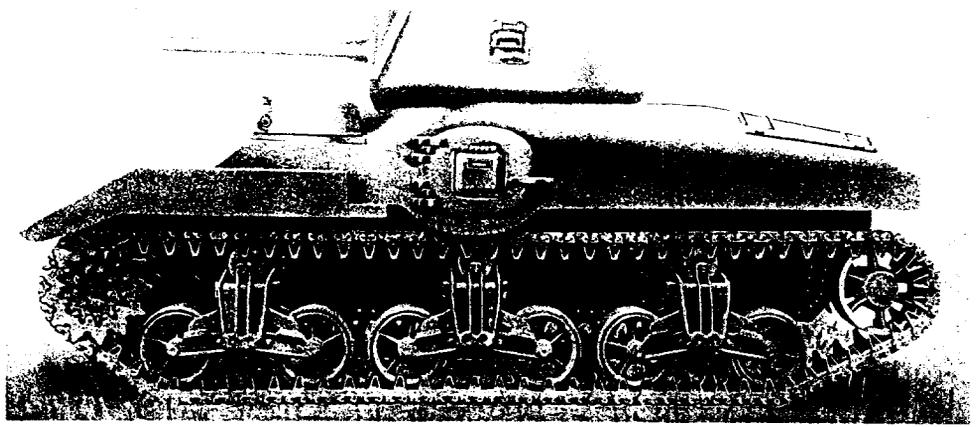
**MEDIUM TANK, M4A3**, standardized in January, 1942, has a welded hull and a cast turret and is generally similar to Medium Tank, M4, except that it is powered by a 500 hp. Ford tank engine. This is an 8-cylinder, liquid-cooled "V" type engine designed for tanks.

These tanks are built by the Ford Motor Co.

REFERENCES—TM 9-759; OCM 17678, 19982, 19983, 20205, 20518, 21053.

**MEDIUM TANK, M4A4**, standardized in February, 1942, has a welded hull and a cast turret, and is generally similar to Medium Tank, M4, except that it is powered by a Chrysler tank engine power unit, consisting of five banks of cylinders, each of which is in itself a conventional "L" head, water-cooled engine. The five units are geared together and operate as a single unit.

These tanks were built by the Detroit Tank Arsenal (Chrysler).



**MEDIUM TANK, M4A5, THE CANADIAN RAM, MOUNTS 57 MM AND CAL. .30 GUNS**

REFERENCES—TM 9-754; OCM 17855, 19280, 19983, 20205.

**MEDIUM TANK, M4A5**, was given this designation for record purposes by OCM 17856. It is produced in Canada under the designation, RAM II. It is generally similar to the Medium Tank, M4, but has variations requested by the Canadian Government.

Principal armament is a 57 mm gun in a combination mount with a cal. .30 machine gun in the British type cast turret. A small cupola is added on the left front of the hull roof and mounts a cal. .30 machine gun. A smoke projector is mounted on the right side of the turret front plate.

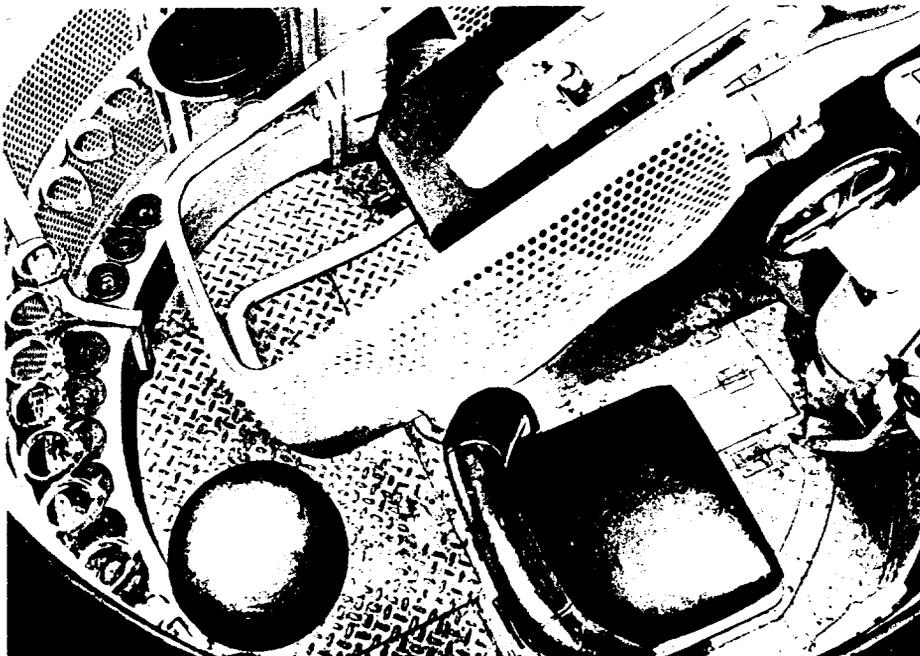
The tank is powered by a Wright R975 engine.

The pilot tank was manufactured by the American Locomotive Co.

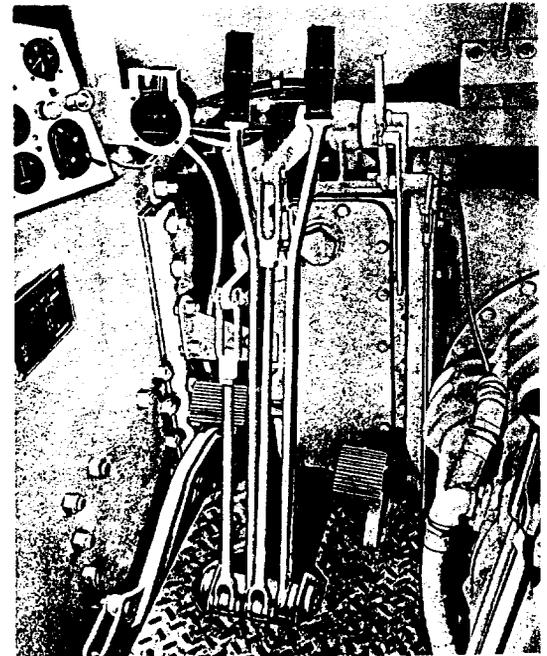
REFERENCE—OCM 17856.

**MEDIUM TANK, M4A6**, is similar to Medium Tank, M4A4, but is powered by an RD-1820 Ordnance engine manufactured by the Caterpillar Tractor Co. This is a radial Diesel-type engine with a displacement of 1,820 cubic inches. This tank is manufactured by the Detroit Tank Arsenal (Chrysler).

REFERENCES — OCM 19200, 19439, 19630, 19631, 20716.



**GUN MOUNT AND GUARD AND TURRET SEATS IN MEDIUM TANK, M4A1**

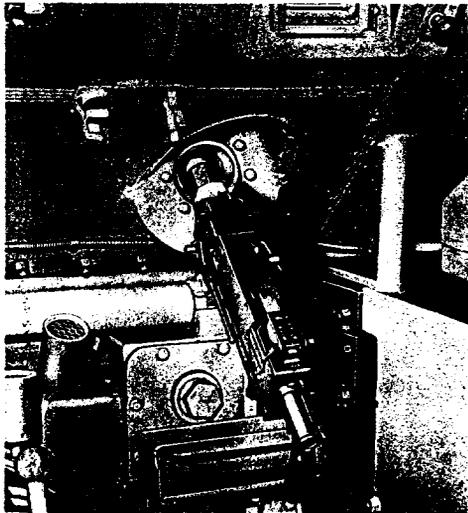


**STEERING LEVERS AND OTHER DRIVING CONTROLS**

TYPICAL CHARACTERISTICS

	M4	M4A1	M4A2	M4A3	M4A4	M4A6
Crew.....	5	5	5	5	5	5
<b>Physical Characteristics</b>						
Weight (gross).....	66,500 lb.	66,500 lb.	69,000 lb.	68,500 lb.	71,000 lb.	71,000 lb.
Length.....	19 ft., 4 ins.	19 ft., 2 ins.	19 ft., 5 ins.	19 ft., 4½ ins.	19 ft., 10½ ins.	19 ft., 10½ ins.
Width.....	8 ft., 7 ins.	8 ft., 7 ins.	8 ft., 7 ins.			
Height.....	9 ft.	9 ft.	9 ft.	9 ft.	9 ft.	9 ft.
Ground clearance.....	17½ ins.	17½ ins.	17½ ins.	17½ ins.	15¾ ins.	15¾ ins.
Tread (center to center of tracks).....	83 ins.	83 ins.	83 ins.	83 ins.	83 ins.	83 ins.
Ground pressure, per sq. in.....	13.7 lb.	13.7 lb.	14.2 lb.	14.1 lb.	13.4 lb.	13.4 lb.
Ground contact length at 0° penetration.....	147 ins.	147 ins.	147 ins.	147 ins.	160 ins.	160 ins.
<b>Performance</b>						
Sustained speed on level.....	24 m.p.h.	24 m.p.h.	29 m.p.h.	26 m.p.h.	25 m.p.h.	25 m.p.h.
Maximum grade ability.....	60%	60%	60%	60%	60%	60%
Trench crossing ability.....	7 ft., 5 ins.	8 ft.	8 ft.			
Vertical obstacle ability.....	24 ins.	24 ins.	24 ins.	24 ins.	24 ins.	24 ins.
Fording depth (slowest forward speed).....	36 ins.	36 ins.	40 ins.	36 ins.	42 ins.	42 ins.
Fuel capacity.....	175 gals.	175 gals.	148 gals.	174 gals.	150 gals.	150 gals.
Cruising range.....	120 miles	120 miles	150 miles	130 miles	100 miles	100 miles
Maximum drawbar pull.....	42,350 lb.	42,350 lb.	44,800 lb.	43,050 lb.	47,600 lb.	47,600 lb.
Engine, Make.....	Continental	Continental	G.M. 6-71	GAA-III	Chrysler	Caterpillar
Model.....	R975-C1	R975-C1	6046	V-W.C.	5-line W.C.	RD-1820
Fuel (gasoline).....	80	80	50	80	80	45
(Diesel).....	—	—	—	—	—	—
Max. governed speed.....	2,400 r.p.m.	2,400 r.p.m.	2,100 r.p.m.	2,600 r.p.m.	2,400 r.p.m.	2,000 r.p.m.
Net hp. at r.p.m.....	353 at 2,400	353 at 2,400	375 at 2,100	450 at 2,600	370 at 2,850	450 at 2,000
Max. torque (lb.-ft. at r.p.m.).....	800 at 1,800	800 at 1,800	1,000 at 1,400	950 at 2,100	1,025 at 1,200	1,470 at 1,200

(See additional engine characteristics on pages 28 and 29.)



ASSISTANT DRIVER'S STATION IN RIGHT BOW

Armament and Ammunition

- 75 mm Gun, M3, and 1 cal. .30 Browning Machine Gun, M1919A4 (flexible) . . . In Combination Gun Mount, M34A1, in turret
- 1 cal. .30 Browning Machine Gun, M1919A4 (flexible) . . . . . In bow
- 1 cal. .50 Machine Gun, M2, H.B. (flexible) . . . . . On turret (antiaircraft)
- 1 Mortar, 2-Inch, M3
- 1 Tripod Mount, M2, Cal. .30
- Provision for:
  - 1 cal. .45 Submachine Gun . . . . . Equipment of crew

Ammunition, Stowage

	M4, M4A2, M4A3, M4A4, M4A5	M4A1
75 mm (H.E., M48, A.P., M72; A.P.C., M61) . . . . .	97	90
Cal. .30 (A.P. and tracer) . . . . .	4,750	4,750
Cal. .45 . . . . .	600	600
Cal. .50 (A.P. and tracer) . . . . .	300	300
Grenades, Hand (Fragmentation, Mk. III, 4; Smoke, H.C., M8, 4; Offensive, Mk. III, w/fuze, Detonating, M2; Thermite, incendiary, 2) . . . . .	12	12
Smoke Ammunition (minimum) . . . . .	12	12

Armor	Actual	Basis
Hull, Front, Upper.....	2 ins.	2-4 ins.
Lower.....	1½-2 ins.	2-2½ ins.
Sides.....	1½-2 ins.	1½-2 ins.
Rear.....	1½ ins.	
Top.....	1 in.	
Bottom.....	½-1 in.	
Turret, Front.....	3 ins.	3¾ ins.
Sides.....	2 ins.	2 ins.
Top.....	1 in.	
<b>Vision and Fire Control</b>		
Periscope, M4 (w/Telescope, M38).....	1	
Periscope, M6.....	6	
Gunner's quadrant, M1.....	1	
Bore sight.....	1	
Telescope, M70F.....	1	
Azimuth Indicator, M19.....	1	
Elevation quadrant, M9.....	1	

<b>Communications</b>	
Radio.....	SCR-508
Command tank.....	SCR-506
Interphone stations.....	5
Flag set, M238.....	24
Battery, Voltage Total.....	24
<b>Fire Protection and Decontamination</b>	
Fire Extinguisher—CO <sub>2</sub> —10 lb. (fixed).....	2
CO <sub>2</sub> —4 lb. (hand).....	2
Decontaminating Apparatus, M2, 1½ qts.....	2
<b>Track, Type..... Rubber block</b>	
Width.....	16½ ins.
Pitch.....	6 ins.
No. of shoes per vehicle.....	158 (Medium Tank, M4A4, uses 166 shoes)
<b>Suspension, Type..... Volute spring</b>	
Wheel or tire size.....	20x9

Idler, Type.....	Fixed
Wheel or tire size.....	28½x9
<b>Final Drive, Type..... Herringbone</b>	
Gear ratio.....	2.84:1
Sprocket, no. of teeth.....	13
Pitch diameter.....	25.038
<b>Differential, Controlled, Gear ratio..... 3.53:1</b>	
Ring gear, no. of teeth.....	60
Pinion, no. of teeth.....	17
Steering ratio.....	1.515:1
<b>Transmission, Type..... Mechanical synchromesh</b>	
Gear ratios, First speed.....	7.56:1
Second speed.....	3.11:1
Third speed.....	1.78:1
Fourth speed.....	1.11:1
Fifth speed.....	.73:1
Reverse.....	5.65:1

# MEDIUM TANKS M4 (105 MM HOW.), M4A3 (105 MM HOW.)—STANDARD

These modifications of Medium Tanks, M4 and M4A3, were designed to combine the firepower of a 105 mm howitzer with the performance characteristics of a medium tank. They are supplied in addition to the medium tanks with 75 mm guns authorized by Tables of Basic Allowances, and to replace the 75 mm Howitzer Motor Carriages, M8, in Battalion Headquarters Companies, Medium Tank Battalions.

The 105 mm Howitzer, M4, is mounted in a Combination Gun Mount, M52, with one cal. .30 Machine Gun, M1919A4, flexible, in a 360° hand-traversed turret. No gyrostabilizer is provided. The howitzer is a redesign of 105 mm Howitzer, M2A1.

Other armament is the same as for Medium Tanks, M4, and M4A3.

The cast turret has a partial turret basket. A fighting seat for the gunner, a convoy seat for the tank commander and a riding seat for the loader are provided. All seats traverse with the turret.

A commander's vision cupola is provided above the turret. Equipped with six prismatic vision blocks, of 3 inch, laminated, bullet-resisting glass, it affords a wide field of view.

There is a suitable floor over the stowage space on either side of the power tunnel. Pistol ports and lifting hooks are the same as for Medium Tanks, M4, and padding and safety belts are furnished wherever required. A pintle for towing an ammunition trailer is provided.

Construction of two pilot Medium Tanks, M4A4, mounting the 105 mm howitzer, was authorized by Ordnance Committee action in December, 1942. Designated Medium Tank, M4A4E1, the vehicle was tested at Aberdeen Proving Ground and at Fort Knox, Ky. Modifications deemed necessary were incorporated in new pilot models designated Medium Tank, M4E5. Standardization of the vehicles was approved in August, 1943.

**MEDIUM TANK, M4 (105 mm HOW.),** is based on Medium Tank, M4, using a Continental R975-C1 engine.

**MEDIUM TANK, M4A3 (105 mm HOW.),** is based on Medium Tank, M4A3, using a Ford GAA engine.

REFERENCES — OCM 17202, 17316, 19394, 21113, 21347.



MEDIUM TANK, M4 (105 MM HOWITZER), SHOWING DETAILS OF TOP OF HULL AND TURRET

## TYPICAL CHARACTERISTICS

Crew ..... 5

### Physical Characteristics

Weight (gross, approx.)	{ M4—66,500 lb. M4A3—68,500 lb.
Length	{ M4—19 ft., 4 ins. M4A3—19 ft., 4 1/2 ins.
Width	8 ft., 7 ins.
Height	9 ft., 2 1/16 ins.
Ground clearance	17 1/8 ins.
Tread (center to center of tracks)	83 ins.
Ground contact length	147 ins.
Ground pressure	{ M4—13.7 lb./sq. in. M4A3—14.1 lb./sq. in.

### Armament

105 mm Howitzer, M4, and 1 cal. .30 Machine Gun, M1919A4 (flexible)	{ In Combination Gun Mount, M52
Elevation	-10° to +35°
Traverse	360°
1 cal. .30 Machine Gun, M1919A4 (flexible)	In bow mount
1 cal. .50 Machine Gun, M2, HB (flexible)	On turret
1 Mortar, 2 inch, M3	
1 Tripod Mount, cal. .30, M2	
Provision for:	
1 cal. .45 Submachine Gun	

### Ammunition, Stowage

105 mm Howitzer	66 rounds
Cal. .30	4,000 rounds
Cal. .50	300 rounds
Cal. .45	600 rounds
Grenades, Hand (Fragmentation, MK. II, 6; Smoke, W.P., M 15, 6)	12
Smoke Bombs, 2 Inch, MK. I	18

### Armor

	Actual	Basis
Hull, Front, Upper	2 ins.	2-4 ins.
Lower	1 1/2-2 ins.	2-2 1/2 ins.
Sides	1 1/2-2 ins.	1 1/2-2 ins.
Rear	1 1/2 ins.	
Top	1 in.	
Bottom	1/2-1 in.	
Turret, Front	3 ins.	3 3/4 ins.
Sides	2 ins.	2 ins.
Top	1 in.	

### Performance

Maximum speed on level—M4	24 m.p.h.
M4A3	26 m.p.h.
Maximum grade ability	60%
Trench crossing ability	7 ft., 5 ins.
Vertical obstacle ability	24 ins.
Fording depth (slowest forward speed)	36 ins.
Fuel capacity—M4	175 gals.
M4A3	174 gals.
Cruising range—M4	120 miles
M4A3	130 miles

### Vision and Fire Control

Commander's vision cupola	1
Periscope, M6	6
Periscope, M4, with Telescope, T73	1
Gunner's Quadrant, M1	1

### Communications

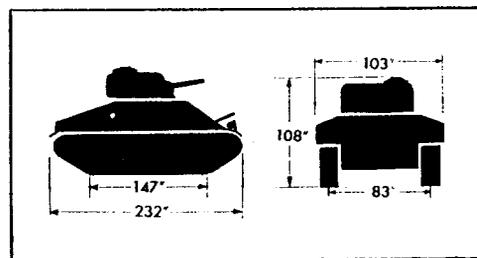
Radio	SCR-508, 528, or 538
Interphone stations	5
Flag Set	M238

Battery, Voltage, total ..... 24

### Fire Protection and Decontamination

Fire Extinguisher—CO <sub>2</sub> —10 lb. (fixed)	2
CO <sub>2</sub> —4 lb. (hand)	2
Decontaminating Apparatus, M2, 1 1/2 qts.	2

(Other characteristics same as for Medium Tanks, M4 or M4A3.)



# LIGHT TANK ENGINES

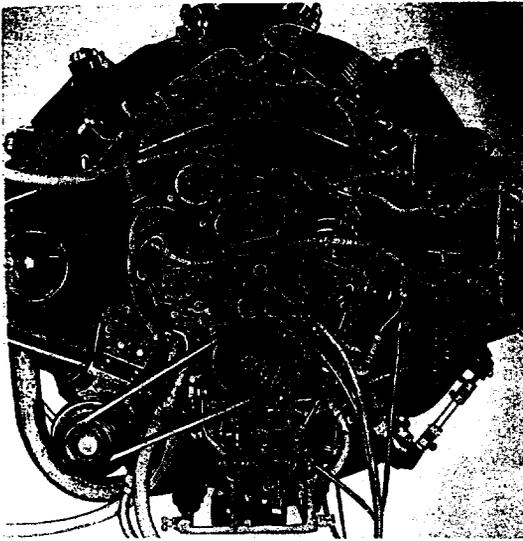
## TYPICAL CHARACTERISTICS

	CONTINENTAL W-670-9A	GUIBERSON T-1020-4	CADILLAC Series 44 <sup>†**</sup>	LYCOMING O-435-T
Type	Radial, A.C.	Radial, A.C.	V-8, L.C.	Opposed, A.C.
No. of cylinders	7	9	8	6
Cycle	4	4	4	4
Fuel, Octane or cetane	80 Octane	40 Cetane	80 Octane	80 Octane
Type	Gasoline	Diesel	Gasoline	Gasoline
Bore and stroke	5 $\frac{1}{8}$ x 4 $\frac{5}{8}$ in.	5 $\frac{1}{8}$ x 5 $\frac{1}{2}$ in.	3 $\frac{1}{2}$ x 4 $\frac{1}{2}$ in.	4 $\frac{7}{8}$ x 3 $\frac{7}{8}$ in.
Displacement	667 cu. in.	1,021 cu. in.	346 cu. in.	434 cu. in.
Compression	6.1:1	14.5:1	6.77:1	6.25:1
Max. governed speed	2,400 r.p.m.	2,200 r.p.m.	Not governed	2,800 r.p.m.
Gross hp.	262 at 2,400 r.p.m.	245 at 2,200 r.p.m.	148 at 3,200 r.p.m.	192 at 2,800 r.p.m.
Max. gross torque	590 lb.-ft. at 1,700 r.p.m.	645 lb.-ft. at 1,300 r.p.m.	280 lb.-ft. at 1,200 r.p.m.	360 lb.-ft. at 2,100 r.p.m.
Crankshaft rotation (facing drive end)	Clockwise	Clockwise	Clockwise	Clockwise
Length	32 in.	37 in.	65 $\frac{3}{16}$ in.	48 in.
Width	53 $\frac{1}{4}$ in.*	45 $\frac{1}{2}$ in.	25 $\frac{3}{8}$ in.	35 $\frac{1}{2}$ in.
Height	42 $\frac{3}{8}$ in.	45 $\frac{1}{2}$ in.	38 $\frac{3}{32}$ in.	31 $\frac{1}{4}$ in.
Ignition	Magneto	Compression	Battery	Battery
Weight, Dry	1,070 lb.	700 lb.	584 lb.	1,000 lb.
Weight, Installed	1,214 lb.			

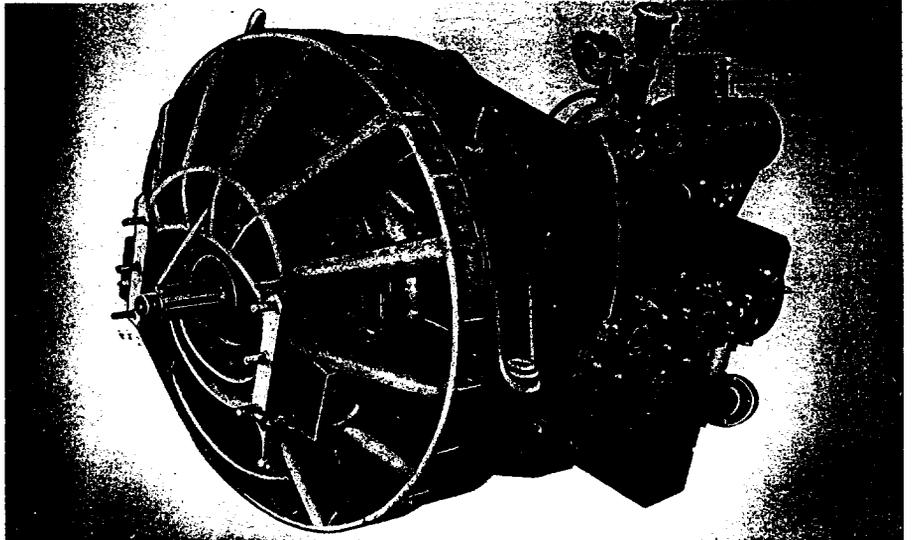
\*To outside of exhaust manifold.

†Data for Series 42, used on Light Tanks M5 and M5A1, essentially same except: Length, 63 in., Width, 27 $\frac{1}{4}$  in., Height 36 in.

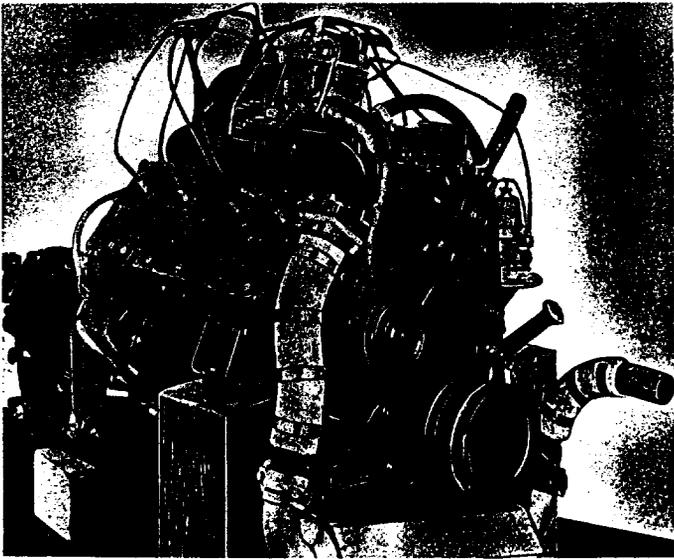
\*\*Two of these engines used in each Light Tank M24.



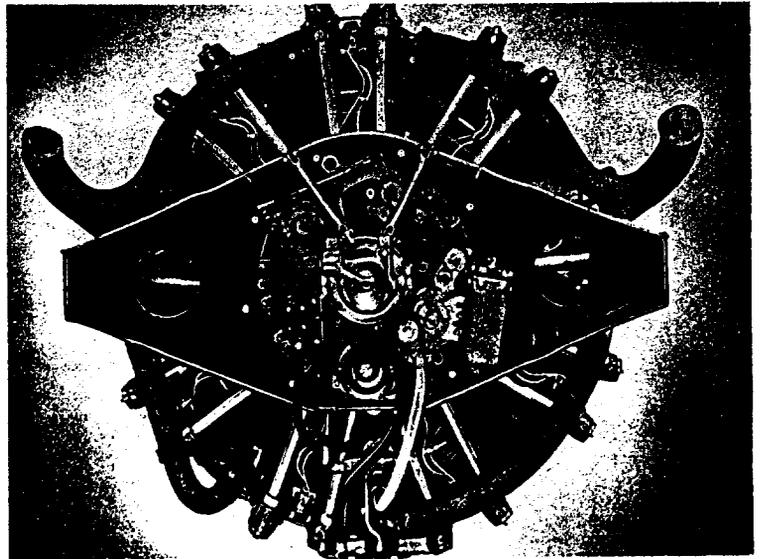
CONTINENTAL ENGINE W-670-9A, LIGHT TANK M3 SERIES



LYCOMING GASOLINE ENGINE O-43-T USED ON LIGHT TANK T9E1

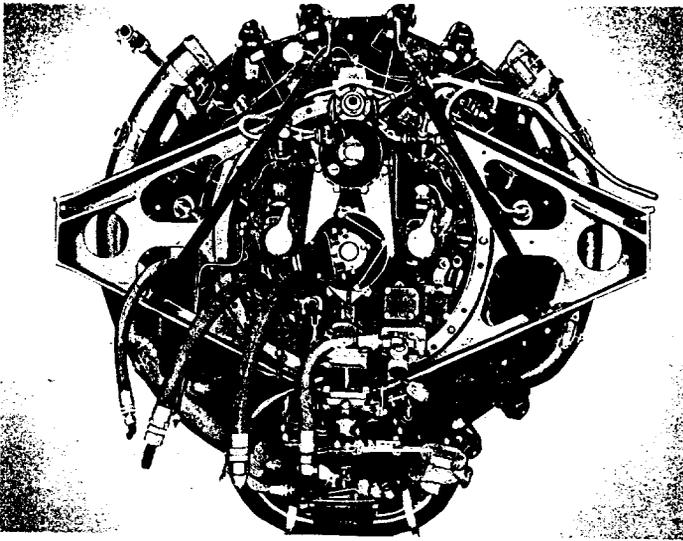


CADILLAC ENGINE SERIES 44 USED ON LIGHT TANK M24

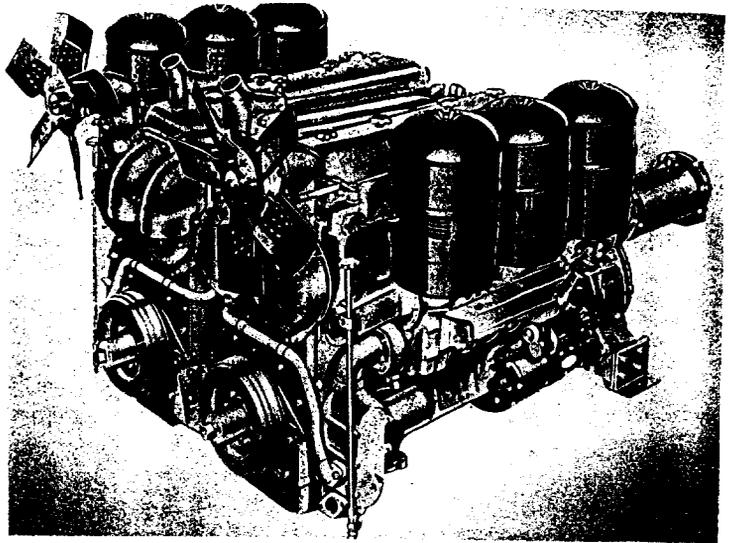


GUIBERSON ENGINE T1020-4 USED ON LIGHT TANK M3 (DIESEL)

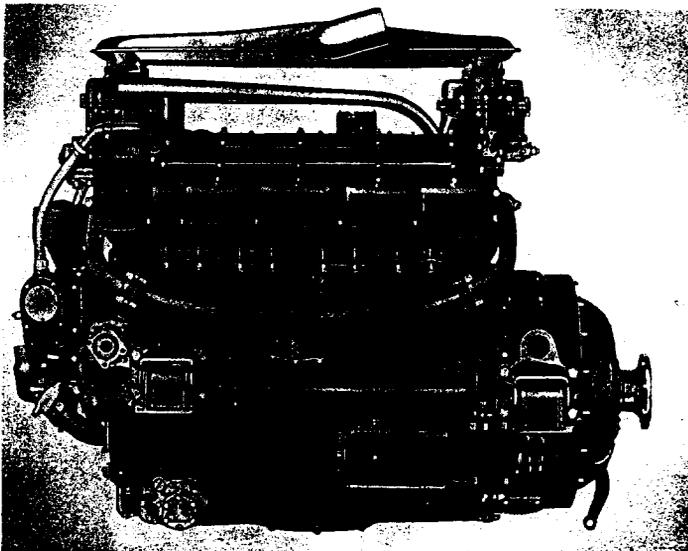
# MEDIUM AND HEAVY TANK ENGINES



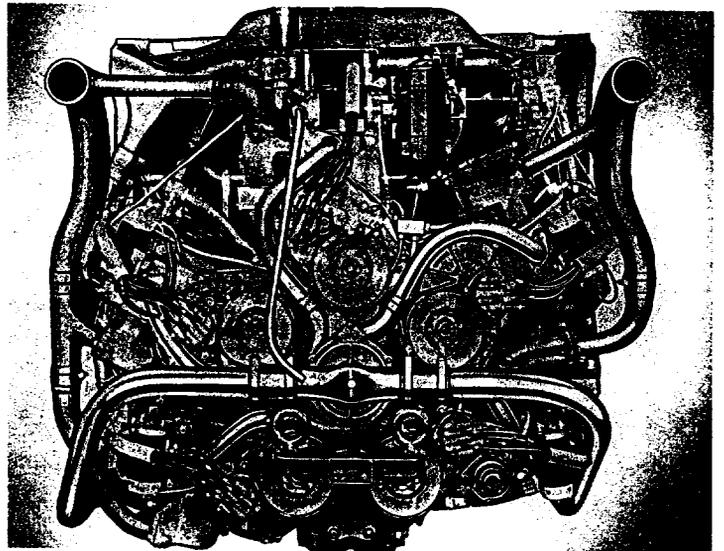
CONTINENTAL ENGINE FOR MEDIUM TANKS M4, M4A1



GENERAL MOTORS POWER UNIT FOR MEDIUM TANK M4A2



FORD GAA ENGINE IS USED IN THE MEDIUM TANK M4A3



CHRYSLER POWER UNIT FOR MEDIUM TANK M4A4

## TYPICAL CHARACTERISTICS

	CONTINENTAL R-975-C1*	G.M. DIESEL 6046	FORD GAA†	CHRYSLER A-57
Type	Radial, A.C.	2-line, L.C.	V-8, L.C.	8-line, L.C.
No. of cylinders	9	12	8	8
Cycle	4	2	4	4
Fuel, Octane or cetane	80 Octane	40 Cetane	80 Octane	80 Octane
Type	Gasoline	Diesel	Gasoline	Gasoline
Bore and stroke	5 x 5½ in.	4¼ x 5 in.	5.4 x 6 in.	3⅞ x 4½ in.
Displacement	973 cu. in.	850 cu. in.	1,100 cu. in.	1,253 cu. in.
Compression	5.7:1	16:1	7.5:1	6.2:1
Max. governed speed	2,400 r.p.m.	2,100 r.p.m.**	2,600 r.p.m.	2,850 r.p.m.
Gross hp.	400 at 2,400 r.p.m.	410 at 2,900 r.p.m.	500 at 2,600 r.p.m.	425 at 2,850 r.p.m.
Max. gross torque	890 lb.-ft. at 1,800 r.p.m.	885 lb.-ft. at 1,900 r.p.m.	1,040 lb.-ft. at 2,200 r.p.m.	1,060 lb.-ft. at 1,400 r.p.m.
Crankshaft rotation (drive end)	Clockwise	Clockwise‡	Clockwise	Clockwise
Length	53 in.	65½ in.	60⅞ in.	54⅞ in.
Width	45 in.	59⅞ in.	33¼ in.	58¾ in.
Height	45 in.	46¾ in.	47½ in.	56½ in.
Ignition	Magneto	Compression	Magneto	Battery
Weight, Dry	1,137 lb.	5,110 lb.	1,560 lb.	5,400 lb.

\*R-975-C4 essentially same except: Gross hp., 460 at 2,400 r.p.m.; Max. torque, 1,025 lb.-ft. at 1,800 r.p.m.; Weight, dry, 1,212 lb.

\*\*Crankshaft speed of each 6-cylinder half of power plant.

†Characteristics of Ford GAN engine are generally similar.

‡At power take-off flange out of transfer case, which couples both halves of the power plant, steps up the shaft speed, and reverses rotation with respect to the cranks of each half of the power unit.

The variety of medium tank engines shown here is a tribute to the resourcefulness of American industry, in cooperation with the Ordnance Department, in meeting an emergency.

When the program for the quantity production of medium tanks was inaugurated in 1940, it became necessary to find sources of sufficient engines. Medium Tank M3 used the Continental (Wright)R-975 engine, an aircraft type of engine adapted for use in tank. Medium Tank M3 (Diesel) used the Guiberson T-1400 Diesel engine, but only a few of these were built.

To avoid conflicting with the Air Forces, whose need for engines was equally imperative, efforts were made to adapt commercial truck and passenger car engines, already in production, for use in tanks.

First such engine authorized for use as an alternate power plant was the G.M. 6046 Diesel engine, made up of two stand-

ard bus and truck type engines. In the medium tank installation, the engines, located one on either side of the engine compartment, are connected through a step-up gear and double clutch housing to a common propeller shaft. Originally authorized for use in Medium Tank M3A3 by Ordnance Committee action in December 1941, these engines are now used in Medium Tank M4A2 and in vehicles based on these tanks.

The Chrysler A-57 power unit consists of five conventional passenger car engines, geared together to operate as a single unit. Originally authorized for use in Medium Tank M3A4, it was used subsequently in Medium Tank M4A4.

The Ford GAA engine is an 8-cylinder, V-type engine designed specifically for tanks. It was introduced in Medium Tank M4A3 by Ordnance Committee action in January 1942. A modification known as

the Ford GAN engine is being used in Medium Tank T23. Virtually the same engine, known as model GAF, is used in Heavy Tank T26E3.

Ordnance Committee action in May 1943 authorized the use of the RD-1820 Ordnance engine in Medium Tank M4A4 hulls, and designated this vehicle Medium Tank M4A6. This engine was formerly known as the Caterpillar D-200A engine.

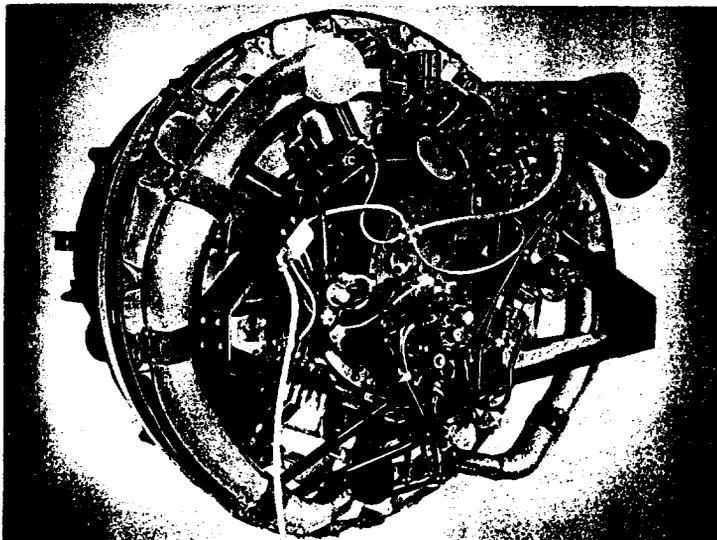
Heavy Tanks M6 and M6A1 use Wright G-200 series engines, Model 781C9GC1. Heavy Tank T1E1, sometimes referred to as the M6A2, uses a modification of this engine, designated Model 795C9GC1, which is directly coupled to an electric generator.

REFERENCES—OCM 17503, 17578, 17678, 18283, 19200, 19439, 19630, 19631, 20607, 20796, 25785.

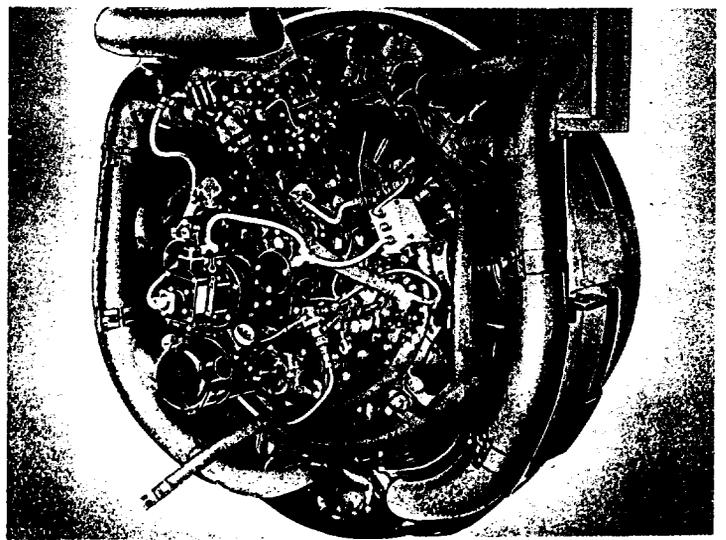
## TYPICAL CHARACTERISTICS

	ORDNANCE ENGINE RD-1820	GUIBERSON T-1400	WRIGHT G-200 781C9GC1	WRIGHT G-200 795C9GC1**
Type.....	Radial, A.C.	Radial, A.C.	Radial, A.C.	Radial, A.C.
No. of cylinders.....	9	9	9	9
Cycle.....	4	4	4	4
Fuel, Octane and cetane.....	40 Cetane	40 Cetane	80 Octane	80 Octane
Type.....	Diesel	Diesel	Gasoline	Gasoline
Bore and Stroke.....	6 $\frac{1}{8}$ x 6 $\frac{7}{8}$ in.	5 $\frac{3}{4}$ x 6 in.	6 $\frac{1}{8}$ x 6 $\frac{7}{8}$ in.	6 $\frac{1}{8}$ x 6 $\frac{7}{8}$ in.
Displacement.....	1,823 cu. in.	1,400 cu. in.	1,823 cu. in.	1,823 cu. in.
Compression.....	15.5:1	14.3:1	4.92:1	4.92:1
Max. governed speed.....	2,000 r.p.m.*	2,400 r.p.m.	2,300 r.p.m.	1,950 r.p.m.
Gross hp.....	497 at 3,000 r.p.m.†	350 at 2,400 r.p.m.	800 at 2,300 r.p.m.	675 at 1,950 r.p.m.
Max. gross torque.....	945 lb.-ft. at 2,100 r.p.m.†	935 lb.-ft. at 1,400 r.p.m.	1,850 lb.-ft. at 2,300 r.p.m.	1,810 lb.-ft. at 1,950 r.p.m.
Crankshaft rotation (drive end).....	Clockwise	Clockwise	Clockwise	Clockwise
Length.....	56 in.	41 $\frac{1}{2}$ in.	52 in.	101 $\frac{1}{8}$ in.
Width.....	55 in.	50 in.	55 in.	64 $\frac{1}{4}$ in.
Height.....	55 in.	50 in.	55 in.	58 in.
Ignition.....	Compression	Compression	Magneto	Magneto
Weight, Dry.....	3,536 lb.	1,100 lb.	1,350 lb.	7,900 lb.
Weight, Installed.....			1,711 lb.	8,261 lb.

\*Engine crankshaft speed.  
†These data refer to power take-off flange on output shaft out of step-up gear transfer case.  
\*\*Data for this power plant take into consideration the direct-coupled main propulsion generator.

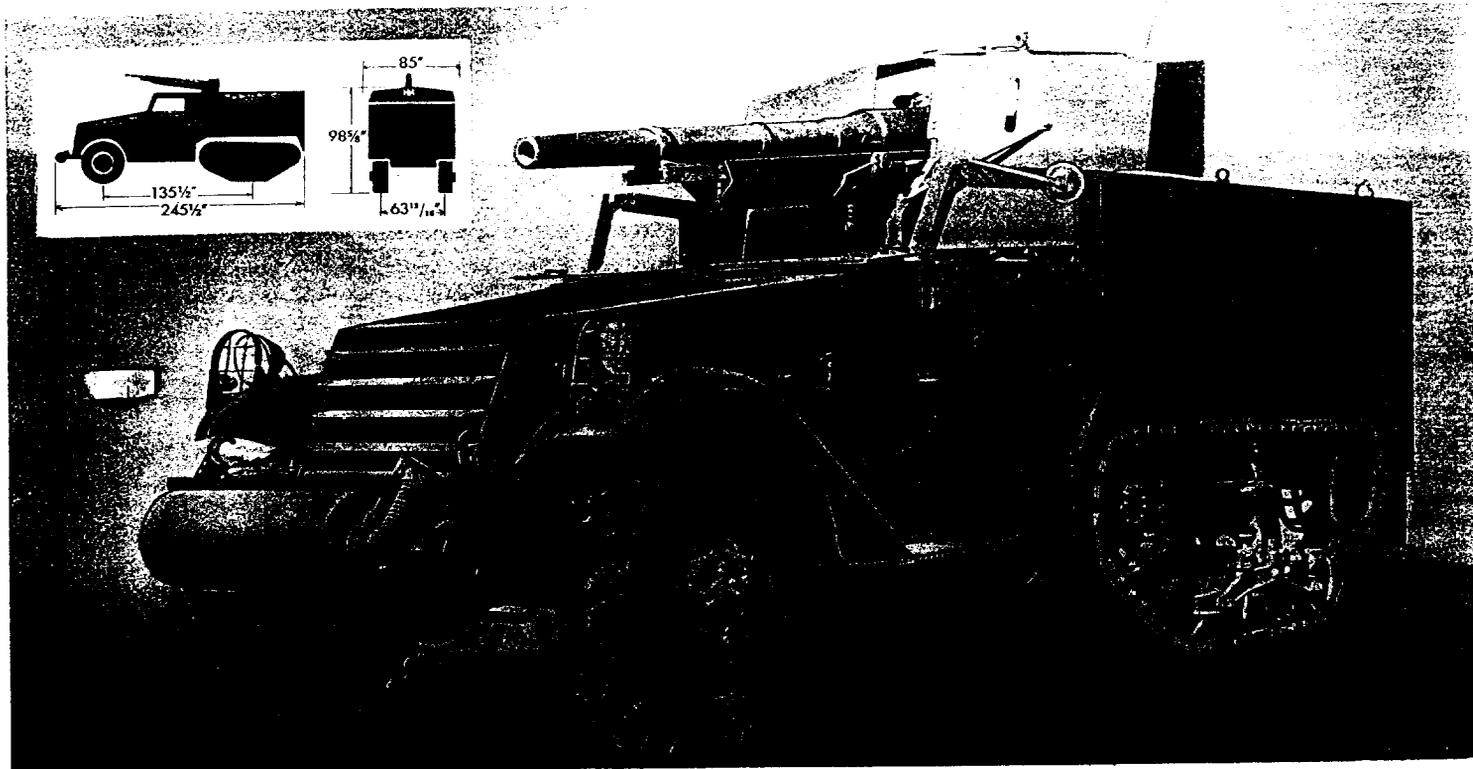


RD-1820 ORDNANCE ENGINE USED IN MEDIUM TANK, M4A6



WRIGHT G-200 SERIES ENGINE USED IN HEAVY TANKS

# 75-MM GUN MOTOR CARRIAGES M3, M3A1



75-MM GUN MOTOR CARRIAGE M3, WITH MODIFIED GUNSHIELD FOR INDIRECT SIGHTING DEVICE; THE M3A1 DIFFERED ONLY IN GUN MOUNT

## TYPICAL CHARACTERISTICS

<b>Crew</b> .....	5	<b>1 Grenade Launcher</b> .....	For rifle	<b>Forcing depth (slowest forward speed)</b> .....	32 in.
<b>Physical Characteristics</b>		<b>Ammunition, Stowage</b>		<b>Turning radius</b> .....	30 ft.
Weight (gross) .....	20,000 lb.	75-mm (H.E., Mk. I; H.E., M48; Chem., Mk. II; A.P.C., M61; A.P., M72) 59 rounds		<b>Fuel capacity</b> .....	60 gal.
Length .....	20 ft., 5 1/2 in.	Grenades (Hand: Fragmentation, Mk. II, 5; Smoke, M8, 5; Thermite, Incendiary, 2; Rifle: M9A1, 10) .....	22	<b>Cruising range</b> .....	200 miles
Width .....	7 ft., 1 in.	<b>Armor, Front, sides, and rear</b> .....	1/4 in.	<b>Vision and Fire Control</b>	
Height .....	8 ft., 2 5/8 in.	Windshield shield .....	1/2 in.	Direct—Slits in windshield and wingshields	
Height of center line of bore .....	82 in.	Wingshields .....	1/4 in.	Telescope M33 .....	1
Ground clearance .....	11 3/16 in.	Top, engine compartment .....	1/4 in.	Telescope Mount M36 .....	1
Tread, Front .....	64 1/2 in.	Gun shield, Front .....	5/8 in.	Instrument Light M17 .....	1
Rear .....	63 13/16 in.	Sides and top .....	1/4 in.	<b>Communications</b>	
Wheelbase .....	135 1/2 in.	<b>Performance</b>		Radio .....	SCR-510
Ground contact length .....	46 3/4 in.	Maximum speed on level .....	45 m.p.h.	Flag Set M238 .....	1
Tire equipment .....	8.25x20, 12-ply, combat	Speed on 4% grade .....	25 m.p.h.	<b>Fire Protection and Decontamination</b>	
<b>Armament</b>		Maximum grade ability .....	60%	Fire Extinguisher, CO <sub>2</sub> -2 lb. ....	1
1 75-mm Gun M1897A4, on Mount M3 or M5		Vertical obstacle ability .....	12 in.	Decontaminating Apparatus M2, 1 1/2 qt. ....	1
Provision for:				(Other characteristics same as for Half-Track Personnel Carrier M3.)	
1 Cal. .30 Rifle M1903					
4 Cal. .30 Carbines M1					

The 75-mm Gun Motor Carriage M3, the first standardized American self-propelled antitank weapon used in World War II, provided high mobility for the 75-mm gun. Standardized in November 1941, it was put into production in time to aid in the rout of Rommel's troops in North Africa.

It was reclassified as Limited Standard in March 1944 upon the standardization of 76-mm Gun Motor Carriage M18, and was declared obsolete in September 1944.

The gun was carried on Mount M3, a mount adapted from the 75-mm Gun Carriage M2A3. It could be elevated from -10° to +29° and could be traversed 19° to the left and 21° to the right.

The 75-mm Gun Motor Carriage M3A1, which was also declared obsolete in September 1944, used Gun Mount M5, adapted from Gun Carriage M2A2. Its gun could be elevated from 6 1/2° to +29° and traversed 21° right and 21° left. Both vehicles had a gunshield that gave protection against cal. .30 armor-piercing bullets at 250 yards and overhead protection from frontal attack by aircraft. The shield traversed with the gun.

An A. P. C. projectile fired from the gun had a muzzle velocity of 2,000 feet per second, and would penetrate 3 inches of face-hardened plate at 1,000 yards.

The gun was loaded and operated from the crew compartment. Stowage space

was provided for 59 rounds of ammunition and for a cal. .30 rifle and four cal. .30 carbines, which were the personal equipment of the crew.

Body armor was the same as on Half Track Personnel Carrier M3, including hinged protective shields for the windshield and doors. A detachable canvas top was provided. The vehicle was equipped with a two-way radio.

The pilot vehicle was built by the Autocar Co.

REFERENCES—TM 9-306, 9-710; M3: OCM 16970, 17054, 17377, 17450, 17878, 18072, 18160, 20680, 21002. M3A1: OCM 18682, 20253, 22918, 23202, 24942, 25260; SNL G-102, Vols. 8 and 9.

# 105-MM HOWITZER MOTOR CARRIAGES M7, M7B1 — SUBSTITUTE STANDARD

## 105-MM HOWITZER MOTOR CARRIAGE M37 — STANDARD

Standardization in January 1945 of 105-mm Howitzer Motor Carriage M37 added another vehicle to the combat team built upon the Light Tank M24 chassis and continued the line of powerful weapons started with 105-mm Howitzer Motor Carriage M7, which helped rout Rommel in Libya.

All are lightly-armored, open-top vehicles in which a 105-mm howitzer is the primary armament. The pulpit-like appearance of the machine gun compartment caused the M7 to be nicknamed "The Priest" by British troops.

**105-MM HOWITZER MOTOR CARRIAGE M7** was standardized in April 1942 and was reclassified as Substitute Standard in January 1945. The vehicle is based on a Medium Tank M3 chassis which has a Continental R-975-C1 gasoline engine, syncromesh transmission, and a vertical volute spring suspension.

Principal armament is a 105-mm Howitzer M2A1 mounted at the front of the crew compartment. The howitzer can be elevated from  $-5^{\circ}$  to  $+35^{\circ}$  and can be traversed  $30^{\circ}$  to the right and  $15^{\circ}$  to the left. An HE shell, fired from this howitzer, has a muzzle velocity of 1,550 feet per second at an elevation of  $44^{\circ}$  and a maximum range of 12,205 yards.

A Cal. .50 Machine Gun M2 HB (flexible) on a ring mount is provided for use against low-flying aircraft. Provision is made for 3 cal. .45 submachine guns.

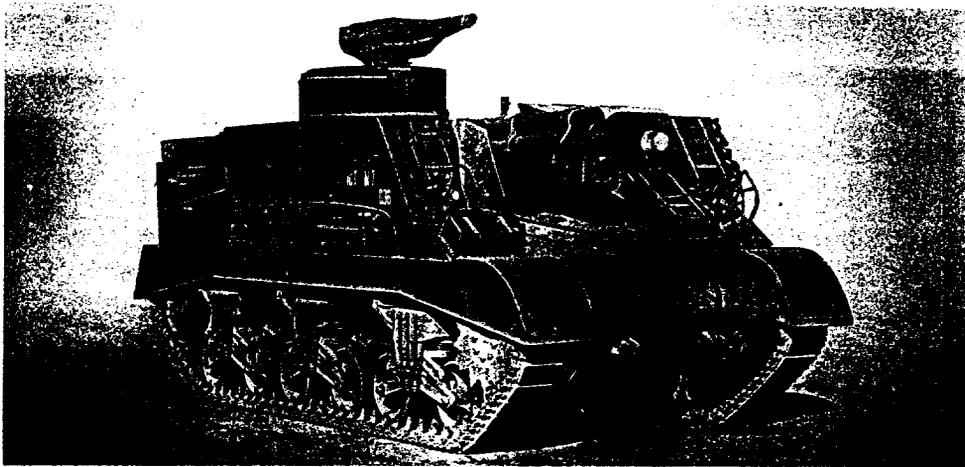
The crew of seven consists of the driver, chief of section, gunner, and four cannoners. The crew compartment is protected by  $\frac{1}{2}$ -in. armor at the front, sides, and rear, and is open at the top. The upper portion of the side and rear armor is hinged and held in position by lock pins. Grip handles, which serve as ladders leading to the crew compartment, are at both sides of the vehicle.

Direct vision for the driver is through a removable windshield and indirect vision through a protectoscope. The vehicle has five speeds forward and one reverse, the maximum speed being 24 m.p.h.

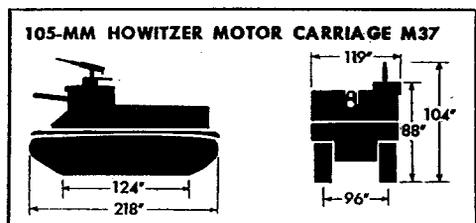
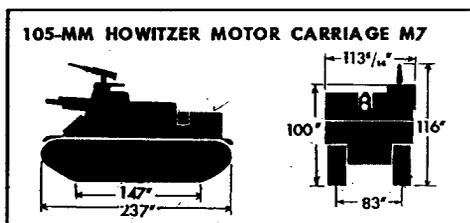
The pilot vehicle was manufactured by the American Locomotive Co.

REFERENCES—TM 9-731E; OCM 17760, 18007, 18120, 18151, 18226, 19327, 19525, 20680, 21002, 21211, 23540, 23712, 24984, 25812, 26429; SNL G-128.

**105-MM HOWITZER MOTOR CARRIAGE M7B1** is based on the Medium Tank M4A3 chassis and is powered by a Ford GAA, V-8, gasoline engine. Stand-



105-MM HOWITZER MOTOR CARRIAGE M7 USES MEDIUM TANK M3 CHASSIS



105-MM HOWITZER MOTOR CARRIAGE M37 HAS LIGHT TANK M24 CHASSIS

ardized in September 1943, it was reclassified as Substitute Standard in January 1945.

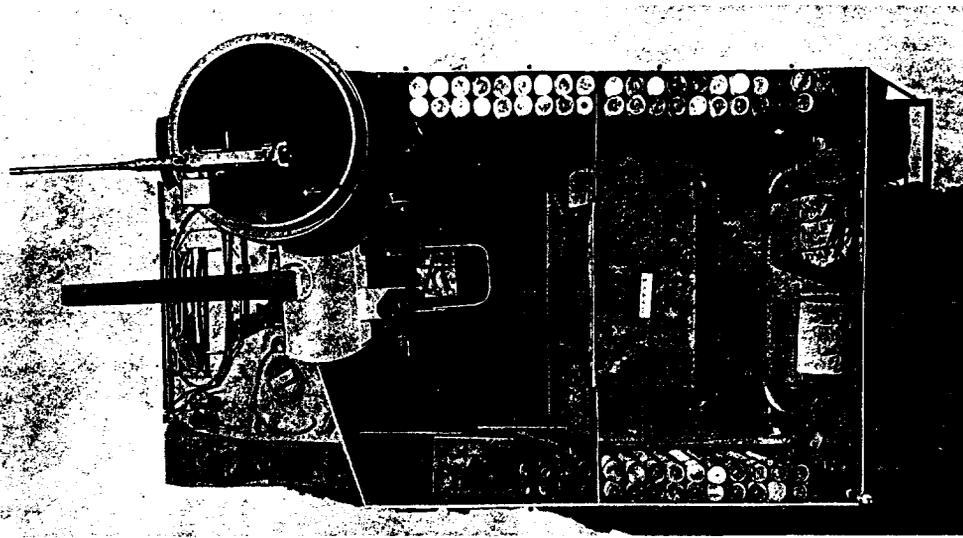
Physical characteristics and performance of this vehicle are generally similar to those of 105-mm Howitzer Motor Carriage M7, the only difference being in the variations of the respective tanks.

REFERENCES—TM 9-749; OCM21720, 25812, 26429; SNL G-199.

**105-MM HOWITZER MOTOR CARRIAGE M37** was standardized in Jan-

uary 1945. It is a lighter, more mobile, and less expensive 105-mm howitzer motor carriage than the earlier vehicles, which were based on medium tank chassis, and has better armor protection.

It is a full track-laying vehicle, with individual torsion bar suspension, driven from the front sprocket. Like the Twin 40-mm Gun Motor Carriage M19, it has a chassis similar to the Light Tank M24, forming another member of a combat team of vehicles designed for maximum interchangeability.



OVERHEAD VIEW OF THE M37, SHOWING OPEN FIGHTING COMPARTMENT

Shorter but wider than the 105-mm Howitzer Motor Carriages M7 and M7B1, the M37 provides greater working space for the crew members and increased space for ammunition stowage. Armor plate

1/2 in. thick affords protection at the front, sides, and rear of the vehicle, and also over the driver's compartment.

Principal armament is a 105-mm Howitzer M4, which when firing the HE shell at

a muzzle velocity of 1,550 feet per second and at an elevation of 44°, has a range of 12,205 yards. The howitzer, which is carried on Mount M5, can be elevated from -10° to +45° and can be traversed 22 1/2° left and 22 1/2° right. A Cal. .50 Machine Gun M2 HB (flexible) on a concentric ring mount is provided. Provision is made for carrying one cal. .45 submachine gun and six cal. .30 carbines.

Power is supplied by twin Cadillac engines through Hydra-Matic transmissions and a transfer unit with synchronizer that provide eight forward speeds up to 35 m.p.h. and four reverse speeds up to 18 m.p.h.

Indirect vision for the driver is provided by a periscope.

Provision is made for installing a telephone and reel unit, with interphone communication for the chief of section and the driver. A British No. 19 wireless set may be installed if 24 rounds of ammunition are removed.

REFERENCES—OCM 20679, 21009, 22304, 22435, 24883, 25812, 26429.

CHARACTERISTICS OF 105-MM HOWITZER MOTOR CARRIAGES M7, M7B1, M37

	M7*, M7B1**	M37†
<b>Crew</b> .....	7	7
<b>Physical Characteristics</b>		
Weight.....	50,634 lb.	40,000 lb.
Length.....	19 ft., 9 in.	18 ft., 2 in.
Width.....	9 ft., 5 5/16 in.	9 ft., 11 in.
Height.....	8 ft., 4 in.	7 ft., 4 in.
Over A. A. gun.....	9 ft., 8 in.	8 ft., 8 in.
Ground clearance.....	17 1/8 in.	17 in.
Tread (center to center of tracks).....	83 in.	96 in.
Ground contact length.....	147 in.	124 in.
Ground pressure.....	10.4 lb./sq. in.	10.1 lb./sq. in.
<b>Armament</b>		
105-mm Howitzer.....	M2A1 in Mount M4	M4 in Mount M5
Elevation.....	-5° to +35°	-10° to +45°
Traverse.....	30° right, 15° left	22 1/2° right, 22 1/2° left
1 Cal. .50 Machine Gun		
M2 HB (flexible).....	On ring mount	On ring mount
Provision for:		
Cal. .45 submachine guns.....	3	1
Cal. .30 carbines.....	0	6
<b>Ammunition, Stowage</b>		
105-mm.....	69 rounds	90 rounds
Cal. .50.....	300 rounds	900 rounds
Cal. .45.....	1,620 rounds	600 rounds
Hand Grenades.....	8	8
<b>Armor</b>	<b>Actual</b>	<b>Basis</b>
Hull, front, upper.....	1/2 in.	1/2 in.
Lower.....	2-4 1/4 in.	2-4 1/2 in.
Sides, upper.....	1/2 in.	1/2 in.
Lower.....	1 1/2 in.***	1 1/2 in.
Rear, upper.....	1/2 in.	1/2 in.
Lower.....	1 1/2 in.***	1 1/2 in.
Bottom, front.....	1 in.	1 in.
Rear.....	1/2 in.	1/2 in.
Top, forward.....		1/2 in.
Gun mount shield.....		1/2 in.
<b>Performance</b>		
Maximum speed on level.....	25 m.p.h.	35 m.p.h.
Maximum grade ability.....	60%	60%
Trench crossing ability.....	7 ft., 6 in.	7 ft.
Vertical obstacle ability.....	24 in.	42 in.
Fording depth (slowest forward speed).....	48 in.	42 in.
Turning diameter.....	62 ft.	40 ft.
Fuel capacity.....	179 gal.	115 gal.
Cruising range (approx.).....	85-125 miles	100-150 miles

<b>Vision and Fire Control</b>		
Periscope M6.....	0	2
Protoscope.....	1	0
Panoramic Telescope M12-A2, w/Instrument Light M19.....	1	1
On Mount M21A1, w/8-in. filler piece.....	1	0
On Mount T96.....	0	1
Telescope M76G (3-power), on Mount T95, w/Instrument Light M33.0	1	1
Elbow Telescope M16 or M16A1C.....	1	0
Telescope Mount M42.....	1	0
Instrument Light M36 (for M16A1C).....	1	0
Aiming Post M1, w/Aiming Post Light M14.....	2	2
Range Quadrant M4.....	1	0
Range Quadrant T14, w/Instrument Light M18.0	1	1
Gunner's Quadrant M1.....	1	1
Fuze Setter M22.....	1	1
<b>Communications</b>		
Flag Set M238.....	1	1
Panel Set AP50A.....	0	1
Provision for:		
Telephone EE-8-( ) and Reel Unit RL-39.....	0	1
Interphone RC-99.....	0	1
British Wireless Set No. 19.....	0	1††
<b>Battery, Voltage, total</b> .....	24	24
<b>Fire Protection and Decontamination</b>		
Fire Extinguisher CO <sub>2</sub> -10 lb. (fixed).....	2	2
CO <sub>2</sub> -4 lb. (hand).....	2	2
Decontaminating Apparatus, 1 1/2 qt.....	3	2

\*Other characteristics same as for Medium Tank M3.

\*\*Characteristics of M7B1 same as for M7 except: weight, 50,000 lb.; length, 20 ft., 3 1/4 in.; ground pressure, 10.3 lb./sq. in.; maximum speed, 26 m.p.h.; fording depth, 36 in.; fuel capacity, 168 gal.

\*\*\*Soft plate, minimum ballistics of 1/2-inch armor.

†Other characteristics same as for Light Tank M24.

††Displaces 18 rounds of 105-mm ammunition.

# SCOUT CAR M3A1—STANDARD

This vehicle, designed for high-speed scouting duty, consists of a specially designed, commercial type, 4-wheel truck chassis, surmounted by an armored body mounted on a double-drop type, channel section frame. It can attain a maximum road speed of 55 m.p.h. It was standardized in June 1939.

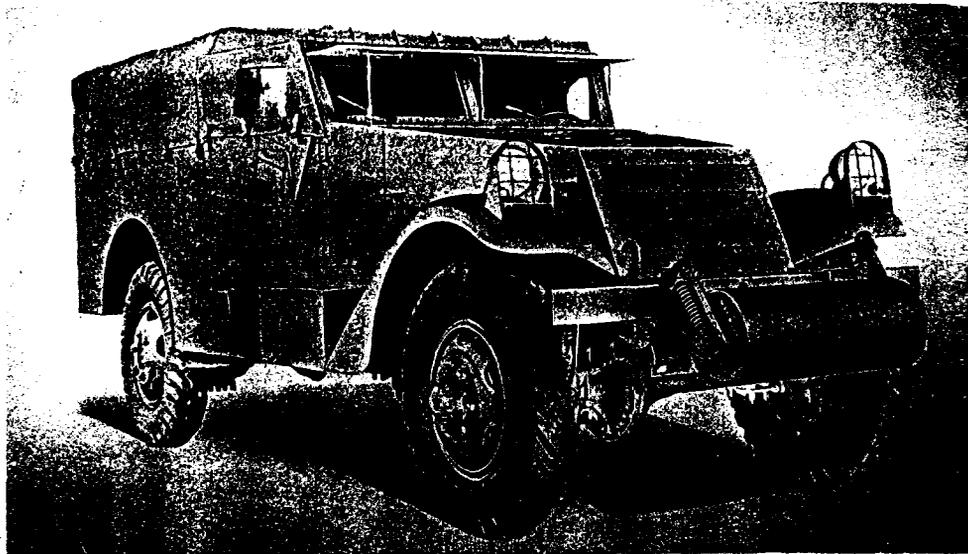
Seats are provided in the driver's compartment for the driver and the observation commander, and in the personnel compartment for six additional riders.

Armament consists of a cal. .50 and a cal. .30 machine gun. These can be fired from the skate rail which encircles the body interior and permits the gunners to aim in any direction, or on tripod mounts independently of the vehicle.

The body is protected by 1/4-inch armor on the sides and rear. Top and side protection for the engine is provided by the armored hood. Armored shutters, controlled from within the driver's compartment, protect the radiator.

The windshield is of shatter-proof glass. An armor plate windshield shield, 1/2-inch thick, with direct-vision slots, is hinged above the windshield, and other armor plate shields are hinged above the doors. These can be swung into position to provide additional protection in combat areas.

The detachable canvas top is supported by three removable bows and the wind-



SCOUT CAR M3A1 WITH TOP UP AND RADIATOR SHUTTERS CLOSED

shield frame. Side curtains are of canvas with pyralin windows.

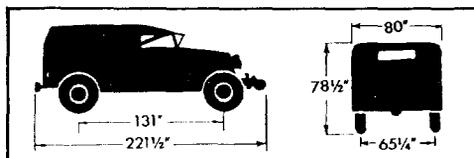
Ammunition racks are located at both sides of the personnel compartment, and space is provided between the front seats for additional ammunition or a radio set. The radio mast is mounted inside the body. Smaller sections for ammunition and water chests and a tool box are behind the front seats.

The vehicle is powered by a 6-cylinder Hercules 110 hp. gasoline engine. The pilot vehicle was built by the White Motor Co.

REFERENCES — TM 9-705, 9-1706 9-1709; OCM 13253, 13578, 13997, 14321 14386, 14965, 15064, 15948, 17919, 17952 18312, 20483, 20680, 20723, 21002 SNL G-67.

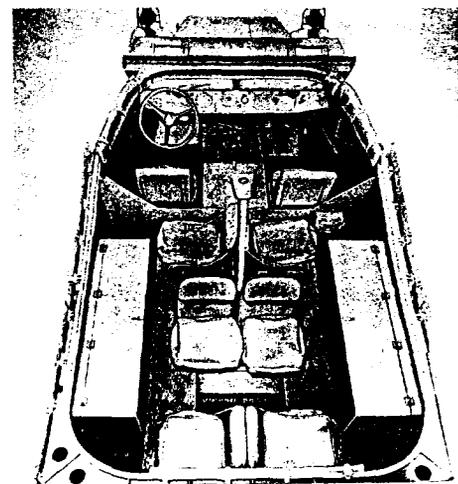
## TYPICAL CHARACTERISTICS

<b>Crew</b> .....	8
<b>Physical Characteristics</b>	
Weight (gross).....	12,400 lb.
Length.....	18 ft., 5 1/2 in.
Width.....	6 ft., 8 in.
Height.....	6 ft., 6 1/2 in.
Ground clearance.....	15 3/4 in.
Center of gravity, Above ground.....	33.9 in.
Rear of center line of front axle.....	81 in.
Tread (center to center, rear).....	65 1/4 in.
Wheelbase.....	131 in.
Ground pressure.....	60 lb./sq. in.
Tire equipment.....	8.25x20, combat
<b>Armament</b>	
1 Cal. .50 Browning Machine Gun M2 HB (flexible).....	Skate rail mount
1 Cal. .30 Browning Machine Gun M1919A4 (flexible).....	Skate rail mount
1 Cal. .30 Tripod Mount M2	
1 Cal. .50 Tripod Mount M3	
2 Cal. .30 or cal. .50 carriage assemblies	
1 Cal. .50 cradle assembly	
Provision for:	
1 Cal. .45 submachine gun	
<b>Ammunition, Stowage</b>	
Cal. .50.....	750 rounds
Cal. .45.....	540 rounds
Cal. .30.....	8,000 rounds



<b>Armor</b>		<b>Actual</b>
Windshield shield.....	1/2 in.	
Engine compartment.....	1/4 in.	
Sides and rear.....	1/4 in.	
<b>Performance</b>		
Maximum speed on level.....	50 m.p.h.	
Maximum grade ability.....	60%	
Vertical obstacle ability.....	12 in.	
Fording depth (slowest forward speed).....	28 in.	
Angle of approach.....	37°	
Angle of departure.....	35°	
Turning diameter.....	28 1/2 ft.	
Fuel capacity.....	30 gal.	
Cruising range.....	250 miles	
Maximum drawbar pull.....	6,155 lb.	
Vision—Direct.....	Slits in shields	
<b>Communications</b>		
Radio.....	SCR-506, 508, or 510	
Battery, Voltage, total.....	12	
<b>Fire Protection and Decontamination</b>		
Fire Extinguisher, CO <sub>2</sub> -2 lb. (hand).....	1	
Decontaminating Apparatus M2, 1 1/2 qt.....	1	
<b>Engine, Make and model..... Hercules JXD</b>		
Type.....	In-line, L.C.	
No. of cylinders.....	6	
Displacement.....	320 cu. in.	
Fuel (gasoline).....	70-80 octane	
Net hp.....	87 at 2,400 r.p.m.	
Max. torque.....	220 lb.-ft. at 1,150 r.p.m.	
<b>Transmission, Type... Combination sliding and constant mesh</b>		
<b>Gear ratios</b>		
First speed.....	5.00:1	
Second speed.....	3.07:1	
Third speed.....	1.71:1	
Fourth speed.....	1.00:1	
Reverse.....	5.83:1	

Transfer Case, Gear ratios.....	1.00:1; 1.87:
Steering, Type.....	Cam and twin lew
Differential, Gear ratio.....	5.14:
Suspension, Type.....	Semi-elliptic leaf spring
Clutch, Type.....	Dry, single-pla
Fan, Type.....	6-blad
Radiator, Type.....	Fin and tub
Capacity of system.....	19 c
Brakes, Type.....	Internal-expansio
Operation.....	Hydraul
Brakes, Parking, Type.....	Dr
Location.....	Rear of transfer ca



OVERHEAD VIEW, SHOWING SEATING

## HALF-TRACK CARS M2, M2A1—LIMITED STANDARD

## HALF-TRACK PERSONNEL CARRIERS M3, M3A1—LIMITED STANDARD

## HALF-TRACK CAR M3A2—STANDARD

Half-Track Car M2 and Half-Track Personnel Carrier M3, the basic half-track vehicles, were standardized in 1940 and used throughout 1941 and 1942. With the addition of ring mounts for antiaircraft use and with other modifications, their designations were changed to M2A1 and M3A1 respectively. All of these vehicles are now classified as Limited Standard and will be replaced in production by Half-Track Car M3A2.

Consisting of a specially designed, commercial-type, front-and-rear drive truck chassis with an armored hull, the half-track vehicle can attain a maximum road speed of 40 m.p.h. Because of its endless-band track-laying rear drive, however, it can be used over rough terrain. It will cross ditches which are not sufficiently deep to cause the front or rear to become embedded. Some models are provided with a roller at the front to assist in climbing out of ditches. On other models, the roller is replaced by a winch for use in towing the vehicle out of soft terrain.

The body is protected by  $\frac{1}{4}$ -in. armor at the sides and rear. Top and side protection is given the engine by the armored hood. The radiator is protected by armored shutters which can

be opened or closed or set in three intermediate positions from within the driver's compartment. The windshield is of shatter-proof glass.

For further protection, a  $\frac{1}{2}$ -in. armored shield is hinged above the windshield frame, held open by three supports, and additional armored shields are hinged to the doors. In combat zones, the windshield can be removed and these shields swung into place. They are provided with direct-vision slots.

The detachable top is of canvas and is supported by three removable bows and the windshield frame. Removable side curtains with transparent windows also are provided. Mine racks are mounted on the sides of late production models.

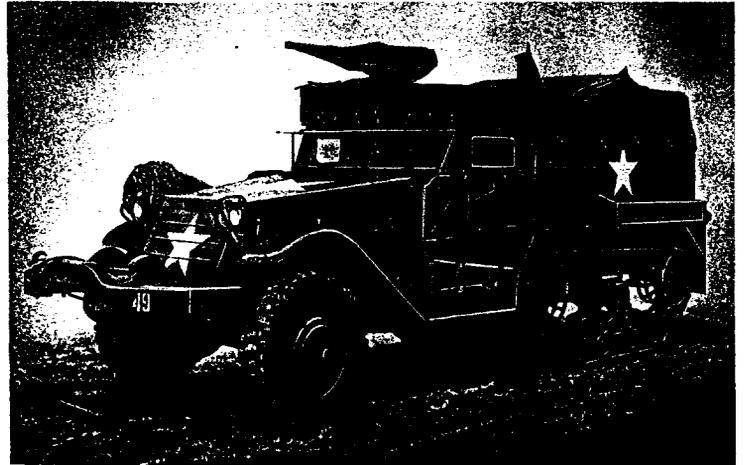
Power is supplied by a White 160AX gasoline engine.

**HALF-TRACK CAR M2—LIMITED STANDARD**, has seats for a crew of ten. A skate rail surrounds the interior of the vehicle. By the use of two carriage mounts, a cal. .30 and a cal. .50 machine gun can be moved along this rail and fired in any direction.

This vehicle can be used as a prime mover for the 105-mm howitzer.



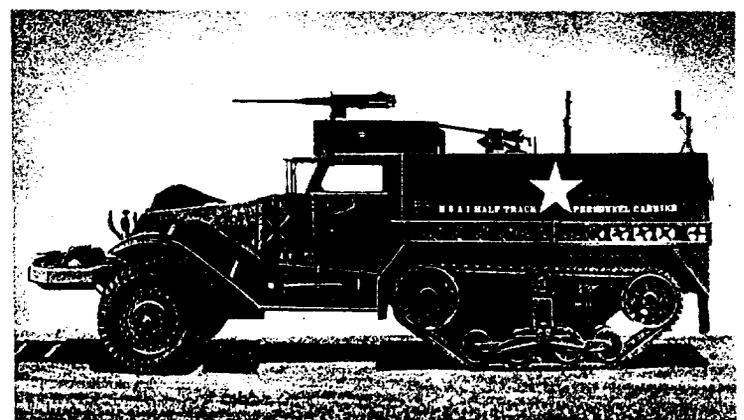
HALF-TRACK CAR M2 HAS GUN RAIL AROUND INTERIOR



HALF-TRACK CAR M2A1 HAS RING MOUNT FOR MACHINE GUN



HALF-TRACK PERSONNEL CARRIER M3 HAS PEDESTAL MOUNT



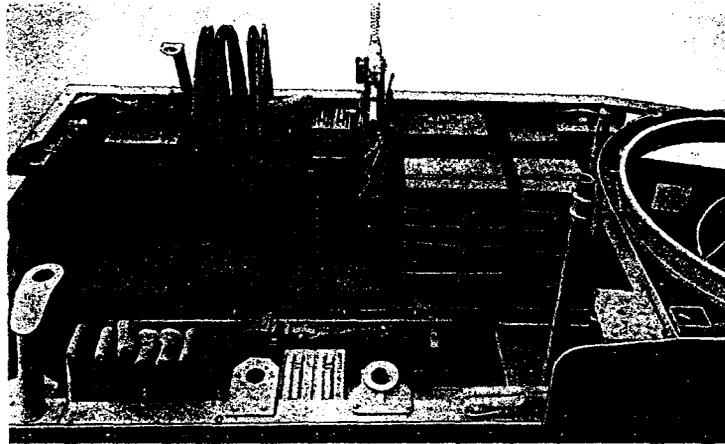
HALF-TRACK PERSONNEL CARRIER M3A1 WITH WINCH AT FRONT

## HALF-TRACK CARS M2, M2A1, M3A2—HALF-TRACK PERSONNEL CARRIERS M3, M3A1 (Continued)

**HALF-TRACK CAR M2A1—LIMITED STANDARD**, is similar to the M2 but has an M49 ring mount for cal. .50 machine gun over the assistant driver's seat. By use of this mount the cal. .50 HB machine gun can be traversed 360° from a single position, permitting rapid fire against low-flying aircraft as well as against ground targets. It can be elevated from -15° to +85°.

Three fixed pintle sockets are mounted, one on each side and one on the rear of the body, permitting the use of a cal. .30 machine gun.

**HALF-TRACK PERSONNEL CARRIER M3—LIMITED STANDARD**, is generally similar to the M2 but has seating accommodations for 13 men. The body is about 10 inches longer than on the M2 and has a door at the rear. Instead of a skate rail, the vehicle has an M25 pedestal mount for a cal. .30 machine gun, which is secured to the floor of the personnel compartment.



TYPICAL STORAGE ARRANGEMENT OF HALF-TRACK CAR M3A2

This half-track, with modifications, is used as the chassis for several gun motor carriages.

**HALF-TRACK PERSONNEL CARRIER M3A1—LIMITED STANDARD**, is similar to the M3 but has an M49 ring mount for a cal. .50 machine gun over the assistant driver's seat.

Three pintle sockets are mounted, one on each side and one on the rear of the body.

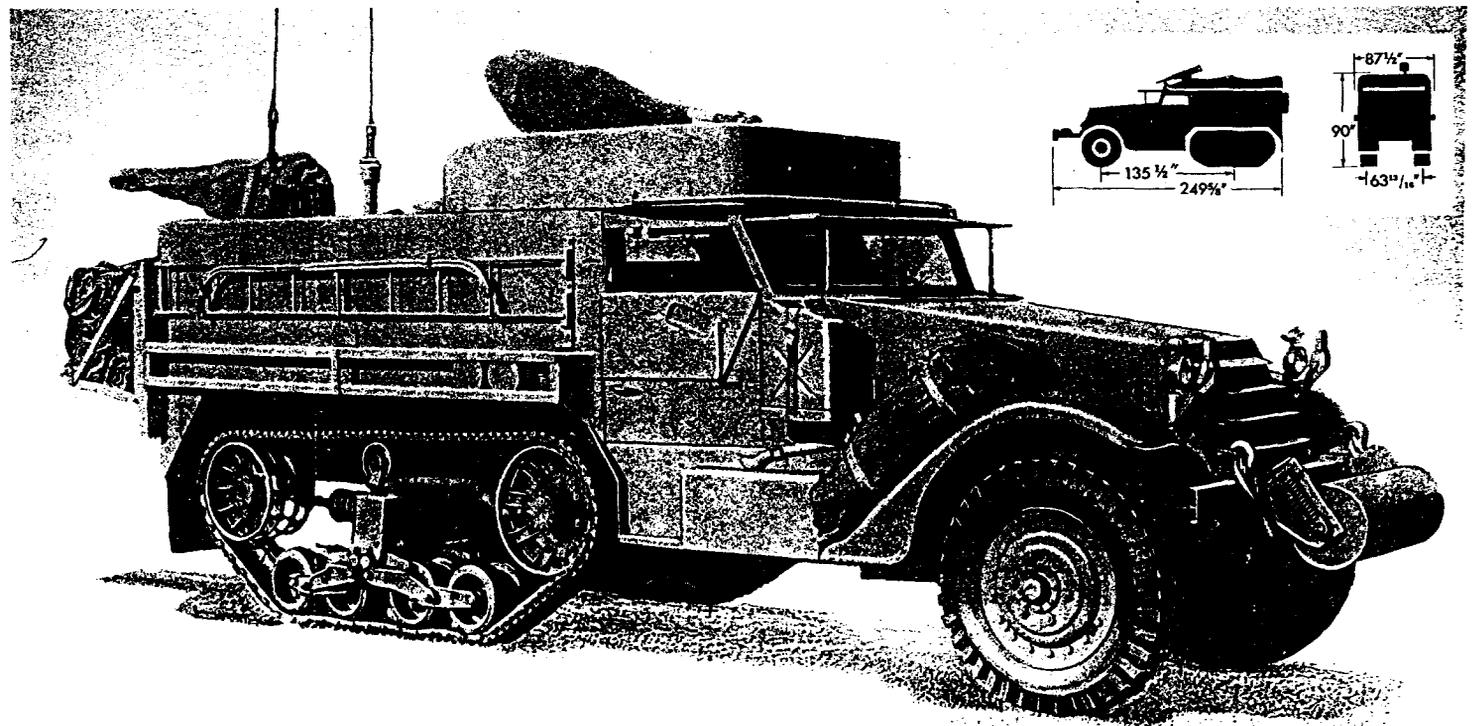
**HALF-TRACK CAR M3A2—STANDARD**, is a modification of the Half-Track Personnel Carrier M3A1 designed to take the place of Half-Track Personnel Carriers M3 and M3A1, and Half-Track Cars M2 and M2A1.

Variations in stowage arrangements, through the use of suitable boxes, give the vehicle a variety of uses. Crews range from 5 to 12 men, depending on the amount of stowage carried and the tactical purpose intended.

Normally the vehicle mounts one cal. .50 machine gun or one cal. .30 machine gun, together with the required vehicular accessories, tools, spare parts, and equipment which are provided for all half-tracks. Under such circumstances, a crew of 12 can be carried. Three pintle sockets are provided to accommodate additional machine guns when authorized.

When the vehicles carry special loadings or have radios installed, personnel are displaced. As an example, if an SCR-50 radio is installed, the crew is reduced by two men.

The basic vehicle is equipped to stow and carry 330 rounds of cal. .50 ammunition and 2,000 rounds of cal. .30 ammunition. When used as a machine gun squad carrier, however, additional ammunition is carried in place of two of the seat position. When used by a heavy machine gun squad armed with water-cooled machine guns, these guns and their accessories are substituted for the air-cooled cal. .30 machine gun.



HALF-TRACK CAR M3A2 WITH FRONT ROLLER. VEHICLE HAS RING MOUNT AND THREE PINTLE MOUNTS FOR MACHINE GUNS. IT SEATS 5 TO 12 MEN.

**HALF-TRACK CARS M2, M2A1, M3A2—HALF-TRACK PERSONNEL CARRIERS M3, M3A1** (Continued)

Miscellaneous equipment boxes are provided for carrying additional stowage items pertaining to special loading of different organizations. When the vehicle is used to carry cargo in considerable quantity, fewer personnel are carried.

Half-Track Car M3A2 is intended for manufacture by the Autocar Co., the Diamond T Motor Co., and the White Motor Co.

A Ring Mount M49, for a cal. .50 machine gun, is erected above the assistant driver's seat, for use against low-flying aircraft. A one-piece armor shield protects the machine gunner.

REFERENCES—TM 9-710, 9-710A; OCM 16112, 16187, 16410, 16679, 17952, 18312, 18394, 20070, 20368, 20438, 20680, 21002, 21501, 21782; SNL G-102, Vols. 1, 2, 3, 4.

**TYPICAL CHARACTERISTICS**

	<b>M2</b>	<b>M2A1</b>	<b>M3</b>	<b>M3A1</b>	<b>M3A2</b>
<b>Crew</b> .....	10	10	13	13	5 to 12
<b>Physical Characteristics</b>					
Weight (gross).....	19,800 lb.	19,600 lb.	20,000 lb.	20,500 lb.	21,200 lb.
Length—with roller.....	19 ft., 6 <sup>3</sup> / <sub>4</sub> in.	19 ft., 6 <sup>3</sup> / <sub>4</sub> in.	20 ft., 3 <sup>1</sup> / <sub>2</sub> in.	20 ft., 3 <sup>1</sup> / <sub>2</sub> in.	20 ft., 3 <sup>1</sup> / <sub>2</sub> in.
with winch.....	20 ft., 15 <sup>7</sup> / <sub>8</sub> in.	20 ft., 15 <sup>7</sup> / <sub>8</sub> in.	20 ft., 9 <sup>5</sup> / <sub>8</sub> in.	20 ft., 9 <sup>5</sup> / <sub>8</sub> in.	20 ft., 9 <sup>5</sup> / <sub>8</sub> in.
Width—without mine racks.....	6 ft., 5 <sup>1</sup> / <sub>4</sub> in.	6 ft., 5 <sup>1</sup> / <sub>4</sub> in.	6 ft., 5 <sup>1</sup> / <sub>4</sub> in.	6 ft., 5 <sup>1</sup> / <sub>4</sub> in.	6 ft., 5 <sup>1</sup> / <sub>4</sub> in.
with mine racks.....	7 ft., 3 <sup>1</sup> / <sub>2</sub> in.	7 ft., 3 <sup>1</sup> / <sub>2</sub> in.	7 ft., 3 <sup>1</sup> / <sub>2</sub> in.	7 ft., 3 <sup>1</sup> / <sub>2</sub> in.	7 ft., 3 <sup>1</sup> / <sub>2</sub> in.
Height—overall.....	7 ft., 5 in.	8 ft., 10 in.	8 ft., 5 in.	8 ft., 10 in.	8 ft., 10 in.
Ground clearance.....	11 <sup>3</sup> / <sub>16</sub> in.	11 <sup>3</sup> / <sub>16</sub> in.	11 <sup>3</sup> / <sub>16</sub> in.	11 <sup>3</sup> / <sub>16</sub> in.	11 <sup>3</sup> / <sub>16</sub> in.
Tread—front.....	64 <sup>1</sup> / <sub>2</sub> in.	64 <sup>1</sup> / <sub>2</sub> in.	64 <sup>1</sup> / <sub>2</sub> in.	64 <sup>1</sup> / <sub>2</sub> in.	64 <sup>1</sup> / <sub>2</sub> in.
rear.....	63 <sup>13</sup> / <sub>16</sub> in.	63 <sup>13</sup> / <sub>16</sub> in.	63 <sup>13</sup> / <sub>16</sub> in.	63 <sup>13</sup> / <sub>16</sub> in.	63 <sup>13</sup> / <sub>16</sub> in.
Wheelbase.....	135 <sup>1</sup> / <sub>2</sub> in.	135 <sup>1</sup> / <sub>2</sub> in.	135 <sup>1</sup> / <sub>2</sub> in.	135 <sup>1</sup> / <sub>2</sub> in.	135 <sup>1</sup> / <sub>2</sub> in.
Ground contact length.....	46 <sup>3</sup> / <sub>4</sub> in.	46 <sup>3</sup> / <sub>4</sub> in.	46 <sup>3</sup> / <sub>4</sub> in.	46 <sup>3</sup> / <sub>4</sub> in.	46 <sup>3</sup> / <sub>4</sub> in.
Tire equipment (combat, 12-ply).....	8.25 x 20	8.25 x 20	8.25 x 20	8.25 x 20	8.25 x 20
<b>Armament</b>					
Cal. .50 Machine Gun M2, HB (flexible).....	1	1		1	1
Cal. .30 Browning Machine Gun M1919A4 (flexible).....	1	1	1	1	1
Pedestal Mount M25.....			1		
Ring Mount M49 for cal. .30 or cal. .50 Machine Gun.....	1	1		1	
Carriage assembly.....	1	1		1	
Cradle assemblies.....	2	2	1	2	
Cal. .50 Tripod Mount M3.....	1	1		1	1
Cal. .30 Tripod Mount M2.....	1	1	1	1	1
Machine Gun Mounts M35.....	2	2			
Provision for:					
Rocket Launcher, AT, 2.36-in., M9 or M1A1.....					1
Cal. .45 Submachine Gun M3 or M1928A1.....	1	1	1	1	1
Cal. .30 Rifles M1 or Carbines M1.....			12	12	12
<b>Ammunition, Stowage</b>					
Cal. .50.....	700 rounds	700 rounds	700 rounds	700 rounds	330 rounds*
Cal. .30.....	7,750 rounds	7,750 rounds	4,000 rounds	7,750 rounds	2,000 rounds*
Cal. .45.....	540 rounds	540 rounds	540 rounds	540 rounds	180 rounds
Rockets, Grenade, AT, 2.36-in., M6.....					6
Grenades, Hand (Fragmentation, Mk. II; Smoke, WP, M15; Smoke, Colored, M6 or M18).....	10	10	22	22	24
Mines, AT, H.E., w/Fuze M1.....	14	14	24	24	24
<b>Armor—Front</b> ..... 1/4 in.					
Sides and rear..... 1/4 in., F.H.					
Windshield protective plate..... 1/2 in.					
<b>Performance</b>					
Maximum speed on level..... 40 m.p.h.					
Maximum grade ability..... 60%					
Vertical obstacle ability..... 12 in.					
Fording depth (slowest forward speed)..... 32 in.					
Turning radius..... 30 ft.					
Fuel capacity..... 60 gal.					
Cruising range (approx.)..... 175 miles					
<b>Vision</b>					
Driver..... Slits in windshield and wingshield					
<b>Communications</b>					
Radio..... SCR-193 or 506, and 508 and 593; 284 and 508 and 593; 193 or 506, and 508 or 528 or 510 or 608 or 610 or 628. (Or any of these individually)					
<b>Battery, Voltage, total</b> ..... 12					
<b>Fire Protection and Decontamination</b>					
Fire Extinguisher, CO <sub>2</sub> -4 lb. (hand)..... 1					
Decontaminating Apparatus M2, 1 1/2 qt..... 3					
<b>Engine, Make and model</b> ..... White 160AX					
Type..... In-line, "L"					
No. of cylinders..... 6					
Cycle..... 4					
Fuel (gasoline)..... 80 octane					
Bore and stroke..... 4 x 5 1/8 in.					
Displacement..... 386 cu. in.					
Compression..... 6.3:1					
Net hp..... 128 at 2,800 r.p.m.					
Max. torque..... 300 lb.-ft. at 1,200 r.p.m.					
Crankshaft rotation..... C-Clockwise					
Length..... 52 1/4 in.					
Width..... 26 in.					
Height..... 37 in.					
Ignition..... Battery					
Weight, dry..... 1,015 lb.					
Weight, installed..... 1,207 lb.					
<b>Transmission, Gear ratios</b>					
First speed..... 4.92:1					
Second speed..... 2.60:1					
Third speed..... 1.74:1					
Fourth speed..... 1.00:1					
Reverse..... 4.37:1					
<b>Transfer Case</b>					
Gear ratios..... 1.00:1; 2.48:1					
<b>Differential, Track Drive, Gear ratio</b> ..... 4.444:1					
Ring gear, No. of teeth..... 40					
Pinion, No. of teeth..... 9					
<b>Differential, Front Axle, Gear ratio</b> ..... 6.8:1					
Ring gear, No. of teeth..... 34					
Pinion, No. of teeth..... 5					
Steering ratio..... 23.4, 19.5, 23.4:1					
<b>Final Drive</b>					
Sprocket, No. of teeth..... 18					
Pitch diameter..... 22.918 in.					
<b>Suspension, Track, Type</b> ..... Volute spring					
Wheel or tire size..... 12 x 4 1/8 dual					
<b>Suspension, Front</b>					
Type (longitudinal leaf)..... Semi-elliptic					
Wheel or tire size..... 8.25 x 20					
Wheel construction..... Ventilated disk					
<b>Idler, Wheel size</b> ..... 12 1/2 x 9 3/8					
<b>Track, Type</b> ..... Endless band					
Width..... 12 in.					
Pitch..... 4 in.					
<b>Master Clutch, Type</b> ..... Dry, single plate					
<b>Radiator, Type</b> ..... Fin and tube					
Capacity of system..... 26 qt.					
<b>Brakes, Type</b> ..... Internal expanding					
Operation..... Hydraulic					
<b>Brakes, Parking, Type</b> ..... Disk					
*When organizational use of vehicle requires it, 600 rounds of additional cal. .50 ammunition or 6,000 rounds of additional cal. .30 ammunition are carried, and personnel capacity is reduced by two men.					

# 1/4-TON, 4X4, TRUCK—STANDARD

This vehicle, popularly called the "jeep," is one of the outstanding automotive developments of this war. Developed by the Quartermaster Corps, it and other motor transport vehicles were transferred to the Ordnance Department in August, 1942.

It has been found useful in a variety of ways, and despite its light weight has been able to function under rigorous conditions. Operated by a crew of two, it has a space for equipment or additional personnel.

The truck is capable of operation over unimproved roads, trails, and open, rolling, and hilly cross country. It will climb a 60% grade, and will operate at a speed of 65 m.p.h. on level highways. It can ford a stream 18 inches deep, while fully equipped and loaded. It has a cruising range of approximately 300 miles on 15 gallons of gasoline.

Towing a 37 mm antitank gun, it will climb a 7% grade, and can achieve a speed of 20 m.p.h. on a level highway.

Power is supplied by a four-cylinder L head gasoline engine equipped with a counter-balanced crankshaft. The clutch is a single-plate, dry-disk type. The transmission is of the three-speed, synchromesh type, which, through a transfer case, provides six speeds forward and two reverse.

The vehicle has internal-expanding, hydraulic four-wheel brakes and a mechanical handbrake.

A base plate is provided for a pedestal mount for a cal. .30 or a cal. .50 machine gun. The infantry uses the Cal. .30 Machine Gun Mount, M48, on the dash, and other arms use the Pedestal Truck Mount, M31.

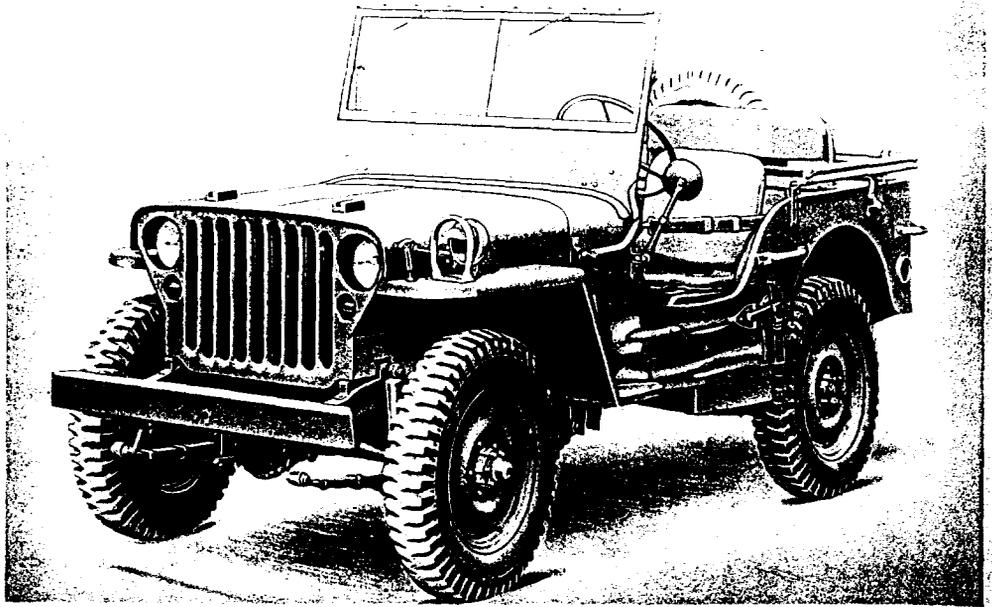
Provision is made for a lighting socket connection for a trailer, and for a radio outlet. The windshield may be folded down over the hood when desired. A removable canvas top is provided.

Desert equipment includes a radiator surge tank, a power-driven air compressor, a low-pressure tire gage, a 3-inch copper fin radiator, and a fuel filter, relocated to minimize vapor lock.

A tandem hitch makes it possible to use two of these vehicles for emergency towing of a 155 mm howitzer. When used in this way, speed is limited to 30 m.p.h. on level highway, and 10 m.p.h. down hill.

The vehicles are produced, to identical specifications, by the Willys-Overland Motors, Inc., and the Ford Motor Co.

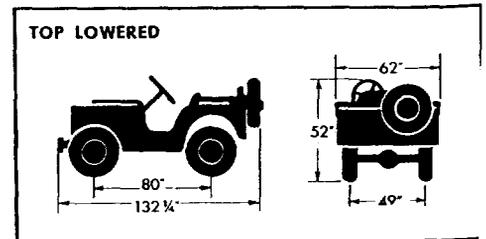
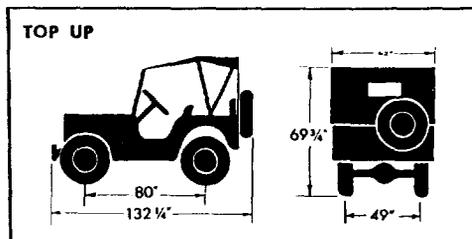
REFERENCES—MCM 8c; TM 10-1207, 10-1349; OCM 19107, 19549, 21179, 21221, 21590, 21788.



THE POPULAR "JEEP" TRANSPORTS PERSONNEL AND CARGO; TOWS GUNS OR 1/4-TON TRAILER

## TYPICAL CHARACTERISTICS

<b>Crew</b> .....	2	<b>Cycle</b> .....	4
<b>Physical Characteristics</b>		<b>Fuel (gasoline)</b> .....	68 octane
Weight (gross) .....	3,253 lb.	<b>Bore and stroke</b> .....	3 1/8 x 4 3/8 ins.
Length .....	11 ft., 1/4 in.	<b>Displacement</b> .....	134.2 cu. ins.
Width .....	5 ft., 2 ins.	<b>Compression ratio</b> .....	6.48:1
Height—top of cowl .....	3 ft., 4 ins.	<b>Net h.p.</b> .....	54 at 4,000 r.p.m.
top of steering wheel .....	4 ft., 4 ins.	<b>Max. torque</b> .....	105 lb.-ft. at 2,000 r.p.m.
with top up .....	5 ft., 9 3/4 ins.	<b>Crankshaft rotation</b> .....	C'Clockwise
Ground clearance .....	8 3/4 ins.	<b>Length</b> .....	27 ins.
Wheelbase .....	80 ins.	<b>Width</b> .....	29 1/2 ins.
Tread (center to center of tires) .....	49 ins.	<b>Height</b> .....	26 3/4 ins.
Ground pressure .....	20.8 lb./sq. in.	<b>Ignition</b> .....	Battery
Tire equipment. 6.00x16, 6 ply (mud and snow)		<b>Weight</b> .....	355 lb.
<b>Armament</b>		<b>Master Clutch, Type</b> .....	Dry, single plate
Provision for one cal. .30 or cal. .50 machine gun		<b>Radiator, Type</b> .....	Fin and tube
<b>Performance</b>		<b>Capacity of system</b> .....	11 qts.
Maximum speed on level .....	65 m.p.h.	<b>Transmission, Gear ratios</b>	
with towed load .....	20 m.p.h.	First speed .....	2.67:1
Maximum grade ability .....	60%	Second speed .....	1.56:1
with towed load .....	45%	Third speed .....	1.00:1
Angle of approach .....	45°	Reverse .....	3.55:1
Angle of departure .....	35°	<b>Transfer case, Gear ratio, Low</b> .....	1.97:1
Fording depth .....	18 ins.	High .....	1.00:1
Fuel capacity .....	15 gals.	<b>Differential, Gear ratio</b> .....	4.88:1
Cruising range (approx.) .....	300 miles	Type of drive .....	Hypoid bevel
with towed load .....	260 miles	<b>Steering ratio</b> .....	14, 12, 14:1
Normal towed load (37 mm gun carriage or 1/4-ton, 2-wheel, cargo trailer) .....	1,000 lb.	<b>Suspension, Type</b> .....	Semi-elliptic
Payload (including driver and assistant) .....	800 lb.	Wheel construction .....	Divided
Turning radius .....	17 1/2 ft.	<b>Brakes, Type</b> .....	Internal Hydraulic
<b>Communication</b> .....	Radio outlet	<b>Brakes, Parking, Type</b> .....	External Contracting
<b>Battery, Voltage</b> .....	6-12	<b>Front Axle, Type</b> .....	Full floating
<b>Engine, Type</b> .....	"L" head	<b>Rear Axle, Gear ratio</b> .....	4.88:1
<b>No. of cylinders</b> .....	4		



**CATALOGUE OF**  
**STANDARD**  
**ORDNANCE**  
**ITEMS**

**SECOND EDITION 1944**

**VOLUME II**



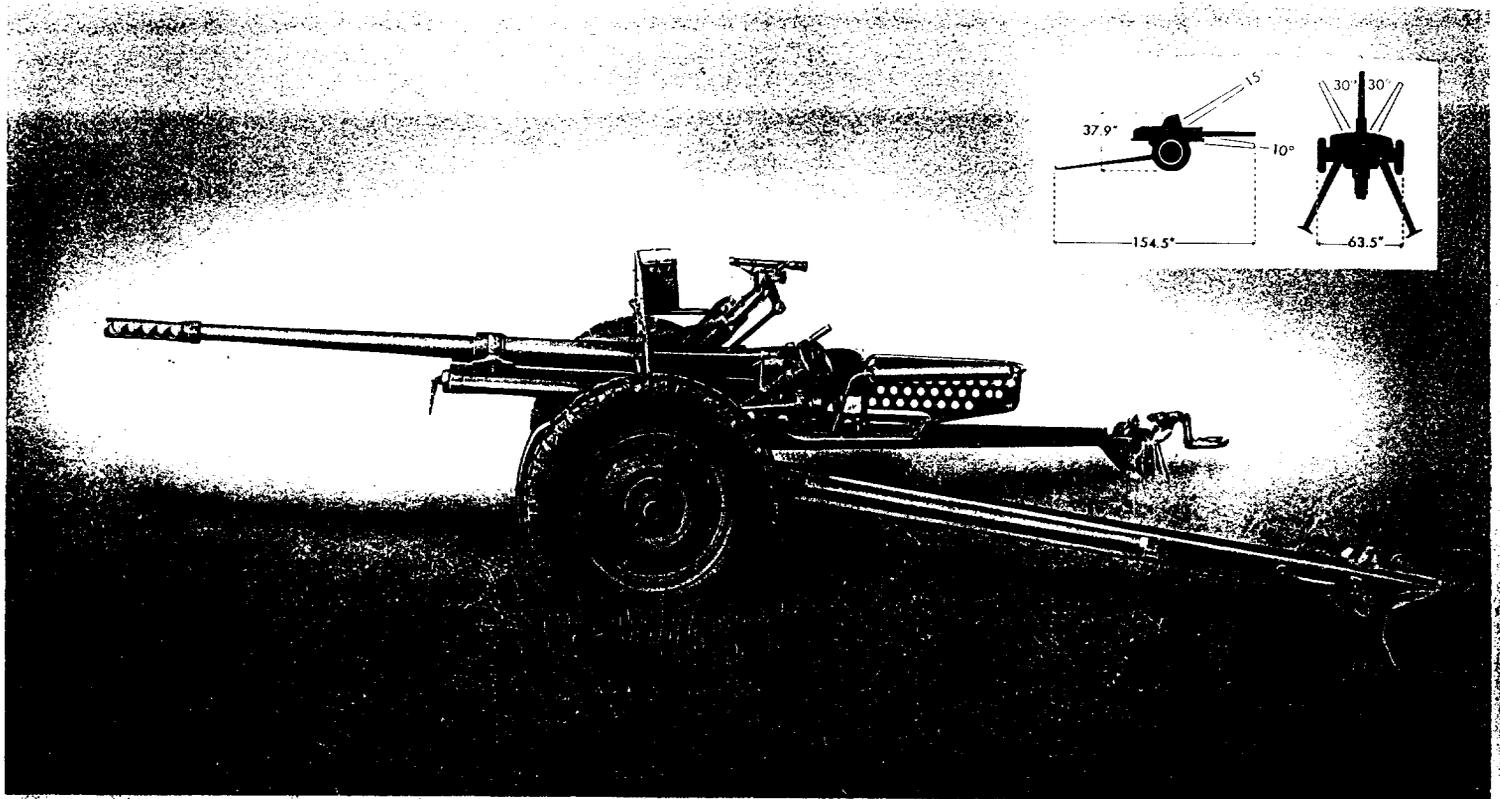
**Office of the**  
**Chief of Ordnance**  
**Technical Division**

**WASHINGTON, D. C.**

**C O N F I D E N T I A L**

**RESTRICTED**

# 37 MM ANTITANK GUN M3A1—CARRIAGE M4A1—STANDARD



LEFT SIDE VIEW OF THE 37 mm GUN, M3A1, ON THE M4A1 CARRIAGE, SHOWING GAS DEFLECTOR NO LONGER USED ON THIS GUN

## PRINCIPAL CHARACTERISTICS

### GUN, M3A1

Weight	191 lb.
Length (overall) of gun	6 ft., 10½ ins.
Length of bore	53.5 calibers
Muzzle velocity	2,900 f./s.
Volume of chamber	19.92 cu. ins.
Travel of projectile in bore	69.95 ins.
Maximum powder pressure	50,000 lb./sq. in.
Type of mechanism	Drop block
Rate of fire (approximate)	25 rds./min.
Range	12,850 yds.

### RECOIL MECHANISM

Type	Hydrospring
Weight	77½ lb.
Normal recoil (- 1 in. + ½ in.)	20 ins.

### AMMUNITION

	M63, H.E.	M74, A.P.	M51B2, A.P.C.
Weight of complete round	3.13 lb.	3.14 lb.	3.43 lb.
Weight of projectile (as fired)	1.61 lb.	1.92 lb.	1.92 lb.
Weight of bursting charge	.085 lb.	.0 lb.	.0 lb.
Weight of powder charge	.49 lb.	.32 lb.	.53 lb.
Type of ammunition	Fixed	Fixed	Fixed
Muzzle velocity	2,600 f./s.	2,900 f./s.	2,900 f./s.
Armor penetration homogeneous plate			
20° from normal— 500 yds.	1.4 ins.		2.4 ins.
1,000 yds.	1.0 in.		2.1 ins.

Maximum recoil	20½ ins.
Spring pressure (average)	217 lb.
Maximum piston-rod pull	6,000 lb.

### CARRIAGE, M4A1

Total weight without gun	721 lb.
Height of lunette (limbered position)	29½ ins.
Length of carriage from muzzle to lunette	154½ ins.
Width over hub caps	63½ ins.
Height (traveling position)	37⅞ ins.
Trail spread (maximum) (included angle)	60°
Elevation (maximum), carriage on wheels	15°
Depression (maximum), carriage on wheels	-10°
Traverse (maximum, right)	30°
Traverse (maximum, left)	30°

The 37 mm guns are the lightest weapons of the field-gun type used in the U.S. Army. The original 37 mm gun supplied to the U.S. Army in 1917-18 was the M1916, of French design. It was a comparatively low-velocity weapon not suited for antitank employment.

The 37 mm Gun, M1916, is classified as Limited Standard for manufacture, but as Standard for issue, with its cradle, as subcaliber equipment. The Carriages, M1916, M1916A1 and M1916A2 are also Limited Standard.

The desirability of a light, highly mobile antitank gun, using armor-piercing and high-explosive shells, resulted in the production of the 37 mm antitank matériel whose design features closely resemble the German Rheinmetall weapon.

The 37 mm Antitank Gun, M3, represents the most powerful piece that has been manufactured to weigh less than 1,000 pounds. Recent developments in ammunition have increased the muzzle velocity from 2,600 feet per second to 2,900 feet per second, with consequently greater armor penetration.

**GUN, M3**—The rifled barrel is a one-piece forging threaded to screw into a breech ring recessed for a vertically sliding block which is operated manually. The recoil system is of the hydrospring type, including a buffer mechanism which prevents possible damage to the weapon due to sudden stopping of the recoiling parts. The estimated life of the gun at normal pressure is approximately 2,500 rounds.

**GUN, M3A1**—Addition of gas deflectors to the M3 gun changed its designation to M3A1. These gas deflectors were subsequently removed, but all 37 mm, M3, guns with muzzles threaded for gas deflectors are now designated M3A1.

**CARRIAGE, M4**—This carriage has a split trail and pneumatic tires. It can be towed by a prime mover on roads or across country, and by its crew. Elevating and traversing mechanisms are attached to the mount. Adjustments in traverse are normally made by the use of the traversing handwheel, although a traversing release handle allows rapid changes in traverse through free movement of the gun. The handle must be held in position during free traverse, for on release of the handle the gun is automatically locked to the traversing mechanism.

In order to increase stability of the gun during firing, wheel segments which swing on the axle raise the tires off the ground. The segments are locked in both travel and firing positions by a handle-actuated plunger.

The Telescope, M6, is held in position by the Telescope Mount, M19, which is attached to the gun carriage by means of a bracket, assuring movement of the sight with the gun during traverse.

While a 37 mm gun squad consists of six men, the Carriage, M4, is designed for one-man control of aiming, elevating, traversing and firing.

Carriage, M4, is classified as Limited Standard.

**CARRIAGE, M4A1**—This carriage is identical with the Carriage, M4, except that for quick adjustment of the gun in traverse a release mechanism permits traverse to be effected by pressure of the right shoulder and arm against the shoulder traversing bar so long as the traversing release handle is locked to the rear. With the traversing release handle in its forward position, the gun may be traversed by use of a traversing knob.

The classification of this carriage is Standard.

## Sighting and Fire Control Equipment

### On Carriage Equipment

Telescope, M6

Telescope Mount, M19

### Off Carriage Equipment

Lensatic compass

Bore sight

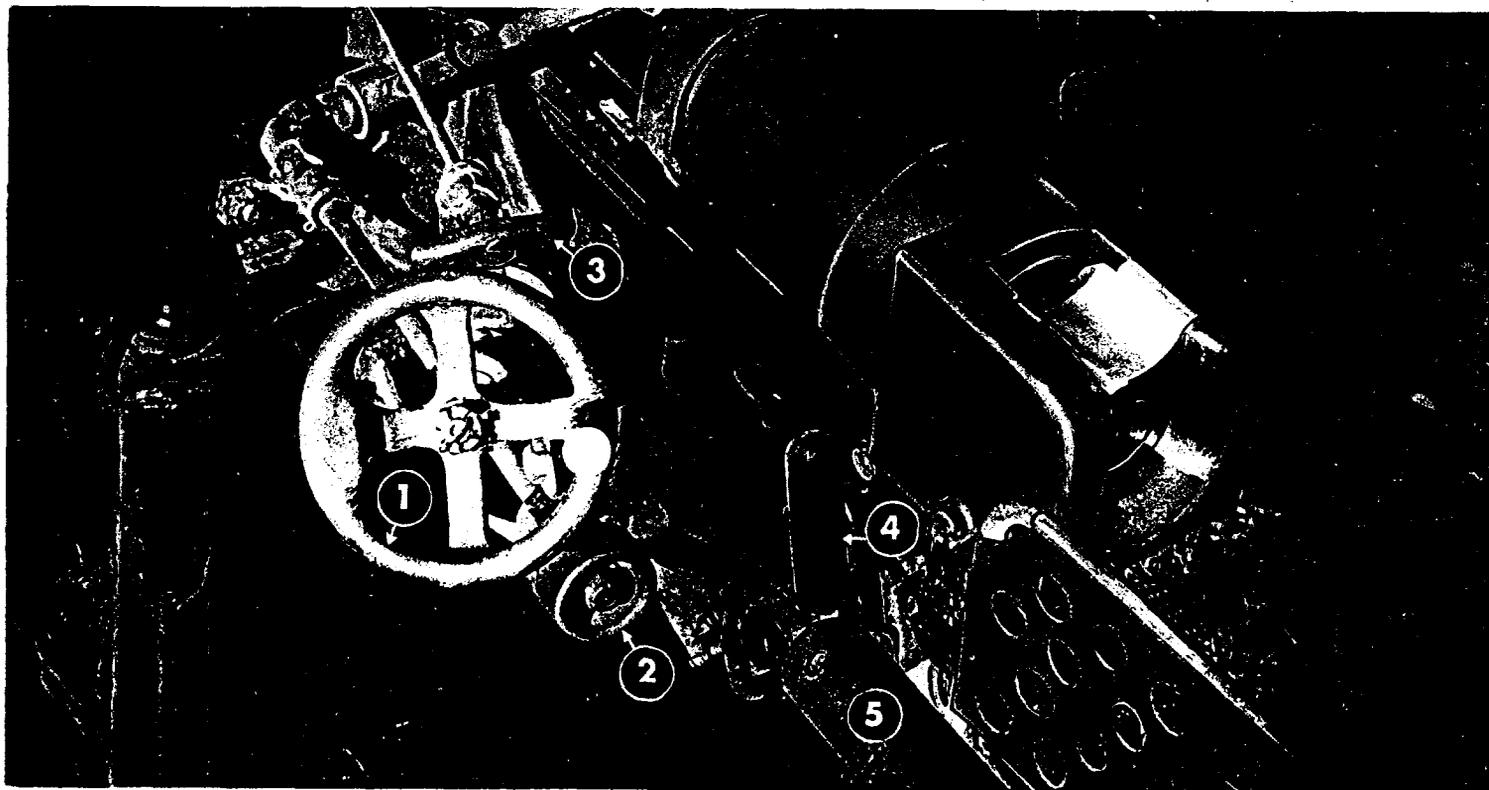
## Ammunition

Ammunition for the 37 mm gun is in the form of fixed rounds. It consists of A.P.C. Shot, M51B1, with tracer; H.E. Shell, M63, with B.D. fuze, M58; canister, M2; A.P. Shot, M74, with tracer; T.P. Shot, M51, with tracer, and Drill Cartridge, M13.

## Trainers

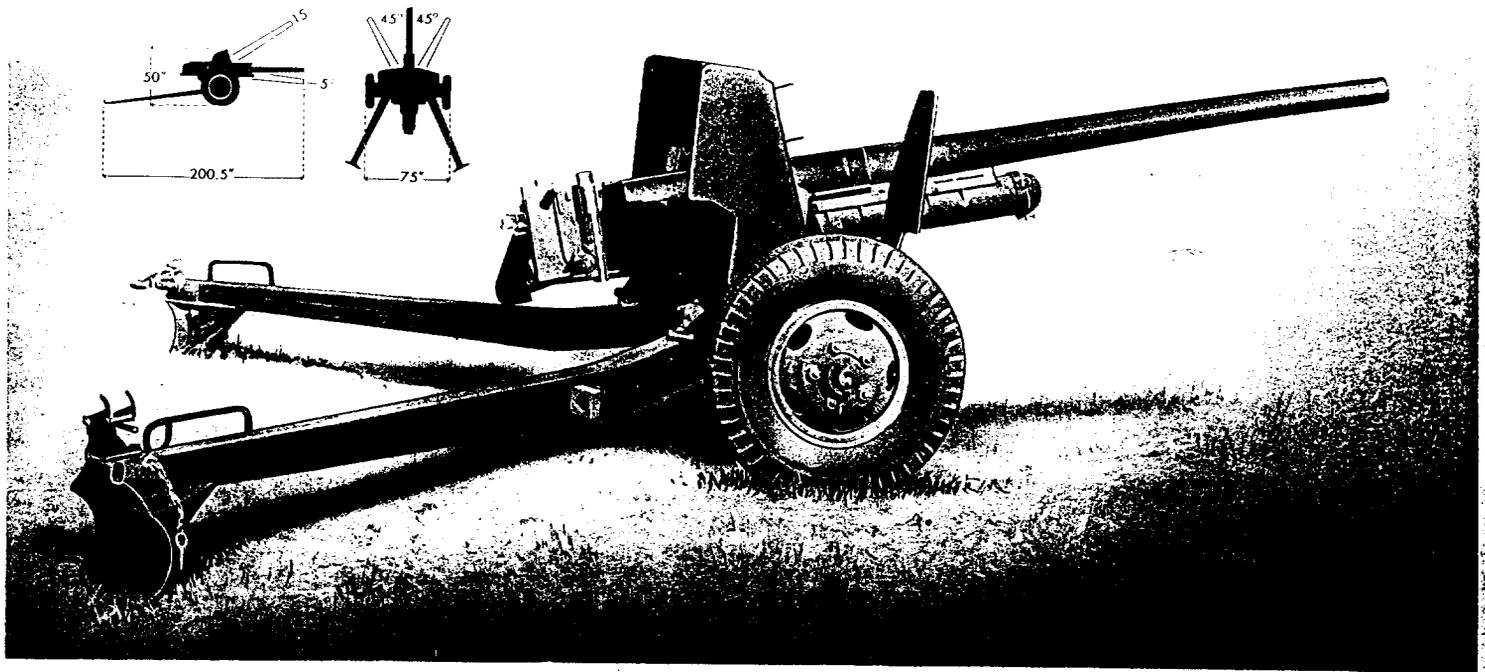
Subcaliber equipment for 37 mm guns comprises the rifle, subcaliber, cal. .22, M2A1, and the rifle, subcaliber, cal. .30, M1903A2, both minus the stock and front and rear sights, together with mount, subcaliber, cal. .22-.30, M6. Rifles and mount are classified as Standard.

REFERENCES—FM 23-70; TM 9-2005, v.3.



BREECH VIEW OF 37 mm GUN, M3A1, Showing (1) Elevating Wheel; (2) Traversing Wheel; (3) Traversing Lock and Lever; (4) Trigger-actuating Handle; (5) Shoulder and Arm Traversing Bar

# 57 MM ANTITANK GUN M1—CARRIAGE M1A3—(BRITISH) SUBSTITUTE STANDARD



57 mm ANTITANK GUN, M1, ON CARRIAGE, M1, IN FIRING POSITION; CARRIAGE, M1A3, IS CARRIAGE, M1, WITH MINOR MODIFICATIONS

British battle experience indicated the need for a light gun more powerful than the 2-pounder (37 mm) which could be employed as an antitank weapon or be mounted in a tank or gun motor carriage. This requirement was met by the 6-pounder gun, standardized in America for Lend-Lease manufacture as the 57 mm Gun, M1.

O.C.M. 16489, dated 20 February 1941, authorized the preparation of drawings of the British 6-pounder gun, carriage and on-carriage fire control equipment converted to American gears, threads and tolerances. On 15 May 1941, O.C.M. 16722 recommended standardization of the British-American 57 mm matériel as Gun, M1, Carriage, M1, Telescope, M18, and Telescope Mount, M24.

Modifications were made to the M1 Carriage which culminated in the present Carriage, M1A3. These changes included substitution of free traverse for gear traverse, and new lunette, drawbar, and trail lock assemblies.

## Ammunition

Ammunition for the 57 mm, M1, Gun is in the form of fixed rounds. It consists of A.P. Projectile, M70.

## PRINCIPAL CHARACTERISTICS

### GUN, M1

Weight of gun	755 lb.
Overall length	117 ins.
Length of bore	50 cal.
Muzzle velocity	2,700 f./s.
Volume of chamber	100 cu. ins.
Travel of projectile in bore	96 ins.
Maximum powder pressure	46,000 lb./sq. in.
Breech mechanism	Vertical sliding wedge
Rate of fire (approximate)	30 rds./min.
Rifling	Right-hand, 1 turn in 30 cal.
Range	10,260 yds.

### RECOIL MECHANISM, M1

Type	Hydrospring
Weight, with slipper	373 lb.
Normal recoil (-1 in. + 1/2 in.)	29 3/4 ins.
Maximum recoil	31 1/2 ins.

### CARRIAGE, M1A3

Total weight without gun	1,945 lb.
Height of lunette (limbered position)	22 ins.
Length of carriage (muzzle to lunette)	200 1/2 ins.
Width over hub caps	75 ins.
Height (traveling position)	50 ins.
Trail spread (maximum) (included angle)	90°
Elevation (maximum), carriage in firing position	15°
Depression (maximum), carriage in firing position	-5°

Traverse (maximum, right)	45°
Traverse (maximum, left)	45°
Width of tread (c/l—c/l of wheels)	57.7 ins.

### AMMUNITION

Weight of complete round A.P., M70	12.56 lb.
Weight of projectile (target practice or armor piercing)	6.28 lb.
Weight of powder charge (approximate)	2.25 lb.
Type of ammunition	Fixed
Armor penetration—homogeneous plate	
20° from normal— 500 yds.	3.4 ins.
1,000 yds.	2.7 ins.
2,000 yds.	1.9 ins.

## Sighting and Fire Control Equipment

### On Carriage Equipment

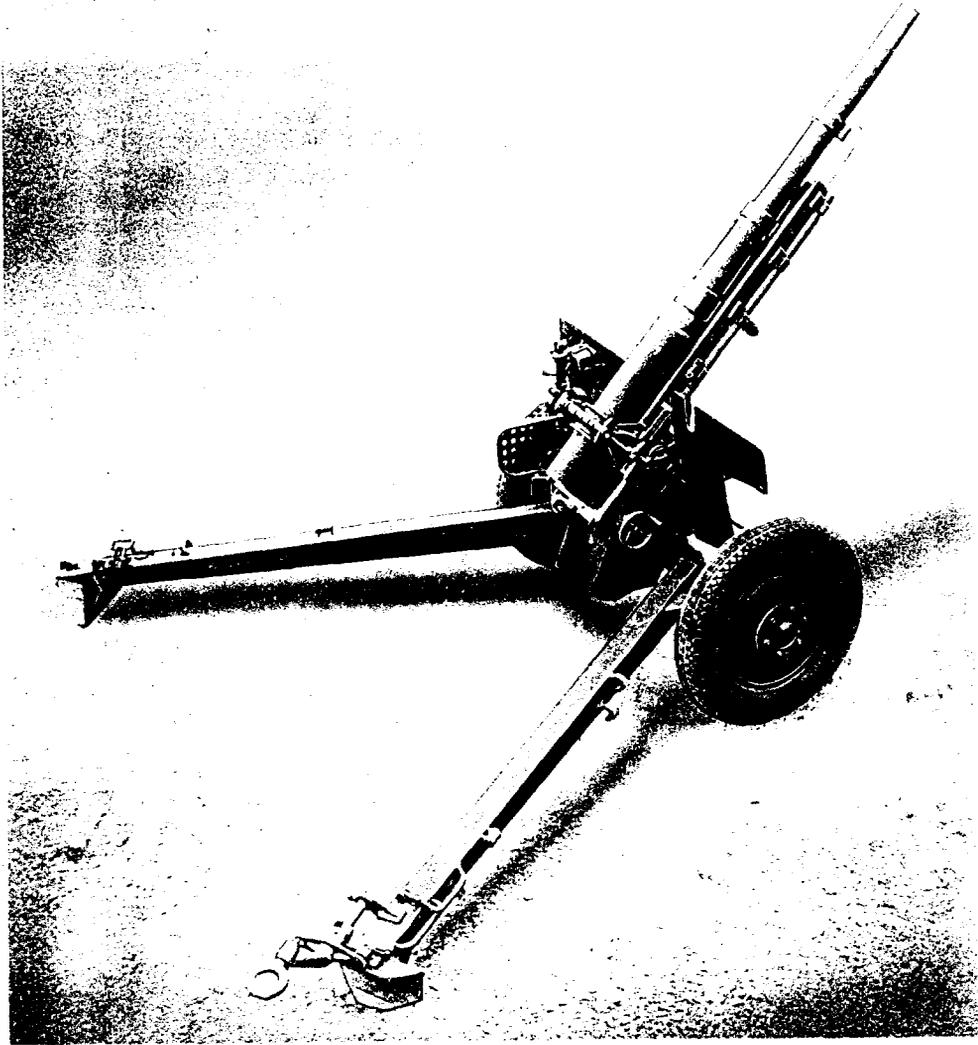
Telescope, M18  
Telescope Mount, M24A1

### Off Carriage Equipment

Gunner's Quadrant, M1

REFERENCES—TM 9-2005, v. 5; TM 9-303.

# 75 MM GUNS M1897A2, M1897A4—CARRIAGE M2A3—STANDARD



75 mm GUN, M1897A2, ON CARRIAGE, M2A3, IN FIRING POSITION

These weapons are modernizations of the 75 mm Gun, M1897. The M1897A2 is standard for the manufacture of the complete gun, while the M1897A4 is standard for conversion of existing M1897 guns (O.C.M. 14510).

In 1917 the A.E.F. in France and certain regiments in the United States were equipped with the French 75 mm M1897 gun as the standard for light field artillery matériel. The performance of this gun in battle was such that it was considered the most effective light field gun used in World War I. A considerable number of these guns were purchased from France, while similar guns were manufactured in the United States. The parts of the American and French manufactured guns are identical and interchangeable.

As mounted on modernized carriages which may be towed at any speed, the 75 mm gun is today a far more formidable weapon than was its counterpart in the last war. New ammunition, including armor-piercing projectiles, has been developed to give greatly increased range. These guns are now being withdrawn from service to be placed on self-propelled mounts. No further production of these guns has been undertaken.

**GUN, M1897**—This gun and its variations are of built-up construction with breechblocks of the cylindrical Nordenfeld eccentric screw type threaded on the exterior to fit the breech recess. The breechblock is opened by rotating 120° around its axis and automatically ejects the empty

## PRINCIPAL CHARACTERISTICS OF 75 mm GUN, M1897A2, AND CARRIAGE, M2A3

### GUN, M1897A2

Caliber	75 mm
Weight	1,026 lb.
Overall length	107.125 ins.
Length of bore	34.5 cal.
Muzzle velocity	1,778, 1,950, 2,000 f./s.
Volume of chamber (M61, A.P.C.)	88.05 cu. ins.
Travel of projectile in bore (M61, A.P.C.)	88.99 ins.
Maximum powder pressure (M61, A.P.C.)	38,000 lb./sq. in.
Type of block mechanism	Nordenfeld screw block
Rate of fire	.6 rds./min.
Range (M61, A.P.C.)	13,870 yds.

### RECOIL MECHANISM

Type	Hydropneumatic
Weight	237.21 lb.
Normal recoil	44.9 ins.
Maximum recoil	48 ins.
Maximum piston-rod pull	11,250 lb.

### CARRIAGE, M2A3

Total weight without gun	2,338 lb.
Height of lunette (limbered position)	29 ins.
Length of carriage (muzzle to lunette)	220.5 ins.
Width over hub caps	80 ins.
Tread width (c—c/ of wheels)	70 ins.
Height in traveling position	56 ins.

### AMMUNITION

Weight of complete round	19.49 lb.
Weight of projectile	14.60 lb.
Weight of projectile explosive charge	1.47 lb.
Weight of propelling charge	1.93 lb.
Type of ammunition	Fixed

### Armor penetration—homogeneous plate

20° from normal—	500 yds.	3.2 ins.	2.8 ins.
	1,000 yds.	2.7 ins.	2.5 ins.
	2,000 yds.	2.1 ins.	2.1 ins.

Trail spread (included angle)	60°
Elevation (maximum) (on wheels)	45°30'
Depression (maximum) (on wheels)	—9°14'
Traverse (maximum, right) (on wheels)	30°9'
Traverse (maximum, left) (on wheels)	30°15'
Total weight of gun, mechanism, and carriage	3,400 lb.

	M48, H.E.	M72, A.P.	M61, A.P. C.
Weight of complete round	19.49 lb.	18.80 lb.	19.98 lb.
Weight of projectile	14.60 lb.	13.93 lb.	14.92 lb.
Weight of projectile explosive charge	1.47 lb.		.17 lb.
Weight of propelling charge	1.93 lb.	1.90 lb.	2.16 lb.
Type of ammunition	Fixed	Fixed	Fixed

cartridge case. The normal life of the gun is approximately 10,000 rounds.

**GUN, M1897A4**—Rollers, sweeper plates with felt pads and part of the jacket are removed from the M1897 gun and replaced by steel rails and bronze strips attached to supports on the gun.

**GUN, M1897A2**—This gun is identical with the M1897A4 and is standard for new manufacture.

**CARRIAGE, M1897**—About 2,800 of the French-manufactured M1897 carriages were purchased. They were issued and stored without distinction as to their source. The gun slides on a steel-forged cradle trunnioned on a rocker assembly enabling changes of elevation to be made without disturbing the angle-of-site setting. The rocker is trunnioned on a single trail supported by the axle housing. The hydropneumatic (Puteaux) recoil system assures constant recoil. The carriage has steel-tired wheels and is equipped with a combination road brake and firing support.

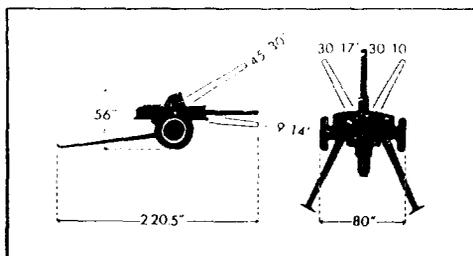
**CARRIAGE, M1897M1**—This is the American manufactured version of Carriage, M1897, differing from the M1897 in the recuperator system which has a respirator assembly instead of a front plug, shields, lunette, wheels, wheel guards, spares and accessories. Parts of this carriage are not interchangeable with those of the M1897.

**CARRIAGE, M1897A2**—When equipped with a handspike, the M1897 takes the designation M1897A2.

**CARRIAGE, M1897M1A2**—This is the M1897M1 equipped with a handspike.

**CARRIAGE, M1897A4**—Fitting high-speed adapters to the M1897, M1897A2, M1897M1 and M1897M1A2 changes the model designation of any of these carriages to M1897A4. The modification consists essentially of a high-speed adapter, the substitution of pneumatic tires on disk and rim wheels in place of steel- or rubber-tired wheels and the replacement of the former brake system by one using internal-expanding brakes.

All modifications of the M1897 carriage through M1897A4 possessed the inherent disadvantages of limited elevation and traverse, with a maximum normal gun range of only 6,930 yards. By burying the trail, it was possible to obtain a range of 9,200 yards. It was, therefore, considered essential to design a new carriage to mount the M1897 gun which would overcome these handicaps. This was done in 1934,



when the first of a new M2 series was originated.

**CARRIAGES, M2A1 AND M2A2**—A distinguishing feature of these carriages is the split trail which permits an elevation of +45°, resulting in approximately 39% greater range than that obtained in earlier models with a solid trail. For high-speed transport, the carriages are equipped with pneumatic-tired disk and rim wheels with internal-expanding brakes. Equilibrators neutralize unbalanced weight in the gun and recoil system. Traverse is increased to 85°. In firing position with the trails spread, an adjustable jack may be used to support the carriage weight, thus forming a three-point support consisting of the jack and spades. On level ground the gun may be fired safely from the wheels with the trails in either of the spread positions.

**CARRIAGE, M2A3**—The carriage is a modification of the Carriage, M2. It is of the split trail type, equipped with a drawbar for use with a motorized unit. The lower part of the top carriage is modified to provide clearance for the pivoted axle. The trails and spades are 19 inches shorter than those of the M2. The firing jack is replaced by segments, and the carriage has a pivoted axle which automatically adjusts itself to permit laying the piece with the wheels at an angle of up to 10° to the horizontal. The Recoil Mechanism,

M2, combines the cradle, recoil and recuperator cylinders which check movement in recoil and counter recoil gradually to prevent displacement of the carriage.

### Sighting and Fire Control Equipment for Carriage, M2A3

#### On Carriage Equipment

Panoramic Telescope, M12A1, on Telescope Mount, M22  
Elbow Telescope, M14, on Telescope Mount, M23  
Range Quadrant, M5

#### Off Carriage Equipment

Aiming Post, M1  
Gunner's Quadrant, M1  
Bore sight  
Aiming Circle, M1  
Compass, M2  
1-Meter-Base Range Finder, M7 or M1916  
B. C. Telescope, M65 or M1915A1

### Ammunition

Ammunition for the 75 mm Guns, M1897A2 and M1897A4, is in the form of fixed rounds. It consists of H.E. Shell, Mk. I, with P.D. Fuzes, M46 and M47; H.E. Shell, M48, with P.D. Fuze, M48, and T.-S.Q. Fuze, M54; chemical Shell, Mk. II, with P.D. Fuze, M46; Shrapnel, Mk. I, with 21-second Combination Fuze, '07M; A.P. Shot, M21, and semi-A.P. Shot, M72.

### Trainer

For training purposes only, the 37 mm Subcaliber Gun, M1916, is used to provide practice in laying and firing the 75 mm matériel. The 37 mm Subcaliber Mount, M2, is used on 75 mm Gun Carriage, M1897, only. The 37 mm Subcaliber Mount, M8, is used on Carriages, M1897M1A2 and M1897A4. The 37 mm Subcaliber Mount, M7, is used on 75 mm Gun Carriages, M2, M2A1, M2A2 and M2A3.

REFERENCES—TM 9-2005, v.3; TM 9-1305.

### Comparison of Gun Carriages

	M1897	M1897M1A2	M1897A4	M2A1	M2A2	M2A3
Weight of gun and carriage complete (in pounds) . . . . .	2,657	2,657	3,007	3,675	3,675	3,400
Length of recoil (in inches) . . . . .	44.9	44.9	44.9	41.5-46	41.5-46	44.9
Height of axis from ground (in inches) . . . . .	40.4	40.4	44.4	47	47	47
Maximum elevation . . . . .	19°	19°	19°	46°	46°	49°30'
Maximum depression . . . . .	10°	10°	10°	10°	10°	9°15'
Maximum traverse, right . . . . .	3°	3°	3°	45°	45°	30°9'
Maximum traverse, left . . . . .	3°	3°	3°	40°	40°	30°15'
Muzzle velocity (f./s.) . . . . .	1,955	1,955	1,955	1,955	1,955	1,778 1,950 2,000
Maximum range (in yards) . . . . .	9,200	9,200	9,200	12,780	12,780	13,950

# 3 INCH ANTITANK GUN M5—CARRIAGE M6—STANDARD

Inadequacy of existing antitank guns when opposed by heavily armored vehicles resulted, in September, 1940, in the preparation of specifications for a 3" gun sufficiently powerful to destroy the most formidable tanks then in use. It was recommended that a gun be constructed to combine the 3 inch antiaircraft gun tube, T9, the 105 mm breechblock, and the 105 mm Howitzer Carriage, M2. This gun and its carriage were standardized in December, 1941, as 3 Inch Antitank Gun, M5, and Carriage, M1. Further tests by the Tank Destroyer Command resulted in the adoption of the M5 gun and M1 carriage as a standard antitank weapon late in 1942. In 1943 the M1 Carriage was modified and designated 3 Inch Gun Carriage, M6. This carriage is now Standard.

**3 INCH GUN, M5**—The gun consists of a long-barreled tube, a modified breech ring, and a breech mechanism pertaining to the 105 mm Howitzer, M2A1.

**3 INCH GUN CARRIAGE, M1**—The carriage is a combination of the 105 mm Howitzer Carriage, M2, and the 105 mm Howitzer Recoil Mechanism, M2, with minor modifications. This carriage is now Limited Standard.

**3 INCH GUN CARRIAGE, M6**—The 3 Inch Gun Carriage, M6, standardized 18 November 1943, is basically a modification of the 3 Inch Gun Carriage, M1.

Additional protection is afforded by a new sloping shield and a shield apron with fittings secured to the axle. This apron insures approximately five inches



3 INCH ANTITANK GUN, M5, ON CARRIAGE, M6, IN FIRING POSITION AT 0° ELEVATION

clearance between the bottom of the apron and the ground when the gun is in firing position with the carriage resting on the tires.

In order to limit the cant of the axle to 5° on either side, axle stops are provided. To secure the segments in firing and traveling positions, wheel segments with necessary fittings are provided for 9.00x20 combat tires.

Handspikes, ratchet wrenches and a castor wheel facilitate manual movement of the carriage for short distances. The castor wheel (4.00x8 tire) is designed to be carried on top of the trails when not in use.

The Recoil Mechanism, M9A1, has a five-inch extension on the recoil piston rod, replacing the four-inch extension used on the Recoil Mechanism, M9, with no other change.

New traveling locks are provided in order to carry the muzzle of the gun approximately 12 inches higher in the traveling position.

There also is a shoulderguard, with opening for removal of the breechblock. Gun Section Chest, M7, has been modified for stowage of sighting equipment and it is secured to the trails when traveling. The maximum elevation is 30°.

## Ammunition

The standard ammunition for this gun is in the form of complete fixed rounds. It consists of H.E. Shell, M42A1, with M.T. Fuze, M43, and A.P.C. Projectile, M62, with B.D. Fuze, M66.

REFERENCES — OCM 16517; OCM 17251; OCM 21870; OCM 22132; TM 9-2005, v.3; TM 9-303.

## Sighting and Fire Control Equipment

### On Carriage Equipment

Telescope Mount, M41A1  
Panoramic Telescope, M12A3  
Telescope, M41  
Telescope Mount, M50  
Elbow Telescope, M29  
Range Quadrant, M6

## PRINCIPAL CHARACTERISTICS

### GUN

Caliber of gun..... 3 ins.  
Weight of gun..... 1,475 lb.  
Overall length..... 158.4 ins.  
Length of bore..... 50 cal.  
Muzzle velocity  
A.P. 15 lb. projectile..... 2,600 f./s.  
H.E. 12.7 lb. projectile..... 2,800 f./s.  
Volume of chamber..... 200 cu. ins.  
Travel of projectile..... 127.3 ins.  
Maximum powder pressure..... 34,000 lb./sq. in.  
Type of block mechanism... { Horizontal sliding,  
hand-operated  
Rate of fire..... 12 rds./min.  
Maximum range (A.P.C., M62)..... 16,100 yds.

### RECOIL MECHANISM

Type..... Hydropneumatic  
Weight..... 473 lb.

### AMMUNITION

Weight of complete round..... 24.36 lb.  
Weight of projectile..... 12.87 lb.  
Weight of bursting charge..... .84 lb.  
Weight of propelling charge..... 4.57 lb.  
Type of ammunition..... Fixed  
Armor penetration—homogeneous plate  
20° from normal, 500 yds..... 4.2 ins.  
1000 yds..... 3.85 ins.  
2000 yds..... 3.1 ins.

### Normal recoil

at 0°..... 30.5 ins.  
at 30°..... 34.5 ins.  
Maximum recoil..... 44 ins.

### CARRIAGE

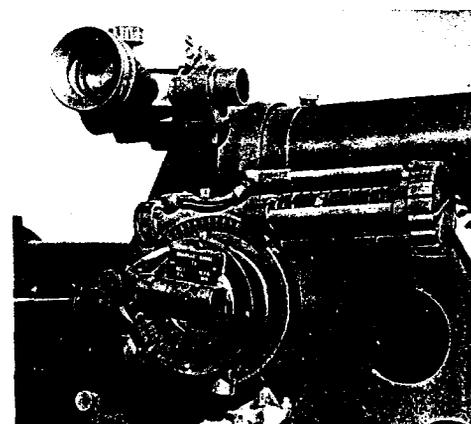
Total weight without gun..... 4,375 lb.  
Height of lunette (limbered position)..... 27 ins.  
Length of carriage (muzzle to lunette)..... 272 ins.  
Width over hub caps..... 82 ins.  
Tread width (c—c/ of wheels)..... 70 ins.  
Overall height (limbered position)..... 62 ins.  
Elevation (maximum)..... 30° 13'  
Depression (maximum)..... 5° 35'  
Traverse (maximum, right)..... 23°  
Traverse (maximum, left)..... 23°  
Total weight of gun, mechanism, and carriage..... 5,850 lb.

### M42A1 H.E.

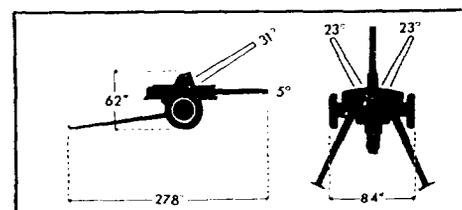
Weight of complete round..... 24.36 lb.  
Weight of projectile..... 12.87 lb.  
Weight of bursting charge..... .84 lb.  
Weight of propelling charge..... 4.57 lb.  
Type of ammunition..... Fixed

### M62 A.P.C.

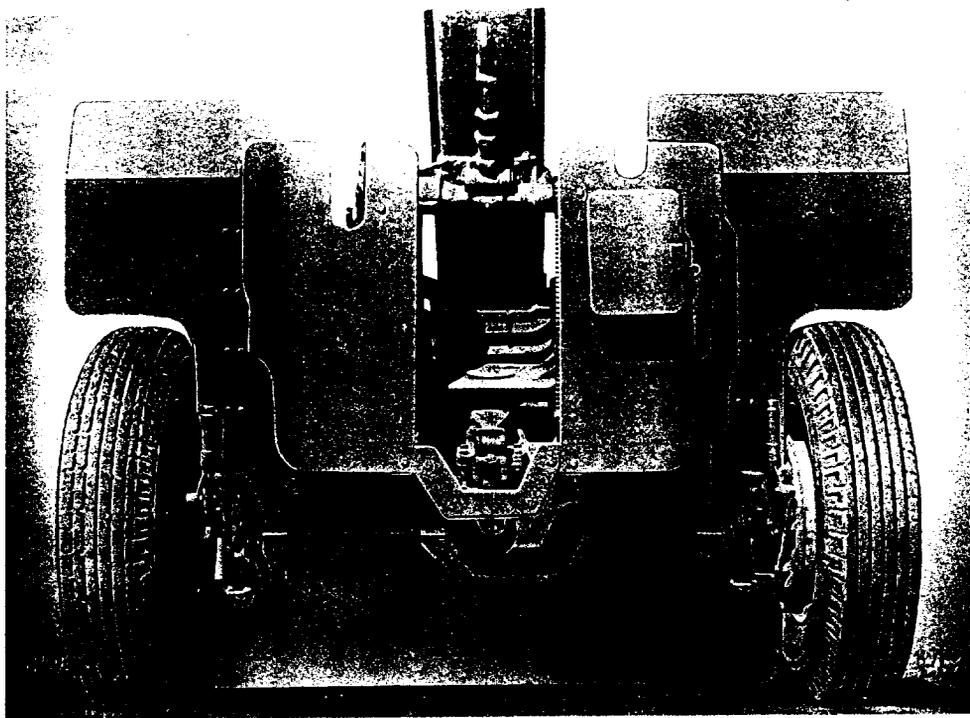
Weight of complete round..... 27.23 lb.  
Weight of projectile..... 15.43 lb.  
Weight of bursting charge..... .17 lb.  
Weight of propelling charge..... 4.62 lb.  
Type of ammunition..... Fixed



Right-hand view of the breech end of 3 inch Antitank Gun, M5, on Carriage, M6, showing Elbow Telescope, M29, and Range Quadrant, M6.



# 105 MM HOWITZER M2A1—CARRIAGE M2A2—STANDARD



LEFT REAR VIEW OF 105 mm HOWITZER, M2A1, ON CARRIAGE, M2A2

## PRINCIPAL CHARACTERISTICS

### HOWITZER, M2A1

Caliber.....	105 mm
Weight.....	1,080 lb.
Overall length.....	101.35 ins.
Length of bore.....	22.5 cal.
Muzzle velocity.....	1,550 f./s.
Volume of chamber.....	153 cu. ins.
Travel of projectile in bore.....	81.67 ins.
Maximum powder pressure.....	28,000 lb./sq. in.
Type of breech mechanism.....	Sliding
Rate of fire.....	4 rds./min.
Range.....	12,500 yds.

### RECOIL MECHANISM, M2A1

Type.....	Hydropneumatic
Weight.....	457 lb.
Normal recoil.....	42 ins.
Maximum recoil.....	44 ins.
Maximum piston-rod pull.....	12,980 lb.

### CARRIAGE, M2A2

Total weight (with howitzer and recoil mechanism).....	4,970 lb.
--------------------------------------------------------	-----------

Height of lunette (limbered position).....	18 ins.
Length of carriage (muzzle to lunette).....	236 ins.
Width over hub caps.....	82 ins.
Tread width (c/l—c/l).....	70 ins.
Height in traveling position.....	65.75 ins.
Trail spread (included angle).....	28° left, 29° right
Elevation (maximum) on wheels.....	65°
Depression (maximum).....	—5°
Traverse (maximum, right).....	23°
Traverse (maximum, left).....	23°
Total weight of gun, mechanism, and carriage.....	4,260 lb.

### AMMUNITION

Weight of complete round (with M1 H.E. shell).....	41 lb., 12 oz.
Weight of projectile.....	33 lb.
Weight of projectile explosive charge, M1.....	4.8 lb.
Weight of propelling charge (approximate).....	2.94 lb.
Type of ammunition.....	Semi-fixed

## Sighting and Fire Control Equipment

### On Carriage Equipment

Panoramic Telescope, M12A2  
Telescope Mount, M21  
Range Quadrant, M4  
Telescope Mount, M23  
Elbow Telescope, M16

### Off Carriage Equipment

Aiming Circle, M1  
Compass, M2  
1-Meter-Base Range Finder, M7 or M1916  
B. C. Telescope, M65  
Hand Fuze Setter, M17  
Graphical Firing Table, M4

## Ammunition

Ammunition for the 105 mm Howitzer, M2A1, is in the form of fixed and semi-fixed rounds. It consists of H.E. Shell, M1, with P.D. Fuze, M48, and T.-S.Q. Fuze, M54; Chemical Shell, M60, with P.D. Fuze, M57; Smoke Shell, B.E., M84, with Fuze, T.-S.Q. M54, and H.E., A.T. Shell, M67, with B.D. Fuze, M62.

REFERENCES—TM 9-2005, v.3; TM 9-325.

The major development in 105 mm howitzer matériel has been in carriage design. The present Carriage, M2A2, capable of transport at speeds up to thirty-five miles an hour, is a modification of the Carriage, M1, designed for draft by horses or slow tractors.

The 105 mm Howitzer, M2A1, is also mounted on the self-propelled motor carriage, M7, and the medium tanks, M4 and M4A3.

**HOWITZERS, M2 AND M2A1**—Possession of the same general characteristics makes these howitzers interchangeable. The only difference between the two models is in the design of their breech rings. A sliding-type breechblock is used with either howitzer. The piece is fired by a lanyard attached to a firing mechanism on the cradle.

**CARRIAGE, M2**—The M2 carriage has a split trail, pneumatic-tired disk and rim wheels, and brakes operated from the driver's seat of the prime mover.

The unbalanced weight of the howitzer is neutralized by a single-unit, spring-type equilibrator. The elevating arcs serve as a seat for the trunnions of the carriage. The elevating mechanism on the cradle may be operated from either side of the carriage. The axle and the support are designed to compensate for irregularities of the terrain when the howitzer is in firing position.

The M2A1 hydropneumatic recoil mechanism is of the constant-length type. The howitzer and recoil system are attached to a sleigh. The piston rod is attached to the cradle and remains stationary during recoil and counter recoil.

**CARRIAGE, M2A2**—The 105 mm Howitzer Carriage, M2A2, is the M2A1 Carriage with newly designed shields which give considerably more protection than did the shields used on the M2A1.

The Carriage, M2A2, is classified as Standard.

## 155 MM HOWITZER M1—CARRIAGE M1

## 155 MM HOWITZER M1918—CARRIAGE M1918A3 (Continued)

**155 mm HOWITZER, M1**—The barrel of this howitzer is of monobloc construction. It is considerably longer and heavier than the barrels in previous models, and is equipped with an interrupted-thread, screw-type breechblock. The range is nearly 4,000 yards greater than that of the M1918. This howitzer was classified as Standard in O.C.M. 16724 dated 15 May 1941.

**155 mm CARRIAGE, M1917**—This is a French manufactured carriage with a box trail, steel-tired wood wheels and a curved shield. Recoil and counter recoil of the howitzer on its recoil are regulated by a hydropneumatic recoil system, housed in a sleigh to which the howitzer is connected. The trail flasks contain bearings in which the cradle trunnions are seated. This carriage is classified as Limited Standard.

**155 mm CARRIAGE, M1917A1**—This is the carriage, M1917, with a straight shield, a sight port, rubber-tired wheels and provision for Quadrant Sight, M1917A1, and Panoramic Sight, M1917. This carriage is classified as Limited Standard.

**155 mm CARRIAGE, M1917A2**—When the M1917A1 carriage is furnished with a cradle lock and drawbar for motor draft, it is designated Carriage, M1917A2. These modifications eliminate the need for a limber. This carriage is classified as Limited Standard.

**155 mm CARRIAGE, M1917A3**—This is the M1917 carriage with the addition of a high-speed axle, wheels with pneumatic tires, a drawbar and a cradle traveling lock. This carriage is classified as Limited Standard.

**155 mm CARRIAGE, M1917A4**—The addition of torque rods to Carriage, M1917A2, changes the model designation to M1917A4.

**155 mm CARRIAGE, M1918**—In its main constructional details this carriage is similar to the M1917. The wheels have rubber tires, and the shield consists of right and left shield plates suitably tied together. A panoramic-sight case is attached to the left shield plate. This carriage is classified as Limited Standard.

**155 mm CARRIAGE, M1918A1**—Experiments begun by the Ordnance Dept. in 1933 for the purpose of adapting 155 mm howitzer matériel to high-speed transport resulted in connecting the carriage to the prime mover by means of a drawbar and in new bearings designed to reduce friction. In 1934 the M1918E4 was produced with pneumatic-tired wheels possessing lubricant-retaining features in the bearings. Improvements in these modifications were incorporated in the M1918E5, standardized in 1936 as Carriage, M1918A1.

**155 mm CARRIAGE, M1918A3**—This is the Carriage, M1918A1, when equipped with torque rods. This carriage is classified as Substitute Standard.

**155 mm CARRIAGE, M1**—This carriage is interchangeable with the Carriage, M1918 used for the 4.5" Gun, M1. The recoil mechanism is of the hydropneumatic type. Length of recoil varies automatically with the elevation and the zone of fire. Equilibrators of the spring type neutralize the unbalanced weight of the gun. The carriage has a split trail, pneumatic tires with self-sealing inner tubes and air brakes controlled by the driver of the prime mover. This carriage was classified as Standard by O.C.M. 16724 dated 15 May 1941.

REFERENCES—TM 9-2005, v.3; TM 9-330; TM 9-331; TM 9-1331.

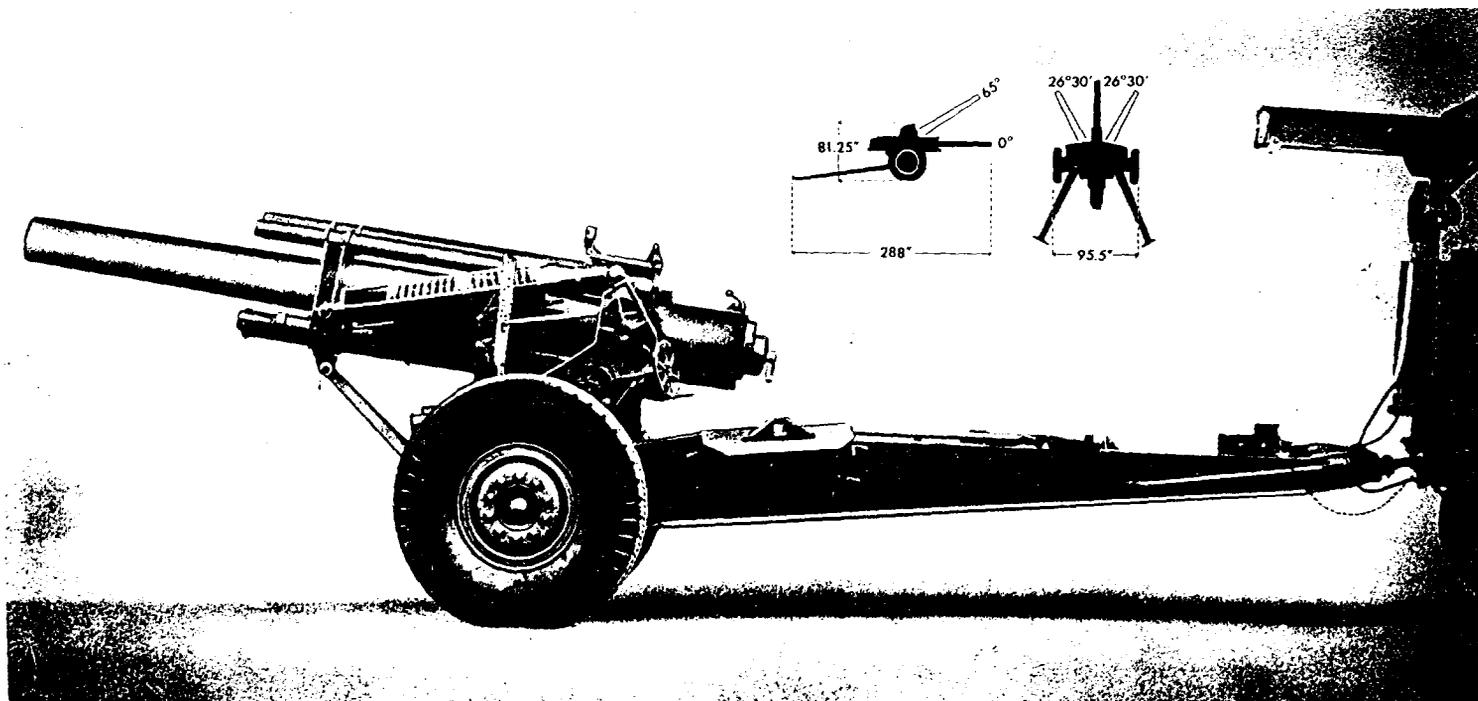
### Sighting and Fire Control Equipment

#### On Carriage Equipment

Panoramic Telescope, M12  
Telescope Mount, M25

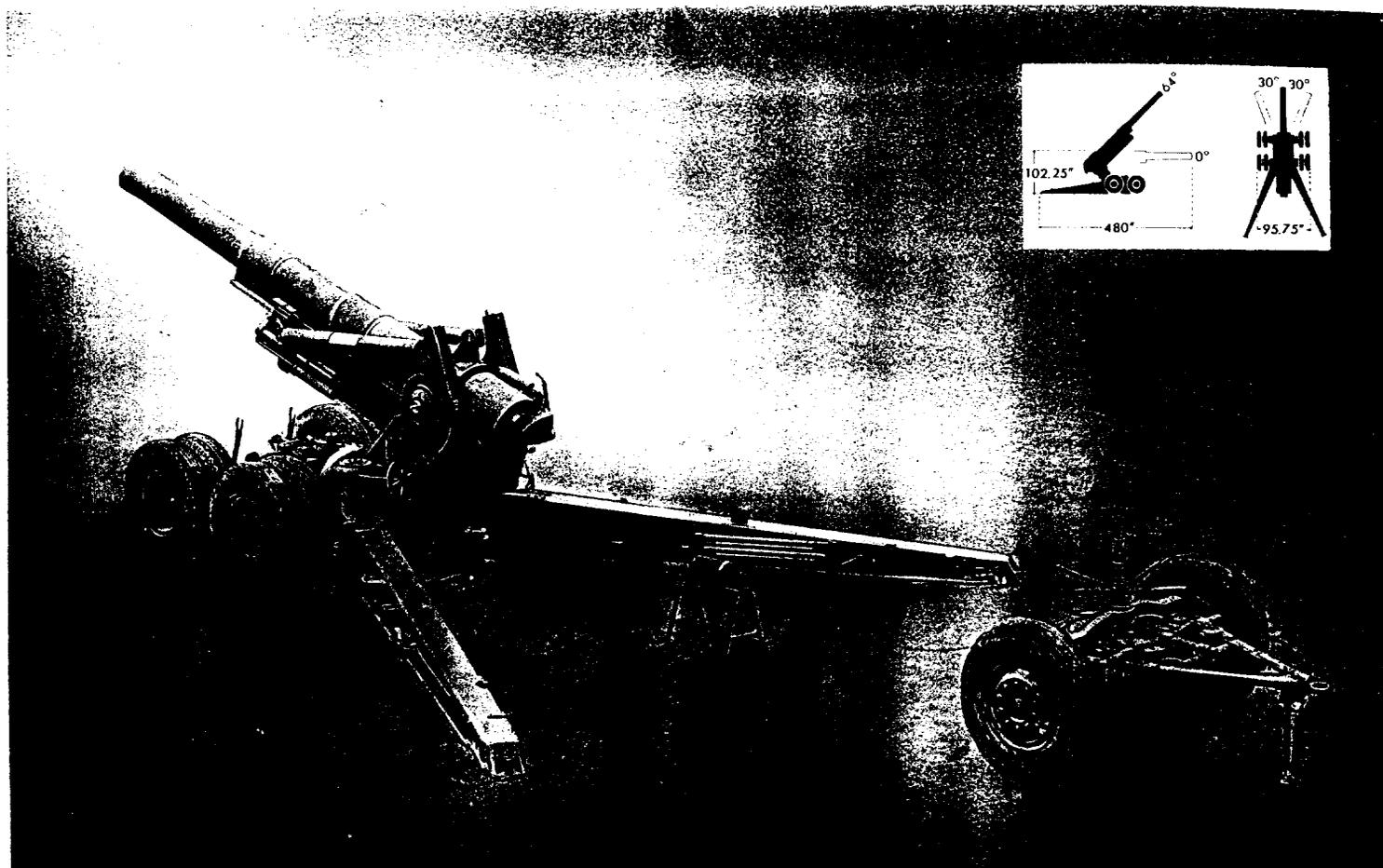
#### Off Carriage Equipment

Gunner's Quadrant, M1  
Aiming Circle, M1  
Bore Sight  
1-meter-base Range Finder, M7 or M1916  
Hand Fuze Setter, M1913A1  
B. C. Telescope, M65 or M1915A1  
Hand Fuze Setter, M21  
Graphical Firing Table, M5 (with M1917 and M1918 matériel)  
Graphical Firing Table, M12 (with M1 matériel)



155 mm HOWITZER, M1, IN TRAVELING POSITION

# 8 INCH HOWITZER M1—CARRIAGE M1—STANDARD



8 INCH HOWITZER, M1, IN FIRING POSITION, WITH LOADING TRAY AND HEAVY LIMBER, M2

## PRINCIPAL CHARACTERISTICS

### HOWITZER, M1

Caliber..... 8 ins.  
 Weight..... 10,240 lb.  
 Overall length..... 209.59 ins.  
 Length of bore..... 25 cal.  
 Muzzle velocity..... 820, 900, 1,000, 1,150,  
 1,380, 1,640, 1,950 f./s.  
 Volume of chamber..... 1,527 cu. ins.  
 Travel of projectile in bore..... 173.83 ins.  
 Maximum powder pressure..... 33,000 lb./sq. in.  
 Type of block mechanism.. Interrupted-screw type  
 Rate of fire..... 1 rd. in 2 mins.  
 Range..... 18,510 yds.

### RECOIL MECHANISM, M4

Type..... Hydropneumatic  
 Weight..... 3,890 lb.  
 Normal recoil..... 63 ins. at 0° to 32 ins. at 64°  
 Maximum recoil..... 70 ins.  
 Maximum piston-rod pull at 65°..... 139,850 lb.

### CARRIAGE, M1

Total weight of carriage and limber  
 without howitzer..... 21,460 lb.

Height of lunette (limbered position)..... 27 ins.  
 Length of carriage (muzzle to lunette)..... 40 ft.  
 Width over hub caps..... 95<sup>3</sup>/<sub>4</sub> ins.  
 Width overall of bogie..... 98<sup>7</sup>/<sub>8</sub> ins.  
 Tread width (c/—c/ of wheels) (limber) 83<sup>1</sup>/<sub>2</sub> ins.  
 Height in traveling position..... 102<sup>1</sup>/<sub>4</sub> ins.  
 Trail spread (included angle)..... 60°  
 Elevation (maximum) (firing base)..... 64°  
 Depression (maximum) (firing base)..... 0°  
 Traverse (firing base) (right)..... 30°  
 Traverse (firing base) (left)..... 30°  
 Total weight of gun, mechanism  
 and carriage..... 31,700 lb.

### AMMUNITION

Weight of complete round..... 213.96 lb.  
 228.75 lb.  
 Weight of projectile shell, M106..... 200 lb.  
 Weight of projectile explosive charge..... 29.6 lb.  
 Weight of propelling charge... 10.75 lb. (approx.)  
 Type of ammunition..... Separate loading

The present 8" howitzer used by the U. S. Army is the M1, a development from the Howitzers, Mk. VI, Mk. VII and Mk. VIII-<sup>1</sup>/<sub>2</sub> issued to the A.E.F. during the first World War. These howitzers were manufactured in both England and the United States. While they differ in certain respects, they have the same types of breechblocks and firing mechanisms.

**8 INCH HOWITZER, MK. VI**—This howitzer is mounted on the Mk. VI carriage. The barrel is of built-up construction, consisting of a jacket shrunk on over a tube. A shrunk-on breech ring carries a lug for connecting the gun to the recoil mechanism. A breech bushing is provided for reception of a lever-operated breechblock of the interrupted-screw type having an asbestos obturator pad in the mushroom head. Two types of noninterchangeable firing mechanisms are utilized. In one a T-tube friction primer inserted in the breech is fired by means of a lanyard pulling a friction wire out of the tube. The other type is of the percussion variety, in which a percussion primer fitting into the breechblock is fired by a lanyard-operated hammer striking a firing

## 8 INCH HOWITZER M1—CARRIAGE M1 (Continued)

pin. Front and rear guide rings support the howitzer in the cradle. This howitzer is classified as Limited Standard.

**8 INCH HOWITZER, MK. VII**—This howitzer, of wire-wound construction, was superseded by the Mk. VIII- $\frac{1}{2}$  because it was found necessary to thicken the powder chamber walls to prevent their cracking. It is classified as Limited Standard.

**8 INCH HOWITZER, MK. VIII- $\frac{1}{2}$** —This howitzer is also of the built-up type, but has an inner and an outer tube over which the jacket is shrunk. No guide rings are included, as the jacket supports the weight of the cannon. Other details are identical with those of the Mk. VI. This howitzer is mounted on the Mk. VII carriage, and is classified as Limited Standard.

**8 INCH HOWITZER, M1**—This weapon is of built-up construction. The tube screws into a breech ring fitted with lugs for support of the breechblock carrier and attachment of the recoil mechanism. The carrier-supported breechblock is of the two-cycle, interrupted-screw type. It is equipped with a spring-actuated counterbalance, a percussion type of firing mechanism and an obturator mechanism. With the exception of the spindle, pads and other parts of the obturator, the breech mechanisms of the 8" Howitzer, M1, and the 155 mm Gun, M1, are interchangeable. This howitzer is classified as Standard (O.C.M. 15938).

**8 INCH HOWITZER PLATFORM, M1917**—When in firing position, the Mk. VII and Mk. VIII- $\frac{1}{2}$  howitzers rest on a demountable firing platform buried flush with the surface of the ground. For transport, the platform is loaded on a two-wheeled cart attached to the howitzer carriage. The cart and platform are each classified as Limited Standard.

**CARRIAGES, MK. VI AND MK. VII (British)**—These carriages differ mainly in the weight and clearance of the trails, those of the Mk. VII being raised and strengthened to accommodate the Mk. VIII- $\frac{1}{2}$  howitzer. The cradle rests in the trunnion bearings of a top carriage which is pivoted in the front transom of the trail to permit traverse. A hydropneumatic, long-recoil type recoil mechanism carried by the cradle contains both the recoil brake and the recuperator. The trail is of the box type cut away to allow clearance for recoil of the howitzer when it is fired at high angles of elevation. All-steel wheels, 66" in diameter, with tires 12" wide, are fitted with brakes acting independently on each wheel. These carriages are classified as Limited Standard.

**CARRIAGE, M1**—This carriage is identical in design and construction with the 155 mm Gun Carriage, M1. Since the howitzer is considerably heavier than the gun, it is necessary to increase the nitrogen pressure in the howitzer recoil mechanism, M4. The howitzer remains in the battery position during transport. This carriage is classified as Standard (O.C.M. 15938).

**HEAVY CARRIAGE LIMBER, M2**—This is the same limber used with the 155 mm Gun Carriage, M1.

### Sighting and Fire Control Equipment

#### On Carriage Equipment

Quadrant Mount, M1  
Panoramic Telescope, M12  
Telescope Mount, M18A1

#### Off Carriage Equipment

Gunner's Quadrant, M1  
Bore Sight  
Aiming Post, M1  
Aiming Circle, M1  
B. C. Telescope, M65 or M1915A1  
Hand Fuze Setter, M21  
Graphical Firing Tables, M8 (short range) and M9 (long range)

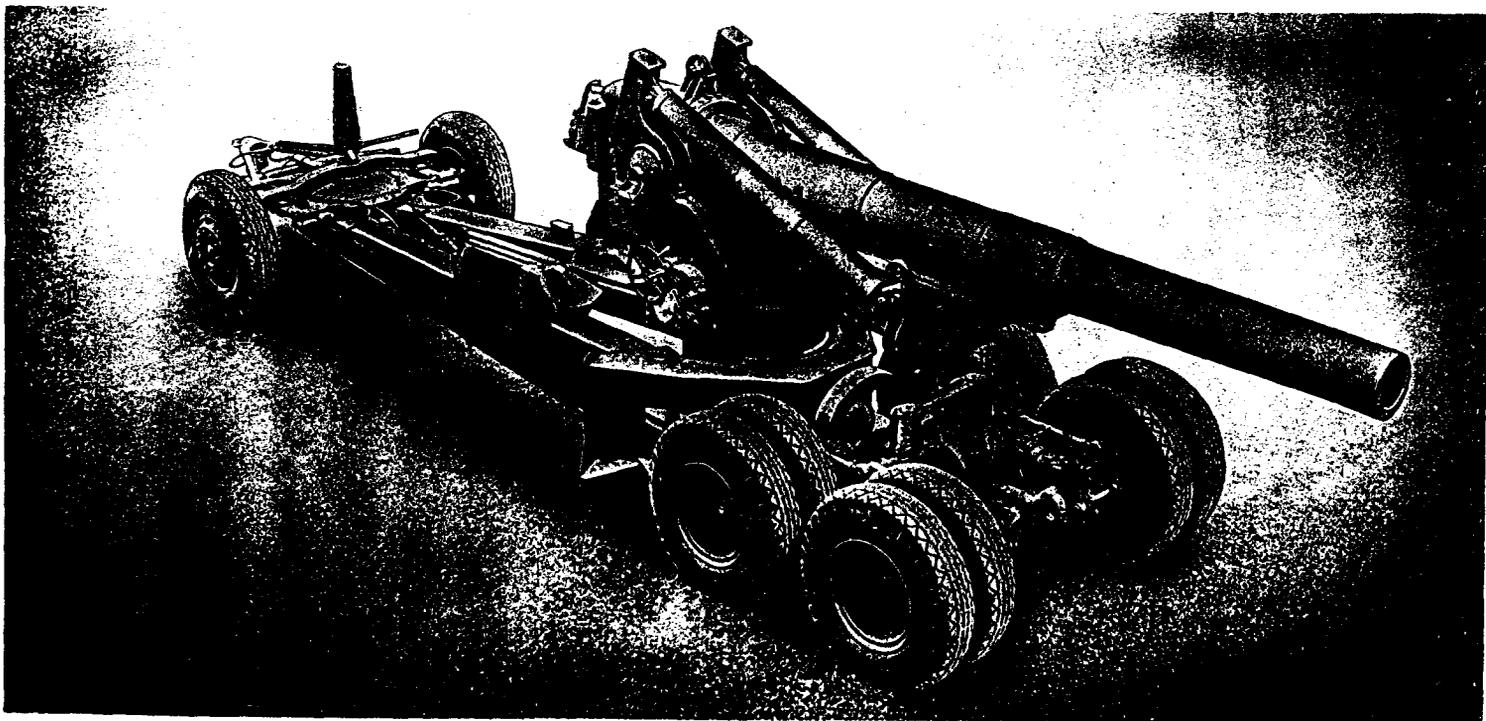
### Ammunition

The 8" Howitzer, M1, uses separate-loading, high-explosive ammunition with different weights of powder charges to give seven zones of fire. It consists of H.E. shell, M106, with P.D. fuze, M51A1, and M.T. fuze, M67.

### Trainer

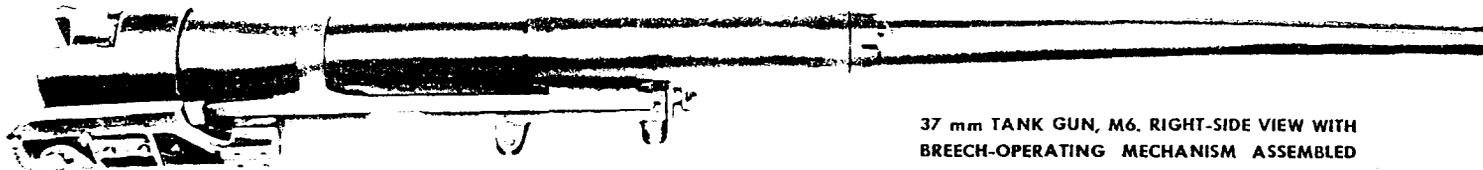
The 37 mm Gun, M1916, on Subcaliber Mount, M10, is used for practice in laying and firing the 8" Howitzer, M1.

REFERENCES—TM 9-2005, v.3; TM 9-335; TM 9-1335; FM 21-6.



8 INCH HOWITZER, M1, ON CARRIAGE, M1, IN TRAVELING POSITION

# 37 MM GUN M6—STANDARD FOR TANKS



37 mm TANK GUN, M6. RIGHT-SIDE VIEW WITH BREECH-OPERATING MECHANISM ASSEMBLED

The 37 mm tank guns were developed from the 37 mm Antitank Gun, M3, the first model being the 37 mm Tank Gun, M5. Addition of an automatically opened breechblock changed the designation to the M6, standardized by O.C.M. 16279 dated 14 Nov. 1940. The M5 barrel is shorter by about 5 inches than the barrels of the other guns.

The 37 mm Gun, M6, is standard for use on Light Tanks, M3A1, M3A3, M5 and M5A1; on Medium Tank, M3, and its variations, and on the 37 mm Light Armored Car, M8. The gun is carried on the M23, M24 or M44 Mount.

The barrel is a one-piece forging or casting with a rifled bore, threaded to screw into the breech ring. Two bearings support the barrel and align it in the yoke of the sleigh. Keys are employed to prevent rotation of the barrel.

The breech ring is broached to receive the drop-type breechblock. A breech-operating mechanism is bolted to the recoil cylinder. Recoil of the gun automatically opens the breechblock, extracts the empty cartridge case, locks the breech in an open position and cocks the gun. Rounds are inserted into the breech manually.

The recoil cylinder is assembled with the trunnion pins mounted in the trunnions of the yoke. It is provided with rails to guide the sleigh and contains a recoil mechanism of the hydrospring type, the counter-recoil spring, and a buffer mechanism.

In tanks with power traverse the gun is fired by a solenoid-firing device connected with the trigger. In other cases the hand-operated trigger actuator causes the firing process to start.

The gun may be elevated by a hand-wheel, but a throw-out lever permits free movement of the weapon.

Traverse of guns mounted in tanks with power-traversing mechanisms is obtained by power-drive rotation of the turret. In tanks equipped with manually operated turrets only, the gun can be traversed 10° right or left by means of a traversing knob. When greater traverse is necessary the turret must be rotated or the tank turned in direction.

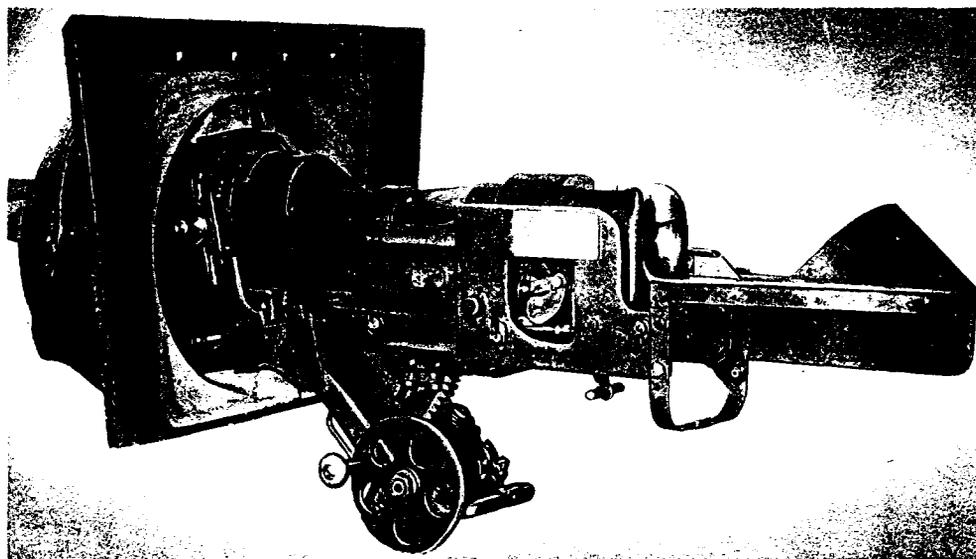
A shield is attached to the yoke and recoil cylinder by bolts, or, in some tanks, direct to the turret.

## PRINCIPAL CHARACTERISTICS

Weight of gun.....	190 lb.	Muzzle vel., A.P.C. Shot, M51B2.....	2,900 f./s.
Total weight of gun and mount.....	700 lb.	Muzzle vel., H.E. Shell, MK. II.....	2,750 f./s.
Length of barrel.....	78 ins.	Muzzle vel., H.E. Shell, M63.....	2,600 f./s.
Overall length of gun.....	82.5 ins.	Maximum range (M51B2).....	12,850 yds.
Diameter of bore.....	1.457 ins.	Weight of H.E. projectile.....	1.61 lb.
Rifling, uniform R.H.....	1 turn in 25 cal.	Weight of A.P.C. Shot, M51B2.....	1.92 lb.
Weight of powder charge.....	8 oz. (approx.)	Weight of recoil mechanism.....	77.5 lb.
Volume of powder chamber.....	19.92 cu. ins.	Length of recoil.....	6-8 ins.
Maximum powder pressure (Rated for A.P.C. Shot, M51B2).....	50,000 lb./sq. in.	Maximum elevation.....	+20°
Maximum rate of fire.....	30 rds./min.	Minimum elevation.....	-10°
Maximum rate of fire, aimed.....	15-20 rds./min.	Maximum traverse (manually operated turret).....	10° in each direction

### ARMOR PENETRATION AT 20°

	Homo. Plate		Face-Hard. Plate	
	500 yards	1,000 yards	500 yards	1,000 yards
A.P.C. Shot, M51B2, Supercharge.....	2.4 ins.	2.1 ins.	2.1 ins.	1.8 ins.



37 mm GUN, M6, MOUNTED IN COMBINATION MOUNT, M23, IN TURRET OF LIGHT TANK, M5

A traveling lock inside the turret is utilized to prevent undue wear on the elevating mechanism.

A spent-case deflector is bolted to the recoil cylinder and has suspended from it a bag to receive the ejected cartridge cases.

### Ammunition

Ammunition is in the form of fixed rounds. It consists of a Canister, M2, H. E. Shell, M63, with B.D. Fuze, M58; H. E. Shell, Mk. II, with B. D. Fuze, M38A1, and A.P.C. Shot, M51B2, with tracer.

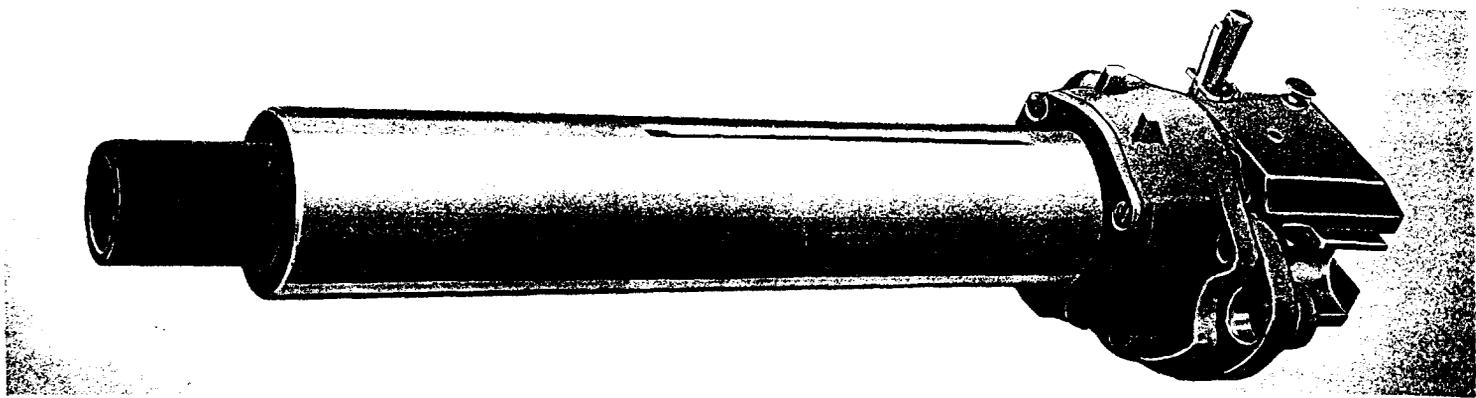
### Sighting Equipment

Sighting equipment varies with the tank in which the gun is mounted. The following table designates the sighting equipment used with each tank.

Tank	Tele-scope	Peri-scope
Light Armored Car, M8.....	M70D	—
Light Tanks, M3A1, M3A2.....	M40A2	M4A1
Light Tanks, M3A3, M5A1.....	M70D, M40A2	M4A1
Light Tank, M5.....	M40A2	M4A1
Medium Tank, M3, and variations.....	M19A1	M2
Heavy Tanks, M6, M6A1*.....	M15, M39A2	M8A1

\*O.C.M. 19199 specifies that all 37 mm guns shall be removed from heavy tanks.

# 75 MM HOWITZER M3—MOUNT M7—STANDARD



75 mm HOWITZER, M3

The decision to adapt the Pack Howitzer, M1 or M1A1, for use in the Howitzer Motor Carriage, M8, necessitated spot welding and keying a tube mounting support in place over the howitzer tube. This mounting support increased the outside diameter of the tube to fit the central bore of the cradle. Pack howitzer tubes modified in this manner were designated Howitzers, M2. They are now classified as Substitute Standard.

Since there were insufficient M2 tubes to supply the required number of howitzer motor carriages, new tubes were made with the howitzer mounting support integral with the tube. These tubes were given the designation of 75 mm Howitzer, M3, and classified as Standard.

Howitzers, M2 and M3, are manually loaded weapons fired electrically by means of a solenoid, or manually by a hand firing mechanism handle. The tube assembly differs from that of the M1 or M1A1 Howitzers only in the hoop at the rear end of the mounting support on the M2 and in the flash detector which is integral with the howitzer shield in both the M2 and M3 models.

The tube is screwed into a breech ring containing a breechblock of the horizontal sliding wedge type. A recoil tube retainer, which provides the means of attaching the two recoil cylinder assemblies to the tube assembly, is bolted to a breech yoke support on the tube.

The tube assembly is supported and aligned in a cradle which is a part of the mount assembly. The tube mounting support, which is finish-ground, rides in liners inside the cradle.

The Firing Lock, M13, fits into an axial hole in the breechblock. It is of the continuous-pull, self-cocking type, and is retained in position by sector lugs on its exterior which engage with lugs in the breechblock.

The hydrospring recoil mechanism consists of two recoil cylinders, one on each side of the howitzer, which are held and located in the cradle. A counter-

recoil buffer is attached to the front cover of each cylinder.

Howitzers, M2 and M3, are mounted in 75 mm Howitzer Mount, M7, which rests on trunnions in the turret of the Howitzer Motor Carriage, M8. The mount assembly is composed of a cradle with two recoil cylinders, a firing mechanism, and a recoil guard. The shield is attached to the forward end of the cradle and is elevated and depressed with it. Rotation of the howitzer is prevented by a key in the cradle which rides in a groove in the howitzer tube mounting support.

The firing mechanism is mounted on the rear end of the recoil guard. An electrical system is provided for primary use, with current supplied by the vehicle battery. The system operates electrically from a firing button, activating the electro-magnetic solenoid, and then through a mechanical series of linkages to a trigger chain hooked directly to the trigger. A hand firing system, which may be employed in case of failure of the elevation system, is operated by the hand firing mechanism handle and utilizes the mechanical linkage of the electrical firing system.

A recoil guard of tubular framework with right and left shields surrounds the breech. It is attached to the cradle and acts as a support for the electrical firing mechanism.

Elevation is accomplished by means of an elevating mechanism mounted on the right rear wall of the turret. A train of gears inside the elevating mechanism case connects with a pinion that meshes with the elevating quadrant rack on the howitzer cradle. The elevating mechanism is operated by a handwheel which may be engaged with or disengaged from the gear train by means of a shifter lever and a sliding gear.

Traverse is obtained by rotating the turret. A handwheel operates a gear train and a pinion meshed with the traversing rack bolted to the under side of the turret roof. A traversing lock is provided to lock the turret in traveling position.

## Sighting and Fire Control Equipment

Telescope, M70C  
Telescope Mount, M44, with Panoramic Telescope, M12A5  
Gunner's Quadrant, M1

## Ammunition

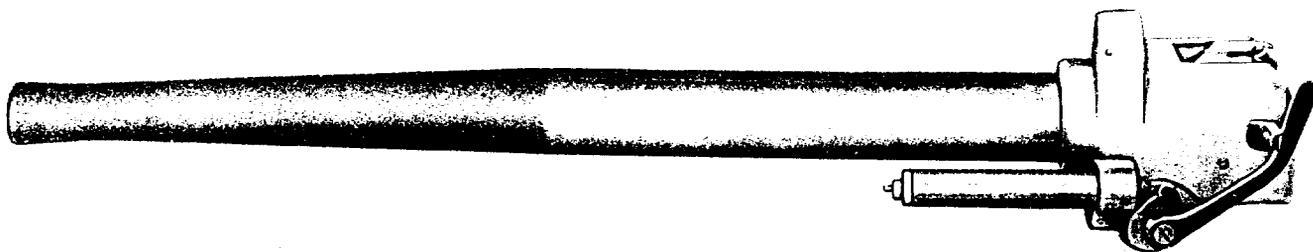
Ammunition is in the form of fuzed, fixed and semifixed complete rounds. It consists of Shell, fixed, H.E., A.T., M66, with Fuze, B.D., M62; Shell, fixed, H.E., A.T., M66, steel case, with Fuze, B.D., M62; Shell, semifixed, H.E., M41A1, with Fuze, P.D., M48, M48A1, or M48A2; Shell, semifixed, H.E., M41A1, with Fuze, P.D., M54; Shell, semifixed, H.E., M48, with Fuze, P.D., M48, M48A1, M48A2 or M54; Shell, semifixed, H.E., M48, steel case, with Fuze, P.D., M48, M48A1, M48A2, or M54; Shell, semifixed, gas, persistent, H, M64, with Fuze, P.D., M57; Shell, semifixed, gas, persistent, H, M64, steel case, with Fuze, P.D., M57; Shell, semifixed, smoke, FS, M64, with Fuze, P.D., M57; Shell, semifixed, smoke, phosphorous, WP, M64, with Fuze, P.D., M57; Shell, semifixed, smoke, phosphorous, WP, M64, Steel case, with Fuze, P.D., M57.

REFERENCES—OCM 21025; OCM 21293; TM 9-318.

## CHARACTERISTICS

Weight of 75 mm Howitzer, M2.....	318 lb.
Weight of 75 mm Howitzer, M3.....	421 lb.
Length of bore.....	35.91 ins.
Length overall.....	54.18 ins.
Rifling	
Length.....	35.91 ins.
Twist.....	Uniform, right, one turn in 20 cal.
Number of grooves.....	28
Depth of grooves.....	0.03 in.
Width of grooves.....	0.1866 in.
Width of lands.....	0.14439 in.
Type of breechblock.....	Horizontal sliding
Maximum powder pressure.....	20,600 lb.
Muzzle velocity.....	700, 810, 950, 1,250 f./s.
Maximum range (Shell, H.E., M41).....	9,760 yds.
Maximum elevation.....	40°
Maximum depression.....	-20°
Traverse of turret (with howitzer).....	360°
Normal recoil.....	11.62 ins.
Type of recoil mechanism.....	Hydrospring

# 75 MM GUN M3—STANDARD FOR TANKS



75 mm GUN, M3, SHOWING TUBE, BREECH RING, COCKING LEVER, CLOSING SPRING CYLINDER AND OPERATING HANDLE

The 75 mm Gun, M3, a development from the Tank Gun, M2, was standardized by O.C.M. 17018, dated 24 July 1941. The M2 gun is now designated as Limited Standard.

The M3 gun is a single-shot, flat-trajectory weapon differing from the M2 only in having the tube lengthened by 26.6", with a higher muzzle velocity and greater range as a result. It is equipped with a drop-type breechblock automatically opened. This weapon is mounted in Medium Tanks, M4, M4A1, M4A2, M4A3, M4A4, and in Medium Tank, M7, using Mounts, M34, M34A1 and M47.

The alloy steel tube screws into the breech ring, where it is locked into position with a key. The breech ring contains the vertical sliding breechblock assembly and the principal operating parts of the gun. The breech mechanism is composed of the breechblock assembly, firing mechanism, extractors, spline shaft, breechblock crank, operating crank, closing mechanism and related parts. A hole bored through the center of the breechblock houses the percussion mechanism.

The breech may be opened by means of an operating handle secured to the spline shaft.

Manual loading of each round automatically closes the block. The gun can be fired either manually or by means of a solenoid. During counterrecoil after firing, the gun is cocked, the block is opened, the cartridge case is extracted and the breechblock is locked in an open position for insertion of the next round.

The gun recoils in the mount, which consists of a horizontal rotor upon which is mounted the elevating mechanism and traversing mechanism; the hydraulic recoil mechanism, supported by trunnions which rotate in the trunnion seats of the horizontal rotor; an elevating shield, bolted to the trunnions of the recoil mechanism and projecting through an opening in the rotor; two recoil cylinders, held by the cradle and trunnion assembly upon which are mounted the solenoid, firing lever link, and firing lever of the firing mechanism; and a shoulder guard, bolted to the cradle, covering the firing mechanism and extending beyond the rear face of the breech.

## CHARACTERISTICS

Weight of gun, recoil mechanism and elevating shield at trunnion.....	1,763 lb.
Weight of gun.....	910 lb.
Length of gun.....	118.38 ins.
Muzzle velocity, A.P. shell (weight 14.92 lb.).....	2,030 f./s.
Muzzle velocity, H.E. shell (weight 14.60 lb.).....	1,515 f./s.
Maximum powder pressure.....	38,000 lb./sq. in.
Rate of fire.....	20 rds./min.
Maximum range, A.P. shell.....	14,000 yds.
Maximum elevation.....	19°12'
Maximum depression.....	7°48'
Traverse, left.....	14°
Traverse, right.....	14°

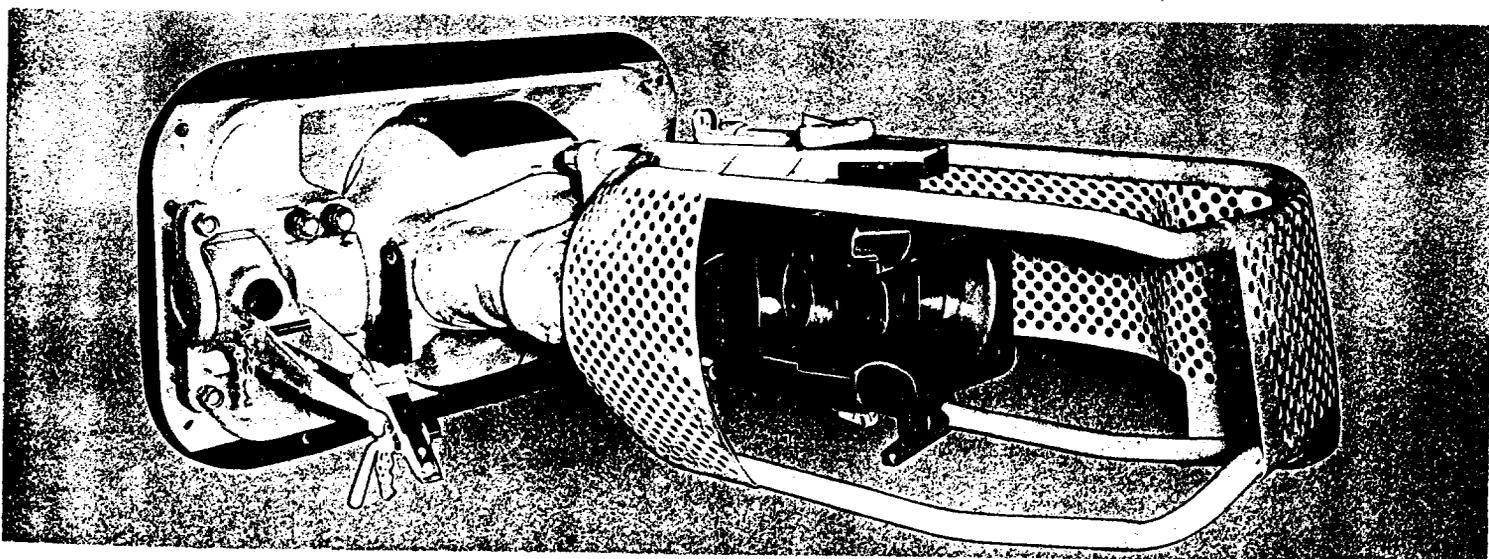
## Sighting Equipment

Periscope, M10, or M4A1  
Telescope, M38A1  
Azimuth Indicator, M19

## Ammunition

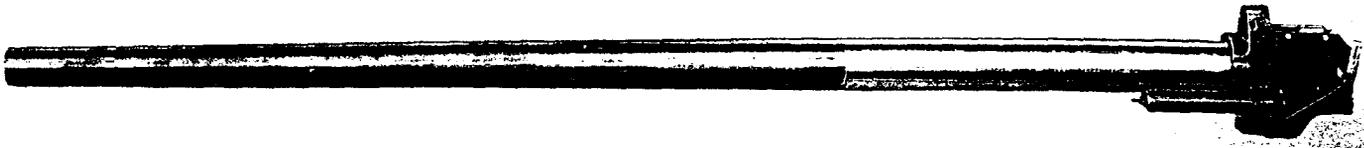
Ammunition is in the form of complete, fixed rounds. It consists of A.P.C. shell, M61, with tracer, and B.D. fuze, M66A1; H.E. shell, M48, normal charge, with P.D. fuze, M48.

REFERENCES—FM 23-95; TM 9-307; TM 9-2005, v.5; Oldsmobile Training Manual, 75 mm, M3, Tank Gun.



BREECH END OF 75 mm GUN, M3, WITH RECOIL MECHANISM AND SHOULDER GUARD

# 76 MM TANK GUN M1A2—STANDARD



76 MM TANK GUN, M1A1. THE M1A2 DIFFERS FROM THE M1A1 ONLY IN HAVING THE MUZZLE END THREADED FOR ATTACHMENT OF A MUZZLE BRAKE

The 76 mm Gun, M1A2, is a modification of the M1 Gun of the same caliber. The original 76 mm Gun, M1, was designed to provide tank weapons of greater power and armor penetration than were possible with 75 mm armament.

**76 mm GUN, M1**—This gun was designed to use the 3" H.E. Shell or A.P.C. Projectile with a different cartridge case. The gun tube and extractors were constructed to accommodate the redesigned cartridge, but the breech ring and breech mechanism were similar to those used on the 75 mm Gun, M3. This 76 mm Gun, M1, is now Limited Standard.

**76 mm GUN, M1A1**—In order to better adapt the M1 Gun to use with various tanks and gun motor carriages, the contour of the tube was changed, and the recoil slide surface on the tube was

lengthened 12 inches, thus permitting the trunnion position to be set farther forward to obtain better balance. The M1 gun with these modifications was designated 76 mm Gun, M1A1, and is classified as Limited Standard.

**76 mm GUN, M1A2**—In the 76 mm Gun, M1A2, the rifling twist is one turn in 32 calibers instead of one turn in 40 calibers as in the M1 and M1A1 Guns. All tubes are threaded at the muzzle to allow assembly of a muzzle brake, and a ring is provided to cover the threaded portion of the tube when the muzzle brake is not in place. This gun is classified as Standard.

### Sighting Equipment

Telescope, M47A2  
Periscope, M4A1

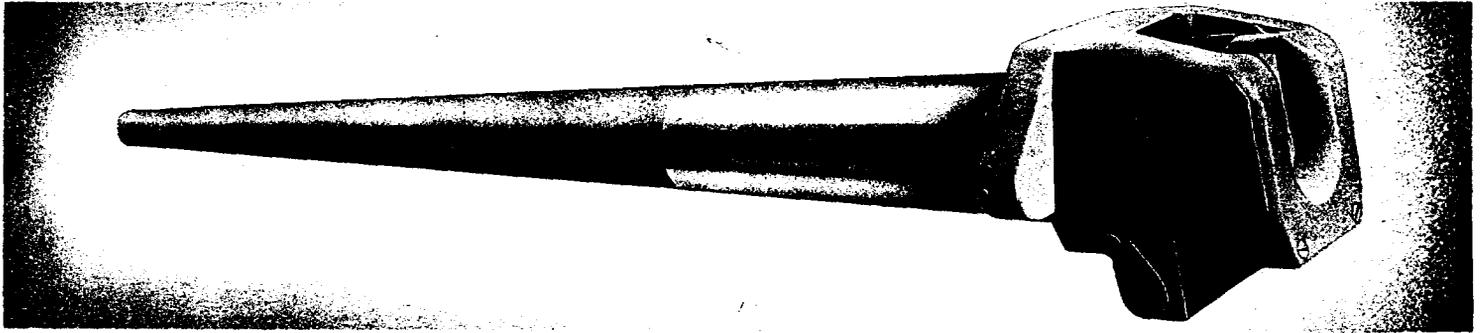
### Ammunition

Ammunition is in the form of complete fixed rounds. It consists of Shell, H.E., 3 Inch, M42A1, with Fuze, P.D., M48A1; Projectile, 76 mm, A.P.C., M62, with Fuze, B.D., M66A1, and Shell, Smoke, M88.

### CHARACTERISTICS

Diameter of bore..... 76.2 mm (3 ins.)  
Length of bore..... 52 cal.  
Overall length of gun..... 167.75 ins.  
Weight of gun..... 1,204 lb.  
Weight of tube..... 940 lb.  
Capacity of chamber..... 142.6 cu. ins.  
Muzzle velocity (H.E. Shell, M42A1) 2,800 f./s.  
Rated maximum powder pressure.... 43,000 p.s.i.  
Maximum range (H.E. Shell, M42A1)..... 14,780 yds.  
Type of breechblock..... Semi-automatic, vertical drop

# 3 INCH TANK GUN M7—STANDARD



3 INCH TANK GUN, M7

The 3" Gun, M7, was designed for use in Heavy Tanks, M6 and M6A1. It was also adopted as standard armament for the 3" Gun Motor Carriage, M10. Ammunition for this weapon is the same as that for the 3" antitank and antiaircraft guns.

O.C.M. 16200, dated 24 October 1940, initiated the development of a 3" gun similar to 3" Gun, T9, for the Heavy Tank, T1. It was designated 3" Gun, T12, with interior dimensions and ballistics practically identical with those of the 3" Antiaircraft Gun, M3, and the 3" Antitank Gun, M5. After firing tests, the T12 was standardized as 3" Gun, M7, by O.C.M. 18467, dated 9 July 1942.

The 3" Gun, M7, is a high-velocity, manually loaded weapon employing a semi-automatic breech mechanism with a

vertical drop-type breechblock. The general functioning of the gun is very similar to that of the 75 mm Gun, M3. A solenoid-actuated mechanism is used for firing the gun. The recoil mechanism and mount for this gun are supplied along with the vehicle.

### Ammunition

Ammunition is in the form of complete fixed rounds. It consists of A.P.C. projectile, M62, with B.D. fuze, M66A1; A.P. shot, M79, and H.E. shell, M42A1, with M.T. fuze, M43.

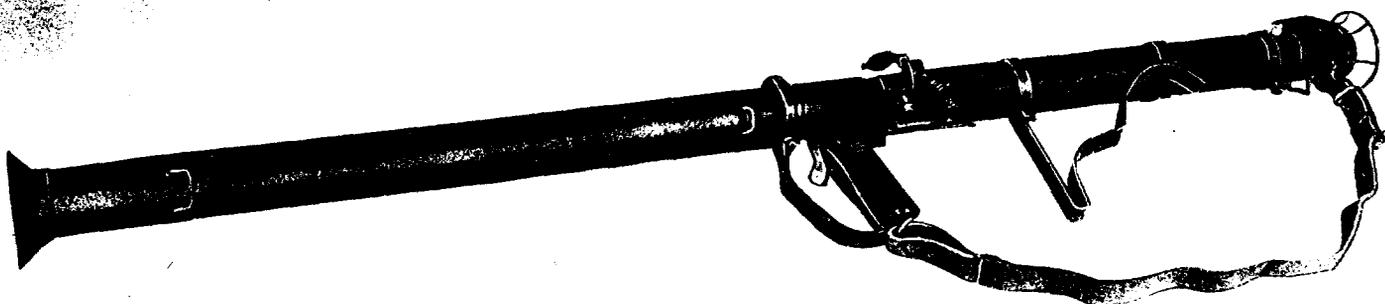
**SIGHTING EQUIPMENT**—Sighting equipment for the 3" Gun, M7, varies according to the type of vehicle in which the gun is installed.

Tank or Armored Car	Telescope	Telescope Mount	Panoramic Telescope	Azimuth Indicator	Periscope
M10, M10A1 M6, M6A1	M70G M39A1	M30	M12A4	M18	M6 M8A1

### CHARACTERISTICS

Diameter of bore..... 3 ins.  
Length of bore..... 50 cal.  
Overall length of gun..... 158.1 ins.  
Travel of projectile..... 128.49 ins.  
Weight of gun only..... 1,990 lb.  
Capacity of chamber (with A.P.C., M62) 205.58 cu. ins.  
Maximum powder pressure..... 38,000 lb./sq. in.  
Muzzle velocity (A.P.C., M62)..... 2,600 f./s.  
(H.E., M42A1)..... 2,800 f./s.  
Maximum range (A.P.C., M62)..... 16,100 yds.  
Breech mechanism..... semi-automatic drop block  
Recoil mechanism..... hydraulic

# LAUNCHER, ROCKET, ANTITANK, 2.36 INCH, M9—STANDARD



ROCKET LAUNCHER, A.T., M9, LEFT SIDE

The rocket launcher, popularly known and widely publicized as the "Bazooka," represents the adaptation to modern warfare of one of the oldest forms of military pyrotechnics, the rocket. It represents, too, the first practical development of a rocket gun or rocket launcher as a shoulder weapon for infantry use against tanks and other armored targets.

The launcher is an open tube approximately 54 inches long and 2.365 inches in internal diameter equipped with a shoulder stock, a pistol grip, electrical firing mechanism, and sights. The Rocket, M6A3, is 19.4 inches long and weighs 3.38 pounds. It carries a shaped charge of TNT capable of penetrating heavy armor at angles of impact up to 30°. The optimum range is approximately 200 yards although the rocket may be em-

ployed at ranges as great as 600 yards. The Rocket, 2.36 inch, M6A3, is illustrated and described in the ammunition section of this catalogue.

In its original form the rocket launcher was supplied with a wooden shoulder stock midway of its length and was not reinforced for additional bore-safety. A two-cell dry battery supplied the spark for ignition of the rocket's propelling charge, pressure on the trigger completing the circuit.

The first models of the launcher were equipped with a hinged rear sight and fixed front sights. These were followed by a peep rear sight and a front sight in the form of a rectangular frame at the muzzle of the launcher. The vertical sides of the frame carried graduations for ranges of 100, 200, and 300 yards.

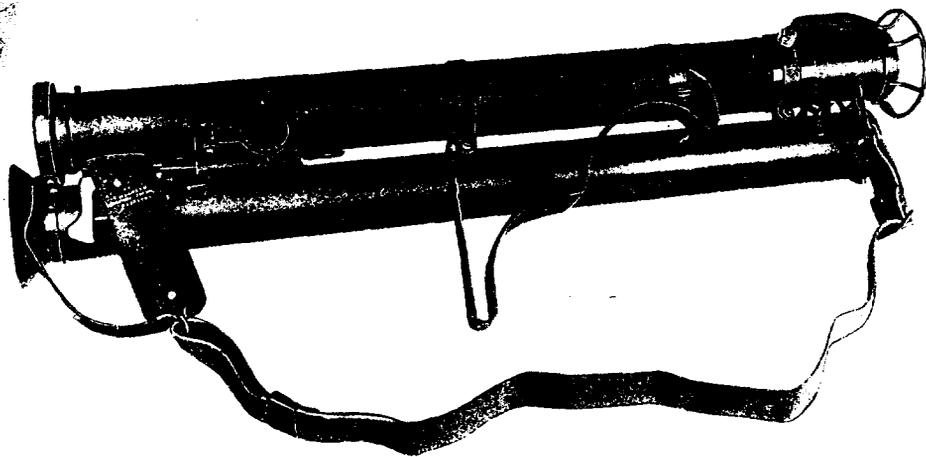
The rocket launcher was introduced as a combat weapon during the North African campaign of 1942-43. Use in battle indicated the need for various improvements and for a model which could be broken down into two approximately equal loads for use by parachute troops. The present launcher, M9, represents the development of those tactical requirements.

Since a higher safety factor was required, the tube of the launcher is now wrapped with wire around all that portion adjacent to the operator's face. The skeleton stock is of metal and is shaped so as to permit two shoulder positions for ease of sighting at high and low elevations and for prone shooting. Midway of the tube is a flange with bayonet joints which breaks the launcher into sections which may be carried by paratroopers or packed into containers for aerial delivery. Reassembly can be effected in a few seconds without tools and the joint locked rigidly.

The dry cells which supplied the ignition spark in the earlier models have been replaced by a self-contained magneto operated by pressure on the "squeezer" type trigger. A one-way safety switch incorporated in the trigger mechanism cuts out the magneto and prevents generation of an electrical impulse as the trigger returns to position.

The sight is an optical ring hinged to fold against the tube when not in use and protected by a cover. An adjustable range scale provides graduations from 50 to 700 yards in 50-yard increments.

Assembled and ready for firing, the rocket launcher measures 55 inches overall and weighs approximately 14½ pounds.



ROCKET LAUNCHER, M9, BROKEN DOWN

## LIGHT TANKS

Light tanks are those which weigh 20 tons or less. By this definition even the Japanese so-called medium tanks and the German PzKW III medium tank fall into this class.

All early light tanks were armed with 37mm guns. The Germans have mounted a 50mm and a short-barreled 75mm weapon in their latest light tanks, whereas the new U. S. Light Tank, M24, mounts a 75mm cannon. The Japanese have used a short-barreled 57mm gun in their Model 97 tank and a 47mm tank gun with a higher velocity in their latest model (2597 Special).

Light tanks are primarily reconnaissance vehicles, and accordingly their armor is not designed to "slug it out" with enemy tanks or antitank guns.

U. S. Light tanks have always been praised for their reliability and mobility. The early M3 and M5 models were criticized for their lack of firepower, although at close ranges this weapon is capable of knocking out the heavy tank of the Germans. The U. S. 37mm gun was at least as powerful as the German and Japanese counterparts in the field at that time.

The M24 incorporates all the battle experience gained earlier in the war, including such features as gyrostabilizers and Hydramatic transmission. It takes full advantage of sloping armor commensurate with the weight limitations specified by the using services. It has seen considerable service in Europe, and reports on its battle-field performance contain nothing but praise.



Pz. Kptw. III Aus. A, B, C, D, E (Sd. Kfz. 141)



Reports on the early development of the Pz. Kw. III do not agree. The following summary conforms to the best information available.

*Model A*—Weighed about 20 tons. Its suspension arrangement consisted of eight small bogie wheels each side on semi-elliptical, laminated springs, with three return rollers. Motivating power was generated by a Maybach V-12 gasoline engine rated 300 hp. Armament consisted of a 3.7 cm Kw. K., two light machine guns in the turret, and one light machine gun in the front plate of the superstructure. Armor consisted of 30 mm plate all around.

*Model B*—Same as Model A except for suspension which consisted of five medium size bogie wheels and two return rollers.

*Model C*—Principal change was the new type suspension which incorporated six bogie wheels and three return rollers, which became standard for the Pz. Kw. III tank. It is believed that torsion bar suspension evolved in this model.

*Model D<sup>1</sup>*—At this point in the development the previous models were given the nomenclature D<sup>1</sup>. Commander's tanks are known to have been produced serially from this period on.

*Model E*—Represents the first model in which the definite Pz. Kw. III type has been crystallized. It embodies the improvements made in previous models. It carried the same armament (3.7 cm Kw. K.) and had a suspension arrangement of six bogie wheels sprung on torsion bars and three return rollers.

A self-propelled equipment known as the Sturmgeschütz has been developed from the Pz. Kw. III. It consists of the Pz. Kw. III chassis mounting a short-barreled 7.5 cm Kw. K. The chassis was later used to mount the 7.5 cm Kw. K. 40, long-barreled gun, and the 10.5 cm howitzer.

SPECIFICATIONS

(Model C)

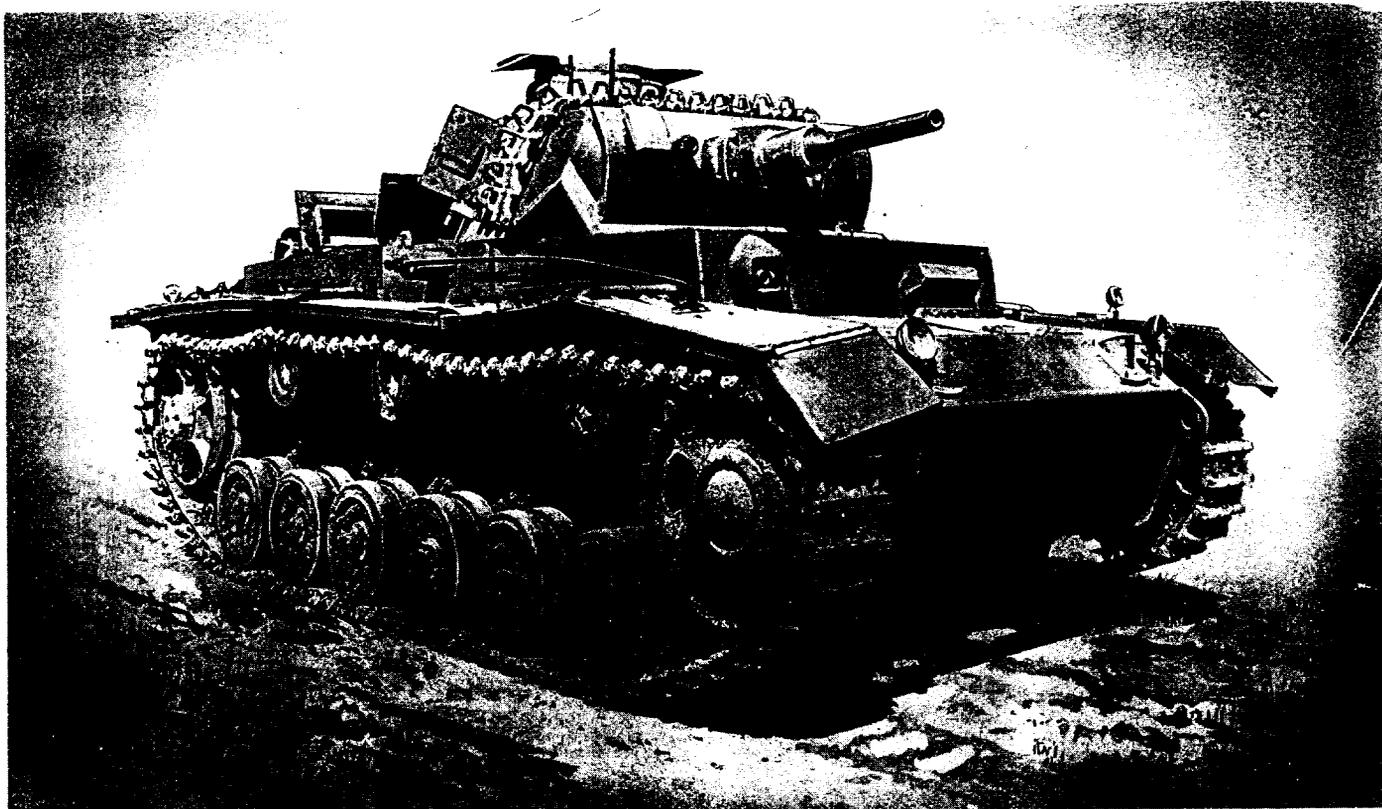
Weight .....	21 tons
Length .....	17 ft., 9 ins.
Width .....	9 ft., 7 ins.
Height .....	8 ft., 3 ins.
Ground clearance .....	15 ins.
Tread centers .....	8 ft., 1 7/8 ins.
Ground contact .....	(approx.) 10 ft., 6 ins.
Width of track .....	14 1/2 ins.
Pitch of track .....	
Track links .....	
Fording depth .....	3 ft.
Theoretical radius of action	
Roads .....	100 miles
Cross-country .....	60 miles
Speed	
Roads .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor	
Front plate .....	30 mm
Sides .....	30 mm
Armament .....	3.7 cm Kw. K. 3 MG's
Ammunition .....	
Engine .....	Maybach V-12, 300 hp.
Transmission .....	Synchromesh—10 speeds forward, 4 reverse.
Steering .....	Epicyclic, clutch brake
Crew .....	5

# MEDIUM TANKS

GERMAN



Pz. Kpfw. III Aus. F, G, H (Sd. Kfz. 141)



**Model F**—This is the first tank of the series to mount a 5.0 cm Kw. K. electrically fired tank gun in place of the 3.7 cm Kw. K. and also the first to have a new type mantlet. This mantlet has a thick shield on the front which moves with the gun. A single machine gun is mounted coaxially on the right of the 5.0 cm gun and the hull machine gun is retained.

The hull consists of three separate subassemblies: (1) lower hull, (2) front superstructure carrying turret, and (3) rear superstructure covering the engine compartment. All units are of single skin welded construction.

The turret forms the roof of a spacious fighting compartment, being mounted over the middle part of the hull. It has no rotating platform, the commander and the gunner having seats suspended from and rotating with the turret. The loader apparently stands on the floor of the fighting compartment. The commander's cupola is bolted to the roof of the turret on the center-line to the rear.

The suspension is the same as that used in Model E.

The engine is the Maybach V-12, gasoline, rated 320 hp. Its transmission is the synchromesh type with 10 speeds forward and 4 reverse. Its steering is of the epicyclic, clutch brake type with hydraulic control.

**Model G**—Identical in armament, mantlet, and mechanical components to Model F, the only difference being in the cupola, which is more squat and has all-around vision.

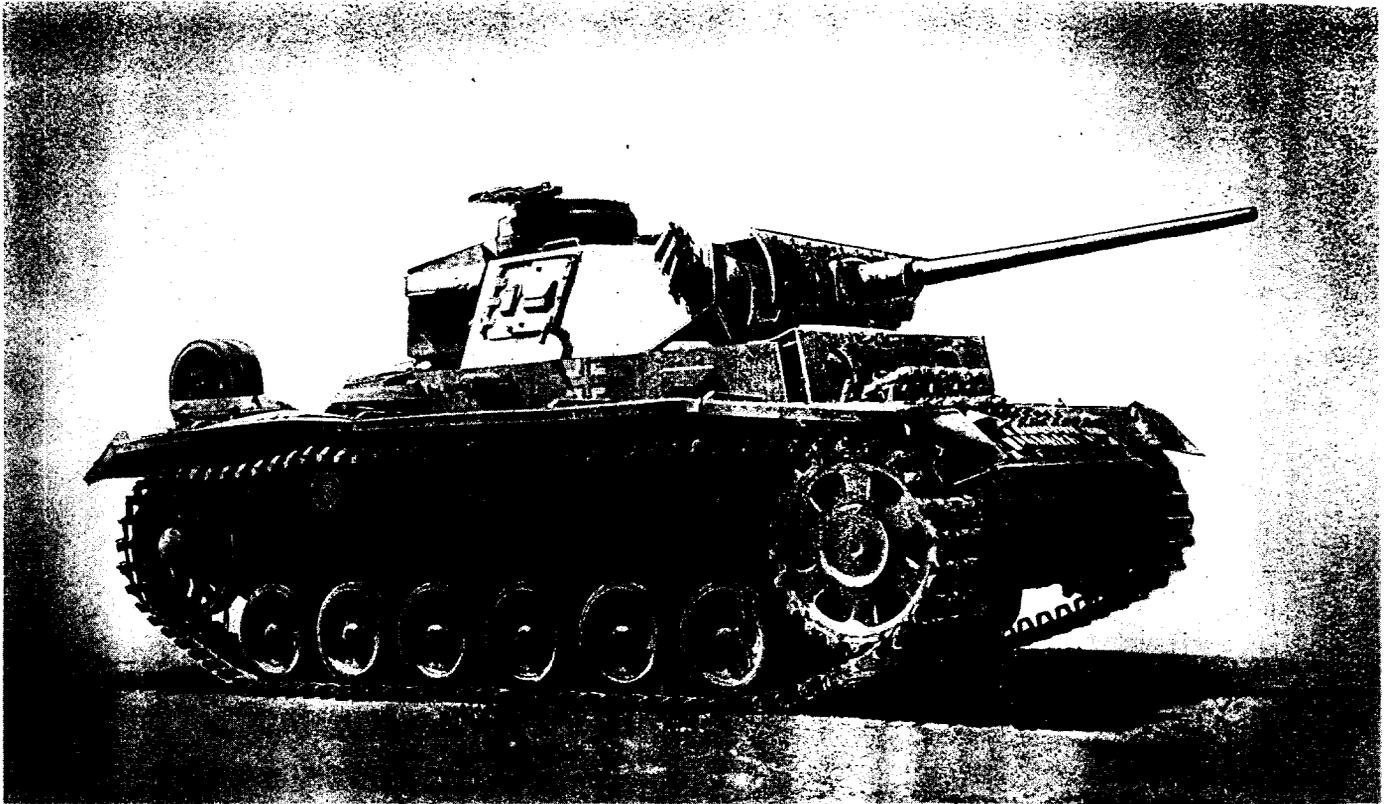
**Model H**—This model has additional 32 mm plates bolted on the front of the superstructure, on the upper and lower nose plates and on the tail plate. The outstanding recognition features of this model are its front sprocket which has six spokes, and its rear idler which is more open than the earlier type, though it has eight spokes. Wider tracks and narrower bogie wheels are also used.

## SPECIFICATIONS

Weight .....	22 tons
Length .....	17 ft., 9 ins.
Width .....	9 ft., 7 ins.
Height .....	8 ft., 3 ins.
Ground clearance .....	15 ins.
Tread centers .....	8 ft., 1 7/8 ins.
Ground contact .....	(approx.) 10 ft., 6 ins.
Width of track .....	14 1/2 ins.
Pitch of track .....	4 3/4 ins.
Track links .....	90
Fording depth .....	3 ft.
Theoretical radius of action:	
Roads .....	100 miles
Cross-country .....	60 miles
Speed:	
Road .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor:	
Front plate .....	30 + 32 mm
Sides .....	30 mm
Armament .....	5.0 cm Kw. K. 2 MG's
Ammunition .....	
Engine .....	Maybach, HL 120, V-12, 320 hp.
Transmission .....	Synchromesh, 10 forward, 4 reverse, and 6 forward, 1 reverse.
Steering .....	Epicyclic, clutch brake
Crew .....	5



Pz. Kpfw. III Aus. J, K (Sd. Kfz. 141)



*Model J*—The principal differences between Model J and earlier models are:

1. Increased thickness of basic armor plate on certain front and rear plates from 30 mm to 50 mm and the addition of spaced armor on the front of the gun mantlet and the front plate of the superstructure.

2. Hydraulically operated steering in the earlier models has been replaced by mechanical steering. As previously reported, the complicated Maybach Variorex ten-speed gear was abandoned in Model H in favor of a manual six-speed and reverse gear box.

3. Wider tracks—15 inches instead of 14½ inches. The heavier track necessitated a change in the spacing of the return rollers. Front and rear rollers are now mounted directly over the Luvax shock absorbers and prevent the track fouling the latter.

4. The tail plate has been modified to give better protection to the rear air outlet; it also allows the smoke device to be mounted inside the plate.

5. One or two mild steel bars, welded at each end, are fixed across the middle of the nose plate. The track shoes are placed behind the bars and are held in position by the bridge of the shoe.

6. The mounting of the 5.0 cm Kw. K. 39 (long gun) was incorporated in the latest of the Model J tanks.

The most prominent recognition points of this model are: the mounting of the hull machine gun is of prominent ball type; the driver's visor consists of a single hinged piece of armor instead of two separate plates; the front sprocket and rear idler are similar to those in Model H; particularly squat turret, pear-shaped with circular cupola well set to the rear.

*Model K*—Same as Model J. This model mounted the 5.0 cm long gun (Kw. K. 39).

## SPECIFICATIONS

Weight .....	22 tons
Length .....	17 ft., 9 ins.
Width .....	9 ft., 8 ins.
Height .....	8 ft., 3 ins.
Ground clearance .....	15 ins.
Tread centers .....	8 ft., 2½ ins.
Ground contact .....	9 ft., 4½ ins.
Width of track .....	15 ins.
Pitch of track .....	4¾ ins.
Track links .....	90
Fording depth .....	3 ft.
Theoretical radius of action:	
Roads .....	100 miles
Cross-country .....	60 miles
Speed:	
Road .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor:	
Front plate .....	50 mm
Sides .....	30 mm
Armament .....	5.0 cm Kw. K. 39 2 MG's
Ammunition .....	5.0 cm gun—75 rds.
Engine .....	Maybach HL 120 TRM, V-12, 320 hp.
Transmission .....	Manual, 6 speeds forward, 1 reverse
Steering .....	Epicyclic, clutch brake
Crew .....	5

Pz. Kpfw. III Aus. L, M, N, O (Sd. Kfz. 141)



**Model L**—In this model the loader's visor in the right of the gun mantlet has been omitted as well as the vision openings on each side of the turret in front of the access doors. Spaced armor is always fitted on the front of the superstructure and fittings for spaced armor are provided on the gun mantlet, but the curved spaced plate is not always fitted in the latter position. The long 5.0 cm Kw.K. 39 is balanced by a torsion bar. The torsion bar compensator is mounted on the roof of the turret and connected to the gun by means of a link. On the cupola of this model a metal framework is attached, probably to serve as a rest for the gun. In other respects Model L is identical to Model J. German markings on this tank indicate that it was prepared for tropical or desert use. Preparation consisted of slight changes in the air-cooling system and addition of deflectors on the rear of the tank to prevent the exhaust gases and cooling air from striking the ground.

**Model M**—This model is similar to Model L with the exception that it has no loading doors fitted on the side of the hull.

**Models N, O**—Reports indicate the existence of these models but no details are available.

A few Model L tanks and many Model M and N tanks now mount the 7.5 cm Kw.K., which is the short gun formerly fitted in the Pz. Kpfw. IV. Recent models of the Pz. Kpfw. III now in service mount, therefore, either the 5 cm long gun or the 7.5 cm short gun. When the latter gun is mounted, the spaced armor plate on the gun mantlet and the fittings for it are omitted altogether. The mantlet is one of the Pz. Kpfw. III type without loader's visor, but the recoil gear casing and armored protecting sleeve in front of the mantlet are of the type provided on the Pz. Kpfw. IV. In a captured Model N mounting a short 7.5 cm Kw.K., the sighting telescope was a T.Z.F. 5b, which is the type used with this gun in the older Pz. Kpfw. IV's. Stu. G. 7.5 cm K.

## SPECIFICATIONS

Weight .....	22 tons
Length .....	17 ft., 9 ins.
Width .....	9 ft., 8 ins.
Height .....	8 ft., 3 ins.
Ground clearance .....	14 ins.
Tread centers .....	8 ft., 2½ ins.
Ground contact .....	9 ft., 4½ ins.
Width of track .....	15 ins.
Pitch of track .....	4¾ ins.
Track links .....	90
Fording depth .....	3 ft.
Theoretical radius of action	
Roads .....	100 miles
Cross-country .....	60 miles
Speed	
Roads .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor	
Front plate .....	50 + 20 mm
Sides .....	30 mm
Armament .....	7.5 cm Kw.K.
	2 MG 34's
Ammunition .....	5.0 cm gun—78 rds.
	MG's—4950 rds.
Engine.....	Maybach V-12, HL 120 TRM, 320 hp.
Transmission.....	Manual operation, 6 speeds forward, 1 reverse.
Steering .....	Epicyclic, clutch brake
Crew .....	5

## MEDIUM TANKS

Medium tanks are those in the 22- to 40-ton weight class. Although the Japanese have so-called medium tanks, they are lighter than the American medium tanks and in the interest of fair comparison have been compared with American light tanks. The German PzKw V and VI are considered as heavy tanks.

The using services of our Army have built the Armored Force around the Medium Tank, M4. As in German tanks, the main armament has advanced from a relatively low-velocity 75mm gun to a high-velocity 76mm gun which has been standard in U. S. medium tanks for over a year. The M4 Sherman is famed for its tough armor, considering its weight limitation of 33 tons. It is considerably superior to the German PzKw IV.

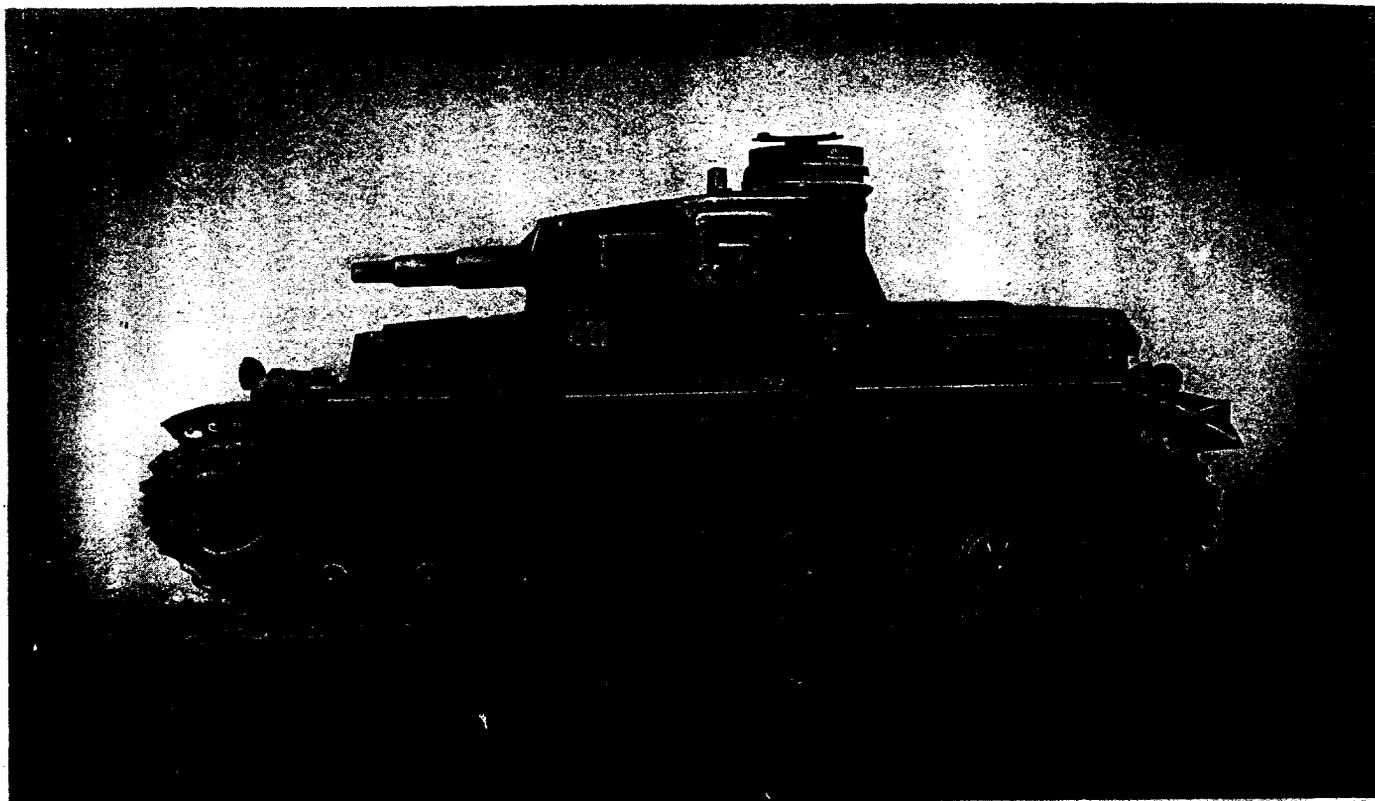
As many top commanders such as Patton and Devers have testified, the greatly superior mechanical reliability and maneuverability under most conditions, the power traverse, and the use of a gyrostabilizer, have not only made the U. S. M4 tank superior to the German PzKw IV but also enabled our 30-ton medium tanks to outfight the heavy German tanks.

To provide an assault tank with heavy frontal armor for use in ETO, a number of M4A3E2 tanks with a frontal armor basis of 5 1/2 - 10" have been produced. Reports indicate they have been highly successful for the purpose intended.

The Japanese have tanks in this weight class, but they have never been encountered in action and no reliable technical data are available.



Pz. Kpfw. IV Aus. A, B, C, D, E (Sd. Kfz. 161)



Weighing up to 24 tons in battle array, it is the standard German medium tank. Ten models, A, B, C, D, E, F, F<sup>2</sup>, G, H, K, are known to have been produced. All models utilize the same suspension arrangement of eight evenly spaced bogie wheels, 18½ inches in diameter, sprung in pairs on each side, with four return rollers. All models mount the 7.5 cm Kw. K. except Models F<sup>2</sup> and G, which mount the 7.5 cm Kw. K. 40. The chassis of this tank is used as a self-propelled mount for heavier guns, such as the "Hornet," the "Bee," and the "Grizzly Bear."

*Model A*—An early experimental type. It weighed 20 tons, unladen, and had a 5-speed transmission (S.F.G. 75) and an H.L. 108 T.R. Maybach engine.

*Model B*—The first model to bear the standard Pz. Kw. IV type number Sd. Kfz. 161. This model had a new type of 6-speed transmission (S.S.G. 76) and an improved H.L. 120 T.R.M. Maybach engine

*Model C*—Distinguishable from Model B by its "wish-bone" aerial deflector. It was the first model to have an armored sleeve protecting the turret machine gun, and the front plate of its superstructure extends straight across the tank in one piece.

*Model D*—The fixed outer gun mantlet is dispensed with and the moving portion is fitted with a thick front shield, the edges of which overlap and protect the mantlet joints. The driver's compartment extends farther forward than the machine gunner's compartment. The basic armor in this model is 30 mm in thickness in front and 20 mm on the sides. Its unladen weight is 20½ tons.

*Model E*—Distinguishable from the Model D by its new type of front driving sprocket, and by the new design of shutter (single hinge) on the driver's visor. The nose plate armor is increased from 30 mm to 50 mm. Weight is 21.5 tons, unladen.

## SPECIFICATIONS

Weight .....	21.5 tons
Length .....	19 ft., 4 ins.
Width .....	9 ft., 7 ins.
Height .....	8 ft., 6 ins.
Ground clearance .....	15¼ ins.
Tread centers .....	7 ft., 11 ins.
Ground contact .....	11 ft., 6 ins.
Width of track .....	14¼ ins.
Pitch of track .....	4¼ ins.
Track links .....	99
Fording depth .....	3 ft.
Theoretical radius of action:	
Roads .....	130 miles
Cross-country .....	80 miles
Speed:	
Road .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor:	
Front plate .....	50 mm
Sides .....	30 mm
Armament .....	7.5 cm Kw. K. 2 MG 34's
Ammunition .....	7.5 cm gun—105 rds. MG's—2,700 rds.
Engine .....	Maybach HL 120 TRM, V-12, 320 hp.
Transmission .....	Synchromesh—6 speeds forward, 1 reverse.
Steering .....	Epicyclic, clutch brake
Crew .....	5



Pz. Kpfw. IV Aus. F1, F2, G, H, K (Sd. Kfz. 161)



*Model F*—The hull, superstructure, and turret, as in all other known models of the Pz. Kpfw. IV, is of welded construction. The basic frontal armor, including superstructure and turret of Model F, was increased to 50 mm; on the sides to 30 mm. The main hull superstructure projects over the top of the tracks, providing additional stowage space and a wide base upon which to mount the turret. The turret floor is carried by brackets from the turret ring and consequently rotates with the turret.

The suspension consists of 4 bogie assemblies, each fitted with two rubber-tired bogie wheels 18½ inches in diameter on each side, with a quarter elliptic spring anchored beneath the leading axle arm of each assembly. There is a front sprocket, the spokes of which are bent outward from the hub cap giving the outside a dished appearance, a rear idler which has 7 spokes instead of 8 as in previous models, and 4 return rollers.

The power plant consists of a Maybach HL 120 TRM, V-12 O.H.V., 4-stroke, gasoline engine, rated 320 B.H.P. at 3,000 r.p.m.

The armament consists of a 7.5 cm Kw. K., 24 cal. in length, a coaxial 7.92 mm MG 34 mounted in the turret, and a 7.92 mm MG 34 at the right of the front plate of the superstructure.

*Model F<sup>2</sup>*—Same as Model F except that it carried the initial experimental mounting of the Kw. K. 40, 43 cal. in length.

*Model G*—Produced in 1942. Same as Model F except that the mounting of the Kw. K. 40 was continued. The gun was fitted with a double baffle muzzle brake.

*Models H, K*—These models are referred to in German documents published during 1943.

## SPECIFICATIONS

Weight .....	26 tons
Length .....	19 ft., 4 ins.
Width .....	9 ft., 7 ins.
Height .....	8 ft., 6 ins.
Ground clearance .....	15 ins.
Tread centers .....	7 ft., 11 ins.
Ground contact .....	11 ft., 6 ins.
Width of track .....	15 ins.
Pitch of track .....	4¾ ins.
Track links .....	98
Fording depth .....	3 ft.
Theoretical radius of action:	
Roads .....	130 miles
Cross-country .....	80 miles
Speed:	
Road .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor:	
Front plate .....	50 mm
Sides .....	30 mm
Armament .....	7.5 cm Kw. K. 40 2 MG's 34
Ammunition .....	7.5 cm gun—87 rds. MG's—2,250 rds.
Engine.....	Maybach HL 120 TRM, 320 hp.
Transmission .....	Synchromesh—6 speeds forward, 1 reverse.
Steering .....	Epicyclic, clutch brake
Crew .....	5

# HEAVY TANK—"Tiger"

GERMAN



Pz. Kpfw. "Tiger" (8.8 cm Kw. K. 36 L/56) (Sd. Kfz. 181)



The Pz. Kpfw. VI was introduced into service by Germany in the latter part of 1942.

Its construction incorporates a notable departure from past German practice in that the superstructure is welded to the main hull instead of being bolted. The use of heavy armor called for flat plates wherever possible, resulting in a simple box-like contour. Another interesting development in construction involves plate interlocking, secured by welding, in addition to the normal step jointing. This has no doubt been made necessary by the use of thicker armor, which ranges from 102 mm in the front nose plate to 92 mm in the cast steel gun mantlet, and 80 mm in the side superstructure.

The hull is divided into four compartments. The floor of the fighting compartment is suspended from and rotates with the turret. The turret is centrally mounted between the hull side plates. A circular fixed cupola, with an inside diameter of 20 inches, is mounted in the turret roof.

The suspension consists of front sprocket, rear idler, and eight triple, rubber-tired bogie wheels 31½ inches in diameter sprung on torsion bars. The wheel assemblies straddle each other in such a manner that the outer rims of four of the wheels on each side may be removed to accommodate the narrow (20½ inch) transportation track. For combat a wider (28½ inch) track is utilized.

The mechanical layout follows orthodox German practice. The Maybach, V-12, 642 hp. engine is mounted centrally at the rear.

The armament consists of an electrically fired 8.8 cm Kw.K. 36 with coaxial 7.92 mm MG 34 in the turret, a ball-mounted MG 34 in the vertical plate, a 9 mm machine gun stowed, six smoke generators, and three mine throwers mounted on the superstructure roof. The existence of a Model "P" has also been reported.

## SPECIFICATIONS

Weight (in battle order).....	63 tons
Length .....(excl. gun) 20 ft. 8½ ins.	
Width ..... 12 ft. 3 ins.	
Height ..... 9 ft. 4¼ ins.	
Ground clearance ..... 17 ins.	
Tread centers ..... 9 ft. 3½ ins.	
Ground contact ..... 12 ft. 6 ins.	
Width of track ..... 28½ ins.—20½ ins.	
Pitch of track ..... 5¼ ins.	
Track links ..... 96	
Fording depth ..... 15 ft.	
Theoretical radius of action	
Roads ..... 87 miles	
Cross-country ..... 53 miles	
Speed	
Roads ..... 25 miles	
Cross-country ..... 15 miles	
Armor	
Front plate ..... 102 mm at 70° to horiz.	
Sides ..... 80 mm at 80° to horiz.	
Armament.....	8.8 cm Kw.K 36
	2 MG 34's
M.V. ....	2624 l/s
Wt. of projectile.....	21 lb.
Ammunition .....	8.8 cm—92 rds.
	MG's—5100 rds.
Engine.....	Maybach HL 210, V-12, 642 hp.
Transmission .....	Preselector, hydraulic—8 speeds
	forward, 4 reverse.
Steering .....	Controlled differential, hydraulic
Crew .....	5

BATTLE FIELD REPORTS ON MEDIUM TANKS

Headquarters  
THIRD UNITED STATES ARMY  
Office of the Ordnance Officer  
APO 403

KRD/rfo  
19 Mar 45

SUBJECT: Examination of Causes of Rendering Tanks Inoperative

TO: Chief of Staff, Third U. S. Army

1. At the direction of the Commanding General, a study of the causes for rendering of both American and German tanks inoperative in battle has been instituted. Submitted herewith is the first partial report covering tanks destroyed in battle as determined by actual examination of the tanks reported on.

2. 107 American M4 Medium Tanks examined.

72 - Tanks or 67% were destroyed by enemy gun fire as follows:

3 - Hit by rockets.  
17 - Hit by 88mm AP.  
52 - Hit by 75mm AP

5 - Tanks were destroyed by mines.

30 - Tanks or 28% were destroyed by terrain obstacles or mechanical deficiencies.

Of the 72 tanks destroyed by gun fire, 42 or 58% burned.

For details of location of hits on tanks, see Inclosure 1 and 2

3. 100 German Mk III and IV tanks examined.

59 - Tanks or 59% were destroyed by enemy gun fire as follows:

8 - Hit by rockets.  
4 - Hit by 90mm AP/  
47 - Hit by 75mm or 76mm AP.

1 - Tank destroyed by mine.

40 - Tanks or 40% were destroyed by terrain obstacles or mechanical deficiencies.

Subject: Examination of Causes for Rendering Tanks Inoperative. (Cont'd)

Of the 59 tanks destroyed by gun fire, 20 or 34% burned.

For details of location of hits on tanks, see Inclosures 3 and 4.

4. 36 German Mk V and VI tanks examined.

30 - Tanks or 83% were destroyed by enemy gun fire as follows:

- 9 - Hit by rockets.
- 2 - Hit by 90mm A.P.
- 19 - Hit by 75mm or 76mm AP.
- No tanks destroyed by mines.

6 - Tanks or 17% were destroyed by terrain obstacles or mechanical deficiencies.

Of the 30 Tanks destroyed by gun fire, 12 tanks or 40% burned.

For details of location of hits on tanks, see Inclosures 5 and 6.

5. DISCUSSION: The value of mobility over heavy armament is born out by the fact that 83 per cent of the Mk V and VI German tanks were destroyed by gun fire as compared to 67 per cent for American M4 and 59 per cent for German Mk III and IV. The minor importance of shoulder rocket guns is evidenced by the low percentage of tanks destroyed by their use, both American and German. The American tank appears to be more susceptible to fire when hit than the German. The recognizable groups of hits as shown on inclosures 2, 4 and 6, show that the German and American gunner is shooting for the driver and assistant driver on his front shots. The American aims more for final drive than the German. On the side shots, the German is still shooting at the spot on the forward sponson in which ammunition was stored in early M4 tanks. It is evident from this study that either the American 75mm gun or the 76mm gun is capable of destroying any German tank.

For the Army Ordnance Officer:

K. R. DANIEL,  
Lt. Col., Ord. Dept.  
Asst. Ord. Officer

6 Incl:

- 1 - Statistics, M4 American Tank
- 2 - Plot of All Hits, M4 American Tank
- 3 - Statistics, Mk III and IV German Tanks
- 4 - Plot of All Hits, Mk III and IV German Tanks
- 5 - Statistics, Mk V and VI German Tanks
- 6 - Plot of All Hits, Mk V and VI German Tanks

## SELF-PROPELLED HOWITZERS - LIGHT

Early in this war the value of mounting guns larger than 75mm on a tank chassis was appreciated, and the 105mm Howitzer on the medium tank chassis was developed and produced in time to take part in the battles of Africa. The first model was designated the 105mm Howitzer Motor Carriage, M7, and nicknamed the "Priest". The M37, an approved version, is now standard.

Although, designed primarily for use as artillery, this weapon can be used effectively against tanks with its HEAT (shaped-charge) ammunition. The 105mm howitzer is not turret mounted and has only a limited traverse. The vehicle also mounts a cal..50 machine gun in a ring mount for antiaircraft protection and for use against light ground targets. The success of the 105mm howitzer in this chassis has led to the installation of a number of 105mm howitzer in later models of the M4 tank (see Medium Tanks).

The Germans have mounted 105mm howitzers on both their PzKw II and PzKw III chassis. There is also scant information concerning a 105mm howitzer mounted on the modified chassis of the PzKw IV Medium Tank.

Up to the present time the Japanese have not used any weapons similar to these against our forces.

The German and U. S. 105mm howitzers are about equal. The U.S. self-propelled mounts have the advantage of superior reliability of the tank components on which they are based.

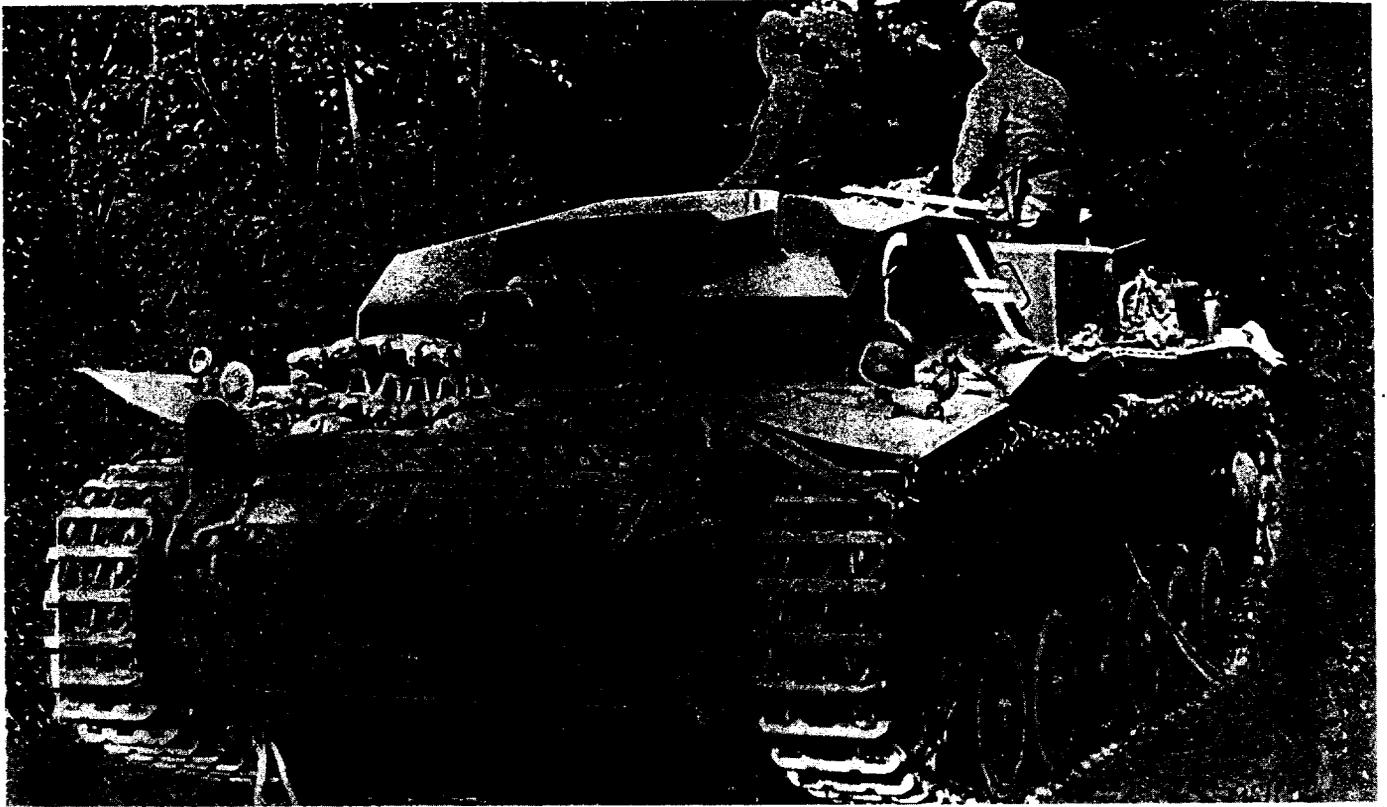
BATTLE FIELD REPORTS ON THE  
105MM HOWITZER MOTOR CARRIAGE, M7

"We have been in combat 63 days with the M7's and during that time we have had very few weapons out on account of motor trouble. Their extreme mobility has been very useful in the terrain and especially during the Cherbourg campaign and the break through. I like them and the men like them." (Intell Bulletin #18 from General Blakely on the Combat Record of the M7, organic in the 4th. Div. Artillery.)

"The self-propelled howitzer proved to be a very effective weapon for close direct fire, and it is believed to be the proper weapon for the infantry cannon company in this type of operation." (Exp. of 7th. Div. in Capture of Southern Part of Kwajelein Atoll)

"All officers who had observed our 105mm self-propelled gun were very enthusiastic about it." (Ref: OKD 385/177.1 No. 7 Report of Col. Reynolds and Col. Rotch, AGF)

Sturmgeschütz 7.5 cm K. (Sd. Kfz. 142)



The Sturmgeschütz is an assault weapon. Unlike the two other classes of self-propelled guns, antitank and artillery, which consist merely of guns placed in the hull of a tank with shields erected around the front and sides thereof, the assault gun is built into the hull and is consequently nearer the ground and has a much more solid superstructure built round the gun. The original Sturmgeschütz consisted of the turretless chassis of a Pz. Kpfw. III tank, upon which was mounted the Stu. G. 7.5 cm K., a short-barreled (69.5 inch) piece found in the first models of the Pz. Kpfw. IV. Since the power plant and other mechanical components of the chassis of the Sturmgeschütz are identical to those of the Pz. Kpfw. III tank, and their weights are approximately the same, the performance data of the two are comparable.

The turret of the original tank has been removed and replaced by a squat superstructure, reducing the height of the vehicle from 8 feet, 3 inches as a tank to 6 feet, 5 inches as an assault weapon. The gun compartment is roofed over, but there is no rotating turret. The fighting compartment is armored as follows: front 53 mm, sides 43 mm, top 11 mm.

The gun, which is mounted low in the hull and fires forward, is identical to the 7.5 cm Kpfw. K. short tank gun, originally the main armament of the Pz. Kpfw. IV tank. It is primarily a close support weapon, the ammunition scale comprising only 25% A.P. against 10% smoke and 65% H.E.; its armor-piercing performance is relatively poor. Its muzzle velocity and maximum range firing H.E. shell is 1,378 f. s. and 6,758 yards, respectively. The penetration of A.P.C.B.C. shell against homogeneous armor is reported as follows: 500 yards, 1.81 inches at 30° obliquity, 2.16 inches normal—1000 yards, 1.61 inches at 30°, 1.97 inches normal—1,200 yards, 1.57 inches at 30°, 1.89 inches normal.

## SPECIFICATIONS

Weight .....	21 tons
Length .....	17 ft., 9 ins.
Width .....	9 ft., 7 ins.
Height .....	6 ft., 5 ins.
Ground clearance .....	14 ins.
Tread centers .....	8 ft., 2½ ins.
Ground contact .....	9 ft., 4½ ins.
Width of track .....	15 ins.
Pitch of track .....	4¾ ins.
Track links .....	90
Fording depth .....	3 ft.
Theoretical radius of action	
Roads .....	100 miles
Cross-country .....	60 miles
Speed	
Roads .....	28 m.p.h.
Cross-country .....	15 m.p.h.
Armor	
Front plate .....	50 mm
Sides .....	30 mm
Armament .....	7.5 cm Kw. K.
Ammunition .....	84 rds.
Engine.....	Maybach V-12, HL 120 TRM, 320 hp.
Transmission .....	6 speeds forward, 1 reverse
Steering .....	Epicyclic, clutch brake
Crew .....	4

SELF-PROPELLED GUNS AND HOWITZERS, MEDIUM, 150 - 155mm

The Germans have used in this war a number of improvised self-propelled howitzers in the 150mm class. The most frequently encountered are:

15cm SIG 33 mounted on the Pzkw I and Pzkw II chassis,  
15cm SFH 18 mounted on the Pzkw IV chassis,  
15cm STUH 43, also mounted on the Pzkw IV chassis.

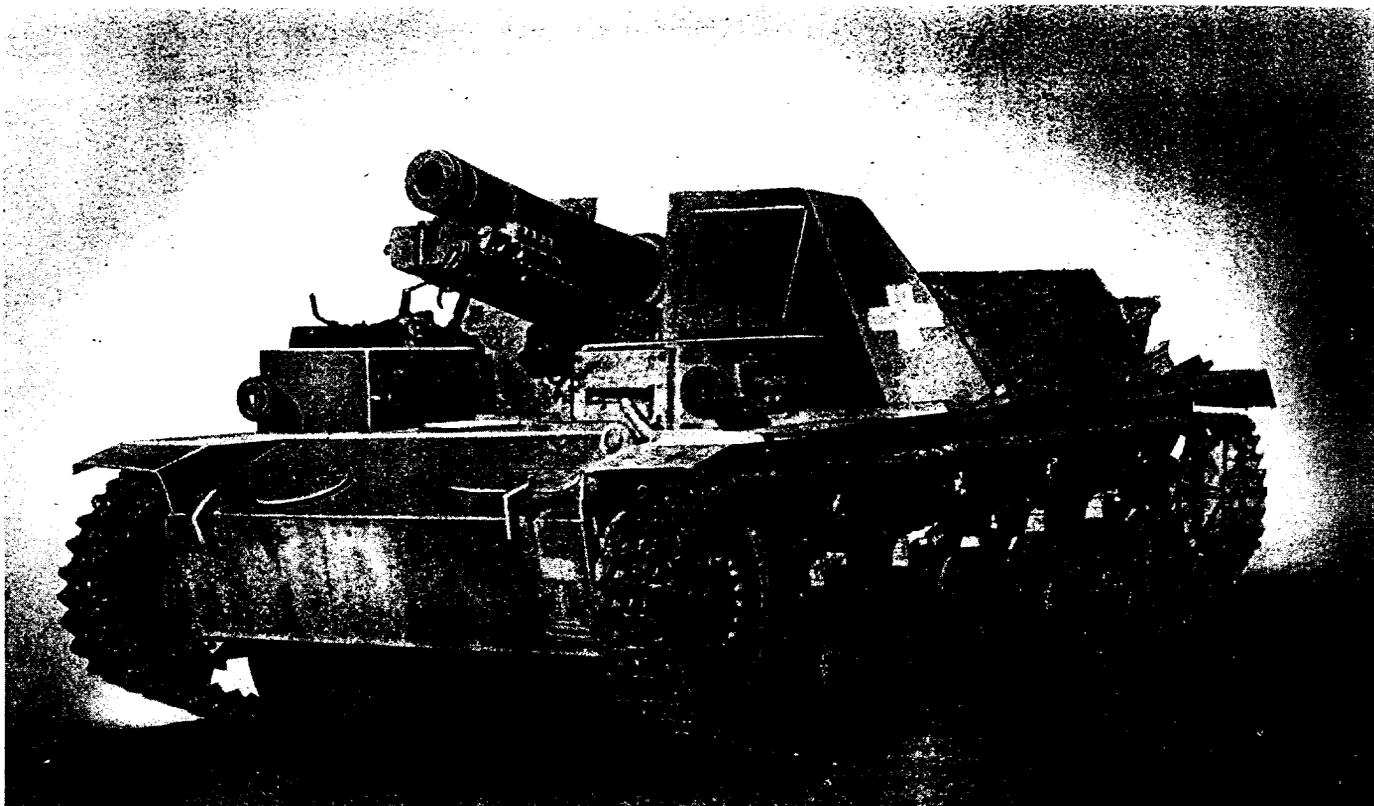
The Japanese have one self-propelled 15cm howitzer on a medium tank chassis. The maximum range of any of these weapons is approximately 15,000 yards.

Early in the war, the Ordnance Department developed the 155mm Gun Motor Carriage, M12, using the World War type 155mm GPF, which had a maximum range of 20,100 yards. One hundred of these were manufactured but there were no immediate requirements. Experience in France showed the great value of highly mobile self-propelled artillery of this size, and urgent requirements were then submitted for the improved type recently standardized as the 155mm Gun Motor Carriage, M40 (T83). The M40 mounts the 155mm Gun, M1, which has a maximum range of 26,715 yards. The older M12 fired the first shot into Germany and the new M40 fired the first shot into Cologne. Also recently standardized is the 155mm Howitzer Motor Carriage, M41, (T64E1).

These U. S. weapons, which are mounted on medium tank chassis, demonstrate how successfully large weapons can be mounted on mobile chassis to meet the specific needs of the using services.



Gw. II für 15 cm s. I. G. 33



This vehicle consists of the 15 cm. heavy infantry howitzer mounted in the hull of a modified, turretless Pz. Kpfw. II chassis. The chassis is approximately three feet longer than that of the standard Pz Kw II tank and has six bogie wheels instead of the usual five. The sprockets, rear idlers, bogie wheels, return rollers, steering assembly, gear box and hull nose are those of the Pz. Kpfw. II; the instrument panel is that of a Pz. Kpfw. III. The front shield is in one piece extending straight across the full width of the superstructure. The driver's visor is of the double shutter type. The road performance of this equipment approximates that of the Pz. Kpfw. II tank.

The gun, a standard infantry support weapon, is mounted low in the hull, projecting through a vertical slot in the shield. The gun shield is 15 mm thick and is of shallow construction. It extends about a third of the distance of the superstructure to the rear. Unlike the "Wasp" there are no protecting side plates along the entire length of the superstructure.

The gun is 64.57 inches in length, has a muzzle velocity of 790 f.s. and a maximum effective range of 5140 yards. The casting containing the recuperator and buffer, housed underneath the barrel, extends almost to the end of the barrel. The breech mechanism is similar to the 10.5 cm. I.F.H. 18. The elevating gear is operated from the right and the traversing gear from the left. In field mounting its traverse is 11°, its elevation 0° to + 73°.

Two types of ammunition are fired, the 15 cm. I. Gr. 33 and the 15 cm. I. Gr. 38. The H.E. capacity is high, 21.8%. The only other shell that the weapon is known to fire is a smoke shell, the 15 cm. I. Gr. 38 Nb. The same percussion fuze, s.I. Gr. Z. 23, which weighs 75 lbs., is used in each case.

## SPECIFICATIONS

Weight .....	(approx.) 12 tons
Length .....	(approx.) 18 ft.
Width .....	7 ft., 4 ins.
Height .....	(approx.) 5 ft., 6 ins.
Ground clearance .....	13 ins.
Tread centers .....	6 ft., 2 ins.
Ground contact .....	
Width of track .....	11½ ins.
Pitch of track .....	3% ins.
Track links .....	
Fording depth .....	3 ft.
Theoretical radius of action	
Roads .....	118 miles
Cross-country .....	78 miles
Speed	
Roads .....	25 m.p.h.
Cross-country .....	15 m.p.h.
Armor	
Front plate .....	15 + 20 mm
Sides .....	15 mm
Gun shield .....	15 mm
Armament .....	15 cm. s.I.G. 33
Ammunition (rds.)	
Engine .....	140 B.H.P. Maybach, HL 62 TRM
Transmission .....	6 forward speeds, 1 reverse
Steering .....	Epicyclic clutch brake
Crew .....	Probably 4



Gw. III/IV (Hummel) für 15 cm s.F.H. 18/1 (Sd. Kfz. 165)



This equipment, known as the "Bumble Bee," is composed of the 15 cm heavy field howitzer mounted on a modified Pz. Kw. IV tank chassis. It should not be confused with the 10.5 cm l.F.H. 18/2 ("Wasp"), which is the 10.5 cm light field howitzer mounted on the chassis of a Pz. Kw. II tank. The road performance of the "Bee" will approximate that of the Pz. Kw. IV tank.

In the construction of this vehicle the following modifications were made to the hull of the Pz. Kw. IV tank. The turret top plate mounting the turret traversing ring, the front vertical plate, and the rear partition separating the engine from the fighting compartment have been removed. The engine, cooling-fan assembly and exhaust pipes have been moved forward up to the gear box. A partition has been built across the width of the hull dividing the driver and assistant driver from the fighting compartment. A steel plate separates the engine from the fighting compartment. In place of the driver's entrance hatches a cover similar to a cupola, with lid and shutter type vision, is provided.

The superstructure is in the form of a sloping four-sided shield 10 mm (.39 inch) thick. The front of the shield provides a bulging slot for the traverse and elevation of the gun while the rear plate is fitted with a hinged door.

The gun is mounted well back on the top of the engine cover plate by means of angle iron and steel brackets so that its muzzle projects almost flush with the nose of the hull. It retains its original buffer, recuperator and compensator, and elevating and traversing gears. Its overall length including muzzle brake, with which it must be fitted when firing charge 8, is 17 feet, 4¼ inches. The muzzle velocities of this piece are: Charge 6, 1,020 f. s.; Charge 7, 1,375 f. s.; Charge 8, 1,965 f. s. The maximum ranges are: Charge 6, 10,550 yards; Charge 7, 12,140 yards; Charge 8, 14,380 yards. Its elevation is 0°-39°; traverse each side 16°.

**SPECIFICATIONS**

Weight .....	28 tons
Length .....	20 ft., 4½ ins.
Width .....	9 ft., 4½ ins.
Height .....	9 ft., 4 ins.
Ground clearance .....	15 ins.
Tread centers .....	7 ft., 11 ins.
Ground contact .....	11 ft., 6 ins.
Width of track .....	15 ins.
Pitch of track .....	4¼ ins.
Track links .....	98
Fording depth .....	3 ft.
<b>Theoretical radius of action:</b>	
Roads .....	96 miles
Cross-country .....	62 miles
<b>Speed:</b>	
Road .....	25 m.p.h.
Cross-country .....	12 m.p.h.
<b>Armor:</b>	
Front plate .....	50 mm
Sides .....	30 mm
Shield .....	10 mm
Armament .....	15 cm s.F.H. 18/1
Ammunition .....	
Engine .....	Maybach HL 120 TRKM. 320 hp.
Transmission .....	Synchromesh—6 speeds forward, 1 reverse.
Steering .....	Epicyclic, clutch brake
Crew .....	5

## HALF-TRACK PERSONNEL CARRIERS

Despite the fact that the Germans have many models of half-track (more properly three-quarter track) vehicles and have made wide use of them, the latest battlefield reports contain high praise for the American half-track as an all-around vehicle. This is no doubt due to the great reliability engineered into this vehicle. Earlier in the war our half-track was used as a self-propelled mount for Cal. .50, 37mm, 75mm, and 105mm weapons, but this use has now been taken over by full-track vehicles for all except the Multiple Cal. .50 Gun Motor Carriage.

The German-half-track personnel carriers range in weight from 5 to 7.7 tons when armored and from 3.7 tons through 16.8 tons when unarmored. These vehicles are also used as self-propelled mounts and also as prime movers.

The German half-tracks are well engineered, making maximum use of interchangeability of components among sizes and with other types of combat vehicles. The longer track gives them better flotation on soft ground but the American running gear is less complicated and better adapted for long-range operations. Because of the many varieties of German three-quarter tracks, only a selected number are illustrated.

The Japanese have only recently used any kind of half-track, and no technical data are yet available.

## BATTLE FIELD REPORTS ON HALF TRACK PERSONNEL CARRIERS

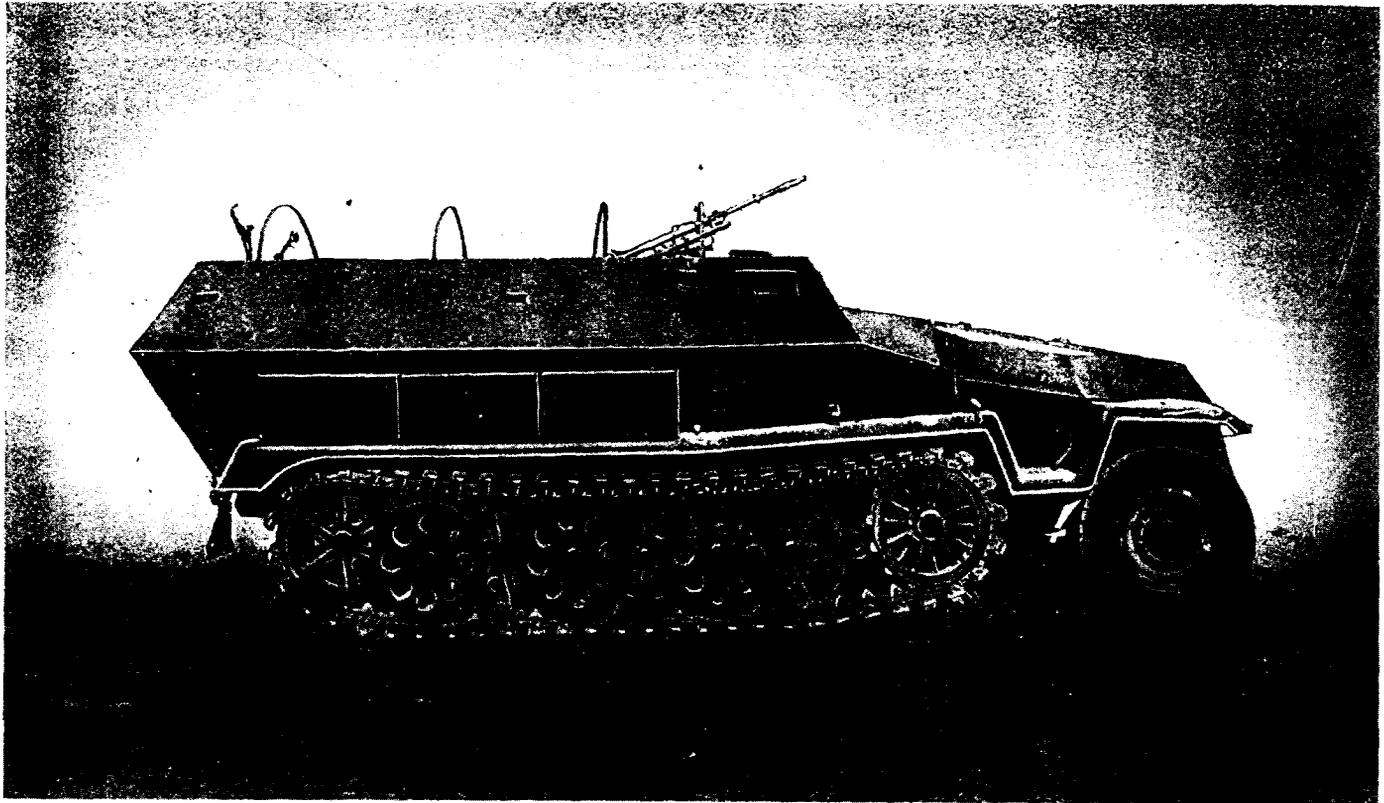
"The American half-track manufactured by Aut-Car, Diamond-T, White, and International Harvester Companies, are no doubt the best vehicles of their type in the world, but if several of the features found in the similar German vehicle were incorporated in our half-tracks they would be even better than they are.

"The advantage of the U.S. tracks in maintenance is much greater in that the engines, chassis, tracks, and suspensions are interchangeable. This is not possible with the many models of the Germans. The U.S. track has more speed and power, making it a better road vehicle, and more maneuverable in cross-country use." (Comment of Lt. Col. R.W. Jenna, Commanding 41st Armored Inf., Regt.)

# MEDIUM ARMORED PERSONNEL CARRIER

GERMAN 

m. gp. Mannsch. Kw. (Sd. Kfz. 251)



This vehicle is a medium armored personnel carrier with the chassis of the Sd. Kfz. 11 (light semitracked prime mover). The Sd. Kfz. 11 has been modified by placing armor on the chassis, altering the cooling arrangement, and mounting the steering wheel in an inverted position. The armor plate thickness measures 7.5 mm on the radiator cover, 8.5 mm on the sides, and 15 mm on the lower front plate, set at angles to the horizontal of 81°, 55-60°, and 55° respectively. It has been reported that these vehicles were used by the motorized infantry of armored divisions. Eight variations are known to exist with designations 251/1 through 251/8. The vehicles are used for infantry, ammunition and as command vehicles with built-in wireless, or ambulances.

The suspension is the same as that utilized for the Sd. Kfz. 11, as is also the power plant and the power train.

The armament normally consists of two 7.92 mm M.G. 34's, one on a mount welded to the front of the chassis and one on an anti-aircraft pedestal mount in the rear of the vehicle. Reports have been received that the 2 cm Kw.K. 30 is also mounted. The vehicle has a seating capacity for eleven men, including the driver.

## SPECIFICATIONS

Weight .....	7.7 tons
Length .....	19 ft.
Width .....	7 ft.
Height .....	7 ft.
Ground clearance .....	12 ins.
Tread centers .....	5 ft. 3 ins.
Ground contact .....	5 ft. 11 ins.
Width of track.....	11 ins.
Track links .....	55
Pitch of track.....	5.5 ins.
Fording depth .....	20 ins.
Theoretical radius of action	
Roads .....	185 miles
Cross-country .....	80 miles
Speed	
Roads .....	
Cross-country .....	
Armor	
Front plate .....	15 mm
Sides .....	8.5 mm
Armament .....	2 7.92 M.G. 34's
Ammunition (rds.) .....	
Trailer load .....	3.3 tons
Engine.....	Maybach, NL 42 TUKRR, 100 hp.
Transmission.....	4 speeds forward, 1 reverse, high and low range
Steering.....	Front wheel and track epicyclic
Crew .....	11

## ARMORED CARS

Armored cars are designed for highway and favorable cross-country reconnaissance. They cannot travel on the unfavorable terrain negotiable by tracked vehicles, but since they are completely wheeled, their running gear has much longer life. Armored cars are by design much more lightly armored than tanks.

The German and U. S. models are fairly similar in appearance. The U. S. types have six wheels, whereas the Germans use four, six, and eight.

The U. S. troops have been provided with the Armored Car, M8, throughout this war. The Armored Utility Car, M20, serves as an accompanying vehicle. The Armored Car, M8, mounts a 37mm Gun.

The Germans have a variety of armored cars, most modern of which weigh 8-1/2 and 11-1/2 tons. The 8-1/2 ton car mounts a single 20mm gun and a heavy machine gun, whereas the 11-1/2-ton car mounts a 50mm tank Gun KWK 39 with a muzzle velocity of 2,700 feet per second. The Germans also have mounted a 75mm low-velocity gun on the eight-wheeled armored car.

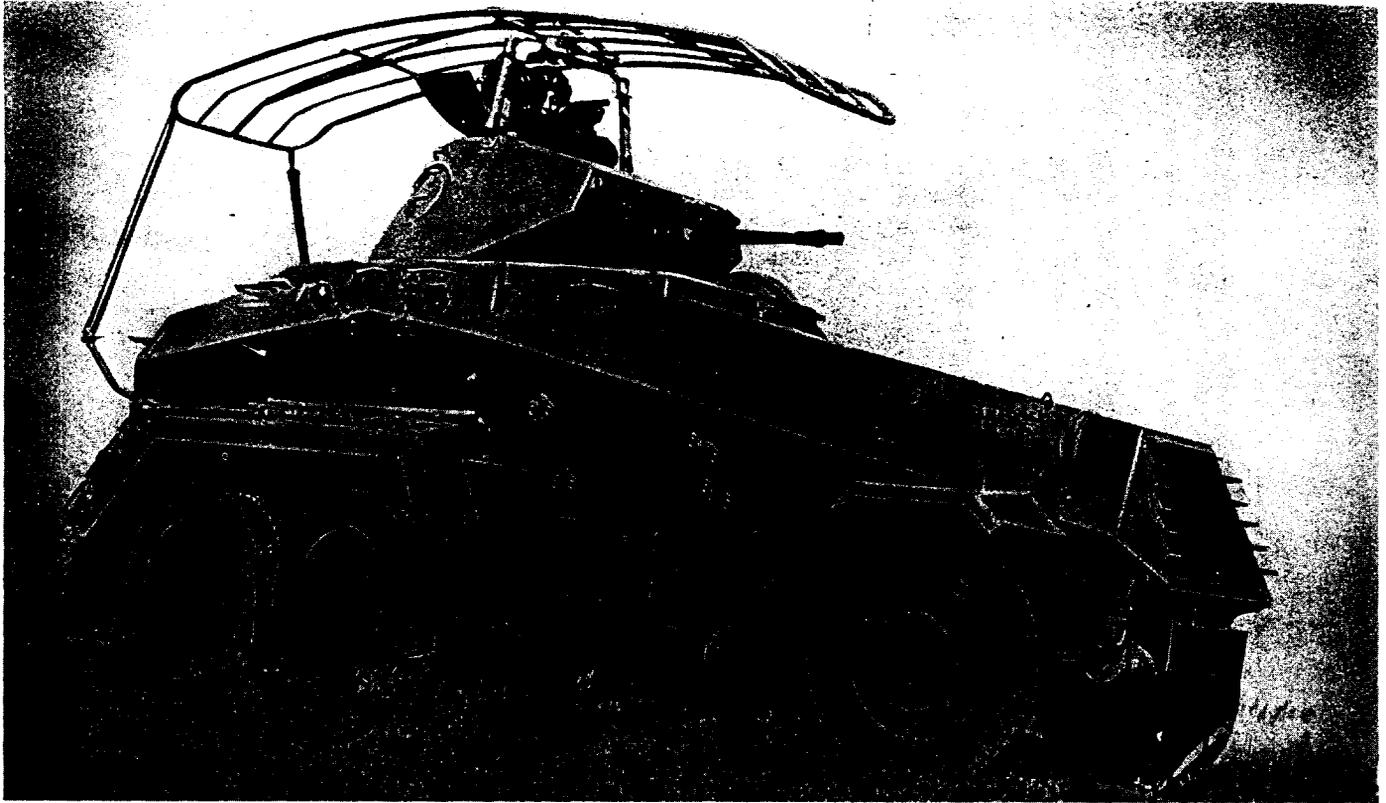
No Japanese armored cars have been encountered in action since the Solomon Islands campaign. The only models for which technical data are available are of the obsolete type used to carry money and securities in this country before the war.

# 6-WHEELED ARMORED CARS

GERMAN



s. Pz. Sp. Wg. (Sd. Kfz. 231, 232, 263)



This six-wheeled armored car is a heavy, highly mobile vehicle with a four-man crew. It is armed with one 20 mm KwK 30 and one M. G. 34 coaxially mounted in the turret.

Like the 8 Rad Panzerspahwagen, the six-wheeled vehicle can be operated from either the front or rear, duplicate controls being fitted at either end. Steering is by front wheels only. It has a six-wheeled final drive; single wheels at the front, and dual double wheels at the rear. The front springs are fitted to the frame with shock absorbers. The rear springs are suspended by tubular traverse, semi-elliptical springs. It has six forward and six reverse speeds.

Special gripper chains are available for fitting over the rear wheels, thus giving each pair the function of a track. Slightly smaller wheels may be fitted outside the front wheels giving extra traction on soft ground.

The engine, manufactured by Bussing Nag, is a water-cooled, 100 horsepower, gasoline type. The superstructure is built by Deutsche Werke, Kiel.

This vehicle carries the same nomenclature as its 8-wheeled counterpart. Model 231 is the heavily armored variation carrying both the cannon and the machine gun. No. 232 is a wireless command vehicle and No. 263 an armored wireless vehicle without the 20 mm gun.

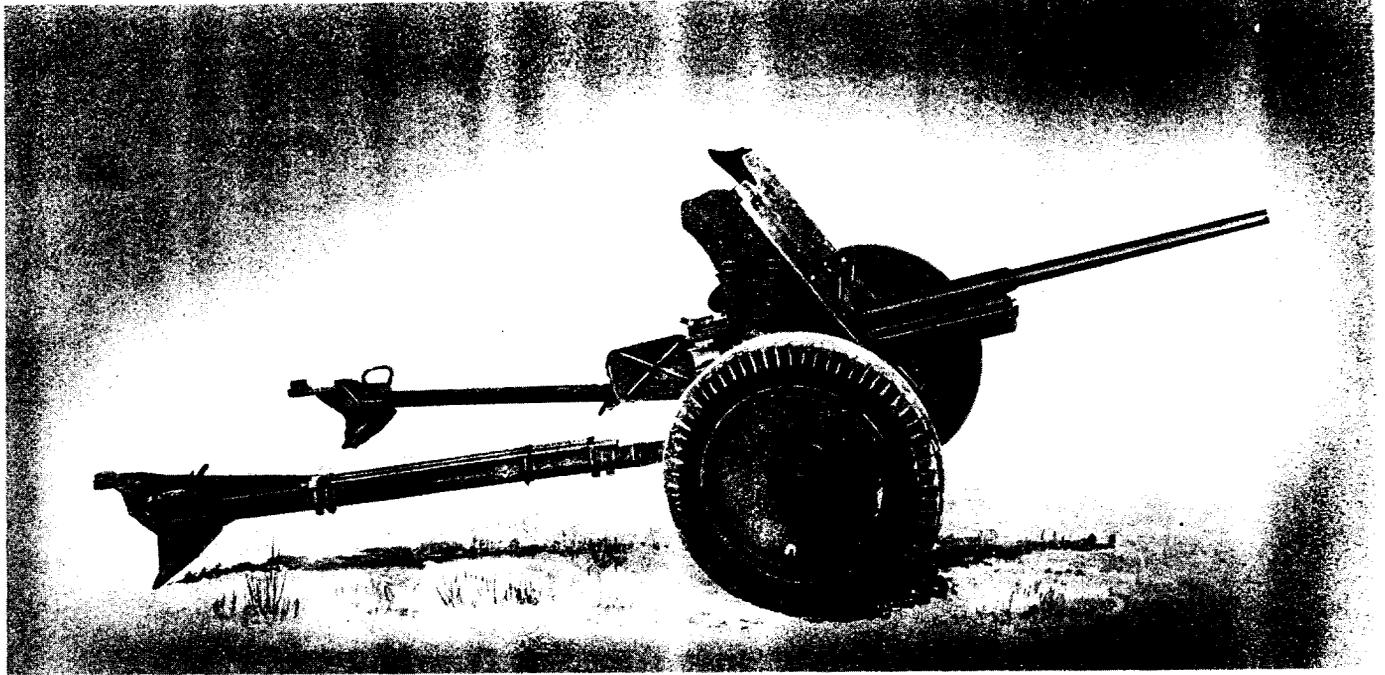
These cars are used for reconnaissance, police patrol work, as command vehicles, and as radio receiving and sending stations.

## SPECIFICATIONS

Weight .....	6 tons
Length .....	18 ft., 5 ins.
Width .....	6 ft., 1 in.
Height .....	7 ft., 4 ins.
Ground clearance .....	9 ins.
Suspension.....	Dual double wheels at rear, single wheels at front
Wheel base.....	Between axles 1 and 2—8 ft., 3 ins. Between axles 2 and 3—2 ft., 11 ins.
Size tires .....	8.27 x 18
Fording depth .....	2 ft.
Theoretical radius of action	
Roads .....	156 miles
Cross-country .....	93 miles
Speed	
Roads .....	45 m.p.h.
Cross-country .....	20 m.p.h.
Armor	
Front plate .....	15 mm
Sides .....	7.5 mm
Armament.....	2 cm Kw.K. 30 7.92 mm M.G. 34
Ammunition .....	
Engine .....	Bussing Nag, 100 hp.
Transmission.....	Constant mesh, helical gear— 6 speeds forward, 6 reverse
Steering .....	Worm and nut
Crew .....	4



## 3.7 cm Pak



The 3.7 cm, formerly the chief German antitank gun, has been largely replaced by the 5 cm (1.97 in.) antitank gun. A stick bomb, 6¼ inches in diameter and with an overall length of 29¾ inches, has been recently introduced for use with the gun. The bomb, a hollow charge type, has a steel rod which fits into the bore of the piece, and a perforated sleeve which fits around the barrel. Its use is likely restricted to short ranges.

The gun is normally towed on its own wheels by a tractor but may also be carried on a lorry. Weighing 950 lbs., it is a suitable weapon for use by air-borne troops.

The piece consists of an "A" tube, jacket and breech ring combined. The breech block is of the horizontal sliding block type with a hand operated block stop.

The axle incorporates independent suspension which is, however, locked when firing, the freeing and locking being controlled by the opening and closing of the trail legs.

The lower carriage has a pivot housing and bearing face for the top carriage. It also carries the traversing rack, the travelling clamp and the locking gear for the trail legs and houses the axle.

The layer stands on the left side of the weapon and operates the traverse with his right hand by a small handwheel (clockwise to the right, anticlockwise to the left). The arc of traverse is 60°. The arc of 21° elevation and 13° depression is completed by 32½ turns of the handwheel, which the layer operates with his left hand.

A hydraulic buffer and spring recuperator are provided.

The straight tube telescope sights are mounted on an upright bracket carried on the top carriage.

The shield is composed of the gun shield and leg shield, of 3/16" armor plate. The leg shield folds under the lower carriage when travelling, and folds down to ground level when in action.

## SPECIFICATIONS

Caliber .....	3.7 cm (1.45 in.)
Weight (firing position) .....	970 lbs.
Length of tube.....	65.52 ins. (50 cal.)
Rate of fire.....	8-10 r.p.m.
Muzzle velocity (A.P. shell).....	2,625 f.s.
Range (maximum-horizontal) .....	600 yds.
Elevation .....	25°
Depression .....	8°
Traverse .....	60°
Ammunition.....	A.P.H.E.; H.E.; stick grenade



The 5 cm Pak 38, introduced during the 1941 campaigns in Greece and Egypt, was developed to combat the more heavily armored vehicles of the Allies.

The gun has a barrel of monobloc construction, threaded at the muzzle for attaching a two-baffled muzzle brake. Because of the position of the breech-operating cam, a minimum length of recoil of approximately 18½ inches is needed to operate the semi-automatic breech mechanism which is of the sliding horizontal block type. The recoil recuperator system is hydropneumatic.

The carriage, constructed of welded steel, is mounted on metal disk wheels with solid rubber tires. Torsion springs which support the gun in travel are automatically locked when the tubular trails are spread. A 5 mm armor shield and apron protect the gun crew. The left side of the shield has a sighting port.

There are four types of ammunition fired from the Pak 38: an armor-piercing capped, high-explosive, ballistic-capped projectile; a high-explosive shell and an A.P.-H.E. (uncapped) shell.

### SPECIFICATIONS

Caliber .....	50 mm (1.97 ins.)
Weight (complete) .....	2,015 lbs. (approx.)
Length of gun (overall).....	15 ft., 3 ins.
Length of barrel (overall).....	9 ft., 3 ins.
Width C-C .....	5 ft., 1 in.
Carriage.....	Welded steel w/solid rubber tires and tubular trails
Breech mechanism.....	Horizontal sliding block
Recoil mechanism .....	Hydropneumatic
Rifling .....	20 lands & grooves; right-hand twist
Muzzle velocity	
A.P.C.-H.E. ....	4.5 lb.—2600 f/s
H.E. ....	4.0 lb.—1800 f/s
Elevation .....	22°
Depression .....	—4°
Traverse .....	80°
Sights .....	Straight tube telescope
Ammunition.....	A.P.; A.P.C.; H.E.

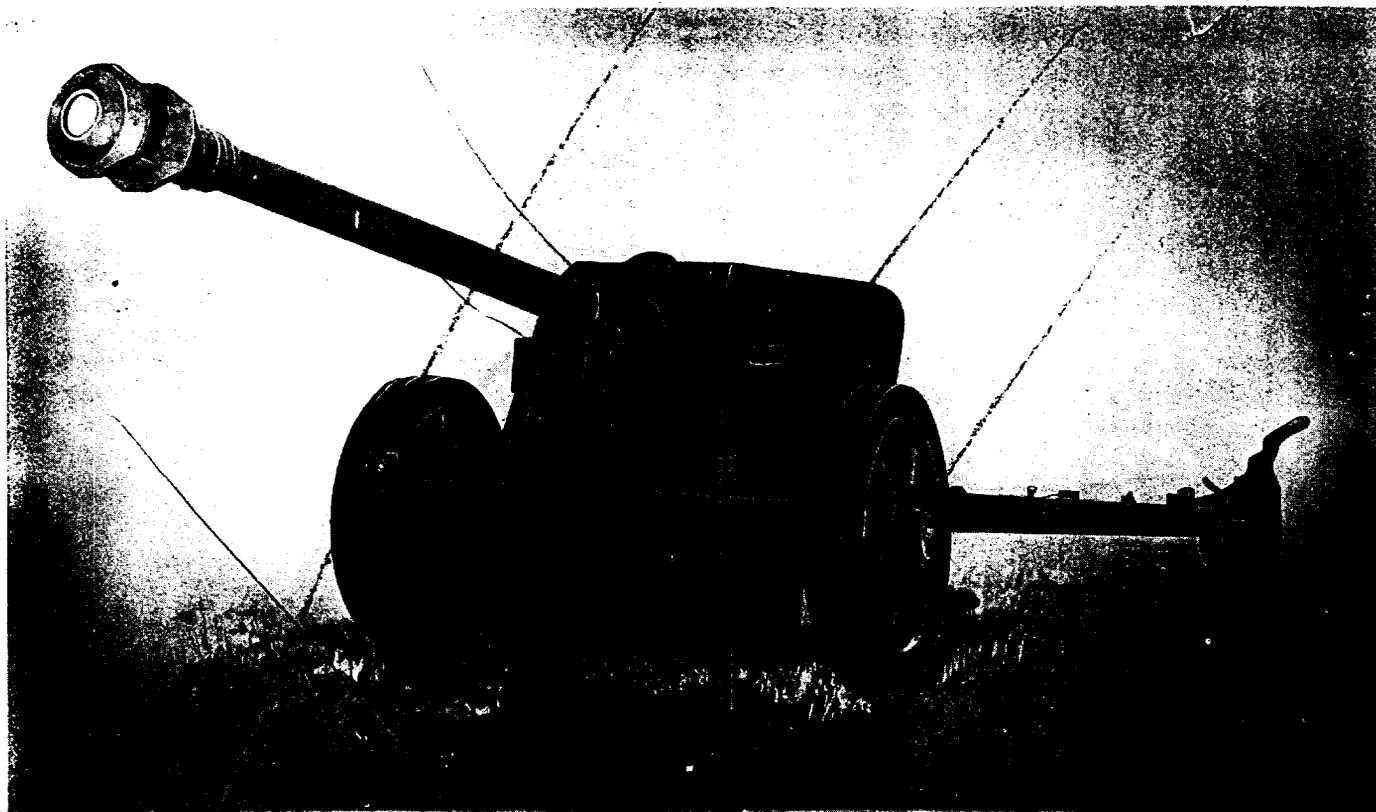
Penetration Range Yards	Thickness of armor in mm	
	30°	Normal
500 .....	2.6	3.1
700 .....	2.4	2.9
1000 .....	2.2	2.6
1200 .....	2.0	2.5

# ANTITANK GUN

GERMAN



7.5 cm Pak 40



The Pak 40, an antitank and antipersonnel weapon, has a barrel of monobloc construction to which is screwed a two-baffled muzzle brake. The horizontal sliding type breechblock operates semi-automatically. Recoil and counterrecoil are effected by means of a hydraulic buffer and a hydropneumatic recuperator.

The welded steel carriage has tubular trails, light alloy steel wheels with solid rubber tires, and a 5 mm spaced armor shield for the protection of the gun crew. There are two types of brakes: air brakes, which are operated from the prime mover, and hand brakes for placing the gun in firing position.

Although no sighting equipment was captured with the gun, it is assumed that there was a telescopic sight for direct fire, a sight for indirect fire, and an auxiliary open sight. Mounts for these sights are attached to the breechring and the left trunnion.

There is also a gun known as the 7.5 cm Pak 97/40. This gun consists of a French Model 1897 piece mounted on the carriage of a German 7.5 cm Pak 40, but usually on Pak 38 carriage.

A modification of this gun is used on the chassis of the Pz. Kw. II tank and the Czech Pz. Kw. 38 (t) converting these vehicles into gun motor carriages.

The 75 mm tank gun, KwK. 40, used in Pz. Kw. IV is an adaptation of the Pak 40.

## SPECIFICATIONS

Caliber .....	75 mm (2.95 ins.)
Length of tube.....	126.1 ins.
Weight (travelling position).....	3,350 lb.
Length (travelling position).....	19 ft.
Length of bore.....	96.89 ins.
No. of grooves.....	32
Width of grooves.....	.175 in.
Depth of grooves.....	.025 ins.
Width of lands.....	.116 in.
Muzzle velocity (A.P.C. shell).....	2525 f/s
Traverse .....	65°
Elevation .....	+22°
Depression .....	-5°
Length of recoil.....	35.43 ins.
Ammunition.....	A.P.-H.E.-H.E. hollow charge
Wt. of projectile (A.P.C.).....	15 lb.



The 8.8 cm Pak 43 is an electrically fired, semiautomatic gun, mounted on a cruciform platform (Kreuzlafette) and transported on two single axle limbers similar to those used on the 8.8 cm Flak 18. It has a very low silhouette, on wheels the height to the top of the shield is 5 feet, 6 inches, and to the trunnions, 4 feet. When emplaced it is 12 inches lower.

The gun can be fired from its wheels without extending the side legs, if the direction of fire does not exceed 30° either side of the longitudinal girders. If the direction of fire is greater than 30°, the side legs must be extended and the pads brought firmly in contact with the ground. There is an automatic electric cut-out to the firing gear which restricts elevation to 12° on early equipments and 16° on later equipments when firing over the mounting legs.

There are several other versions of the Pak 43. The Pak 43/41 (page 113) has a two-wheeled carriage with split trails. The Pak 43/1 (page 34) is a self-propelled gun called the "Rhinoceros." Its chassis is a combination of a Pz. Kw. III and Pz. Kw. IV. The Pak 43, 2 (page 39) is a self-propelled gun called the "Elephant"; it is also mounted on the chassis of the Panther (Pz. Kw. V). All of these guns use the same ammunition and have the same ballistic characteristics.

### SPECIFICATIONS

Caliber .....	88 mm (3.46 ins.)
Weight (traveling position) .....	13,000 lb.
Weight (firing position) .....	7,900 lb.
Length (traveling position) .....	
Length (firing position) .....	
Height (traveling position) .....	5 ft., 6 ins.
Height (firing position) .....	4 ft., 6 ins.
Width (overall) .....	
Length of barrel (w/o muzzle brake).....	247.5 ins.
Length of bore .....	236.9 ins.
No. of grooves .....	32
Width of grooves .....	.202 in.
Depth of grooves .....	.048 in.
Width of lands .....	.134 in.
Muzzle Velocity (A.P.C.B.C. shell) .....	3,280 f/s
(H.E. shell) .....	2,460 f/s
Max. range (horizontal).....	17,500 yds. (H.E. shell)*
Max. range (vertical) .....	
Rate of fire .....	
Traverse .....	360°
Elevation .....	40°
Depression .....	-8°
Length of recoil (normal) .....	47.5 ins.
Ammunition .....	A.P.C.B.C.—H. E.
Wt. of projectile .....	(H.E.) 20.68 lbs.**
	(A.P.C.B.C.) 22 lbs.

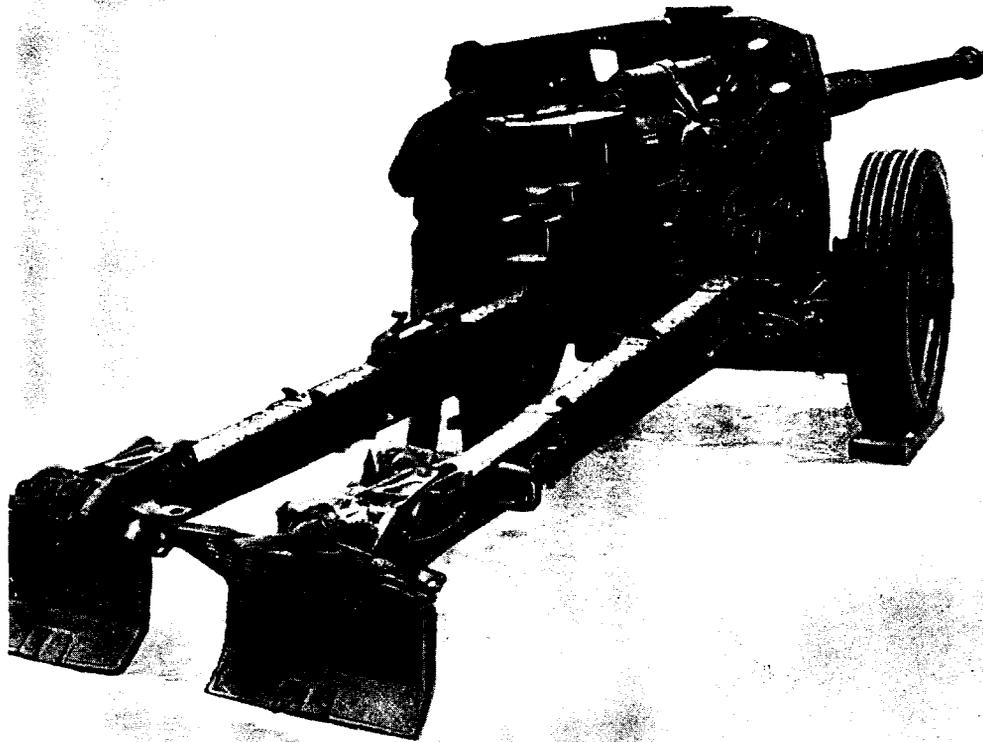
\*Unconfirmed

\*\*AP 40 round (tungsten carbide core)

Pzgr. Patr. 40/43 .....
 16 lb. |

Gr. Patr. 39 HL/A and B .....
 16.8 lb. |

8.8 cm Pak 43/41



The Pak 43, one of German's newer antitank guns, is a more solidly built weapon than the 7.5 cm Pak 40. The gun is mounted on large rubber-tired metal wheels. A sloping double shield, 6 feet, 3 inches in height, is fitted to the carriage for the protection of the gun crew. Split trails, approximately 12 feet long, are also supplied.

A muzzle brake is fitted to the barrel. The semi-automatic breech mechanism of the horizontal sliding block type is operated by a small auxiliary cylinder on the left side of the breechblock.

The buffer and recuperator are contained in one cylinder which is fitted above the barrel; the balancing cylinders are mounted vertically on either side of the carriage.

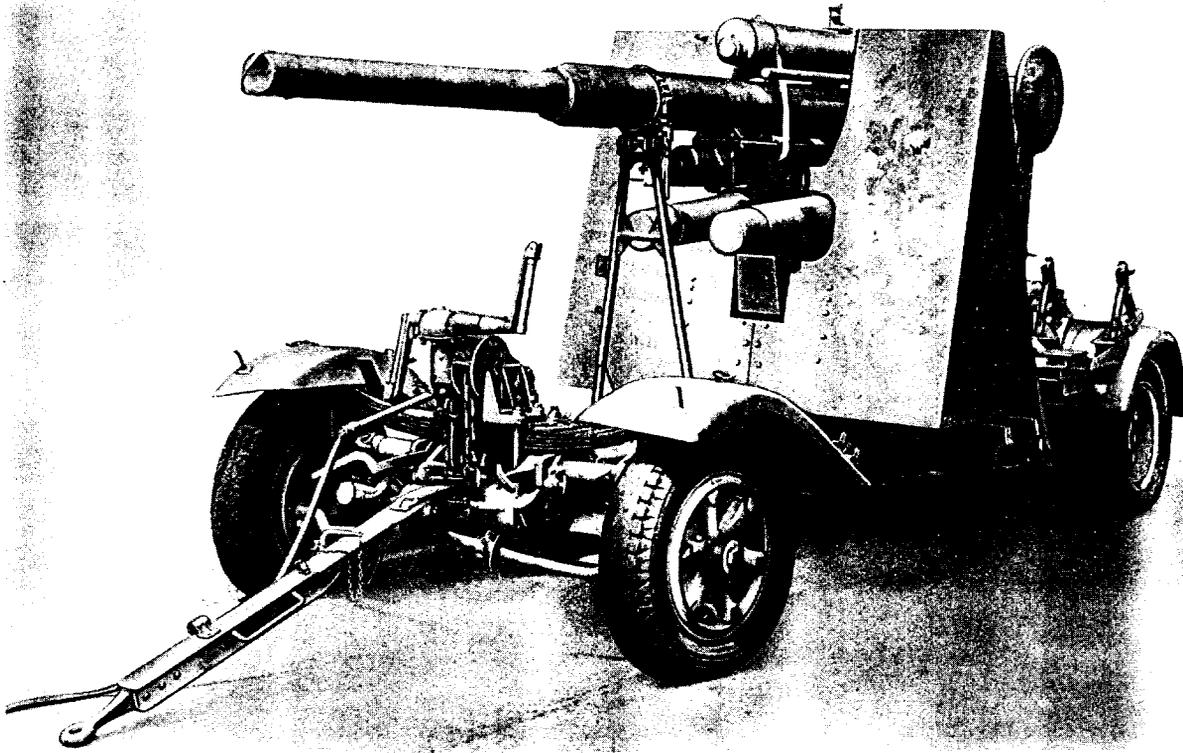
The sight bracket is marked for 8.8 cm Pak 43/41 and 8.8 cm Pak 43 Sfl. This marking tends to confirm the opinion that the Pak 43 is a modification of, or development from, the 8.8 cm Flak 41, which it resembles superficially. This marking also confirms the information that this gun, with the designation 43/1, is used in the self-propelled piece Pz. Jäg. III/IV (the "Hornet").

## SPECIFICATIONS

Caliber .....	88 mm (3.46 ins.)
Weight of gun.....	4.8 tons
Length of piece (including muzzle brake)....	21 ft.
Diameter of wheels.....	4 ft., 6 ins.
Recoil (maximum) .....	2.46 ft.
Muzzle velocity.....	Not known
Range .....	Not known
Elevation .....	38°
Depression .....	-5°
Traverse .....	58°
Ammunition.....	A.P.C.; H.E.; Hollow-charge
Height .....	6 ft., 3 ins.

# MULTI-PURPOSE GUN

8.8 cm Flak 18, 36, 37



This multi-purpose weapon emerged as the most highly publicized artillery piece of the German army during the North African campaign. It is primarily an antiaircraft gun adaptable to antitank and general artillery use. In its antitank role it is fitted with a shield. In its mobile form it is towed on four wheels, usually with an 8-ton half-tracked tractor.

The tube assembly of the gun is of a construction not comparable to any design now in use in this country. It consists of an outer tube or jacket, an inner locking tube and a loose three-section liner. The front and center sections of the liner are keyed in place so as to align the rifling and prevent relative rotation.

The mount is provided with two outriggers for stability when firing in traverses other than directly front or rear. These are hinged to the bottom carriage to travel in a vertical position. During firing the outriggers are let down and secured by half-round locking pins.

The mount is equipped with three means of fire control depending on the usage: data transmission for antiaircraft fire, direct laying for antitank fire and indirect laying for indirect fire.

Specifications listed herewith are based on tests conducted at Aberdeen Proving Ground of a captured 88 mm model Flak 18, under Ordnance Program 5772. The mechanical-type fuse setter and the azimuth indicators were examined at Frankford Arsenal.

The differences implied by the nomenclatures, Flak 18, 36 and 41, refer to different methods of construction.

## SPECIFICATIONS

Caliber .....	8.8 cm (3.46 ins.)
Length of tube.....	184.6 ins.
Weight (travelling position).....	7.9 tons
Weight (firing position).....	5.5 tons
Length (travelling position).....	25 ft., 3 ins.
Length (firing position).....	
Height (travelling position).....	102 ins.
Height (firing position).....	63 ins.
Width (overall): (traveling position).....	94 ins.
Width of trail spread.....	
Length of bore.....	162.4 ins.
No. of grooves.....	32
Diam. of grooves.....	3.552 ins.
Depth of grooves.....	
Diam. of lands.....	3.473 ins.
Muzzle velocity.....(H.E. shell) 2,690 f.s. (A.P.) 2,624 f.s.	
Max. range (horizontal).....	16,183 yds.
Max. range (vertical).....	11,591 yds.
Rate of fire.....	15 to 20 r.p.m.
Traverse .....	2 x 360°
Elevation .....	+85°
Depression .....	-3°
Length of recoil (H.E.).....	31.5 ins.
Ammunition.....	H.E. and 3 types of A.P.
Wt. of projectile.....(H.E.) 20.35 lb.; (A.P.) 20.75 lb.	

# MULTI-PURPOSE GUN

GERMAN 

8.8 cm Flak 41



This new German multi-purpose 8.8 cm gun is built on massive proportions. The piece, which has an overall length of approximately 262 inches, has a built-up tube with a securing collar at the forward end of the jacket.

A breech mechanism of the horizontal sliding type is operated manually by a handle on top of the breech ring; it may also be operated semi-automatically, opening action and extraction taking place during counter-recoil, and closing action following when a round is rammed home.

The hydropneumatic recuperator cylinder is fitted above the barrel; and the buffer is in the cradle. A lug riding in a cam below the left trunnion is geared to rotate the control rod, varying the length of recoil with the elevation. Spring equilibrators are located on either side of the upper carriage.

The elevating mechanism is of the single rack and pinion type. Three elevation speeds are provided and selected by positioning a lever on top of the gear box to which the handwheels are fitted. Three traverse speeds are also provided and selected in the same manner as the elevation speeds.

The cannoneer has the choice of two sitting positions. For direct fire he sits facing the front and fires the gun by pressing an electric push-button with his right foot. The left foot rest, when not depressed, brakes the traverse. When sitting in the anti-aircraft position, the cannoneer faces the side of the gun and matches pointers. Here again the left foot rest is a brake pedal, braking the traverse when released. The gun has a total traverse of 360°. The gun crew is protected by a shield 5/16 inch thick and 7 feet, 3 inches high. Both steel casing and normal casing shells are used.

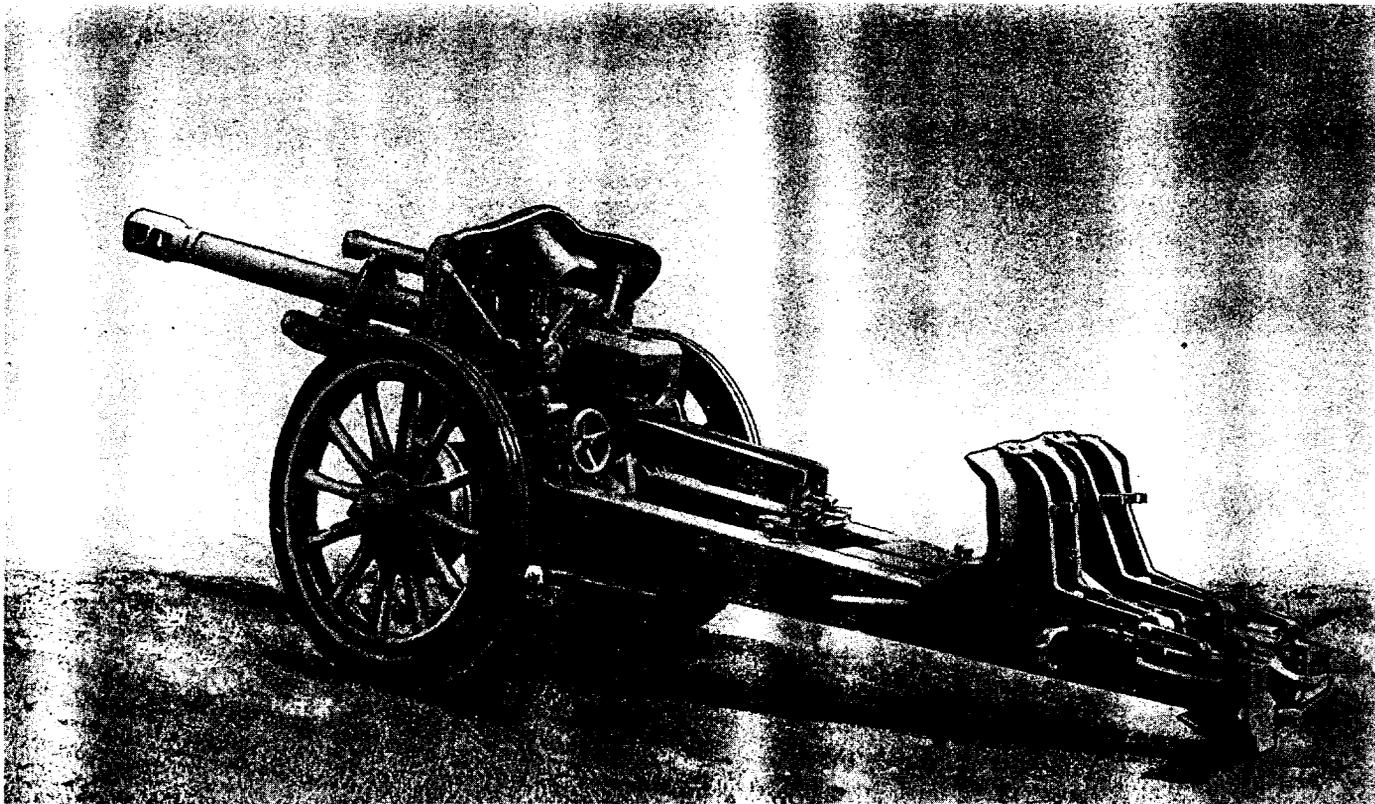
## SPECIFICATIONS

Caliber .....	8.8 cm
Length of tube.....	248 ins.
Weight (travelling position).....	12.3 tons
Weight (firing position).....	8.8 tons
Length (travelling position).....	30 ft., 8 ins.
Height (travelling position).....	7 ft., 6 ins.
Height (firing position).....	50 ins.
Width (overall) .....	94 ins.
Length of tube and breech ring.....	8.8 ft.
No. of grooves...32 lands and grooves, R.H. twist	
Width of grooves.....	.110 ins.
Depth of grooves.....	.038 ins.
Width of lands.....	.242 ins.
Muzzle velocity (H.E. shell).....(3,280 f.s.); (A.P. 3,215 f.s.)	
Max. range (horizontal).....	21,960 yds.
Max. range (vertical).....	16,075 yds.
Rate of fire.....	20-25 rds. per minute
Traverse .....	360°
Elevation .....	+90°
Depression .....	-3°
Length of recoil.....	
Ammunition.....	H.E. (3 types of A.P.)
Wt. of projectile.....	H.E. 20.7 lb.; A.P. 22.4 lb.

# LIGHT FIELD HOWITZER

10.5 cm l. F. H. 18 (M)

GERMAN



In order to obtain longer range, the 105 mm German Howitzer l. F. H. 18 was modified so that the muzzle velocity of the weapon could be increased. The Germans accomplished this by preparing a new propellant charge (Fern ladung—long range charge) which increases the muzzle velocity from approximately 1,542 feet per second to 1,772 feet per second, and the range from approximately 11,670 yards to 13,500 yards. To compensate for the increased velocity and the resulting recoil, the Germans found it necessary to add a muzzle brake. It was also necessary to slightly modify the recoil mechanism and to increase the nitrogen pressure in the counterrecoil cylinders from 730 pounds per square inch to 854 pounds per square inch. To differentiate between the two models, the letter "M" (Mündungsbremse—Muzzle Brake) was added to the old nomenclature, hence the later model is known as the l. F. H. 18 (M).

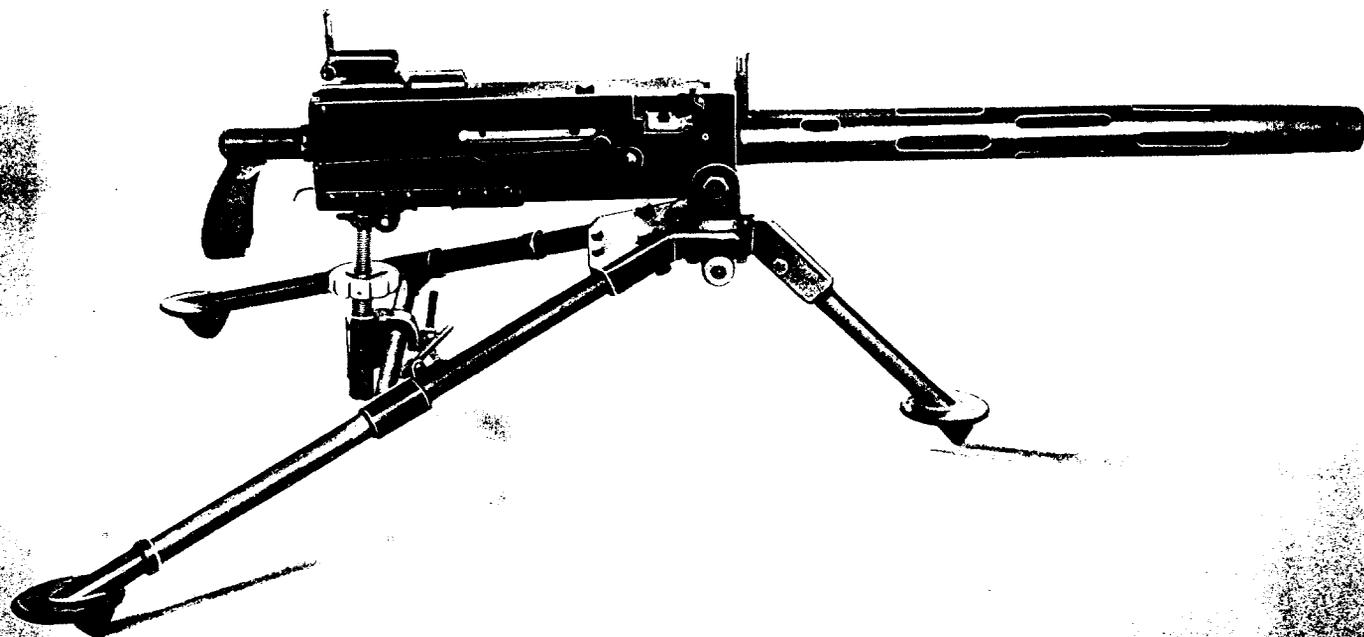
The tube is of monobloc construction. The weapon has a continuous pull firing mechanism and a breech mechanism of the horizontal sliding type. The carriage, of riveted and welded steel, is equipped with split trails, folding spades, wooden wheels with rubber tires, and a protective armor shield 4 mm thick. It also has hand operated friction brakes.

## SPECIFICATIONS

Caliber .....	105 mm (4.13 ins.)
Weight (traveling position) .....	4,255 lbs.
Weight (firing position) .....	
Length (traveling position) .....	19 ft., 6 ins.
Length (firing position).....	20 ft., 5 ins. (at 0° elev.)
Height (traveling position) .....	5 ft., 9 ins.
Height (firing position) .....	5 ft., 9 ins.
Width (overall) .....	6 ft., 6½ ins.
Width of trail spread .....	15 ft., 10 ins.
Length of bore .....	25.7 cal.
No. of grooves .....	32—R.H. Progressive Twist
Width of grooves .....	
Depth of grooves .....	
Width of lands .....	
Muzzle velocity (maximum) .....	1,772 f/s*
Max. range (horizontal) (Reported).....	13,500 yds.
Traverse .....	56°
Elevation .....	40°
Depression .....	7°
Length of recoil .....	39.3 ins.—46.8 ins.
Ammunition.....	H.E. w/P.D. Fuze; Hollow Charge; Smoke; A.P.; Incendiary
Wt. of projectile..	32¾ lb. (Long Range H.E. Shell)

\*Reports indicate that a special long range H.E. shell weighing approximately 32¾ lb. is used with the super charge to obtain this muzzle velocity.

# BROWNING MACHINE GUNS, CAL..30, M1919A4, M1919A5—STANDARD AND M1919A6—SUBSTITUTE STANDARD



BROWNING MACHINE GUN, CAL. .30, M1919A4, ON TRIPOD MOUNT, M2

The Browning Machine Guns, cal. .30, M1919A4, M1919A5, and M1919A6, represent modifications and improvements upon the older M1919A2 which evolved from the M1919, originally designed as armament for the M1917 and Mk. VIII tanks, now obsolete.

They are air-cooled, fabric-belt-fed weapons operating on the short-recoil principle common to all Browning machine guns. All have heavy barrels reciprocating within a steel sleeve, perforated to facilitate cooling. Mechanically they are identical with the Browning water-cooled machine gun, M1917, and working parts are interchangeable.

**M1919A4—STANDARD**—This gun is

issued in two types, fixed and flexible. The fixed gun is used only for tank installation and is mounted as a unit with 37 mm or 75 mm guns. The two move together within the limited elevation and traverse of the tank mounts and the machine gun so installed cannot be aimed individually. It has a vertical buffer tube and is without pistol grip.

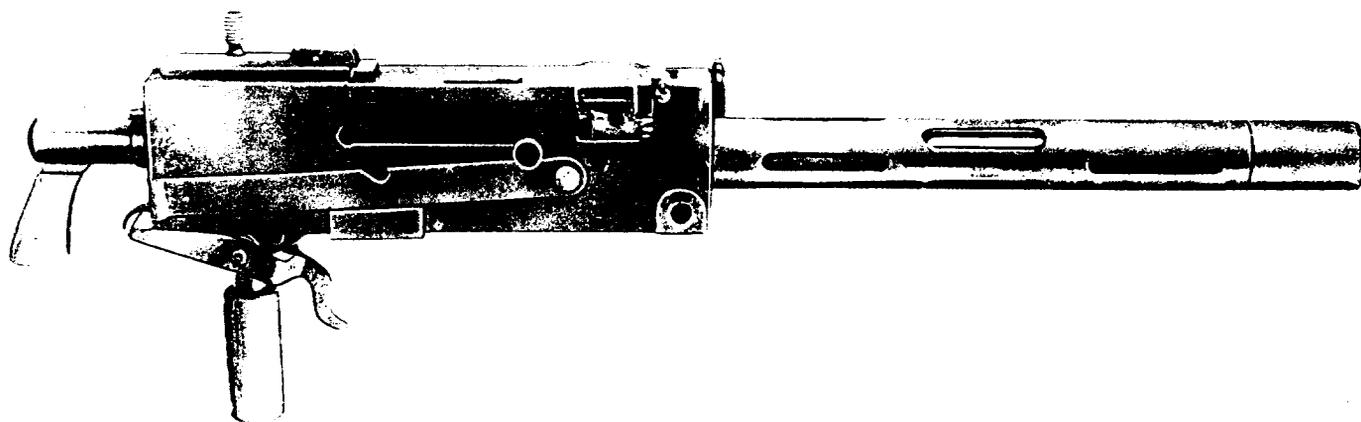
The flexible gun is for more general use. It is used as armament for combat vehicles, armored and unarmored, or may be fired as a ground weapon from the machine gun tripod mount, M2. It is equipped with a pistol grip and is fired from the back plate trigger.

As used by motorized and mechanized units the gun is installed on mounts of

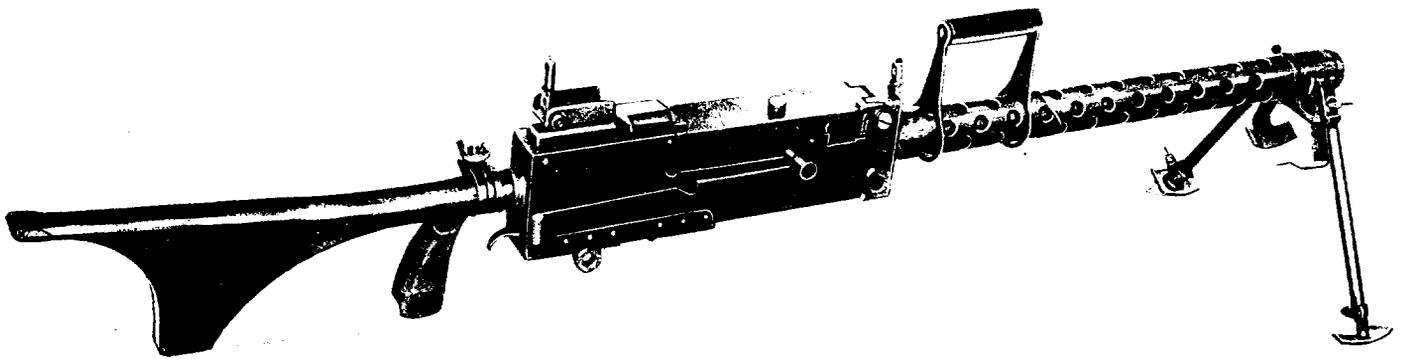
various types, depending upon the type of vehicle and the position of the gun thereon. It is customary to carry a tripod mount, M2, for each gun to adapt the weapon for ground use.

Barrels of the M1919A4, A5, and A6 guns are 24 inches long, 5.37 inches longer than the barrel fitted to the M1919A2. The barrel sleeve has been correspondingly lengthened from 13.7 inches to 19.08 inches. Separate front barrel bearing plugs are provided to permit the use of either M1 or M2 ammunition.

The M1919A2 gun was also modified by the addition of a belt feed lever group assembly which permits assembly and disassembly of the lever from above.



BROWNING MACHINE GUN, CAL. .30, M1919A5



BROWNING MACHINE GUN, CAL. .30, M1919A6

The trunnion block was equipped with a bunter plug to resist wear by the points of the bullets.

Further modifications have been made since the weapon was designated M1919-A4. These include substitution of a buffer plug, buffer ring, and buffer disks for the older tapered form of plug with ring and filler. The change eliminates the "freezing" of ring and plug which retarded buffer spring action.

The bottom plate has been redesigned so that plate, stirrup, and elevating bracket are now a unit. The bottom plate is riveted to the receiver and a recess in the plate serves to locate the gun in the pack hanger.

**SIGHTS**—Sights are of the conventional machine gun type with the front sight mounted on the gun's trunnion block. The rear sight base is mounted on a bracket on the left side plate of the receiver. The folding leaf bears a mil elevation scale graduated for the sight radius of 13.94 inches. Each division on the elevation scale represents 100 yards

and the scale is graduated up to 2,400 yards.

**M1919A5—STANDARD**—In mounting the Browning machine gun, cal. .30, M1919A4, in the Light Tank, M3, it was found necessary to provide a special bolt-retracting slide and a different cover detent. To identify the weapon and to facilitate field supply and maintenance, the gun so modified was designated M1919A5 and classified as Standard.

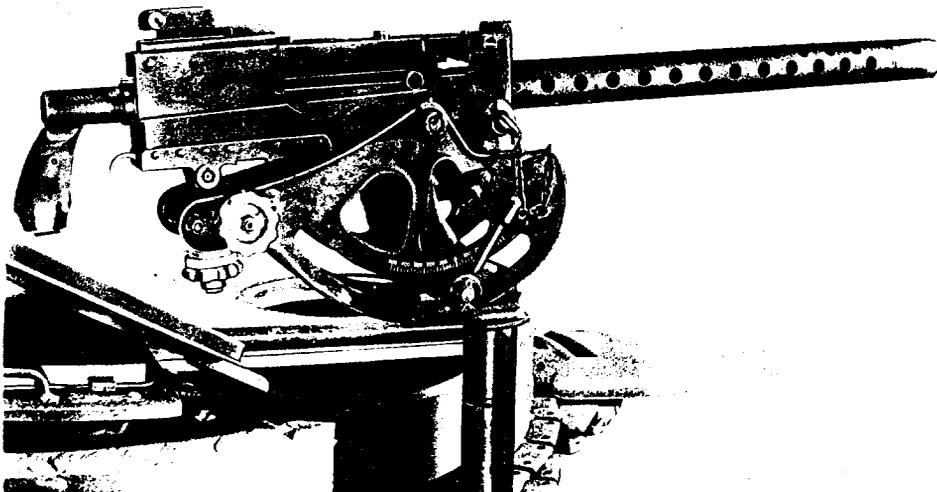
**M1919A6—SUBSTITUTE STANDARD**—The designation of M1919A6 is given the Browning Machine Gun, cal. .30, M1919-A4, as modified for infantry use. The principal modifications, shown in the illustration herewith, include a shoulder stock, a carrying handle, and a bipod mount fixed to the barrel sleeve. A new front barrel bearing was provided and the cover latch changed to permit easier opening of the cover. Changes were made in the barrel plunger and driving spring to assure proper functioning without the muzzle plug.

**CHARACTERISTICS OF BROWNING MACHINE GUNS, M1919A4, M1919A5**

Weight, total	{ Fixed, 30.5 lb. Flexible, 31 lb.
Weight of recoiling parts	11.7 lb.
Weight of barrel	7.35 lb.
Length, overall	{ M1919A5, fixed, 40.8 lb. M1919A4, fixed, 37.94 lb. M1919A4, flexible, 41.11 lb.
Length of barrel	24 ins.
Rifling, length	21.38 ins., 71 cal.
No. of grooves	4
Twist	Right-hand, 1 turn in 10 ins., 33.3 cal.
Depth of grooves	0.004 in.
Cross-sectional area of bore	0.074 sq. in.
Operation	Short-recoil
Feed	Fabric belt, 250 rds.
Cooling	Air
Rate of fire	400-550 rds./min.
Sear release	9 lb.
Trigger pull	7-12 lb.
Normal breech pressure	50,000 lb./sq. in. (copper)

**CHARACTERISTICS OF BROWNING MACHINE GUN, M1919A6**

Weight, total	32.5 lb.
Weight of recoiling parts	7.5 lb.
Weight of barrel	4.65 lb.
Length, overall	53 ins.
Length of barrel	24 ins.
Rifling, length	21.38 ins., 71 cal.
No. of grooves	4
Twist	1 turn in 10 ins., 33.3 cal.
Depth of grooves	0.004 in.
Cross-sectional area of bore	0.074 sq. in.
Operation	Short-recoil
Feed	Fabric belt, 250 rds.
Cooling	Air
Rate of fire	400-450 rds./min.
Trigger pull	8½ lb.
Normal breech pressure	50,000 lb./sq. in. (copper)

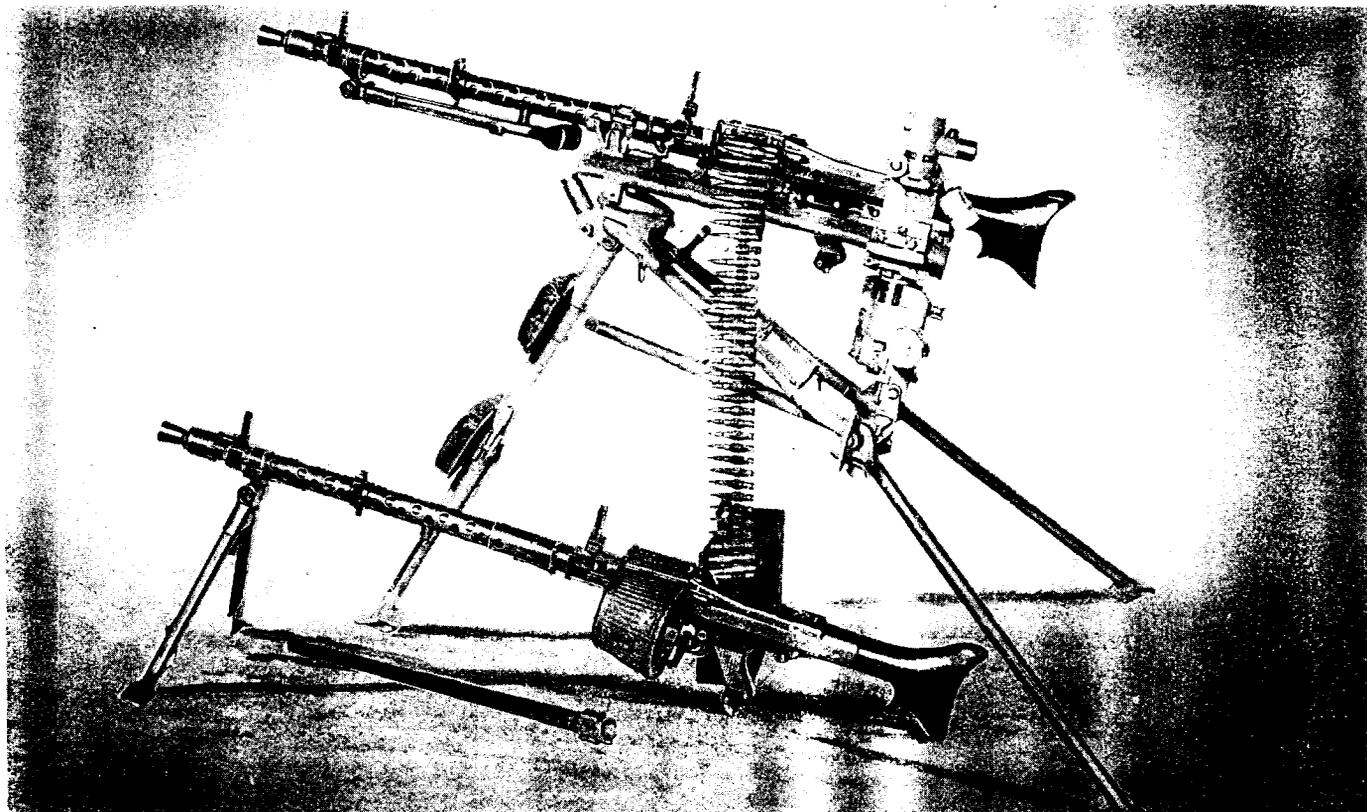


BROWNING MACHINE GUN, CAL. .30, M1919A4, IN A. A. BRACKET MOUNT ON LIGHT TANK, M5

# DUAL-PURPOSE MACHINE GUN

GERMAN 

7.92 mm M. G. 34



The M.G. 34 is a standard machine gun of the German Army. It cannot be compared directly with any American automatic weapon. It is a multi-purpose weapon and is used as a light machine gun, a heavy machine gun, an antiaircraft machine gun, and also on tanks and other vehicles. Because of its adaptability, it is the most common automatic weapon used by the German Armed Forces.

Without bipod mount, the M.G. 34 weighs 24¼ lb., and is occasionally fired by the use of a second soldier's shoulder as a rest. A light bipod adapts it for prone fire and with tripod mount this becomes a heavy machine gun.

The M.G. 34 is a recoil-operated, gas-assisted weapon, belt-fed, and air-cooled. It operates on the Solothurn rotating bolt-head principle. A simple mechanism makes it easy to exchange a heated barrel for a cool one. It is designed to deliver semi-automatic or full-automatic fire.

Studies at Aberdeen Proving Ground show that it is very easy to disassemble in the field, but cannot be regarded as an easy gun to manufacture on a mass production basis, as compared with the M.G. 42.

Studies of captured guns show that this weapon has a high rate of fire—too high for a light machine gun—resulting in poor accuracy in full-automatic operation. When used as a heavy machine gun it shows excellent stability. It is extremely critical as to adjustment, lubrication, and foreign matter.

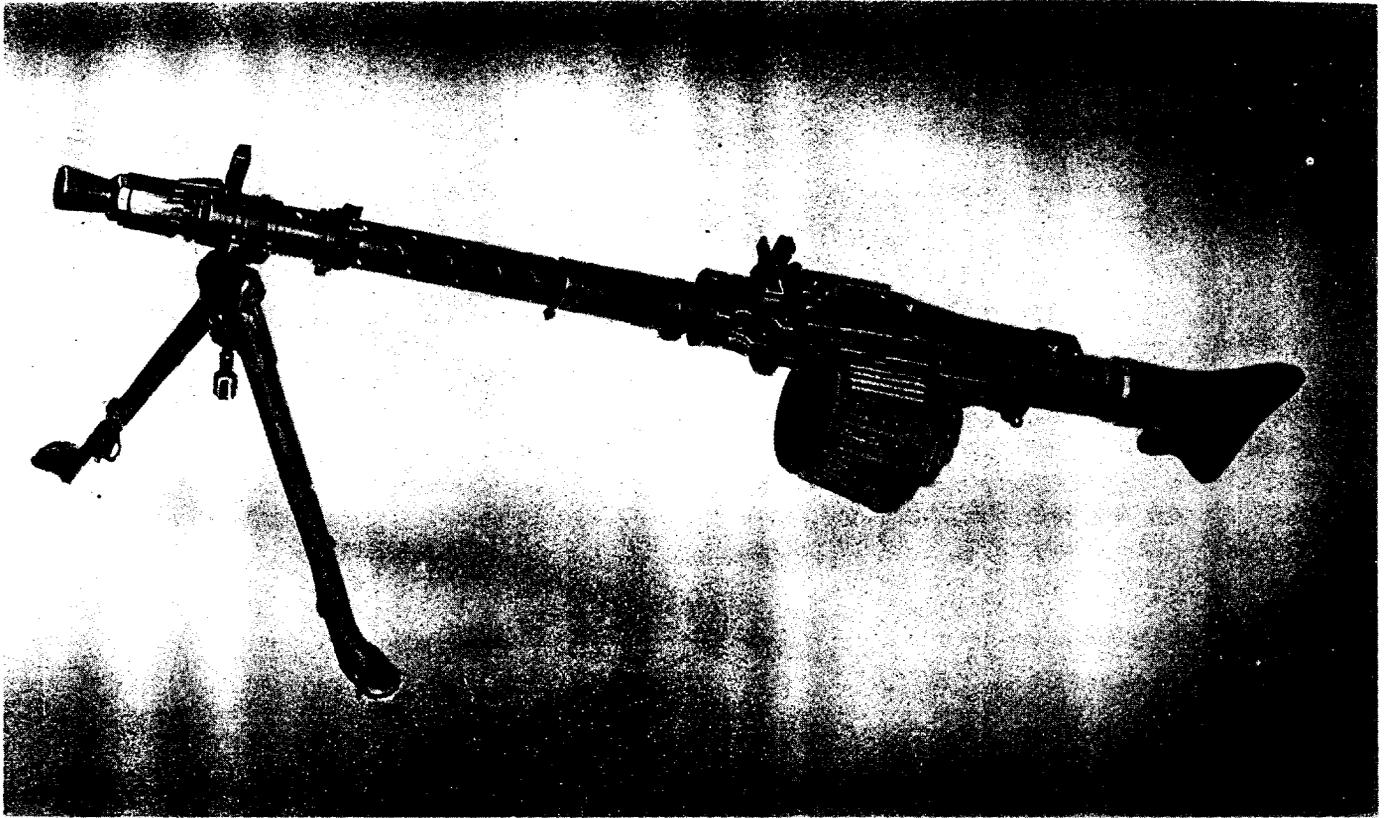
## SPECIFICATIONS

Caliber .....	7.92 mm (.312 in.)
Weight of gun with bipod.....	26¼ lb.
Weight with H.M.G. Tripod mounting.....	68½ lb.
Overall length .....	48 ins.
Principle of operation	Recoil, assisted by muzzle booster. Solothurn type action.
Cooling system .....	Air
Cartridge feed.....	Flexible metallic link belt containing 50 rds. and multiples thereof. Also 50 rd. belt drums and 75 rd. saddle-type drums.
Sights.....	(a) A blade front sight and vertical leaf rear sight with open V notch graduated from 200 to 2,000 meters. (b) An aperture rear sight for use with a "cartwheel" type antiaircraft front sight. (c) A telescopic sight is used on the heavy machine gun tripod mount.
Rifling .....	4 grooves right-hand concentric
Muzzle velocity.....	2,500 to 3,000 f/s depending on type of round used.
Maximum range .....	5,000 yds.
Effective—heavy .....	3,827 yds.
Effective—light .....	600 yds.
Rate of fire (cyclic) .....	800-900 r.p.m.
(practical) .....	100-120 r.p.m.

# DUAL-PURPOSE MACHINE GUN

GERMAN 

7.92 mm. M.G. 34 41



The German 7.92 mm machine gun, M.G. 34/41, represents one of the later developments of the M.G. 34. These developments occurred in the following order: the M.G. 34; M.G. 34 modified; M.G. 34s; M.G. 34/41. In the course of development, the original pattern of the weapon has been largely retained, but each stage has tended toward simplification and elimination of machined parts.

The M.G. 42 is a new design but has the same tactical employment. It is distinguished by a high cyclic rate of fire and fewer machined parts. The M.G. 42 is described on a separate page.

The M.G. 34 modified is used principally in armored vehicles and differs from the M.G. 34 in that it has a heavier barrel jacket adapted to fit ball-type tank hull mounts, a simplified firing-pin nut lock, and bipod clamps for attaching bipod in emergency use; it has no A.A. sight bracket. It can also be mounted on anti-aircraft and heavy ground mounts.

The M.G. 34s and the M.G. 34/41 are identical in appearance, except for the barrel jackets, but are marked as distinct models. They differ from the M.G. 34 as follows: provision for full-automatic fire only; simplified trigger group; shorter barrel with enlarged muzzle end; elimination of firing-pin lock nut; large buffer group; heavier recoil spring; modified feed mechanism. These models can be used on anti-aircraft mounts but appear designed for the heavy ground mount.

## SPECIFICATIONS

Caliber .....	7.92 mm (.312 in.)
Weight .....	24½ lb. w/o bipod
Weight of barrel.....	3¾ lb.
Length .....	44¼ ins.
Length of barrel.....	19¾ ins.
*Muzzle velocity .....	2,500-3,000 f/s
Rate of fire.....	800-900 rds./min. cyclic
Operation.....	Recoil, gas assisted
Ammunition.....	All 7.92 mm Mauser ground types

\*Muzzle velocity varies according to ammunition used.

## RECOILLESS SHOULDER WEAPONS, INCLUDING THE BAZOOKA AND PANZERFAUST

The first widely used recoilless shoulder weapon was the U.S. 2.36" bazooka. It was copied by the Germans, who produced and used an 88mm shoulder rocket launcher. This larger German weapon has an HEAT head capable of penetrating more armor.

An outstanding German development of which there is no U.S. counterpart is the Panzerfaust. This gives the German infantryman a very powerful but very short-range antitank weapon.

The Ordnance Department has developed and recently standardized a 57mm recoilless rifle which combines the power of an artillery piece with the accuracy of a shoulder weapon. Although this has only recently been introduced into the theaters, it promises to be the outstanding recoilless shoulder weapon of the war.

The Japanese have no known weapons in this class, but they probably will produce a copy of either the German or U.S. type.



## Panzerfaust



The German rocket grenade (Faustpatrone—literally "fist cartridge") is a new close-range Nazi weapon used against tanks and other armored targets. It comprises a tube and a head which contains the explosive charge. The weapon weighs 11¼ pounds, has a muzzle velocity of 145 f/s, and a sight range of 33 yards.

The head, which is closed at the front end by a sheet-metal cover, includes a semispherical hollow charge. Toward the rear, the head merges into a rod which includes the small detonating charge 34 and the fuze. The rear of the rod is screwed to a shaft containing four bomb-fins for flight stabilization of the rocket grenade. When not in use, the fins are rolled around the shaft and held together by the tube which is slid over it. The propelling charge is contained in the tube. A sighting rail, fixed to the front end of the tube, when folded down serves as the safety against involuntary cocking of the striker. The sighting rail itself is in turn secured to the rear by the Fuze Safety Pin, which holds it in folded-down position. The lock is located on a line extending from the sighting rail to the rear. It includes and carries the firing-pin (striker), release button, and safety catch.

For firing, the weapon is taken under the right arm, the left hand supporting the grenade two inches behind the front end of the tube. The fuze safety-pin is pulled out, and the sighting rail is snapped up, forming an approximate right angle with the tube. The striker is cocked by pushing the lock forward until the striker is set and the release button emerges. The lock then slides back into its original position, and the release button is pressed, discharging the projectile. Discharge is recoilless, and caution must be taken, as a stream of fire from one to two yards long is ejected from the rear of the tube. The launcher tube is expendable.

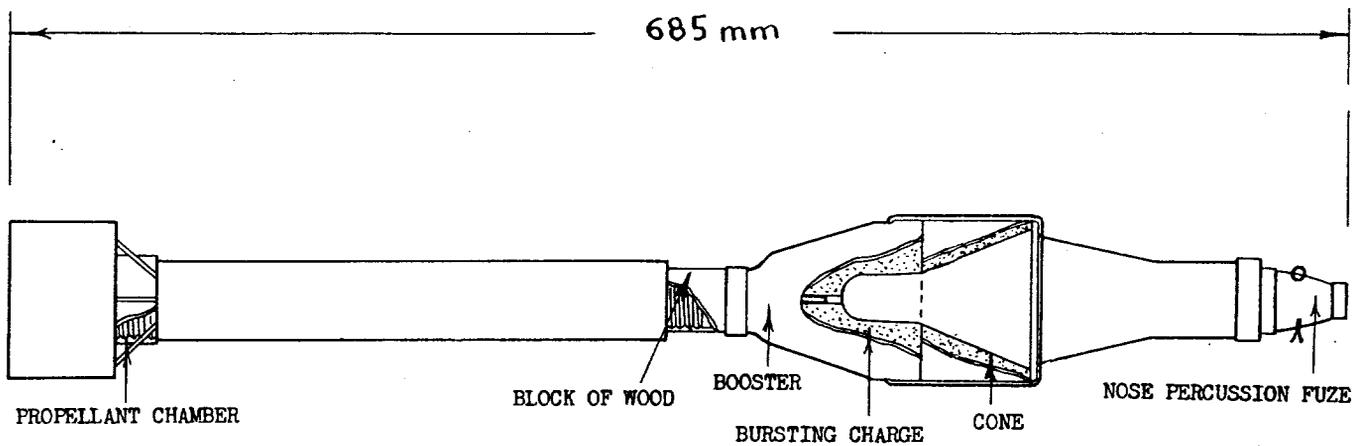
A smaller model is known as the Faustpatrone.

# ANTITANK ROCKET GRENADE

GERMAN



8.8 cm R. Pz. B. Gr.



This projectile is used with the German counterpart of the "Bazooka." It weighs 7.3 pounds and consists of a bomb, propellant chamber, and fin unit. The nose percussion fuze is similar to that used in the high-explosive rifle grenade (Gewehr Spreng-Granate) and the 3.7 cm stick grenade (3.7 cm Stielgranate 41). This fuze is armed by setback.

The bomb body is divided into two parts which are held together by a circular band crimped onto the two halves. The upper section contains a cone forming the hollow charge. The booster charge (Kz. Zdlg. 34 No.) is located in a cavity at the base of the bomb. It is held in place by a few strips of paper. Beneath the booster is a cylindrical block of wood.

The propellant chamber contains seven sticks of tubular propellant 200 mm long, 11.6 mm in external diameter, and 5.6 mm in internal diameter of the jets is 0.5 cm (.19 in.) and the external diameter at the center. The central stick contains a length of quickmatch in a celluloid tube. There is no bottom igniter; the top igniter is contained in an aluminum holder. The composition is similar to that found in other rocket projectiles. It has a top covering of a celluloid-like substance. Situated at either end of the propellant sticks are grid-like spacers. The whole is kept in place by a jammed-in locking ring. The tail unit contains a central venturi tube with an electric fuze fitted to its outer end. Presumably, the electric fuze is blown out on initiation, permitting the gases to escape. The projectile does not rotate. Attached to the outside of the electric fuze is a length of insulated wire which is attached to a contact stud fitted to a piece of wood.

## SPECIFICATIONS

Weight .....	7.3 lb.
Length (overall) .....	685 mm
Diameter (external) .....	88 mm
Length of outer portion of venturi tube.....	42 mm
Length of inner portion of venturi tube.....	21 mm

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## Comparative Ranges/Effectiveness of Tank-Killing Guns

Appendix III

Data on U.S. and German Armor

Maximum Vulnerable Ranges (in yards)

Part of Tank		<i>M4A1</i> penetrates <i>Panzer IV</i>	<i>Panzer IV</i> penetrates <i>M4A1</i>	<i>M4A1</i> penetrates <i>Panther</i>	<i>Panther</i> penetrates <i>M4A1</i>	<i>M4A1</i> penetrates <i>Tiger I(E)</i>	<i>Tiger I(E)</i> penetrates <i>M4A1</i>	<i>M4A1</i> penetrates <i>Tiger II(B)</i>	<i>Tiger II(B)</i> penetrates <i>M4A1</i>
Front	Turret	2,600	1,700	None	3,000	None	2,800	None	5,000
	Upper Hull	100	2,100 <sup>b</sup>	None	3,400 <sup>b</sup>	None	2,400	None	5,000
	Lower Hull	1,000	1,400 <sup>c</sup>	None	2,700 <sup>c</sup>	None	2,200	None	4,500
Side	Turret	4,400	3,600	2,800	4,900	1,100	5,000	None	5,000
	Upper Hull	5,000 <sup>a</sup>	4,600	4,000	5,000	1,900	5,000	600	5,000
	Lower Hull	5,000	4,600	4,000	5,000	1,900	5,000	600	5,000
Rear	Turret	5,000	3,800	2,800	5,000	1,100	5,000	None	5,000
	Hull	5,000	4,200	3,000	4,100	300	5,000	None	5,000

Part of Tank		<i>M4A3 penetrates Panzer IV</i>	<i>Panzer IV penetrates M4A3</i>	<i>M4A3 penetrates Panther</i>	<i>Panther penetrates M4A3</i>	<i>M4A3 penetrates Tiger I(E)</i>	<i>Tiger I(E) penetrates M4A3</i>	<i>M4A3 penetrates Tiger II(E)</i>	<i>Tiger II(E) penetrates M4A3</i>
Front	Turret	4,800	1,600	600	3,000	1,200	1,800	None	4,500
	Upper Hull	2,300	1,400	None	2,800	800	1,800	None	4,500
	Lower Hull	2,800	1,400 <sup>e</sup>	None	2,700 <sup>e</sup>	None	2,200	None	4,500
Side	Turret	<i>5,000</i>	3,100	4,800	4,600	2,600	5,000	2,300	<i>5,000</i>
	Upper Hull	<i>5,000</i>	4,600	<i>5,000</i>	<i>5,000</i>	3,800	<i>5,000</i>	2,600	<i>5,000</i>
	Lower Hull	<i>5,000</i>	4,600	<i>5,000</i>	<i>5,000</i>	3,800	<i>5,000</i>	2,600	<i>5,000</i>
Rear	Turret	<i>5,000</i>	3,100	4,800	4,600	2,600	5,000	2,300	<i>5,000</i>
	Hull	<i>5,000</i>	4,200	<i>5,000</i>	<i>5,000</i>	2,500	<i>5,000</i>	1,800	<i>5,000</i>

<sup>a</sup> Figures in *italic* are *plus*.

<sup>b</sup> Computation of 2.5" at 37°.

<sup>c</sup> Computation of 4.5" at 0°.



**Tank Guns and Ammunition**

<i>Tank</i>	<i>Gun</i>	<i>Ammunition</i>	<i>Muzzle Velocity (f/s)</i>	<i>Projectile Weight (lbs.)</i>
Sherman (M4A1)	75mm, M3	APC, M61	2,030	14.96
Sherman (M4A3—76mm)	76mm, M1A2	APC, M62	2,600	15.44
Panzer IV(H)	75mm, 40	APC, BC	2,526	15.0
Panther (G)	75mm, 42	APC, BC	3,068	15.0
Tiger I(E)	88mm, 36	APC, BC	2,657	20.7
Tiger II(B)	88mm, 43	APC, BC	3,280	22.4

### Armor Thickness and Angle

(First figure is inches, second figure is degrees)

Part of Tank		<i>Sherman</i> (M4A1)	<i>Sherman</i> (M4A3—76mm)	<i>Panzer IV</i> (H)	<i>Panther</i> (G)	<i>Tiger</i> I (E)	<i>Tiger</i> II (B)
Front	Turret	3.0 at 30	2.5 at 40-45	2.0 at 11	4.3 at 14	4.0 at 10	7.1 at 10
	Upper Hull	2.5 at 37-55	2.5 at 47	3.3 at 14	3.2 at 56	4.0 at 24	5.9 at 50
	Lower Hull	4.25-2 at 0-56	4.25-2 at 0-56	1.2 at 61	2.4 at 54	2.5 at 63	3.9 at 50
Side	Turret	2.0 at 5	2.5 at 0	1.2 at 26	1.8 at 25	3.2 at 0	3.2 at 20
	Upper Hull	1.5 at 0	1.5 at 0	1.2 at 0	1.6 at 0	2.5 at 0	3.2 at 0
	Lower Hull	1.5 at 0	1.5 at 0	1.2 at 0	1.6 at 0	2.5 at 0	3.2 at 0
Rear	Turret	2.0 at 0	2.5 at 0	1.2 at 16	1.8 at 25	3.2 at 0	3.2 at 20
	Hull	1.5 at 10-20	1.5 at 22	0.8 at 20	1.6 at 30	3.2 at 9	3.2 at 30

# 11

Lessons From Tunisian Campaign, 1943

**RESTRICTED**

**WAR DEPARTMENT**

WASHINGTON 25, D. C., 15 October 1943.

The following digest, Lessons from the Tunisian Campaign, contained in Training Memorandum No. 44 dated 4 August 1943 from the Allied Force Headquarters, APO 512, is published for the information of all concerned.

[A. G. 370.22 (4 Oct 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,

*Chief of Staff.*

OFFICIAL:

J. A. ULIO,

*Major General,*

*The Adjutant General.*

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II /

**TRAINING LESSONS FROM THE  
TUNISIAN CAMPAIGN**

**SECTION I—INTRODUCTION**

1. The material contained in this publication is not to be considered as tactical doctrine. It represents a summary of the main lessons of the Tunisian Campaign digested from reports of division, separate, and subordinate unit commanders. Only the major combat arms of the Ground Forces are included. It is believed that the lessons and examples given, if applied with judgment and consideration of individual situations, will be of value in the training of organizations which have not yet entered combat.

2. In all reports of battle experience the soundness of basic principles prescribed in standard training literature has been confirmed. Failures or tactical reverses have resulted from misapplication of these principles, or from lack of judgment and flexibility in

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their application, or from attempts to follow book rules rigidly without due consideration of their suitability to existing situations.

3. During the Tunisian Campaign this Headquarters published periodically training memoranda on various subjects, as lessons were gained or weaknesses were disclosed. In the following material subjects previously covered in these memoranda will appear.

#### SECTION II—INFANTRY UNITS

4. In the following paragraphs the term "infantry" refers to the troops of the normal infantry division as distinguished from the armored infantry of the armored division.

5. The experience of our infantry has been extensive and varied. Its missions have included practically all ground operations appropriate to its arm. Its operations have been conducted in all types of terrain, including desert, mountains, and the intermediate features between these extremes as well as terrain types regionally peculiar to Tunisia. From this varied experience, the outstanding lessons and subjects given below are believed by reporting commanders to be of first importance in infantry training.

#### 6. Fire and movement.

In almost every situation the most important single element of infantry combat is the effective use of fire and movement.

#### 7. Observation and seizure of dominant terrain.

Experience continually emphasized the necessity of seizing key terrain features which afford effective observation. Enemy positions subjected to dominant observation rapidly became untenable. Examples of this experience are quoted from the report of a division commander:

... This principle has been taught for years, yet at EL GUETTAR, HILL 772 remained in German hands during the first ten days of the battle. As a result the enemy had artillery observation and was able to fire on anything that moved. As soon as HILL 772 was captured, the German's abandoned the entire position. . . .

The principle was further borne out in the SEDJENANE-BIZERTE operation. During the early days while our enveloping force was getting into position, German observation again dominated us. Our envelopment turned

the enemy out of the line of hills on which his OP's were located. It is now known that the German withdrawal from the GREEN HILL-BALD HILL position started immediately after we occupied the two hills referred to. . . .

Similar experience has been described in the report of another division commander:

. . . AT EL GUETTAR the advance of the Division was slow and costly until the —th Infantry captured and strongly garrisoned the dominant hill in the division sector. Several OP's were set up and observed fire was effectively employed over the entire sector thereafter. As another example, in the operations around BEJA, HILL 575 and HILL 350 were dominant terrain features from which the enemy conducted a very strong defense. Each was captured by local attacks and enemy resistance in that immediate area crumbled as the advantage of observation passed to our hands. . . .

In all offensive operations, the seizure of dominant terrain features as intermediate and final objectives became the core of infantry commanders' plans. Specific effort to cap-

ture key points for artillery observation posts was emphasized, and its importance has been clearly stated in the comment of an artillery battalion executive:

. . . Part of every infantry attack should be directed to seize high ground for artillery OP's. Without them, continued effective support cannot be given. . . .

#### **8. Organization and consolidation of captured ground.**

Experience has shown that German forces invariably launch an immediate counterattack whenever possible to regain lost ground, and precede such attack with prepared artillery fire. Advancing units had to learn to take immediate measures for the organization of captured ground for defense, and to utilize supporting weapons of all calibers for this purpose. On high ground ridge lines had to be avoided, as these features often presented targets for prepared artillery concentrations which preceded counterattack. The following example of this lesson is taken from the report of a division commander:

. . . Several times the infantry was slow to realize that they must not ex-

pose themselves on the skyline after reaching the top of a hill. The German always places artillery fire on positions he has vacated. In the attack on DJEBEL CHENITI by the —th Infantry, advance elements stood up on the skyline instead of continuing down the forward slope and digging in. Artillery fire came down almost immediately causing many more casualties than were suffered in taking the position. . . .

#### **9. Infantry cooperation with tanks.**

The Campaign has demonstrated that excellent results can be obtained through the use of tanks with the troops of the infantry division, as distinguished from the normal action of the armored infantry. It has been found that their employment should follow the principles of cooperation, teamwork, and coordination required for the infantry-artillery team. Two types of infantry cooperation were effective, as determined by the situation. Preliminary preparation for the breakthrough of the tanks, and close support of the tanks in their own breakthrough. In either case, infantry support has been indispensable to the tank action, especially in

consolidating the ground overrun by the tanks.

#### **10. Depth in offense and defense.**

The principle of depth as applied to both offense and defense cannot be overstressed. Disposition and deployment in depth, and the mutual support of all heavy and automatic weapons from positions organized in depth were found essential throughout the campaign. In defense against armored attack, adherence to this principle was vital.

#### **11. Following of artillery fires and concentrations.**

Assault troops learned the advantage and necessity of following closely the line of impact of their supporting artillery concentrations and barrages. The distance between assault wave and concentration or barrage depends on terrain and other conditions. Reports have indicated from 100 to 200 yards as effective distance without undue casualties from the supporting fire. Following at greater distance allows the enemy to recover from the shock of the fire and man his weapons effectively. "This was conclusively

demonstrated," reported a Division Commander, who cited the following examples:

. . . In early action the infantry often allowed artillery concentrations to lift so that 500 yards or more had to be traversed before closing with the enemy. This allowed the German to come up out of his dugouts and recover from the effect of the artillery and man his weapons. As a result our attack was often repulsed with heavy losses.

. . . Later at DJEBEL CHENITI the —th Infantry stormed the hill following the artillery at 100 yards. They took only three casualties from our artillery and overran the position with the bayonet before the defenders had recovered and manned their guns. No casualties were suffered other than the three mentioned above . . .

#### 12. Training in mountain and hill warfare.

The recent campaign has shown that the basic principles of mountain and hill warfare must be learned by all infantry. In order to advance successfully, troops had to avoid natural corridors of approach, which were invariably mined and heavily defended, and work along ridges and high terrain features. In this way the enemy was forced to

abandon strongly defended positions at the heads of the corridors, valleys, and natural approaches. "We learned," wrote a division commander at the close of the campaign,

. . . that to live, we must take to the ridges and advance along them, avoiding avenues of approach up valleys. To advance along valleys was disastrous. Taking to the ridges was tedious, strenuous business, but it saved hundreds of lives and gave physical possession of the high ground. Four times this resulted in the collapse of strong positions and the German was finally driven into open country, his resistance broken, and pursuit tactics made possible . . .

#### 13. Scouting and patrolling.

Scouting and patrolling proved to be one of the most serious deficiencies in the operations of American infantry in Tunisia. Patrol activity was not sufficiently aggressive, and at times failure in effective scouting operations resulted in patrols being ambushed. The campaign continually revealed the necessity of seizing and holding the initiative through continuous, aggressive, and effective scouting and patrol operations. Our ex-

perience has demonstrated the need for much higher proficiency in the subjects and functions requisite to these operations, including map reading, the use of compass and other means of direction control, movement by stealth, avoidance of ambush, and control of patrolling personnel. Leaders of patrols must master the principles of the single objective, individual initiative and responsibility, alert observation, patience, clarity in the issuance and understanding of plans and instructions, boldness of action, accuracy in reporting, and energy and initiative in execution. Prior daylight reconnaissance should precede night patrol operations to insure against elements getting lost or ambushed. These principles have been summarized in the comments of a regimental S-2, whose unit saw continuous action throughout the campaign:

. . . Train men intensively in 'sneaking' and 'peepin', and in how to distinguish and identify different sounds. Teach men to step cautiously and silently, to crawl noiselessly. Train them in the accurate use of the compass night and day, and in map reading. Also in observation—half the information we get is obtained from observation and patrolling . . .

. . . One important battle lesson has been the failure of junior officers to be ice-clear and specific in instructions and directions, especially with regard to patrolling, scouting, and night operations. For night patrol operations a prior daylight reconnaissance must be made. Without adequate prior daylight reconnaissance, night patrols often get lost. In one instance failure to reconnoitre a position and an area for a night operation resulted in a patrol being ambushed by outposts unknown to the patrol leader and his men . . .

In all night operations have but a single objective. Never split a night patrol—always keep it intact. Let every man on scout and patrol know the situation clearly. Give each man a definite job and the responsibility for carrying it out . . .

An all-important point: Train men to report only what they see, and not to include any personal interpretations . . . One outstanding example lesson was the twisting of information reported. An observation post reported that three *Italians* had been seen coming down a certain hill. The information was relayed as three *battalions* coming down the hill . . .

The importance of accurate map reading and interpretation are clearly demonstrated in the report of a division commander at the conclusion of the campaign:

... At FONDOUK and HILL 609 this division had great difficulty in map reading. Officers had difficulty in accurately locating themselves on maps, and in following on the ground a route marked on a map. There are instances of whole battalions becoming lost at night on the way to the jump-off line. These incidents all bring out the fact that map reading has been neglected and must, in the future, be continually stressed in training. . . .

#### 14. Securing and use of accurate G-2 information.

The securing of accurate and timely G-2 information by intelligence personnel was stressed in several of the reports. In all echelons from the battalion intelligence section to the division G-2, the principles of accuracy, timeliness, thoroughness, and alert action must be learned and followed. In one instance, intelligence agencies furnished a division G-2 with an overlay "showing German mortars and probable infantry positions on the slopes of DJEBEL BERDA, and a

delaying position across the GABES-GAFSA road." In reporting this incident, the division commander stated:

... The opinion was that resistance would be light, and no intimation was given of the presence of a strongly organized defensive position. . . . As it turned out, the Germans must have worked two months on their position. Emplacements and dugouts were carved out of the rock in many places. . . . The fact that there was no information of the great strength of this position had a vital bearing on the plan of attack. . . . In marked contrast was the situation at SEDJENANE. There we relieved the British —th Division, and were furnished maps giving all the details of the German positions on GREEN and BALD HILLS and at the head of the SEDJENANE valley. As a result an enveloping maneuver was carried out avoiding all prepared positions. Each enemy position was evacuated as soon as the pressure of the envelopment was felt. . . .

#### 15. Training in all phases of night operations.

In the recent campaign, a large proportion of the infantry operations were carried out

at night. The standard of proficiency of our troops was initially unsatisfactory, but improved as experience was gained. Two vital needs were served by the improvement of our night operations:

*a.* The essential element of surprise when needed.

*b.* The only means, at times, of getting troops into position without severe losses. The essence of successful night operations has been found to be simplicity of plan. The subdivision of duties must be clearly understood by all participants, and the individual responsibilities assumed and carried out with vigor and dispatch. Such planning must provide for continuous, effective control by the leader or commander, and for alternate action in the event that unforeseen developments arise.

#### 16. Miscellaneous.

In addition to major subjects above summarized, the reports of division and lower unit commanders brought out the following miscellaneous points:

*a.* Small unit training, especially with regard to platoon and junior leaders, is of prime importance. The leadership, tactics, and

maneuver of the squad, platoon, and company are vital to the success of combat operations.

*b.* The use of highly trained snipers assumed increasing importance throughout the campaign. The development and effective use of snipers should be given special attention.

*c.* The maintenance of uninterrupted control of all combat elements in action is essential. All leaders and commanders must learn to meet this requirement and develop the ability to cope with sudden changes in the situation without loss of control.

*d.* The use of smoke in different phases of infantry operations assumed unexpected degrees of importance. The employment of smoke grenades, artillery cooperation with smoke shell, mortar smoke shell, and other apparatus, all proved highly effective. Smoke was used for both offensive and defensive operations, for marking and identifying positions, targets, and objectives.

*e.* Effective support from mortars and artillery frequently depends on the work of forward observers. In some infantry regiments officers had learned the technique of adjusting mortar and artillery fire by forward observation methods. This provided a

reserve of forward observers who were of great value in emergency.

*f.* Coordination of all heavy supporting weapons is of first importance in offensive and defensive operations. It must include the coordinated planning of fires for machine guns, cannon company weapons, supporting artillery, and mortars.

*g.* Proficiency in small-arms marksmanship, and the ability to hold fire until targets are within range, were not fully achieved in the campaign.

### SECTION III—FIELD ARTILLERY UNITS

#### 17. General.

The employment of field artillery in the Tunisian Campaign proved to be satisfactory and effective to a high degree. The principles and teachings of the Field Artillery School, when applied with flexibility, judgment, and with due regard to each situation, were proved sound in combat throughout the campaign. The excellent results obtained in one division were attributed by its commander to

... flexibility of organization and employment, experienced and capable battalion commanders; and a very un-

usual degree of mutual confidence and understanding between the organic battalions and the units of the reinforcing artillery brigade . . .

Reports from units also record that enemy prisoners often commented on the power and effect of American artillery fire. "One Nazi who has served on almost every German front," declared one of our division commanders, "said that the American artillery fire was the most deadly that he had experienced." From this successful experience in varying situations over a wide front, the following main subjects and lessons are reported by participating commanders to be of importance for the consideration of all artillery units, especially those which have not yet entered combat.

#### 18. Tactical employment.

*a.* When the organic division artillery was not reinforced, the standard, normal employment was used with excellent results. Operations were decentralized to battalions, but close and effective supervision by Division Artillery Headquarters was preserved. Decentralization afforded the advantage of providing the most rapid means of delivering

adequate fire support on any target, regardless of its location and nature. It also made possible the full advantage of massed fire when necessary, under the control of the Division Artillery Commander. The high degree of success achieved depended largely on able and experienced battalion commanders, expert gunnery officers in all fire direction centers, and complete and effective communications.

b. When the organic division artillery was reinforced, the following methods of employment were used with satisfactory results:

(1) As dictated by the situation, the organic medium battalion, together with the reinforcing battalions, were held in general support.

(2) When the situation required, one or more reinforcing battalions were assigned the mission of reinforcing each organic direct support battalion. Experience showed that it was immaterial whether the reinforcing units were attached to organic direct support battalions, or were assigned support missions without being attached. This was because of the high degree of confidence, understanding,

and cooperation between the organic and reinforcing units.

(3) Combination of the two types of employment of reinforcing artillery above mentioned were used whenever the situation rendered it advisable. The keynote of successful employment, with regard to both organic and reinforcing units, was flexibility, and the fitting of the artillery plan to the individual situation, closely coordinated with the plan of infantry operations.

#### 19. Operational technique.

a. *Reconnaissance*.—Complete and thorough reconnaissance is essential. One serious difficulty that was experienced was caused by lack of time to carry out adequate reconnaissance after receipt of plans and orders. The use of fragmentary orders and warning orders proved highly useful in this respect, but even the continual use of fragmentary orders does not always provide sufficient time for daylight reconnaissance prior to night movement and occupation of position. "On at least three occasions," a division commander reported,

... even this method failed to provide time for daylight reconnaissance,

the battalions receiving their orders after dark for a night move into strange territory to support a dawn attack. In two of these instances, the artillery found itself in position ahead of the infantry when the enemy made surprise attacks before our troops were set. In both occasions howitzers were lost by being overrun, but all of them were subsequently recovered by counterattacks of our infantry . . . . On the third occasion the division received an attack order at 1700 hours to make a night march and attack at dawn. By the time the division could issue its order, it was dark and reconnaissance was made by moonlight, and an effort was made to carry the survey a distance of approximately 10 miles under these conditions. The division attained complete surprise, but adequate artillery support could not be given until after daylight. This incident occurred in the attack on EL GEUTTAR . . . .”

At all times, artillery officers going forward on reconnaissance must be sure of the location of the infantry lines and outposts, and take measures not to go inadvertently beyond our lines. In one instance, it was reported that

an artillery battalion commander and five captains were lost by going forward without checking with the infantry as to location of the front lines. The area they went into was far ahead of our own infantry lines . . . .

*b. Flexibility in all artillery operations.*— All the reports point to the axiom that flexibility in planning and execution is one of the most vital elements in all artillery operations. It must be applied to the planning and delivery of fire, survey, supply, communications, and in fact, to all functions of artillery in combat. A standard S. O. P. was found to be of great value as the basis of all general operations, but no rigid plan, whether of gunnery, communications, or general employment, can be strictly or invariably adhered to. Everchanging situations throughout combat render rigidity of plans and action ineffective and can cause failures at critical times. The marked success of our artillery in the recent campaign can be attributed largely to the achievement of this all-important flexibility in operations. As reported by one of the division commanders,

... The flexibility of fire was astounding. At one time a forward

observer on the north flank conducted fire for a battalion of 155-howitzers located on the opposite flank. . .

*c. Observed fire and forward observation.—*

The great majority of all fires delivered by division and reinforcing artillery were conducted by some type of observation. In one division it was reported that "there was practically no unobserved fire except harassing fires at night." The preponderance of observed fire was largely due to the nature of the terrain, which afforded ridges, hills, and mountains for observation posts, and was also well suited for forward observation methods. Three special situations have been encountered, and probably will be encountered in future operations, that make mastery of all observed fire methods essential to the smaller units, especially the battery and platoon:

(1) In assault landings, when the support artillery often enters action by section, platoon, or battery, and there is no fire direction center in operation in initial stages. Under these conditions the delivery of supporting fire depends entirely on the ability of the platoon and battery commanders to conduct effective observed fire.

(2) In retrograde movements, when communications are often lacking or inadequate, individual batteries may often have to cover the withdrawal of the infantry and other artillery units. Under these circumstances, much will depend on the observed fires of individual batteries, without assistance from the fire direction center. In one instance it has been reported that "a single 105mm howitzer covered the withdrawal of the remainder of its battery and neutralized a 6-gun German battery all by itself."

(3) In a majority of different combat operations, the targets of opportunity that appear should be taken under fire by individual batteries conducting their own observed fire, either from established battery OP's or by forward observers. In this connection a division commander reported at the close of the campaign:

. . . In all of our battles, many favorable targets of opportunity were taken under fire by single batteries and neutralized or destroyed by proper application of the principles of observed fire without assistance from a fire direction center. The tendency, however, is to utilize the FDC and liaison methods

when the ability to adjust fire by command would give quicker effect with a considerable saving in ammunition.

Forward observation proved to be the most effective means of conducting fire in most cases. In one division it is reported that "forward observation methods were used almost entirely . . . Each battalion had at least ten forward observers," who often adjusted the fire of different battalions through the division artillery fire direction center. In another division, one observer had conducted fire from a single gun to seven battalions, and its commander has summarized the experience of his division artillery as follows:

. . . Forward observers are vital. Each battery should have a forward observer in addition to a battery observer closer to the guns. Each battalion should have at least one OP. Observers within a battalion sector must be coordinated, and this coordination should include observation posts from infantry and supporting units. Forward observers are under the direction and control of liaison officers with the front line assault battalions. They

operate through the liaison officers and fire direction center rather than direct with the battery. Forward observers must be continually on the move in order to get observation for effective support for the infantry. . . . At least two OP's in each battalion should be surveyed in order to provide means for combined observation. Any fire close to the infantry should be adjusted and controlled by observers of the direct support battalion involved. This is very important. The principle of flexibility appears in this connection, because any OP should be able to adjust the fire of any battery in the area, especially on targets of opportunity.

Forward observers must be highly proficient in the technique of this method of conducting fire, and must be thoroughly familiar with the principles of gunnery. One faulty tendency reported in one division was that "the observer too frequently calls for fire for effect before he attains a proper adjustment." This practice wastes ammunition and prevents the full effect of the fire from reaching the target.

*d. Communications.*—The experience of all units has shown the soundness of technical

and tactical principles of field artillery communication as prescribed in standard training literature. The need for proficient signal personnel, including men with ability to maintain equipment and resort to improvisation in difficult situations was emphasized by all participating commanders. Artillery signal troops must also develop a high degree of ingenuity in establishing and maintaining communications under all conditions. Wire remains the primary means of artillery communication, with radio as a secondary or emergency channel. The highest cooperation and understanding between wire and radio personnel is essential to insure the combined use of both means when the situation demands. In some rapidly moving situations, wire has been reported as the secondary channel, though this should be regarded as an exception to the general rule. Telephone and radio discipline is vital, to prevent traffic blocking. In all artillery communications, flexibility has been of cardinal importance. All units reinforcing the fire of another unit, or in direct support, must provide communications with the unit so reinforced or supported. Lateral communications between bat-

talions is important, and lateral communications between the division artillery of adjacent divisions is of even greater importance. Prearranged message codes, and a complete and effective SOI are essential.

*e. Unobserved fire.*—In future operations, the terrain may not afford such excellent means of observation as have been experienced in the Tunisian Campaign. In their reports, division commanders have pointed out that the principles and technique of prepared unobserved fires must not be overlooked, but must be mastered by all units. Emphasis was given in these reports to transfers of all types, and to delivery of unobserved concentrations and the massing of fires.

*f. Fire control and direction.*

(1) The standard prescribed technique of the light battalion in direct support of its combat-team infantry regiment proved satisfactory in all cases.

(2) When reinforcing artillery was available, additional battalions were employed to reinforce the fires of the direct support battalion. The mission of the reinforcing units was direct support of the light battalion. The commander of the direct support battalion could plan on the fires of his reinforce-

ing battalions at all times without calling on division artillery headquarters to get the fire. The advantage of high speed in delivery of reinforcing fire was obtained through this system. It is reported very effective in all cases where it has been used.

(3) Another method of controlling the fires of reinforcing or general support units was the placing of them under the control of the division artillery gunnery officer, who assigned them missions on call for help from the direct support battalions. This method has been found to be especially effective when the amount of general support artillery is limited.

(4) Experience has shown that rigid adherence to combat-team organization in a division action often results in complicating and reducing artillery support. In any method of controlling the fire of organic and attached units, all battalions must always be available and under the command of the division artillery commander, who can place their fire wherever most needed.

(5) The German tendency to launch counterattacks in immediate attempt to recover lost ground necessitates immediate prep-

aration of fire to repulse such attacks against newly gained positions. The importance of this point is brought out by one of the division commanders in his report on battle experience:

... The artillery with this division killed more Germans when they made these counterattacks than it did in all the preparation, fire on targets of opportunity, counter-battery, and in support during attack. In fact, the BAR-ENTHIN Regiment must have learned its lesson the hard way, because on the last position, it refused to counter-attack. . .

(6) In some instances, box barrages were used effectively to extricate hard-pressed infantry elements from difficulty.

(7) Rolling barrages were used on some occasions. More generally, to cover the assault of infantry, concentrations were fired at prearranged times determined after consultation with the infantry. These concentrations were of sufficient duration to permit the assaulting infantry to press close to the covering fire before it lifted. Normally the last rounds of such concentrations were smoke, to signal the lifting of the fire.

(8) The effectiveness of time fire with HE shell cannot be exaggerated. Properly used, this type of fire has proved to be annihilating.

(9) Experience has demonstrated that long concentrations of slow fire are more effective against prepared positions than a mass of fire for a short duration. This does not apply to enemy in the open. The enemy themselves substantiate this experience, according to one division commander's report:

. . . Many prisoners testified that the combination of percussion shell, time shell, and white phosphorus took the fight out of them, not only because it was practically impossible to avoid the effect, but also because the continuous pounding shattered their nerves. . .

(10) The importance of liaison functions to artillery operations was borne out in the campaign. The experience of one division is briefly stated in the report of its commander:

. . . Liaison is one of the most effective forms of (artillery) control, and is essential not only between artillery and infantry but also between artillery and artillery. Proper liaison insures cor-

rect combat intelligence, and provides the mechanism through which mass fires can be most profitably employed. . .

*g. Interdependence of artillery and infantry plans.*—All artillery plans must be based on the infantry plan, and the two must be fully coordinated and interdependent. The two should be made simultaneously, and sufficient time for the preparation and execution of the artillery plan must be allowed, especially for reconnaissance, survey, and other vital preparations essential to the artillery action. The difficulty caused by insufficient time for reconnaissance, mentioned in paragraph 19a, *supra*, can in a measure be overcome by closer coordination of the infantry and artillery plans.

*h. Miscellaneous.*

(1) Wide dispersion of pieces within the battery position has been the rule throughout the campaign. Dispersion up to a 200-yard front, and at times wider, has proved effective against counterbattery fire and dive bombing attacks.

(2) Dummy positions have been effective in drawing enemy fire and directing it

away from actual positions. Simulated muzzle blast in front of the dummy pieces is necessary for full effectiveness.

(3) Night harassing fires are very useful for destroying the enemy's rest, unnerving him, and disrupting his night activity. Each gun in the normal division artillery firing on a different point will cause trouble to the enemy in 48 different places simultaneously. Prisoners have confirmed the demoralizing effect of such fire. All night harassing fires must be coordinated with the patrol activities of friendly infantry.

(4) In order to cover wide frontages, batteries should organize positions with pieces in diamond, square, or horseshoe formation.

(5) Observation (Cub) aircraft were highly useful for reconnaissance and for checking camouflage, in addition to their primary mission of providing observation posts. Commanders have reported that these machines are invaluable.

(6) In adjustment on targets at long range, the best results have been obtained by adjusting one element at a time. For targets at short or medium ranges, the standard simultaneous adjustment of all elements should be followed.

(7) Wherever the terrain has been suitable, ricochet fire has been found to be highly effective, especially for reaching personnel on reverse slopes.

(8) Artillery units must provide their own all-around security for battery positions. In terrain encountered in the recent campaign, it was not always possible to rely on the infantry for the protection of battery positions. "In one case," reported an artillery battalion executive, "the Germans seeped through, and the first thing we knew they were throwing hand grenades into our gun pits."

(9) Artillery fire should be placed on enemy positions immediately after bombardment by our air forces. Personnel have the tendency to relax immediately after air bombardment, and sudden artillery fire will take them unprepared and produce considerable casualties.

(10) For the artillery OP's, infantry protection should be provided. Dominating observation is necessary for proper artillery support, and the infantry must assist in obtaining it. In several instances artillery observation had to be secured first before the

infantry could advance to its objective. Delay in obtaining the necessary artillery observation will cause delay in taking an objective.

(11) Range estimation and terrain appreciation with respect to gunnery proved to be especially important. The terrain encountered in the Tunisian Campaign made range estimation particularly difficult. "In this country," declared one battalion commander, "8,000 yards often looks like 4,000. . . . We had some large initial errors in opening fire because of this. . . ."

(12) There are no substitutes for thorough standing gun drill and service practice in preparing artillery units for combat. It is only through experience in actual conduct of fire that officers can master the application of basic gunnery principles to the situations that will be encountered in battle.

(13) The use of smoke shell, especially white phosphorus, proved effective. It was used to assist the infantry in locating itself on the ground, to blind enemy OP's, and for identifying the fire of individual units when several were firing into the same area. White phosphorus was found to be effective against tanks, and when mixed with HE, it was very useful against personnel.

## SECTION IV--ARMORED FORCE UNITS

### 20. General.

a. The outstanding general lesson of the campaign was failure to use the armored division in sufficient strength or in concentrated mass. The one armored division that participated was not employed as a unit until the last phases of the battles for MATEUR and BIZERTE. Previous to these actions, the armor "arrived piecemeal and was used piecemeal throughout." As stated by the commander of one of the combat commands, "offensive action by American (armored) troops was marked by a dispersal of effort." Mass action was in fact precluded by the necessity of spreading the armored division over a wide front because it was the only force available with sufficient mobility and power to meet sudden thrusts over a long and thinly held line. The above mentioned employment, though justified by necessity, should be recognized as contrary to established doctrine. The principle of mass action with armor, employed in depth on a narrow front and directed against weak segments of the hostile line, should be the guiding formula in major offensive armored

action. Dispersal of strength or piecemeal employment should be avoided.

*b.* Two outstanding weaknesses were reported by the division commander in his summary of campaign experience:

(1) The necessity for more thorough and complete training of the individual soldier and small unit, including not only the elementary battle training of the soldier in basic subjects, but also speed and accuracy in the use of crew weapons and all weapons of combat vehicles. The leadership and responsibility of squad and platoon leaders, and the proficiency of these units needed more development.

(2) The necessity of inculcating a disciplined fighting spirit into all grades. Men must be trained to realize and accept with willingness the fact that a price, including the highest personal sacrifice, must be paid for success in battle. This aggressive spirit was lacking in the earlier stages of the campaign, and was developed only after combat experience. "We must," declared the division commander in his comments on this point, "build up the dignity, resourcefulness, and responsibility of the non-commissioned

officer and junior officer in preparation for his duties on the battlefield."

*c.* In general, the fundamental principles of employment of the armored division as taught by the Armored Force School have been proved entirely sound. A weakness lies in the fact that during the stress of battle, especially with green and untried troops, elementary teaching is forgotten or overlooked in a great many instances, with the result that there is unnecessary loss of life and equipment, and at times the tide of battle may be turned with disastrous results.

*d.* The exaggerated reputation of the German Panzer Forces which gained wide circulation after the campaigns in the Lowlands and France has been effectively dissolved. This fact is aptly stated in the report of an American armored force commander:

"The German is skillful, ruthless, and a master of deception. He can be beaten. American soldiers have seen him in retreat. The myth of the invincibility of the German army and its equipment has been exploded. It has been exploded by skillfully led, skillfully fought, and determined troops. The German army can be overcome by no other means."

e. Another lesson from the campaign stems from the inaccurate picture of speed and aggressiveness that had been common in the United States with regard to armored action. Units must not charge blindly into action with the reckless audacity associated with the overworked phrase of "blitzkrieg." On the contrary, they must work forward steadily, skillfully, and with determination, utilizing every means of reconnaissance and covering fire that are at the disposal of the command.

f. Armored units must be recognized and employed as instruments of great opportunity. When they are assigned to assist infantry divisions, they should be placed directly under the control of the Division Commander to whose unit they are attached. The tank commander must be fully consulted and the capabilities and limitations of his tanks must be understood and fitted into the coordinated plan of action. As stated by an armored force commander:

. . . The key terrain feature in the American sector during the final phase in Tunisia was captured by adherence to this principle . . .

g. Campaign experience shows that the standard of battlefield recovery of armored

vehicles in American units must be improved. Plans for recovery should be based not on lines and zones between rear elements but on the type of recovery and maintenance which forward elements are capable of performing in a given period of time. Time, and not distance, should be the governing factor which determines the responsibility for recovery and maintenance between the combat unit and the service unit in the rear.

#### **21. Armored forces in the offensive.**

a. Offensive action is the keystone of all armored force operations. Even in defensive situations, the primary role of armor is that of counterattack.

b. Mass action and concentration of determined effort are the two essential elements in successful offensive action. The coordination of all supporting and cooperating troop elements must be achieved in order to give the armor its full advantage. The hostile front must be skillfully reconnoitered, probed by reconnaissance in force when necessary, and the weak and strong points in the enemy's defenses accurately determined. The mass of armor, assisted by massed artillery fire, closely followed by cooperating infantry to hold the

gains, must be hurled against the known weak segment of the enemy line, and the penetration exploited to the fullest extent. Leading elements must be prepared to take initial losses in order that the following mass may push through and achieve success.

c. Attack formation in depth is of vital importance to offensive armored action. The rear elements must be able to push through the leading units, in order to exploit the latter's gains and carry the blow forward. The attack should be launched on a narrow front, which will give added strength to the depth of formation, and deny the enemy opportunity to bring more than part of his weapons to bear in defense. The habit of attacking all along the line must be avoided.

d. The concentration of artillery fire is a prerequisite to success. One battalion of tanks forming the leading element of an assault should have all three battalions of artillery in support. One artillery battalion should smoke areas adjacent to the objective to nullify hostile flanking fire. The remaining two battalions should deliver heavy concentrations on the objective. The armor can run in close to the supporting artillery fire without probability of material damage. The

concentrated artillery fire, including air-burst HE, will serve to neutralize antitank guns in the way of the advance.

e. Specific missions for the armored elements, proper timing, thorough preparation, and complete understanding of the operation by all elements down to and including each tank commander, are essential to success. Earlier experience showed the need of these principles properly applied, as stated by one armored division commander:

... We have been inclined to move too fast; to attack at a given hour or on a given day without being ready; without the knowledge of the plan being understood down to the lowest elements; without the availability of ammunition and supplies necessary to sustain the effort; and without the command concentrated so that all elements can move into their attack missions on time . . .

It is better to delay an attack until later in the day or even until a later date and have the attack thoroughly prepared and understood, rather than to be faced with the necessity of stopping the attack in order to provide enough impetus in troops and supplies to continue to success . . .

In similar tone, the commander of an armored regiment commented on the same point in his report:

. . . Tank operations must be conducted on a perfected plan to be successful. It is better to delay the attack than to rush in to reach a certain objective by a certain time, without sufficient orders to subordinates or sufficient reconnaissance. Enough time should be granted to make certain that every subordinate commander knows and understands the plan, the mission, adjacent troops, and the rally points. One of the most successful attacks ever made by an organization of this regiment was at HILL 609. It achieved its high degree of success because all commanders concerned appreciated the fact that the *German* and not *time*, was the enemy . . .

f. The assembly area for an armored attack must provide concealment from hostile ground observation. Where terrain makes this impossible, the delay in the assembly area must be brief.

g. The command post must be well forward in attack. When ordered to move, it must displace quickly, and the decision to

displace must be made sufficiently early to prevent confusion during the movement. All units must be informed as to the probable location if a displacement is contemplated. An axis is not sufficient for the command posts of elements that are engaged.

## 22. Armored forces in the defensive.

a. Armored forces are not designed or organized for static defense. Their primary purpose and tactical principle is offensive action. Armored units defend by counter-attacking at the right time and the right place to disrupt and disorganize hostile attack.

b. General defensive principles applicable to armor as well as to other arms have been thus summarized in an armored regimental commander's report of battle experience:

. . . Armored units must learn to apply the principle of being strong at the right spot and of avoiding attempts at holding everywhere at the same time. It is better to give ground in order to attack and defeat the enemy in detail, than to disperse strength by trying to watch every place that the enemy might slip through. The armored division has great possibilities

as a mobile reserve for rapid dispatch to a threatened spot to crush hostile attack by strong counterattack . . .

c. Appreciation of terrain is of special importance in defensive action. Ground which is valuable for offense may become worthless for defense. Commanders should not hesitate to abandon unsuitable ground when the mission changes from offense to defense.

d. The necessity for clarity in instructions, especially for defensive missions, was thus reported by an armored regimental commander:

. . . A mission "you will prevent the debauchment of the enemy through such and such a place" is incomplete in that there is no limiting time factor. If the defender knows that he is to "hold at all costs," his plan will be different from that which contemplates holding until reinforced, or until some other action is ordered . . .

### 23. Armored forces in retrograde movements.

a. In retrograde movements, armored forces should be employed on the flanks to counterattack the hostile pursuit. In cooperation

with the tank destroyer elements, part of the armor should be established in carefully chosen ground in hull-down position to check the advance of enemy tanks with defensive fire.

b. Tanks should never be kept in the battle zone when not being actively employed, especially during lulls or quiet periods. The armor must withdraw from combat at or prior to darkness, and be taken well back to refit and rearm. Unnecessary holding of tanks for several days in the front line materially reduces their effective fighting strength through lack of maintenance.

c. When armored forces are held for counterattack purposes, they must be far enough back to permit freedom of choice of action, even at the expense of loss of terrain. The tanks must be kept concealed, and their movement must be as secret as possible. To do otherwise will permit the enemy to count our strength and match it, thus making our counterattack ineffective.

d. Armored artillery is superior to towed artillery in retrograde movements. Its armor permits it to remain longer in forward areas to cover the withdrawal of foot elements. It can protect itself reasonably well against in-

filtration during daylight, and it can in emergency provide protection against hostile armored attack.

#### 24. Armored infantry units.

*a.* The primary mission of the armored infantry is to assist, cooperate with, and fight in coordination with the armored elements of the division. When occasion requires, armored infantry fights as ordinary infantry, and many of the lessons and experiences given in Section II above, are applicable to the infantry of the armored division. Such subjects as fire and movement, scouting and patrolling, observation, preparation for counter-attack, consolidation of captured ground, depth in offense and defense, apply to all infantry, whether armored or not.

*b.* The outstanding lesson with regard to armored infantry is the prime necessity of following up the advantage or gains achieved by the tanks. Reports have shown that on a number of occasions the supporting infantry did not follow up and consolidate the ground initially taken by the assaulting tanks.

Armored vehicles cannot hold ground indefinitely after they have made their penetration or have gained a position. If the

armored infantry do not follow quickly and occupy the ground gained by the armor, the tanks will eventually be forced to withdraw, and the potentially successful operation becomes unsuccessful. The comments of the commander of one of the armored combat commands in his report indicate that this situation prevailed in four major actions—"at TEBOURBA in December, OUSSELTIA in February, KASSERINE in March, and at MAKNASSY in April."

*c.* The tactical situation in each case must determine the exact manner of employment of armored infantry. Whether it will precede the tanks and prepare the way for their thrust, whether it will follow in the wake of the armor and exploit and consolidate the gains, or whether a combination of both will be used—all depend on the nature of the objective, the terrain, and the situation in general.

*d.* One function important in the action of armored infantry is the stalking and silencing of antitank weapons, locating them and relaying their positions to the artillery, and in general, serving as a means of eliminating this threat to the advancing armor. "Experience has proven," wrote the commander of one

of the combat commands, "at least in the Tunisian Campaign, that the antitank gun is to be avoided (by advancing tanks) as much as possible, and attacked only as a last resort." The skillful use of determined infantry, supported by artillery, to locate and attack these guns will make for success of the armored elements.

#### 25. Armored field artillery units.

a. Armored field artillery is generally capable of being employed in a manner similar to that of ordinary artillery, and the lessons and experience relating to division field artillery in section III also apply to the artillery of an armored division. In addition, armored field artillery possesses the characteristics of mobility and maneuverability in somewhat higher degree than in the case of ordinary towed artillery. It must be aggressively used at all times in offense, and because of its armored, self-propelled carriages, it can be placed well forward in support. The location and disposition of enemy installations govern how far forward armored artillery should be placed. It should be out of range of heavy machine gun fire and light mortar fire, and it should seek position defiladed from

flat-trajectory antitank weapons. Its positions should afford a reasonably well defiladed approach for ammunition vehicles which are not armored.

b. In defensive situations, armored artillery has been found to possess certain advantages over towed artillery, and also disadvantages not present in the latter. Because of its armor it can remain longer in forward areas and cover the withdrawal of other troops, and can be used to protect withdrawing forces against hostile armor in emergency. It also has advantage of quick and effective displacement, and thus can be rapidly shifted from sector to sector when the need arises. The high silhouette and the time required to dig in properly render the self-propelled armored artillery incapable of ready and rapid concealment and camouflage, especially in defensive operations.

c. The following miscellaneous points in tactics and training, taken from the reports of armored field artillery battalion commanders, are included in addition to the material contained in Section III, above:

(1) The fire direction center of an armored field artillery battalion should be

located near the battery positions, and consist of the half-tracks of the S-3, Assistant S-3, Commanding Officer or Executive, and Communications Officer only. The remainder of the headquarters battery should be established well to the rear, from two to four miles from the battery positions.

(2) Batteries should be habitually employed as a battalion, and not as separate batteries.

(3) More thorough and constant reconnaissance should be made by battery personnel for:

- (a) Alternate gun positions
- (b) Avenues of displacement, forward and rear
- (c) Antitank positions
- (d) Rallying or assembly areas for personnel or equipment in the event that sections must be employed individually either in an attack or in a defensive action.

(4) Security observation posts should be established near each battery position. These should be selected so that they can be used for the conduct of fire if necessary.

(5) Firing data should be computed for all avenues of approach to the position immediately after it is occupied.

(6) Dispersion within the battery position cannot be too much stressed. The battery front should approach 250 yards.

(7) Armored artillery is essentially support artillery. It should be employed for direct fire only in case its own positions are attacked.

(8) Each member of the gun crew should be trained in the duties of all other members, from the chief of section to the ammunition handler. All members of the crew must be able to drive.

(9) More attention must be given to the placing and employment of all weapons for close-in defense.

(10) In training, tanks should be used against the field artillery batteries in order that gun crews can obtain experience in observing the movement and approach of tanks, and in direct laying on them.

#### **26. Armored reconnaissance units.**

a. Although the material included in this section is treated in the section covering arm-

ored units, a majority of its lessons and experience apply to the reconnaissance troops of all large units, and to reconnaissance organizations in general. The experience included in the following paragraphs is taken from the report of the armored reconnaissance battalion of the division which participated in the campaign.

b. The action of reconnaissance units must be bold, vigorous, aggressive, and continuous. Reconnaissance troops must be prepared to accept losses in order to obtain information. Boldness must not be construed as recklessness; judgment must be applied to each situation, always with the accomplishment of the mission foremost.

c. The basic principles of action by reconnaissance troops have been proven sound by combat experience. Failure to apply them properly has been the chief cause of unsuccessful operations. The following causes have been given in most cases as those responsible for unsuccessful execution of reconnaissance missions:

(1) The issuance of orders that are not unmistakably clear and concise. This is ap-

plicable to all echelons, including the subordinate units of the reconnaissance battalion.

(2) Misinterpretation of orders.

(3) The presence of terrain obstacles unknown at the time the mission was assigned. Resourcefulness of the reconnaissance leader can often overcome this difficulty. When this is not possible, the fact must be immediately reported to higher authority in order that plans in progress are not upset by failure to execute the given mission.

(4) Lack of determination and aggressiveness in carrying out the mission.

(5) Allowing secondary matters to distract the main effort from the mission.

(6) Allowing initial or light opposition to prevent the full execution of the mission. Light opposition must be ruthlessly overcome, and the mission accomplished even if losses occur.

d. Experience of the reporting reconnaissance battalion has shown that map reading is one of the most vital training needs of both officers and men. As basic and elementary as the subject is, however it is reported that gross errors have been made in locations—in one case individuals on a reconnaissance mis-

sion located themselves as much as 4 miles from their actual position. Similar experience has been reported with respect to the use of the compass. Patrol elements have failed to reach objectives because of their inability to take and follow proper bearings, and have become lost at night as a result.

c. The following miscellaneous points have been emphasized in the reconnaissance battalion commander's report:

(1) In reconnaissance operations of any appreciable size, a reserve must be held out.

(2) In night reconnaissance, the use of vehicles in forward areas must be avoided. A vehicular crew is both deaf and blind against hostile dismounted patrols, which can easily dispose of vehicles.

(3) Radio security in reconnaissance patrol operations must be improved.

(4) Information from reconnaissance units must be disseminated to lower units without delay. It is of utmost importance that intelligence data reach the front line units so that it can be acted on at once.

(5) Reconnaissance reports must be frequent, accurate, and ice-clear. Hourly re-

ports should be rendered even if there is nothing new to report. Negative information is often as valuable as positive. Reporting agencies must not include interpretation of what they have seen. The simple formula of *what, where, and when*, without embellishment must be the rule.

(6) An armored reconnaissance battalion commander recommends that a form of SOP be incorporated into the training of all officers and platoon NCO's, something like the general orders for interior guard, and that all concerned know this SOP thoroughly. To illustrate this point he gives the following example:

... A platoon halts. The commander immediately applies this SOP, such as the following:

(a) Know where I am on ground and map.

(b) Provide for full security.

(c) Dig in if we are to remain for any length of time.

(d) My men know the mission and the situation.

(e) My plans in case of attack are as follows.

(f) Etc., etc.

## SECTION V—TANK DESTROYER UNITS

27. Experience in the Tunisian Campaign reveals that some of the fundamental principles prescribed in training literature have been misinterpreted. The main lesson from the campaign resulted from misconception of the idea of "offensive action." Destroyers must not be used to "hunt tanks." Neither can they be used as tanks in a fire fight with tanks without disastrous losses.

28. The campaign has demonstrated that the maneuver of tank destroyers largely depends on the existence of concealed routes of approach, and on the degree of enemy observation from both observation posts and direct firing antitank guns. The concept of "seek, strike, and destroy" must be modified to meet existing conditions and the capabilities and limitations of the destroyers as applied to the situation and mission. This idea of aggressive action must also be applied to units and not to single vehicles or small groups of vehicles. As stated by the commander of the destroyer group which participated in the campaign, "an *individual* destroyer has not the means to accomplish vigorous reconnaissance to locate hostile

tanks." Likewise experience has shown that tank destroyers, unless in coordination with other arms, can seldom strike at vital objectives. The best method of employment in the campaign was found to be that of establishing a base of fire and giving close direct support to other antitank elements from hull-down positions. Destroyers must not chase tanks. They should reconnoiter for the approach of enemy tank formations and be prepared to meet them with defensive fire from selected hull-down positions. Every effort must be made to establish tank traps into which the hostile tanks may be drawn and destroyed.

29. Attached tank destroyers should not be employed in the role of static antitank guns. Occupying hull-down positions for defensive fire does not imply restriction of movement to avoid artillery fire, to occupy alternate, supplementary, or cover positions, or on change of location when advantage may be gained.

30. Destroyers must be used in numbers. The tendency of some commanders of larger units to which TD battalions have been attached in attaching companies, platoons, or

even sections to small task forces should be discouraged. The battalion is the most effective unit in action. Piecemeal employment is to be avoided the same as in armored forces.

31. Campaign experience has shown that tank destroyer units in addition to their primary role, can be profitably employed on special missions when it is known that there is no threat from enemy armor. These operations included such missions as reconnaissance in force, advance guard for special combat forces, artillery support, and mine and booby trap removal. All these missions were performed successfully, and indicate the versatile possibilities of the organizations in addition to their primary mission. It must be emphasized that these special operations were undertaken only at times when there was known to be no impending threat from hostile armor.

32. Fighting in Tunisia has clearly indicated the necessity of sound training in mine warfare and booby trap clearing for tank destroyer units. Destroyers must often operate in areas that have been mined and booby trapped, and must frequently carry out operations without assistance from engineers. In

establishing tank traps, destroyer units must be capable of using mines offensively.

33. Effective camouflage, concealment, and the use of cover are vital to successful destroyer operations. Combinations of such measures as coloring vehicles with soil, mud, paint and other media; nets and other artificial methods; and the use of brush, debris, and foliage have all been successfully used in the recent campaign. The use of draws, swales, hillocks, natural folds, haystacks, and even buildings for concealment and cover has been found highly effective in the terrain encountered.

34. The reporting commanders have stressed reconnaissance as a never-ending function of tank destroyer units. Reconnaissance for ready, fire, alternate, supplementary, and rally positions must be made before an action. Alternate plans of action also require reconnaissance before such plans can be completed. Commanders, at least down to platoon leaders, should reconnoiter the ground into which they are to operate. Tank destroyer units should not be given missions properly belonging to the reconnaissance troops or battalions of divisions and corps. Their

reconnaissance functions should be limited to their own operations.

#### SECTION VI.—MINE WARFARE AND BOOBY TRAPS

35. Experience in the Tunisian Campaign showed that mine warfare has assumed far greater tactical importance than had been previously realized or anticipated. As developed in the present war, the land mine and the various types of booby traps have proved to be a most formidable and powerful weapon and serious obstacle in the advance and operations of all arms. Much has been learned from the recent campaign, and this experience should be utilized to every advantage in future operations, especially in those conducted by troops who have not yet entered action.

36. The most outstanding lesson derived from the campaign has been the realization and understanding that detecting, disarming, and clearing mines and booby traps is no longer a special or exclusive function of the engineers. Although these operations are primary functions of engineer troops and have expanded with the current developments in the war, it has been learned by experience

that troops of all arms must be proficient in mine warfare. In many instances infantry, artillery, and other organizations must take care of the mine problem in their own areas, since it often becomes impossible for engineer troops to cover every area where mines have been laid.

37. Exposure to mines and booby traps in the numbers encountered in the recent campaign necessitates the distribution of mine detectors to all arms. The general experience of the infantry divisions has led to their recommendation for the allotment of one to two detectors per company, battery, or troop. Each unit of this size must have from its own personnel a squad or section fully capable of using the detector and clearing mines. Detecting and clearing, as well as minelaying, is of special importance to the reconnaissance units of divisions and corps.

38. In forward areas where exposure to mines may be expected, all vehicles of lesser weight than the standard 2½-ton truck should be sandbagged. Experience has shown that sandbags, while they do not prevent damage to vehicles, have often saved the lives of personnel.

39. The dissemination of information concerning mines, minefields, and booby-trapped areas is of utmost importance to the safety of a command. It is the duty of all headquarters to see that information of this nature reaches all echelons without delay. As stated by one division commander,

. . . A great many casualties suffered by this Division through loss of personnel and matériel by mines could have been avoided had this information been furnished everyone concerned . . .

40. Common German practice is to mine the shoulders of roads, and seemingly unused roads, tracks, or trails. Mines are also sown freely throughout country suitable for mechanized approach. Rough terrain not traversed by paths or trails has generally been found relatively free from mines. Road craters, blown culverts and the approaches to by-passes around blown bridges are generally heavily mined. The enemy has also created effective delaying barriers by mining soft and sandy fords and by strewing them with metal fragments to render detectors ineffective. The sporadic mining of long stretches of road has been found to be another German method of delaying advance.

41. The instruction and training principles developed to combat mine warfare have proved highly effective and sound. The mine clearing drill developed in the Libyan Campaign and further developed to meet the requirements of all types of terrain has proved entirely satisfactory. Mastery of the mine clearing drill, understanding of all types and combinations of mines, and confidence on the part of personnel will serve to neutralize the casualty effect of mine warfare. Nothing effective as yet has been fully developed to remove the delaying effect. The majority of casualties from clearing operations have been the result of violations of clearing drill teachings, such as unnecessary movement in suspicious areas, congregating in groups during removal operations, improper detector swinging, and lack of proper or orderly procedure in clearing projects.

42. The commander of the armored division participating in the campaign has frankly stated that

. . . The antitank mine is one of the greatest menaces to the operations of the armored division. The antitank mine has no present antidote except the

slow process of picking up the mines by the use of detectors, or charging through the minefields at great loss of tanks. . .

43. Mine warfare in its offensive phase has been as important as defensive measures. The minefield has become a powerful secondary weapon, and its use must be thoroughly understood. The following points have been emphasized in the reports of combat experience:

*a.* Standardization of minefield markings, routes, and reports is absolutely essential. It has been reported that at times our own minefields have proved to be "more disastrous than those of the enemy." Troops of all arms must be able to recognize standard markings, and must maintain strict compliance with minefield reports, sketches, routes, etc. A standard method should be prescribed and taught before troops arrive in the battle zone.

*b.* The technique of laying minefields needs improvement, especially in night operations. Coordination must be obtained between the organization selecting the sites and those responsible for guarding and protecting them.

The selection of a site for a minefield is of vital importance, because once laid, the field fixes the location of supporting weapons. Ground reconnaissance by capable representatives of each arm is essential. Once the field is laid, it will determine to a large degree the future movements of all units in the area.

*c.* Minefields require constant attendance of guards to pass traffic through gaps and to keep livestock from entering and detonating the mines. The field must also be adequately protected against hostile clearing or rushing with armored vehicles. Infantry protection is necessary to prevent breaching by hostile clearing parties. In daylight the field can be kept under observation and under machine gun and artillery fire. At night listening posts should be established to detect the approach of clearing parties. Sentinels in listening posts should be equipped with flares.

#### SECTION VII—DEFENSE AGAINST AIR ATTACK

44. In the Tunisian Campaign units of all arms were subjected to air attack under various conditions. The experience of different units and arms varied considerably. In one

division, 95% of all air attacks were sustained by the artillery. Certain lessons have been learned and certain principles of defense have received general concurrence by participating units.

45. For positions, bivouacs, and assembly areas, the following measures have been proven effective against all types of air attack:

a. The use of every available means of concealment and natural cover.

b. Effective camouflage measures, including the use of all natural and artificial means. In artillery units, the air observation aircraft has proved invaluable for checking camouflage and discovering defects.

c. Enforcement of the most rigid camouflage discipline. It is not enough that a man observe proper discipline himself. He must also take action to prevent others from committing violations, since the safety of the command is at stake.

d. Proper dispersion of vehicles, weapons, and installations.

e. Proper digging in of personnel and matériel whenever a position or area is to be occupied for any length of time. Properly

dug slit trenches have given adequate protection against the worst bombing. In artillery positions, the slit trenches should be contiguous to the gun pits.

f. Placing of all organic weapons suitable for antiaircraft firing, and the attached antiaircraft weapons and personnel, in suitable position to defend the area. The training of men to fire on hostile aircraft only when:

(1) The aircraft attack

(2) The attacking aircraft are within range.

Fire on aircraft which have not attacked merely invites attack, and gives away the position or area and its extent. This is especially true of hostile reconnaissance planes, which, when fired on, can ascertain the location and extent of the position and area and later return with bombing formations.

g. Manning of antiaircraft weapons at all times, and posting of qualified air sentries in carefully selected positions.

h. If the situation does not require otherwise, artillery should remain silent when hostile aircraft are overhead.

i. Positive identification of aircraft is essential before fire is opened. The best identi-

fication under such circumstances is attack by the aircraft. In the campaign, identification was unsatisfactory, and in many instances friendly planes were fired on and hostile aircraft were allowed to pass within range unmolested.

46. Road movements, convoy, and marches have been subject to all types of air attack. The following defensive measures have been found effective for protection and for minimizing losses:

*a.* Dispersion in column is the most vital single principle. The maintenance of proper distance between vehicles is essential. A distance of 150-250 yards, depending on the terrain should be the minimum. Violation of distance regulations invites disaster.

*b.* An air lookout must be posted on each vehicle. Each air guard must be in position to observe in a 360° direction. If this is not possible on some vehicles, a front and rear lookout should be posted. Lookouts should be relieved at frequent intervals, to prevent men from becoming inadvertently lax.

*c.* When a column is attacked, normally it should halt, spread to both sides of the road, and all mounted weapons should remain

manned and fire. All other personnel should dismount, take cover, and fire every weapon that can be brought to bear on the aircraft.

*d.* A column moving through country subject to air attack should have all radios on the command channel, with operators listening. A warning can be thus spread from one end of the column to the other from any point which may be attacked.

*e.* When in march column and air attack is likely, the fire extinguishers should be loose from their brackets, and ready to be taken by the assistant driver or occupant of the cab if the vehicle is evacuated. One man should be definitely responsible for this function. Often an attack is over very quickly, and if the extinguisher is taken when the vehicle is evacuated, measures can be taken at once to put out a fire. Otherwise the extinguisher may become enveloped in flames, and the chance of saving the vehicle is lost.

*f.* Spare gasoline cans should not be carried in vehicles dispersed throughout the column during daylight marches, unless the existing situation makes such procedure imperative. Many vehicles have been lost through spare gasoline cans being hit by in-

condiary bullets from strafing planes. If the spare cans are carried in one truck at the end of the column, this one vehicle may be lost, but there is far better chance of others not taking fire.

47. The .50 caliber machine gun has proved to be the most effective antiaircraft weapon in most situations. It should be properly dispersed throughout march columns and carefully placed in troop positions and occupied areas. Attached antiaircraft units have been best employed by breaking them up into platoons and assigning them to organizations, especially to the artillery, which is most subject to air attack.

48. Air attack has been generally ineffective against armored vehicles. It has been reported that even dive bombing has failed to cause much damage to medium tanks. Tanks when attacked in this manner should continue to move, zig-zag fashion. Deployed tanks can furnish their own air protection in the armored division. Proper antiaircraft weapons must be provided for headquarters and service personnel.

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Maj. Gen. Omar N. Bradley's Notes on 1st Armored Division Operations

HEADQUARTERS FIFTH ARMY  
A. P. O. #464, U. S. Army

AG 370-Y

SUBJECT: Notes on Operations of 1st Armored Division.

TC: See Distribution.

The attached notes of Major General Omar N. Bradley, made on his visit to 1st Armored Division on 1 March 1943, are published for the information of all concerned.

By command of Lieutenant General CLARK:



CHAS. L. BERTHOLD,  
Colonel, A. G. D.,  
Adjutant General.

1 Incl.

Incl. #1 - Notes of Major General Bradley on visit to 1st Armored Division.

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Recap of pertinent issues from interviews with personnel of the 1st Armored Division, March 1, 1943.

1. The need for a new telescopic, focusable sight is pressing. This new sight must provide 4-6 telescopic power, a larger reticule and some form of illumination.
2. Air-ground support has not yet approached the satisfactory stage. Air support must be made more available to ground combat units to enable them to exploit air-mission targets of opportunity.
3. Some pyrotechnic form of signal identification is necessary to prevent friendly aircraft from destroying our own tanks. Present markings must be retained to permit such restricted ground identification as now exists.
4. Gasoline-powered tanks are regarded by their crews as fire-traps. The men greatly prefer the less inflammable Diesel powered tank.
5. Tank officers point to the need for a range quadrant which would permit them to fire HE from their heavy guns at wide ranges.
6. The frequency of penetration by enemy shell-fire on the turret of the M-4 tank indicates that the recess of indentation formed thereon for the fitting of appliances has dangerously weakened the vehicles defensive armor in a critical area.
7. Our current system of aircraft identification is variously regarded as useless and worthless. Armored units fire on aircraft only when attacked for fear of exposing themselves to reprisal dive-bomber attack.

Maj. Gen. Orlando WARD, Commanding General, 1st Armored Division. Digest of remarks from conference of March 1, 1943:

"It is criminal of our High Command to order attacks at daylight without considering how the early morning sunlight may affect our gunnery. The problem of sun in our eyes must certainly be evaluated since it gives an unalterable advantage of the enemy.

"The Germans have shown us that airplanes are a part of the battle and they have proved to us that aircraft must be as integrated as our tanks. They frequently use them, not only for support in ground operations, but even to divert our attention during actual enemy tank maneuvers. We must be able to call for air support missions on necessity and obtain them promptly and precisely.

"In this country, tanks move slowly. If we attempt to move with great speed we reveal our position. The Germans frequently move into position so slowly that it becomes necessary to line their vehicles up on some terrain feature to distinguish positively that they are actually moving at all.

"Here, like everywhere else, the lower echelons of command must be given time to prepare and rehearse their part in an operation. Higher headquarters frequently disregards this need, precluding the careful preparation needed by the combat elements themselves."

March 1, 1943.

Lt. Col. L. V. Hightower--Executive Officer, 1st Armored Reg., First Armored Division. (Commanding Officer, 3rd Bn., 1st A. R. during battles of Faid Pass and Sidi Bousid).

"In tank fighting nothing is more important than expert reconnaissance of your routes of advance and withdrawal. Several times both we and the Germans have moved up on what we thought was a good clear route only to find a dry wash nine or ten feet high blocking our way, causing us to withdraw. In this country, too, we've learned to move slowly so as not to reveal our position. You can't boil up to battle at high speed without broadcasting your coming in a big cloud of dust.

"German anti-tank gunnery has made our reconnaissance a particularly tough job. They drag their big 88mm guns up behind their tanks and drop them in position. Usually the crew digs the gun in a hole twelve by twelve by six feet deep, practically covering up the shield and exposing only the barrel of the gun. We've found these guns particularly hard to locate and they can break up your entire show if you don't pick them up in time. Apparently they use mats to hide the muzzle blast. Once we hunted a gun within a thousand yards for three days and then only found it by spotting the personnel approaching the gun position.

"Generally they try to suck you into an anti-tank gun trap. Their light tanks will bait you in by playing around just outside effective range. When you start after them, they turn tail and draw you in within range of their 88's. First they open up on you with their guns in depth. Then when you try to flank them you find yourself under fire of carefully concealed guns at a shorter range. We've just got to learn to pick those guns up before closing in on them.

"Air photo missions would certainly help us in this reconnaissance but we can't seem to get pictures that are less than a month old.

"We're still not getting anywhere on bomber air support. When we call for them we wait and seldom does anything happen. The Germans, however, get their air support within a few minutes after they call for it. Once we exposed our position to an enemy tank unit and within thirty minutes their bombers had plastered us and were on their way back for a second load.

"Our system of aircraft identification is absolutely worthless. It's a waste of time to include it in our training schedule. Practically everyone will confuse the Messerschmitt 109 with the Spitfire. Once I heard a man give a man hell for sounding the air raid signal when a couple of Spits passed over. Not until they peeled off for a strafing run did he realize they were Messerschmitts, not Spitfires. We've made it a practice of not firing on them until they come at us. Some men claim they can spot them by the sound of the motor, but that's a tricky and dangerous business for us. The German motor, however, generally has a rougher sound than the drone of the Allied ships.

"Although we've knocked down several enemy aircraft we find our men are having trouble with their leads. You've got to shoot planes or you would ducks. The big fault with our anti-aircraft fire is that about 75 percent of it does not have enough lead. Our boys can't seem to realize the speed of those ships. The 50 cal. guns, however, will keep 'em busy. Our pilots seem to despise the stuff.

"The basic training they had in the States means a lot more to our boys over here. Every time they hit the ground you'll find them digging a helluva big hole. I have yet to see one man get hit in a properly dug trench. One of my lads dug a shallow one and he came out with a bullet clear through the cheeks of his tail. You don't have to mention it to the pline to them. They'll hoop and holler at anyone who uses a light at night regardless of rank.

"We've also learned that it's important for everyone to know how to do with wounds, especially shock. Although I saw one man die of shock from a simple hand wound, I've also seen our men save almost five hundred men by prompt treatment of their wounds with sulpha drugs and proper treatment of shock. Most of the sulpha drugs are administered by the men themselves. Couple of weeks ago one of my sergeants fixed up a man who had been severely wounded on the head and neck when he was blown off a tank. Today the man is back in action.

"We must have a better sight for our guns - something with a four to six telescopic power and something focusable. The sight should have a larger reticule and it must be illuminated for night fighting. This is extremely important; it should be changed immediately.

"There is likewise an indentation on the turret of our M-4 tanks where the armor has been cut down to make room for fittings. It's not a coincidence that most of the penetrations have occurred at this point.

"The support artillery given us is only as good as their observer. Sometimes junior officers who lack proficiency are assigned as observers and the result is anything but satisfactory. Commanders must get in the habit of assigning their best men as artillery observers.

"Our 37's will knock out tanks if the crews will only camouflage their guns perfectly and then hold fire until the enemy comes in at point blank range. German camouflage is excellent; it's hard to believe they can hide a gun as well as they do. We can't use anything at 1000 yards and over except a 105 with an HE shell. The rifle grenade is a good weapon at close quarters and will knock out anything under a Mark III.

"When the Germans go into position they'll hide their guns and tanks in anything, including these Arab huts. Then they dress their personnel in Arab garb while going to and from their positions. Usually they'll try to suck you inside of a 1200 yard range. They frequently use machine guns to range themselves in and you can duck their shells by watching that machine gun fire. When they're moving they'll shoot at anything that looks suspicious and they'll generally knock down every Arab house in sight. We think that's a good idea and are beginning to follow suit. Sometimes they'll get the range with high burst smoke shells. But when we see three of those in a line, we take off. That's the high sign for the Stukas. When firing, we always shoot low--even the ricochets will hit him. Most of our misses have been high.

"We also need a good system for identifying friendly tanks. Once when my radio was knocked out I heard my own tanks turning their guns on me and I really sweated out that approach. At dusk it's always hard to tell which vehicles are friendly and we're always afraid to shoot until they're right on top of us. Several times I've seen American planes shooting up our own troops and I've had the P-39's give my own tanks hell. When the Stukas come over, the German tanks send up a line of rockets and orange smoke to show their positions. We need some similar signal system that we won't confuse with the Germans.

"One evening several Mark IV's followed a British tank column right up to their tank park until a 25 pounder battery spotted the strangers on the tail of the column and blew them off the road.

"You've probably heard a lot about the half-track, sir--and, while she isn't actually a bad vehicle, we're trying to use her for too many things and she's getting a very bad name over here."

March 1, 1943.

1st Lt. H. F. HILLENMEYER, Company Commander, Company H, 1st Armored Reg.,  
1st Armored Division. (Platoon leader, Company H during battles Faid Pass,  
Rebeu, Sidi Bousid).

"Sir, if we're going to get anywhere we must put greater emphasis on good reconnaissance. I know of one instance where we went into battle not knowing what was there. We saw the enemy tanks go into Faid Pass and that night we had a dry run back in our concentration area. Next day when the attack came off we found the thing was a blind--the pass was covered with deadly anti-tank stuff. It plastered our one company that went in.

"The Germans always seem to know what's there before they attack. They use the type of air-photo reconnaissance that we want badly but just can't seem to get. For several days before an attack we can see our watches by the JU-88 that comes over each morning and evening taking pictures. If we fire on him he'll hurry home and come back with a pack of Stukas.

"It's not for me to say, sir, but we need better and closer air-ground support. We can't get the stuff when it's needed and we're catching hell for it. By the time our request for air support goes through channels the target's gone or the Stukas have come instead.

"Once we found a beautiful target, a perfect set-up for a bomber mission. Fifty German tanks came out of hiding into a small knot--fifty of them crowded together. We called for a bomber mission, sat back and waited for it to stumble through channels. The planes came, alright, but they were Stukas--none of ours.

"Another time we spotted ten German tanks running into an olive grove as bait for an 88mm trap. Again we called for an air mission and again nothing came. We're just not getting the air support, sir, because our requests have to go through too many people. The Germans are getting it when they want the stuff and it's pretty hard for us to understand why we don't.

"Those 88's have been causing us trouble because it's hard for us to knock them out with our flat trajectory weapons. They're dug in too deeply and we need real artillery support with good observation to root them out.

"When you fire on the German tanks, they play a bag of tricks. First they stop, causing you to think you knocked them out. When you turn around on something else--wham, they open up on you. Their sight is better than ours--we're very desperately in need of at least a four power telescope sight. You can't make that any too urgent, sir.

"As a platoon leader, I learned that you've just got to lead your men. When you get out front, they'll follow you easily. If you're moving in sections--the platoon leader must go in the forward section. And what's almost as important is the fact that every man must know what's going on. You've got to take them into your confidence and explain the show to them. They'll always respond with better fighting.

"You've probably heard this, too, before, sir--but the smaller units are simply not given enough time to prepare their individual plan of attack or maneuver. Higher headquarters should realize that we need some time to get the show running.

"It would really be worth your time over in the states to shoot at your men at night with tracer bullets. The Germans use all tracers and sometimes they raise hell with the troops. Tracers throw a helluva scare into you anyhow; everyone locks as though it's headed straight for you. The Germans are crack-jacks at night fighting and if we're going to do any--our men need more training in it.

"In a scrap we throw our HE stuff until the enemy comes in range and then we change to armor piercing. Sometimes we set it for delay, fire low and watch the Germans duck wildly as it ricochets over the ground.

"I'm also concerned, sir, with another question of tactics, which is probably none of my business. We had always been taught that the Germans attacked at dawn or in the early morning light. Actually, however, they're even more apt to hit you at dusk with only half an hour of light left in the sky just to confuse you. Then they'll throw everything they have at you, including their star shells and Very lights in an attempt to put you to run.

"They've likewise made a good thing of our attack habits. They seem to know that we customarily use a two-one attack-support plan and they meet it with a double envelopment every time. I'm beginning to think that our attack-support plan just to get away from that standardized procedure that the Germans apparently know we like.

"Everyone will tell you, sir, that our emphasis on early communication is useless. It's simply no good. We don't fire our signals until they start firing. If we did, we would have the Stukas on our necks every time.

"It's extremely important that we keep our star markings, and it's likewise as important, that we develop pyrotechnic signals that are different from the Germans. Several times we were about to open our own tanks until we saw their markings.

"Our men tell us, sir, that the half track given them is a false sense of security--its plate won't stop anything but a 30 cal ball. It'll kill a soldier once if aircraft bullets went through the half track.

"No, sir," he replied, "they only come through one wall and they rattle around."

"One day an 88 shell knocked a piece of armored plate out of one of my tanks while the shell lodged in the tank wall."

"Shut the door," the driver screamed to the man in the turret. "there's tracers coming in down here."

Basken BENNETT, 25, Tank Commander, Company H, 1st Armored Reg., 1st Armored Division. Five years in regular army. Commands M-4 tank.

"These gasoline tanks aren't worth a damn--they catch fire too quickly. I've had two of them shot out from under me and I don't think it would have happened, sir, if I'd been in a Diesel. The plexi-glass slits on some of our tanks are dangerous for the driver. A buddy of mine had one blown into his face by the concussion of a near hit. We've all taken the glass off.

"I'm equipped with the old EE field glasses and they sure give us a hard time. We need better ones, sir--glasses with more telescopic power. And we could use a bigger powder charge on those shells to knock out the Mark IV's--they're tough babies.

"I almost lost my driver and assistant driver once when the tank caught fire as the turret was turned to the rear position. They were able to get out only when another man in my crew jumped back into the burning tank and turned the turret, allowing those two to get away.

"No sir, I have not used any smoke as yet although it might be OK against one of those big Mark VI's."

(Asked to give an account of his experience in the battle of Bad Pass, Sergeant Bennett continued:)

"We had started across the field, sir, when suddenly ten German tanks came up on our flank. They opened up on me and hit me three or four times before any came through. Meanwhile we were firing continuously.

"About that time two 77's went through the turret and I discovered my tank on fire. I called down to the driver and radio man but they must have been hit because they didn't answer. The tank was burning badly so I jumped out with the remainder of my crew. Our tank was burning very fast but it just kept going forward and we jumped into a ditch and watched it go.

"Soon we were surrounded by German tanks. We lay in the ditch for several hours until one of the German tanks started towards us. We thought he was going to run us down so we stood up with our hands over heads. A German officer in the tank spoke good English. He asked us where our arms were and we told him we didn't have any.

"He asked where our carrier was and we pointed to our tank which had travelled several hundred yards down the field before burning completely.

"The German officer then pointed towards our line and told us to go so we took off quickly.

"Altogether we fired about 20 shells. We hit two tanks and I think one was really knocked out because I saw it go up in flames."

March 1, 1943

Sgt. James H. BOISER, 23, Tank Commander, Company B, 1st Armored Regt., 1st Armored Division. Six years in regular Army. Commands M-4 tank.

"Yes sir, this is my third tank, but I've still got all of my original crew with me. We were burned out of our other two tanks under fire. If they were Diesels, it wouldn't have happened, but these gasoline jobs blaze up on the first or second hit and then you've got to get out. None of us like 'em, sir. We'd rather have the Diesels.

"Our ammunition supply has been good--we've always gotten the stuff we needed, although we had to quit our two tanks long before we used up our ammunition. Generally we open up with HE. A tank Commander's gotta remember he can knock the track off a Mark IV long before he can hit him with the AP stuff. The HE might be OK against the Mark VI's, but we always saw too many of them to give it much of a try.

"The Germans usually open up with their machine guns while they're ranging you in with their heavier stuff. The driver can tell when they're coming close so he keeps moving and ducks 'em. I hardly ever talk to my driver in battle--just let him keep drivin'. We always stopped to shoot, but we did turn the stabilizer on when we were moving. I guess the stabilizer's all right for what it was built for.

"The gunnery instruction they gave us in the states was good, sir, I wouldn't change it. There's just one thing you gotta remember when you're fighting Germans. When you shoot at 'em they stop and try to get into thinking you knocked them out. Then when you turn your back on 'em they open up again. Sir, we shoot until they stop and then keep shootin' until they burn up.

"Sometimes we've attacked with the sun in our eyes and that makes pretty tough on the gunner. He can't see where he's shooting while the Germans sit back there and pop any where they want to.

"I think, sir, that if you trained a battalion of infantry to operate at night, they could slip into a German tank park and really rattle 'em. One night after we were burned out of our tank during action, we made our way to within thirty yards of a parked tank thinking it was an Arab tank. They don't seem to worry about security at night.

"With the exception of the gasoline motor our tanks look pretty good to me now. They might, however, put another hole in the basket so that ammunition could be handed to the gunner when the gun is in a rear position.

"It's a good idea, too, to check your ammunition closely. Once we had to climb out of the tank during an action to ram a shell case out of our gun and then hurry back in before the machine guns got me.

(Asked to give an account of his experience in the battle of RAMM, Sergeant BOISER continued:)

"I'm on the right of my platoon leader and he's in the center. I've got another tank on my right. We start in at daylight, move down the pass between the mountain and marsh and pretty soon, at nine o'clock, we run into the Germans. They started in with their machine guns, but we just let it rattle by, and then they opened up with their heavy stuff. I looked to the center and saw the lieutenant's tank go up in fire. So I turned my gun on the AT gun that knocked him out and smashed it with my first shot of HE. We knew then it was really hot; nine of our tanks had been cleaned out. They knocked my track off, but I said, "Hell, we'll sit here and use her as a pill box."

"Then one of my boys said our tank was burning. I didn't know how long it had been on fire. It was a gas powered tank and they go up like flares. A diesel wouldn't have done that. Still the fire didn't look too bad, so we stuck by our guns and kept shooting until an explosion almost rocked us out of the tank. One of my crew was wounded, but the others were all right, so we took off toward our own lines. We walked for two hours and carried the wounded man with us. Several times along the way German planes strafed us."

March 1, 1943.

Question was about the use of tanks in action. Colonel Hightower:

"Take it very slowly, Germans do it that way all the time. Don't shift gears once you start, particularly in the dusk, because they will give you away. Keep the tank out of column at all times. Never in column, travel in V, wedge, line, but never in column. Stay off the roads and never use them. You don't need assembly areas. You can go right into it without the area. Get your tank destroyers well forward, infantry ahead and go."

"It is according to the situation whether the infantry goes ahead of the tanks. If it is a defense position that has had a chance to be taken positively and definitely, I would most certainly have the tanks ahead of the tanks. I would have them follow the tanks on foot, but I would have the infantry right there. Once these SS's start to back, you can't get in your tank. Attack them with infantry. Get the infantry on top of the tracks. Don't take any thin skinned vehicles with the tanks. Destroy them the first thing. Don't take your assault guns or mortars with the tanks, because they will smash them in open country."

"The 88, Mark III and Mark IV have terrific telescopic sights and can shoot accurately at twice our sight range. If you get in an open place, they range you and you have to back off and come in again in another place. The reverse speed is too slow. You practically have to creep back."

"We must have a better sight on our tank. The artillery commander got to be right with the assault company commander of the tank. The commander. I mean, say, not more than 35 or 40 yards away. That is SOP. I just mention it because it is so necessary."

"Teach your commanders to stay out of the fight until they are the last tank or thereabouts. They are too prone to become interested in a personal duel and forget about the control of their units.

"A reconnaissance of the field, if you are lucky enough to be able to make it, is the most important thing I can think of.

"Mediums don't get bogged down so easily. If you come to a bog, don't ever let them try to shift gears, shift before. We need a higher speed reverse.

"The Germans bring their 88's towed behind their tanks (may be 75's or both; I know they bring 88's). They tow them up and dig in. Their tanks come out and get your attention and, unless you know their tricks, they lead you right between their guns, get behind you and get you. Don't always bite at the first 88's which shoot at you. There will be several up much closer. The first 88 that barks and the first tank are generally bait and you shouldn't plunge at them. If they stage any night attack or late evening attack, and neither side stays there, they will come out and put their 88's in no-man's-land way ahead of where their tank positions are. Their tanks were within 1000 yards of the pass, but their guns were 4000 yards ahead of the pass.

"Four 88's, if dug in, are a match for any tank company. They are the most wonderful things to camouflage I have ever seen. They are very low to the ground. You can watch the fire coming in, little dust balls on the ground, give them away and shot how low they are. They just skip along the ground. The pit is 12 by 12 by 6. The gun looks like a pencil or black spot. The shield is level with the piece and all you can affectively see is the tube. The crew is even dressed in Arab clothes, and they do everything to camouflage position. You can get them out with HE with your artillery. If a tank gun can find them, you can get them out. Over 1200 yards there is no use in worrying about him. He will bounce off the medium tank at that range. Under 1200 yards, watch out. His gunnery stinks at long ranges. I feel that our men are better. If we can fight a tank for a tank and a gun, I think we can do it; that is giving them great odds, because I would say the gun is worth 4 tanks, but we can do it.

"In my opinion the 37mm is useless, unless you have gun crews with enough guts to stand and shoot from 100 yards. I think we are placing our faith in a false reed there.

"Gasoline driven tanks: Our losses were from burning gasoline; Shells seemed to end up in the gas tank, invariably. The projectile goes streaking through the whole tank dragging the gasoline out with it, and the first thing you know, the whole thing is a flame. It burns very fast. They hit my tank 6 times before they got the gas. An 88 shell went in right behind the left rear bogie and hit the gas tank. You can see the shells coming. You can watch the adjustments they are making. They all seem to be short and behind. Then they get up and begin to shoot under the tank. During this time,

knocked out four tanks. We picked off the leader. You can tell after a while which is the leader by the differences in the vehicles. They pick up such things as half-tracks with two antennas, etc., and are caught on after a while. When you got one of their commanders they stop and seem sort of dead. The 10 German tanks were sitting on a ridge shooting at half-tracks. They had been at my left rear and I hadn't seen them. There was a Mark VI, Mark IVs and some Mark IIIs. They stopped on the crest and did a right flank and started to get in column. They will put a Mark VI in the middle and the others on the flanks, always making one flank heavier than the other, however. We picked out one and hit him and he stopped. We burned the next one. Then the Mark VI, which I thought was a Mark IV, came close. They are hard to identify, but have a more or less square outline with an offset box on the side. You can not identify their guns. We bounced four off the front of him. Then another tank came up right along side of him, and it was easy to move a half to the left and pick him off. We had no AP, so I know a HE will crack a Mark IV. You should shoot low, and it will ricochet and kill them in the turret or damage them so they will be of no use.

"Our 105 is good against tanks. I watched one gun hit 3 tanks coming in a big mass of approximately 30, and with HE shell he collapsed 3 of them like taking shoe boxes and shoving them flat. The rest of them scattered and moved up to the right. We had to leave because more were moving up.

"Lights are excellent for reconnaissance and moving around the combat. Our M-4 Medium is the very best except for the gasoline problem. Wrapping tanks with asbestos or something; they should be heat insulated and possibly armored inside the tank itself. We didn't have any trouble with the ammunition being shot up; this rubber hazard is also false.

"The 50mm is almost the same as to amount of powder, as the 88. I think their anti-tank guns are mostly 88s and 75s. The only 50s I have seen are in Mark IIIs and Mark IV. Just go slow and watch them. Get your reconnaissance out in front; men on foot. If you rush right out there you will rush right into it. You want some artillery well forward. 105's shooting over 5000 yards aren't much value. I think they shouldn't ever be over 2000 yards in either direct or indirect fire.

"I worked against hostile infantry some. We got a few of them and they went in their fox holes. We shot at them and don't know whether or not we got a lot of them. They will stand there and use those 20mm cannons, but it doesn't bother you. I did run across a small German or Italian tank and found the tail end of a rifle grenade near it; the tank was burned and blasted to pieces.

"Anti-aircraft and Stukas--I advocate that the bombers should be at the direct command of the assault echelon commander. One time I saw German tanks in one group and they were hub to hub. I asked for air support. They couldn't miss it; it was a perfect spot and easy to identify. When air support came, it was a bunch of Stukas with 500 lb bombs. They don't hurt the tanks unless there is a direct hit, except for the dust.

have to move out of it. When the Stukas appear the Germans shoot green and white, or green and red flares, changing every day--they also shoot a blast of orange gas to identify themselves. Another thing, they mark a target with three smoke shells. After these 3 bursts you had better clear out, for they will be over in about one minute.

"They use a lot of high burst ranging. The artillery will shoot one, apparently getting the range from the map, and they will hit one overhead and then drop right down on you. It is easy to dodge an 88 because they start with machine gun bullets. When they begin hitting you, turn suddenly right or left to avoid it.

"They have hunters' headlights with their guns on their tanks. If they get this so-called heat shell for the 75 howitzer it makes it a regular tank gun. They shot at us with HE and AP.

"Bore sight to beat hell and don't let the boys try to get the axis of sight and tube coincide at 1000 yards, because when you are shooting at 6000 yards there is no telling where it will hit. Keep your sights parallel. Bore sight on a distant object; the more distant, the more effective. If each tank can have an artillery gunner's quadrant in it, you can do a lot of damage at long ranges. Use as artillery. We had one tank which threw a track which we couldn't possibly get started and we had a lot of ammunition. That commander stood there with his glasses and without a quadrant proceeded to throw a lot of HE and German tanks went in all directions. That quadrant is very worthwhile, and glasses - good glasses - are necessary.

"Before we put a single round of ammunition in their carrying racks we should try them in their guns. A lot of them won't fit and the battlefield is a bad time to find it out, although I know of two sergeants who climbed out under fire and ramed the shells out.

"At SBETLA it was the tanks that bothered us more than the anti-tank guns. There were just too many. With a detached air, we were just seeing how many of them we could get before they got us. The Germans will come up about 60 yards at a time, sitting there locking, then moving again. The Mark VI is the main threat. A 75 against the front will not hurt. Our boys are afraid of the gasoline fires. They always come out of the top of the tank, not the escape hatch. Sometimes they machine gun the crews and other times they don't bother. I was very thankful for physical condition. We had to run about half a mile before even halting. The country was very flat and they could have got us with machine gun fire."

STACK: "We have got to do some sucking in ourselves instead of being sucked in. Move with extended intervals; not as a front, but with a long tail so that when they do pull a trap or envelopment there will be something to back us up. Companies should be deployed with considerable distance between them."

HIGHTOWER: "I think it should be nearer 9 wave tank attack rather than 1/2 wave. Watch the envelopments and hide-outs. I still believe that at 2 to 1 odds we can lick them because our boys can shoot better. I have seen one German tank versus one American tank and the Americans hit many shots before they. They can't hit at all at long ranges.

"Every battery I saw of the 91st F.A. just did a bang up job all the time, and I have had them all at one time or another. "A" Co of the 701 T.D. stayed right to the bitter end and Gray should be promoted. He salvaged vehicles on the field and did a fine job. We could use him in the regiment. He is so utterly fearless and his men are the same way. Of course my men are the bravest in the world.

"If we could get some tank commanders or platoon sergeants and send them back to talk to their NCO's, and officers for that matter, they would be so much help. Sergeant Bowzer, one of the men I saw get out of his tank and get his gun clear, is one I have in mind. Sergeant \_\_\_\_\_ is another. Hillenmeyers would be excellent for sending on instruction matters and they named Lt. Moore from the 2nd battalion.

"Our reconnaissance suffered less than anything else, were not right in the middle of it, but they were in peeps and could see things. Those reconnaissance peeps should be radio equipped. The half-track reconnaissance is absolutely wrong for that type of country. I don't think they can get around as well as peeps in wooded country either. For a reconnaissance battalion perhaps the half-track is OK, but for the regimental reconnaissance, no."

STACK: "They have got to be willing to stand there and slug it out. Can't fight at 5,000 or 6,000 yards. Particularly tank destroyers. 2,000 to 5,000 is the range."

HIGHTOWER: "They can do it."

STACK: "And the assault guns the same way."

HIGHTOWER: "I would love to see the 75 howitzer displaced by the 105. I would much rather have the T-7 than the half-track. The half-track is faster on the plain, but can't go where the T-7 can. I believe the 75 can be displaced by the 105 on the tank chassis. The command was not undisturbed by the loss of a commander; everything went right on with us, only a very short pause."

Maj. Gen. Ernest N. Harmon's Notes on Combat  
Experience During the Tunisian and African  
Campaigns

NOTES ON COMBAT EXPERIENCE  
DURING THE TUNISIAN AND AFRICAN CAMPAIGNS

By Major General E. N. Harmon

1. Most Essential Requirements for Combat:

In general, our tactical doctrines are sound, the only requirement being to place greater emphasis on some points and less emphasis on others. We need not bow to any other country as to our military preparation. The Germans are superior to us mainly in their thoroughness and greater discipline. I feel that we are inclined to attempt to cram too much into the common soldier. Instead of teaching him a few fundamental things thoroughly, we attempt to cover too wide a field, with the result that when he arrives in the combat zone, he really is not thoroughly competent in anything and has to learn some of the most essential lessons in the combat zone. I consider the following five points to be the most essential requirements for combat:

a. Thorough and Complete Basic Training for the Individual and for Small Units.

This includes not only the elementary basic training of the soldier in all subjects such as discipline, camouflage, dispersion, sanitation, use of cover, etc., but above all, the use of his weapons — perfection in marksmanship and crew drill. Tank battles are usually won by the tanker who gets the first shot in. Speed and accuracy are essential. Crew handled weapons must be worked at night and under heavy fire with speed, accuracy and without second thought — automatically.

The leadership and responsibility of the small unit leaders as the squad and platoon, the perfection of the training of these units must be given greater emphasis and less emphasis placed on the operation of the larger units such as battalion, regiment, and division. The division will succeed only as the platoon succeeds.

b. Development of the Offensive Spirit and Eagerness to Close with the Enemy.

In the consideration of this subject we are up against one of the imponderables. We never know just how green troops and officers will act. We may be assured, however, that the first time in battle all officers and men will be considering their own safety, more or less, rather than the duty which they have to perform. Confidence in battle comes with experience, with leadership, with comrades and weapons. It is absolutely necessary to inculcate a disciplined fighting spirit with a realization that a price must be paid for success and the willingness on the part of the individual officer and soldier to sacrifice himself to gain the objective. Men must be taught that every shell and bomb is not necessarily directed at them personally, that they all have a good chance to survive regardless of the intensity of hostile fire, and that whether or not they survive; someone has to pay a price if success is to be gained. We must build up the dignity, resourcefulness and responsibility of the noncommissioned officer and junior officer in preparation for his duties on the battlefield.

If possible, green troops should be put into a relatively easy fight the first time. Some troops who are forced to enter a severe battle for the first time, and suffer heavy losses, do not seem to recover from it for a long time or until practically all of the original men have left the unit. A man becomes a good soldier only when he put his duty above his personal safety. This is something that can't be taught. On the other hand, strange as it may seem there comes a time when men become battle weary, and then it is better to have fresh, vigorous men than to have tired, experienced soldiers. This time comes earlier with some men than with others depending upon the man's character, but it eventually comes with all of them and must be recognized and watched. If a man has taken part in many battles and has seen his original squad and platoon mates killed or wounded down to the point where only he and one or two others are left, he gets a mental complex that it is just a question of time until they will get him, and he begins to think about himself again. At this stage a fresh soldier full of enthusiasm, but with less experience, is much more valuable.

### c. Development of Leadership. \*

Men will follow a good leader practically anywhere and under any conditions of battle. Therefore, the placing in position of leadership of the right men is the most important safeguard for success in battle that a commander can have. Leadership is a natural gift. Some men have it to a very high degree, and others do not have it at all. We must be ruthless in weeding out and changing officers and men around so that the leaders are in the positions of leadership, and the others, regardless of their personal qualifications, are put elsewhere. Up to the time of battle itself, we are inclined to stress administration, paper work, and tactical knowledge above the flare for leadership. In this we are wrong. Wherever possible before battle we must select the natural leaders, and where they are weak in administration or in tactical knowledge, take pains to develop them. We must place the other officers, regardless of how high their qualifications are, on staff jobs or in positions where they are not in contact with the men.

After the first battle, the premium on leadership will be placed higher by all division commanders than it ever was before. In addition to selecting the leaders we must also provide the "second and third stringers" as we say in football. I consider this the most important duty of a division commander, and where time is available, the division commander should not hesitate to investigate as far down as the platoon commanders to see, by personal contact, that the man has the qualifications to lead his platoon and inspire their confidence and the willingness to close with the enemy.

In my last battle I lost two regimental commanders, nine battalion commanders, and forty-three company commanders in the space of twenty days, which illustrates the need for second and third string replacements to step promptly into the job and carry on. A well trained and coordinated division and any unit, for that matter, works on the same principle as a championship football team. Each man must know his job, there must be perfect teamwork, and there must be good substitutes to replace the injured men without weakening the team. There must be no favoritism, and selection must be ruthless. Don't forget that as goes the platoon, so goes the division.

d. Develop Teamwork and Coordinate with All Weapons and Arms of Service.

Some of the more important points under this heading are the coordination of infantry weapons with the artillery. There is a great tendency to let the artillery do the job. The infantry mortar and assault guns are closer to the front and subjected to heavy fire, and they often suffer heavy casualties. For this reason there is a tendency to have them remain silent so as not to draw fire, and let the artillery carry the burden of close in fires as well as the more distant fires. This, of course, is wrong as the infantry weapons are designed to bring close and accurate fire on areas that are difficult to reach by the artillery and on targets that are difficult to describe for the artillery. The effect of the artillery fire is thus minimized and not placed on targets where it should be and which cannot be reached by the shorter range infantry weapons. The massing of all fires on given areas or targets is most important.

The successful defense of the Anzio Beachhead can probably be attributed more to the successful application of massed artillery fires than to any other cause. This was not true in the early stages of the beachhead but was a development as time went on. The sudden concentration of a terrific volume of fire on a target usually insures a complete annihilation of the enemy at that point or the complete neutralization of his effort and is far superior to nibbling away by one battery or one battalion. The fire of all weapons within range should be adjusted so that all can be brought to bear with a maximum volume of fire. We welcomed news of an enemy counterattack forming, for under the system of massed fires the enemy was given a terrific punishment.

The coordination of artillery and infantry includes, above all else, the location of forward observers up with front line companies and platoons and dual means of communication. We learned not to depend on radio entirely, but wherever the situation permitted and wire was available in the theater, to provide the artillery observers with both radio and wire communications. Many times the radio has been put out of action and the wire cut, but with dual communications there still was maintained the vital communications so essential.

The coordinated teamwork between tanks and infantry is very poorly understood and executed except in armored divisions. It is surprising how little division and higher commanders understand the proper teamwork between the tanks and the infantry. Training in this vital teamwork has not been properly stressed in the States. We will not win this war with the tank alone, but we will not win the war without the tank. The enemy uses his tanks with his infantry, and unless our infantry has tanks fighting alongside, they are sure to be ruined by the enemy tanks. I have seen two enemy tanks practically annihilate a regiment of American infantry in twenty minutes. I have seen my own individual tanks mow down from two hundred to three hundred of the enemy in a few minutes time. Our battle trained infantry knows this, but the teamwork between the tanks and the infantry has been sadly neglected. First of all, there must be communication between the tank platoons and the infantry platoons and companies in order that the tank may be directed to the enemy which is holding up the advance, or that the tank may be informed by the infantry of antitank guns or tank traps which will delay or destroy the tank.

Prior to the breakout at the Anzio Beachhead, our G.H.Q. tank battalion were put under my command for training for the operation, with the result that for the first time infantry and tanks acted together as a coordinated team which resulted in a minimum of losses for the infantry and a mutual regard and admiration between the infantry and the tanks such as had never existed before. There must be developed a high degree of cooperation between the tanks, tank destroyers, and artillery.

Throughout the African and Italian campaigns the German Panther and Tiger tanks were superior in armament and gunpower to our tanks. It was, therefore necessary to have tank destroyers right up front with the tanks with their heavier three inch gun. This was the only gun outside of heavy artillery that could handle the Panther and Tiger tanks. Had our tanks been equipped with a more powerful gun, there would have been no need for tank destroyers. The tank destroyer simply had the gunpower that the tank lacked. Therefore, in the attack, the tank and the tank destroyer must go together with the infantry following close behind to take advantage of the ground gained.

In the defense, tanks and tank destroyers must be scattered over the front so as to handle the hostile tanks as they attack our positions. Forward observers from the artillery must ride with the forward line of tanks, and communication must be set up so as to bring the mass of the artillery fire on objectives with speed and accuracy. In general, ordinary artillery fire is not a great menace to the tank, for unless the tank is hit by heavy calibre artillery, it will not be seriously damaged. However, massed artillery fires on tanks has proven to be successful as a great volume of fire usually results in setting some of the hostile tanks on fire.

It should be borne in mind that a small, well drilled, and coordinated team can be counted upon to accomplish more than a larger but less coordinated team. That goes for battles as well as sports. Always take time to coordinate an attack. Don't allow yourself to be hurried. Allow time for your orders to get down to the lower units. Get all your men set. It will pay. Most attacks that fail, fail because they were not well set, and all the means at the disposal of the commander were not put into action.

e. Physical Fitness.

This point is well understood by the American Army and is one of our best training points. However, we must prepare ourselves according to the job that we are expected to do and according to our age. The spectacle of a division commander running across country to get himself in shape is absurd as he will not be required to withstand physical hardship that requires that kind of endurance. He may very well injure himself by such exercise. A division commander must prepare himself to go without sleep, to withstand the worry and responsibility of battle, to be calm and fit.

On the other hand, the infantry soldier must be given long practice marches with full pack, up hill and down so that he can withstand the fatigue of carrying a burden, so that he can withstand exposure in cold and wet weather without getting sick, so that he can go several days without hot food.

The tankier must be able to stand the heat of his tank, the foul atmosphere of his tank, the jolting and body bruises.

The artilleryman must be able to fire all day and all night with little sleep and be strong enough to chuck the ammunition in. The ordinary setting-up exercises are not sufficient. We must prepare our men with hard, gruelling work.

## 2. Speed on the Battlefield.

All movement on the battlefield is relatively slow and deliberate. We get a false picture of speed in maneuvers because we don't play supply accurately, we don't have casualties, and we don't take the time for reconnaissance which is required on the battlefield. In maneuvers we have been guilty of rewarding officers and men for grandstand moves such as would be impossible to make on the battlefield and which give a false impression of what can be accomplished. Speed can be made by rapid decisions, by going rapidly from one reconnoitered place to another, by thinking ahead and being prepared with the solution for emergency when it arises, and, above all, by forethought as to how to handle the contingencies of battle when they come up.

A division commander must always be thinking in terms of what is going to happen from six to twelve hours ahead of the present. Steady boring in all day long is what wins the battle. Many tanks were lost in the early days under the false training idea of boiling down the road into contact where the enemy anti-tank guns were sitting in a trap and picked our tanks off like ducks. Hundreds of infantry men have been sacrificed by throwing them into an attack without coordinating fires, without preparation, without reconnoitering the ground. The mark of a well trained and superior outfit is the deliberate and assured way it goes into battle, checking on every detail, seeing that everything is set, making provisions for what will probably happen in the immediate future. The mark of a Boy Scout division is its great industry, its hurry and bluster and lack of appreciation for and attention to intimate details that go to make up coordination and assured effort.

An objective in battle is usually won in the first few hours after the attack begins, or it is not going to be won at all with the initial combination set up. If the attack jumps off at daylight and is bogged down by ten o'clock in the morning, the division commander must realize that a change in his plan must be made. To put such a change into effect and thoroughly loosen up the battlefield will require at least six to eight hours, so the new assault can't take place much earlier than five or six o'clock in the evening. I have seen many attempts to hurry this schedule with the result of failure in the new attempt. The new change may involve a greater concentration of artillery on a certain front, the throwing in of greater force against a front heretofore weakly attacked, etc. If in doubt as to whether you can attack at a certain hour, it is always best to add another hour to insure a better understanding among the lower units of your plan. Always brief your commanders as far down the line and as thoroughly as time will permit.

The American soldier is fundamentally intelligent and does a lot of thinking for himself. If he understands the general plan and what you are trying to do, he will very often contribute very greatly to the success of that plan. He will surprise you when left to his own devices and in the absence of detailed orders later in the course of battle. We are generally afraid that the private will know too much, and if captured, will talk too much about the plan and thus give it away. I believe this to be over emphasized. If I had time, I would tell all privates practically everything about the plans and would get much better results thereby.

One of the greatest contributing factors to the successful breakthrough in the Anzio Beachhead was the great amount of detailed planning and the great amount of briefing that was given to the noncommissioned officers and privates in the tank and infantry units. Remember that you never know when the second, third, and fourth stringers will step into the shoes of the battalion, company, and platoon commanders. If your attack is to continue smoothly and according to plan, these men must know what it is all about, or your attack is bogged down for hours. I consider this one of the most important things to stress in training and on the battlefield. I also feel that as a result of our school teachings it is one of the most overlooked practical ideas.

Give time for briefing. Add plenty of safety factors on all logistics to take care of the imponderables such as heavy shelling, destruction of trucks and bridges enroute, losing the way, etc. It is better to wait for the battle to begin than to be late arriving in the attack positions.

### 3. Coordination of Tanks, Infantry and Artillery.

The tank-infantry-artillery team is little understood outside the armored divisions, and this lack of understanding is a distinct failure of training in the States. It must be corrected at once.

The tank is designed to bear the brunt of battle, and its crew must be trained to accept the dangers and be willing to lead in the attack wherever the ground permits. On the other hand, the infantry must not sit back on the hill and watch the show. Failure of the tanks to take the lead and bear the brunt of battle has brought disparaging remarks upon them by the infantry. Failure of the infantry to come up and take over the ground taken by the tanks has caused the tanks to curse the infantry. Failure of the artillery to mass its fires and help pave the way by neutralizing the antitank guns and smothering hostile artillery has lost many a fight.

In a later paragraph I will discuss the difference between G.H.Q. tank battalions and the tank battalions of the armored divisions and what I consider to be a remedy to change a rather bad situation.

The following is a training directive issued in preparation for the breakthrough at the Anzio Beachhead relative to infantry, tank, and artillery cooperation. All assault battalions of infantry and assault battalions of tanks were trained along these lines, and the operation was very successful. It is believed the principles are sound and should be adopted as a basis for all infantry and tank cooperation.

"There are two general types of action for tanks and infantry: one in which, due to the character of the terrain, obstacles or concentrations of anti-tank guns in which the infantry makes the principal attack closely supported by tanks; and the other in which, due to the favorable terrain for tanks and where the enemy's principal defensive lines has been broken, tanks go through to exploit the success and the action is characterized by the tanks making the main effort with the infantry in close support to assist them over obstacles encountered, to take over the ground gained, and to outpost the tanks for the night. The tank was developed for the primary purpose of taking the brunt of the battle from the infantry, to go through areas protected by antipersonnel mines and wire, and small arms and machine gun fire. Every weapon available to the enemy is a potential killer of the infantry soldier; only a few weapons are deadly to the tank. The principal enemies of the tank are unfavorable ground for maneuver, antitank mines, antitank guns and artillery. The armor of the tank furnishes reasonably good protection against artillery fire unless artillery of large caliber makes direct hits on the tank itself or very close to it, and even in these cases the tank soldier rarely is injured although his tank may be temporarily put out of action. The casualty rate among tankers is relatively low averaging approximately  $1\frac{1}{4}$  men per tank crew, but of these casualties only a small proportion are fatal, a great majority of the casualties being slight, and the men are returned to duty in a relatively short period of time. The foregoing facts are borne out by statistics kept over a long period of time and obtained from actual tank encounters. It is, therefore, reasonable and right to expect the tanker to move boldly out to the front lead the infantry, and take the brunt of the battle wherever the terrain permits.

"Artillery observers must be up forward with the tanks and with the advanced lines of the infantry to promptly and accurately bring fire on enemy installations holding up the advance. To much cannot be stressed on the importance of the coordination between the artillery, tank and infantrymen. Upon the skill of the artillery and the concentrations of its fires depends the success of the advance, particularly of the tank when held up temporarily by antitank fire.

"Tankers should move forward by bounds covering each other by fire from tanks in hull down positions in the rear. The advance of tanks may be rapid in spots and slow at other times as the tankers must study the ground carefully from one point of advance to another. They must move rapidly from the rear position to the selected position forward. Above all, they should have the attitude and spirit to lead the attack, to continue the advance whether slow or rapid, and continually bore in to arrive at the final objectives. No other thought should be in their minds, otherwise they are not good tankers and the expenditure of money and effort for the manufacture of tanks is wasted.

"The coordination and communication between the infantry and tanks are paramount. There must be established radio means of communication so that the infantry company commander can direct the the tank on to the hostile dispositions which are holding them up and giving them casualties.

"Normally in an attack in which the infantry has the main tasks and is closely supported by tanks, the tanks should be attached directly to the infantry battalions. In the case where the tanks make the main effort the infantry is attached to the task commander or moves under orders of the task force. In the preparation for an attack the tank commander will advise the infantry commander after careful study of the ground, maps and airplane photographs of the best manner in which to employ the tanks. The infantry commander should accept this advice and build his attack around the tank wherever possible. Communications must be thoroughly worked out. This requires in the most cases special radio equipment able to communicate with the tanks to be in the hands of the infantry.

"Special provisions must be made prior to the attack for assisting the tanks over wadis and other obstacles. This must not be left to chance. If there are sufficient engineers available, a detachment of engineers may be set up for this purpose; if not available, then a part of the pioneer section of the infantry reconnaissance platoons, or sections of the reconnaissance companies of the armored regiments, might be used. If neither of the foregoing is available, then the infantry must act aside one or two squads of men equipped with picks and shovels for this purpose. In an emergency any soldiers nearby the tank that is having difficulty must be prepared to come to the assistance of the tank to help it over the obstacle, as the value of the tank in continuing the advance is well worth the use of riflemen for this purpose.

"Tanks should habitually lead the infantry in the attack. ✓ Infantry scouts may ride on the backs of the tanks as far forward as hostile machine gun and rifle fire will permit, and then continue in close proximity to the tanks to point out to them targets and assist them in getting over bad terrain. The infantry assault should follow the tanks closely as possible so as to promptly take advantage of the ground gained by the tanks. The distance behind the tanks will depend principally on the rule that the infantry should not follow the tanks so close as to come under the artillery and other fires which are directed on the line of tanks. As previously stated, this distance varies with the terrain, and with the type and amount of hostile fire being received. If the terrain has been studied carefully prior to the attack, the tanks will know that they can reach a certain line and then will have to halt and take turret defiladed positions while the infantry passes through them and establishes a bridgehead on the further side of the obstacle. Artillery, infantry mortars, and the fire from the tanks should cover the establishment of the bridgehead which normally should include smoke to screen the advance and the bridging operations. As soon as the bridgehead is established or the smoke screen is laid, the tanks should advance promptly and cross the obstacle. Members of each tank crew should promptly reconnoiter on foot for the best crossing site and man detailed to assist the tanks should begin the preparation of the crossings. The tanks should cross immediately after the crossing is prepared and be covered by the fire of tanks remaining in position; all the tanks should get across as soon as possible. Prior to crossing the obstacle, the tanker should study the terrain and have well in mind where he is to go upon reaching the other side. After crossing the obstacle, the tanker goes through the infantry line and leads the advance until he is again stopped by unfavorable terrain, minefields or concentrations of antitank weapons. In case of antitank weapons, artillery fire will be called to neutralize them, in case of minefields, reconnaissance will be made to find a passage through or special means brought up to blow a passage through so that the tank can continue the advance; in case of another obstacle the infantry will have to come up and establish another bridgehead.

"Special provisions should be made by commanders to have infantry or other troops close behind the tanks to take over prisoners. On many occasions in the past, large numbers have surrendered to the tankers and have escaped later for lack of an escort to take them to the rear. While the attack is in progress tanks should not be taken from the battlefield to escort prisoners to the rear unless it is an emergency. Where large groups of prisoners are taken, the tanker may have to escort them until friendly forces can take them over. Planning should provide means to take this burden off the tanker and permit him to continue in the assault.

"The antitank gun is a tremendous asset in the advance of the tanks and is an absolute necessity where the hostile tanks are superior in numbers or in armor and armament to our own tanks. It, therefore, will be the practice to attach tank destroyer units to the assault tank units. The tank destroyer units will follow the tanks closely from one hull down position to another so as to be able to cover the advance of the tanks with direct fire. The closest cooperation and means of communication between the tanks and the tank destroyers is essential. When the infantry is attacking without tanks but with tank destroyers, the same principles apply for the use of the tank destroyers with the infantry.

"It is a fixed rule and a point of honor that neither our tanks or tank destroyers will permit their infantry to be overrun by hostile tanks, no matter what it costs to themselves.

"Upon reaching the objective the tanker and tank destroyer must remain on the objective until the position is secured and the danger from counterattack by either infantry or tanks, or a combination of both, has been eliminated. Thereafter certain tanks and tank destroyers may be required to remain on the objective or close thereto while the others may proceed on another mission or go into reserve to refuel and refit.

"Provisions must be made in the employment of both tanks and tank destroyers for replacing the armored elements in the assault when they have to go to the rear to replenish their ammunition or gas without the loss of tanks and tank destroyer support. This is highly important. Reserve platoons of tanks and tank destroyer elements must be prepared to move to the front promptly to make the replacement. The relief must be made so that there will be continuity of armored support.

"The above principles will be taught to all tankers, tank destroyer personnel and all infantry. Much has been said about what armor will do in battle. Let us make good our promise of support. Let the infantry follow us closely and assist us to get forward and thereby have established between the armor, artillery and infantry that mutual respect and comradeship on the battlefield which is so essential to the success of our cause."

#### 4. Observe the Principles of Mass.

Many attacks during the African and particularly in the Italian campaigns failed because the principle of mass was not observed. This permitted the enemy

to move his reserves freely from one part of the battlefield to another. A good rule to follow is: "If you think you can take an objective with a tooth pick, use a baseball bat to make sure." The massing of artillery fires in particular was a development of the Anzio Beachhead which had an outstanding effect on the successful defense.

Beware of attempting to deceive the enemy by sneaking up on them and not employing all your fire power. It is better to come in with all guns blazing. One of the greatest losses sustained in my own division was in an action where the high command decided to do away with the artillery preparation in the false hope that the enemy would be surprised. The enemy not only were not surprised but were waiting for the attack with the result that the infantry suffered severe losses which would not have occurred had the artillery laid down a curtain of fire to protect them.

We sailed into Safi harbor in North Africa quietly, waiting for the French to fire the first shot, whereas how much better it would have been if we could have come in with all guns blazing to neutralize the shore batteries and installations that were waiting for us and which had been accurately located.

Throughout the African and Italian campaigns there was a continued demand to split the armored division and attach part of its troops to another force. The armored division, like any other division had been developed as a team, and the full success of its power can only be reaped when it acts as a unit and has all of its strength available for use.

#### 5. Air Support.

There was very little close support by air for ground troops in either the African or Italian campaigns. In the African campaign the air was mainly used on strategical missions and on missions for the good of the force as a whole. This was partially due, at least initially, to the lack of strength in the air at that time. There is no attempt here to belittle or minimize the wonderful work of the air in assisting the campaign as a whole, the destruction of the enemy's lines of communication, supply, etc. However, the close teamwork between the ground and the air was lacking. Tactical teamwork between the air and the ground, particularly with an armored division, has great possibilities. The air must receive special training in order to give this essential close cooperation.

In the first place, the air will require intensive training in locating itself on the ground and in picking up landmarks and coordinates. Our forces were repeatedly strafed by our own air by failure of our airmen to recognize our own vehicles and to know where they were at the time. Fortunately, the losses sustained were relatively light from this cause, but it created a distinct feeling among the ground forces that our air could not be trusted to work closely with us and in a desire for the air to work on more distant targets giving a wider margin of territory between the enemy to be worked on and our own advanced elements.

The 1st Armored Division, toward the latter part of the Italian campaign, carried out an experiment with a fighter-bomber group in an effort to develop closer cooperation and to obtain close in air support. The work was carried out with a great deal of enthusiasm by both the air and the armored division and great progress was made. The principal difficulty was in communications and in accurately describing to the air the targets to be worked on. Cub planes were painted yellow on their top wing surfaces and hovered over the hostile targets. They then described the targets to the incoming fighter-bombers. This worked out in a highly satisfactory manner after a little experimentation, but the main difficulty with this system will be that after the enemy has control or partial control of the air, the Cub plane will not be able to live in the air long enough to describe the target.

The greatest single aid to more effective use of armored formations, particularly in pursuit and where they are moving fast beyond close artillery support, would be the development of close air support by reconnaissance, strafing, and bombing. Failure of this air support presents the weakest link in our tactical team today. Let no one think that this close support can be quickly worked out or that because a system has been developed with one division that the same system can be employed with another division without first going through an intensive training period with both the air and ground people involved. It can be done, and it has been done, and the results are tremendously effective. Although the Air Service has been apparently reluctant to go into this work in the past, we find that the air people who are engaged in it and who have worked and overcome the difficulties of communications with the ground people are most enthusiastic about the results obtained. This cooperation requires special communication equipment, special crews to be set up, and intensive training in map reading, orientation, knowledge of ground vehicles and weapons, and their principles of operation.

#### 6. The Fallacy of Attaching Tanks, Tank Destroyers, and Antiaircraft Battalions to Division.

Our present system is to attach G.H.Q. tank battalions, tank destroyer battalions, and antiaircraft battalions to divisions. This has not proven satisfactory, principally for the following reasons:

First, the team play absolutely essential between these elements and the infantry and artillery of the divisions to which attached is not developed to the high degree necessary for successful action. One battalion serves with a division for a while and then is transferred to another division, sometimes in a short period of time, and they do not have the opportunity to work out team play. Second, those small separate battalions are often commanded indifferently, and no one looks after them to see that they have good leadership; whereas, if they were permanently a part of a division, the weakness in leadership would be apparent, and the division commander would take necessary action. Third, they are like orphans in the storm. No one looks after them. They suffer in personnel and maintenance requirements and are shifted around here and there from one corps to another or from one division to another with no one having a personal interest in them except the battalion commander himself. The above are very highly practical considerations although theoretically their needs are not so apparent.

Panzer Grenadier units of the German Army all contain organic tank elements. As long as the tank is so important on the battlefield, our infantry divisions should have organic tank battalions with them. The antiaircraft batteries normally with divisions are equipped with automatic weapons and are usually split up to protect the division artillery and the movement of infantry in trucks and also some of the installations of the division such as headquarters and supply establishments. These units should also work constantly with the same division although the requirement is less important since they have a mere passive defensive role than is true of the tank destroyer and tank battalions.

#### 7. The Tank Division vs. G. H. Q. Tank Battalions.

The quality of the G.H.Q. tank battalion in training for battle, aggressiveness, and general all-around efficiency was far below the standard of the tank battalion in the armored division. There was a continual demand from infantry divisions to get tank units from the armored divisions attached to them for attacks that were the normal objectives for G.H.Q. tank battalions. The reason given in all cases was that the tank units of the armored divisions were so much better trained and has a better fighting spirit and morale than the G.H.Q. tank battalions. Unfortunately, this attitude was generally correct, and the G.H.Q. tank battalions, with notable exceptions, did not do the work that should be expected of them. However, there were reasons for this which have been touched upon in the preceding paragraph.

In the armored divisions, the tank battalions were trained with the infantry and artillery of the division as a coordinated team. They had the benefit of a division commander to look after their leadership, personnel requirements, supply and maintenance problems. These items were lacking in the G.H.Q. tank battalions which were left on their own in practically all of the above items.

Several times during the campaigns officers from the 1st Armored Division were sent over to take command of G.H.Q. tank battalions and replace their commanders. The effect of this leadership was instantly apparent. Prior to the breakout in the Anzio Beachhead all of the separate tank battalions in the beachhead were put under the command of the 1st Armored Division for training, supply maintenance, and administration. This directive was enthusiastically received by the G.H.Q. tank battalions who realized they now had someone who understood their problems and would help them get what they needed to function.

The above discussion brings up the question of whether there should be G.H.Q. tank battalions or armored divisions or both and how they should operate. There should be both. There should be armored divisions with a powerful tank component for breakthroughs, for exploitation, for pursuit, etc. There should also be tank elements as component parts of all infantry divisions. I believe the solution to the problem is the armored division and the tank battalion as a component part of the infantry division. Let us not operate as we did prior to this war, with the infantry developing tanks in one direction and the cavalry in another and with a development of jealousy and incompetency in all directions.

The British and Germans both employ a heavy tank as the accompanying tank for infantry. Many arguments can be brought in on both sides, but after all is said, the main thing in a tank is gunpower and maneuverability. By maneuverability I do not mean speed on roads. I mean ability to negotiate terrain and get over roads and bridges which is just as essential to an infantry accompanying tank as to any other tank. If the above plan is adhered to it will be seen that the same type of tank is required whether it closely supports the infantry in taking limited objectives or whether it is part of an armored division which is predominantly strong in tanks to smash through defensive lines or to sweep around the flanks and rear of hostile positions.

#### 8. Tank vs. Tank Destroyer and Antitank Gun.

The antitank gun is a necessity on the battlefield for the infantry. It should be a towed weapon reasonably easy to manhandle, with a high muzzle velocity.

There is no need for tank destroyers. I believe the whole organization and development of the tank destroyer will be considered a great mistake of the war. In the first place, the doctrine originally promulgated, of the tank destroyer seeking out and pursuing the tank was a fallacy which caused the destruction of many lives and much equipment before it was corrected. The tank destroyer M-10, now in use, has proven of great benefit simply because it contained a 3 inch gun that was the best gun for coping with the Tiger and Panther German tanks. Had this gun or a more powerful gun been installed in a tank, there would have been no need for the tank destroyer.

The 37 TD mounted on a 3/4 ton chassis and a 75 gun mounted on a half track as tank destroyer weapons were absurd and could not possibly take the place even of the Grant tank with a 75 gun. The most effective use for tank destroyers was found to be to split them up into platoons and attach them to tank companies and tank battalions to furnish the extra gunpower required when the superior German tank was met on the battlefield. The German, up to now, has had superiority in tanks and tank gunpower in his Tiger and Panther tanks with their high velocity 88 and 76 calibre guns. Our 3 inch gun in the tank destroyer and our heavy artillery were the only antidotes although our M-4 medium tank was a much superior tank except for its gun and armor.

The Germans have self-propelled guns on the same principle as our self-propelled artillery in the armored divisions except that they went to higher calibres than the 105. They used these guns as roving guns on the battlefield and as such they were highly successful, but no more so than our own self-propelled guns except as to the weight of the artillery piece involved. The foreign armies have always been ahead of us in the development of high velocity pieces of ordnance, and for the last two years our troops have been continually outgunned by German pieces of ordnance. When the day comes that we equip our tanks with a high velocity and heavy calibre gun, there will be no need for tank destroyers as such, and they should be eliminated along with their overhead, etc. The artillery of the Army should develop both self-propelled and towed equipment as both have their use on the battlefield, and both have proven their worth beyond discussion.

## 9. Replacements and Replacement Training.

The replacement situation was not very satisfactory in the African and Italian campaigns. During the African campaign the 2d Armored Division was used in large part to furnish replacements to keep the 1st Armored Division in battle. Although some 19,000 highly trained armored force replacements arrived in Africa, these men were used to create new service units and were lost for their original purpose.

After the Mount Portia fight in Italy, the 6th Infantry of the 1st Armored Division lost heavily and had to fill its ranks with truck drivers, tank destroyer and tank personnel due to lack of infantry replacements.

In general, the replacements are not suited by training to take over their duties in combat. Unfortunately, the replacements received often had to go into the fight immediately and had no opportunity to be trained in their combat duties. Replacements of both officers and men came to the theater with higher rank than they were able to hold due to lack of experience and training in the unit to which sent. As a result, many of the officer replacements could not be used and had to be carried as surplus. This blocked the promotion of deserving men. A great many of the enlisted replacements had to be reduced in grade as they were incapable of holding down the job to which they had been promoted. Many of the enlisted men asked to be reduced after they themselves realized that they were incompetent. There would have been a far more efficient system if enlisted replacements were generally confined to basic privates and the officers were Second Lieutenants, thereby allowing the unit to promote its deserving and experienced men to fill the higher vacancies. It would then have been possible to fill in at the bottom with fresh men from the States. There would be exceptions to this rule as occasionally high ranking officers became casualties, and no suitable replacements were available in the unit. However, in most cases there were suitable men to fill their places within the unit, and if not within the unit itself, officers from adjacent divisions could be found to transfer over and become promoted thereby. These men had the battle experience necessary to carry on in an efficient manner while the battle was still in progress.

A general impression was gained that replacements from the States were not given sufficient intensive combat training but instead were trained generally to fill various specialists' ratings and that their training covered a broad field rather than having the fundamentals for combat stressed. There was small call for clerks and administrative personnel as this type did not suffer the heavy casualties. On the other hand, there was a great demand for the private soldier and the junior officer to fill the depleted ranks of the front line combat platoons and companies.

As a constructive criticism I believe less time should be given to the training in current events and all of the various items that have to be included on the man's service records as having been accomplished such as seeing a certain course of movies or listening to a certain course of lectures or having been psychoanalyzed. More time could then be spent on the fundamental drill and training to fit the man for combat work in the front line.

As soon as replacements arrived they were immediately given intensive training in these fundamental combat duties which were so evidently lacking. However, as stated above, it was the unfortunate rule rather than the exception that the men arrived and were, within twenty-four hours, put into the battle line. They had to learn in the hardest way without having been given sufficient opportunity for training. This situation was particularly true during a long sustained drive where it was essential that the units be kept up to strength in order to continue the attack.

#### 10. Infantry.

The infantry in this war, as in all other wars, has the heaviest casualties. However, their casualties would have been less had they been more soundly trained in the fundamentals and to operate more closely and efficiently with tanks and artillery. I believe it to be a fallacy to call the infantry "the queen of battles" because on the modern battlefield there is no king or queen, nor is any branch of service more important than another. They all have equal importance if the team is worked up properly.

Our infantry soldier was given the lowest classification as to intelligence, which is a mistake as it takes an intelligent man to be a good infantry soldier. The principal points which need to be stressed in infantry training are the fundamentals such as perfection of crew drill, the use of their weapons, and the fundamental formations to make maximum use of cover, terrain, and dispersion as they advance under fire.

Relative to tank-infantry cooperation, if the assault is on a definite single objective, the infantry should be in position to attack before the tanks arrive whenever practicable. Oftentime the infantry in position can observe elements in the situation which were not known or considered in the planning for the attack.

Assault guns were used as infantry direct fire support weapons on several occasions where the tanks had by-passed enemy strong points. The enemy infantry at these strong points engaged our infantry but were soon dispersed by direct fire assault gun support.

A good football team uses about eight to ten plays during a season, these plays are fully developed, and every man thoroughly understands them. He is drilled for hours in the fundamentals. A mediocre football team often has thirty to forty plays none of which are successful as no play is fully understood nor are the men thoroughly drilled day after day in the fundamentals. Good infantry is the same as a good football team and must concentrate on a few formations and drill constantly to perfect themselves. The following are some constructive criticisms that have been made during the training of the 6th Infantry prior to combat and are well worth considering in our preliminary battle training in the States:

"There was a considerable lack of dispersion which is a common fault and must be continually worked upon in order to overcome this natural human instinct to herd. This fault was particularly noticeable when passing over bad ground or

through woods on the part of the assault elements and was a common fault in the approach of the reserve elements under all types of terrain. We must remember that the assault elements are the ones that get in close in rifle and machine gun fire to the maximum, and the reserve elements are the targets for the mortars and the artillery fire. Our artillery continually attempts to separate the reserves and the supply of ammunitions, etc., from reaching the front line elements by destructive fires placed upon them. Usually the front line elements are in such close contact that neither the hostile or friendly artillery can fire on them. We must not be careless in the approach of reserves. They must come up with the greatest dispersion possible with effective control. They must use all cover available in the approach march or they will be pinned down by artillery and mortar fire and if not destroyed will be unable to support their front line elements when needed.

"There was a general lack of maneuver to overcome machine gun and other obstacles holding up the advance. The general tendency was to stop and call for artillery fire on every occasion when stopped by machine guns. It must be realized that artillery may not be able to properly reach the target or may be having priority calls on other missions such that it cannot fire on the target desired. The infantry must be alert to take advantage of the ground and while covering the hostile machine guns by their own fire, maneuver flanking forces to overcome the obstacles from the flank or rear.

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"There was a general tendency on the part of the infantry to depend too much on the artillery and not employ the many excellent close in weapons under their own control such as machine guns, mortars, and assault guns. The artillery has the range necessary to stop the forward movement of hostile reserves and the power to destroy hostile tanks and antitank guns. These targets cannot be efficiently taken under fire by the smaller weapons available to the infantry. On the other hand, the infantry weapons when properly used can handle many of the obstacles that are holding them up on the front fringe of the attack at close range. Every effort must be made by battalion and company commanders to get all of their means into action.

"In capturing ground from the German it is axiomatic that he will immediately counterattack with whatever he has at his disposal. This counterattack may be anything from a few men on up. Our troops upon arriving on a captured objective are more or less disorganized, and do not promptly organize themselves to meet the inevitable counterattack. This reorganization must be done on each platoon, company and battalion front at once. The reorganization includes the digging in by personnel, the proper sighting of machine guns and other weapons, and the prompt registration by the mortars and artillery on the likely avenues of approach by the counterattacking forces. The men of the 6th Infantry remember well that every objective they took in the "mouse trap" during Tunisian campaign was invariably followed by the counterattack. To the credit of the Regiment and also to the prompt action of the Division artillery in support, these counterattacks were with one or two exceptions promptly beaten back. Let us not forget this valuable experience and not fail to impress our new men with action required. Remember that we are having a considerable daily turnover of officers and men due to casualties, and these new people must be continually worked upon to thoroughly learn the

lessons which the older people can teach them and which have been learned the hard way with so much cost in lives and blood.

"Flank protection is paramount. In some cases during attacks the flank protection did not go out far enough. The mission of the flank protecting groups is to prevent surprise and to provide delay until elements from the main body can arrive and repel the threat. This means that the flank detachments have got to go out far enough on the flanks where they can see the approach of the enemy and to terrain that they can hold until help arrives." (1st Armored Division Training Directive).

Training must be continuous as units engaged in battle have an immense turnover. This point will be brought home more clearly when it is realized for example that in the past two years the 1st Armored Division alone has had approximately 34,000 battle and nonbattle casualties although its original strength was approximately 13,000. This illustrates the immense turnover and change in personnel. A division that is on the firing line is always more or less a new division, and after a heavy campaign its battle efficiency is probably not as good as a division in the States with all of its original trained men present, except from the standpoint of battle experience in the surviving members of the combat division.

## 11. Tanks

The war has proven the soundness of the principles taught by the Armored Force, and although many people were skeptical about the use of tanks, the tank has already proven itself a necessity and a bulwark on the battlefield, and in days to come its importance will be increased with better operating terrain available.

Unfortunately, in the Italian campaign the terrain and climate were such as to restrict the use of tanks tremendously, but even in that campaign it was the tank that made the breakthrough out of the Anzio Beachhead. It was the tank that assisted the advance of the infantry and the advance to join the southern force with the beachhead forces. Again it was the tank that bore the brunt of the push from Rome to the Arno River. The tank, however, is not an instrument alone. It must be closely supported by infantry and artillery. The tank was designed to take the brunt of battle from the infantry. Our tankers can be trained with the offensive spirit to lead the infantry in the attack. If the tank does not do this, it has not justified its existence. It's a well known statistical fact that although losses may be heavy in tanks, the losses to the personnel of tanks is relatively light, averaging about one and a fraction man per crew, and of these losses only a small part are fatal. Our tankers have learned to be alert, to observe carefully the foreground, and to go from one defiladed position to another with speed and assurance. Tankers need not be afraid of artillery fire and develop confidence in passing through heavy concentrations of artillery after they receive negligible losses therefrom.

Tanks can operate in much rougher country than was formerly thought possible. Field Marshal von Kesselring, the German Commander in Italy, paid a great tribute to our tanks when he stated that American tanks went through country thought impossible for tank operation and which had not, therefore, been properly

defended against them. He also stated that our tank-infantry-artillery teamwork in breaking out of the beachhead was a flawless example of attention to every detail.

The greatest single attribute of a tanker is to shoot accurately and with speed. The next is the spirit to continually bore in; however, with skill and with his eyes wide open to observe every possible point where the enemy could be concealed. All suspicious points should be shot at, and although the tanker may not see any enemy, the spraying of the ground in front with machine gun fire and the sending of a round of 75 ammunition into every suspicious bush, outhouse, haystack, or other point of natural cover upsets the defenders who do not know whether they have been located or not but who consider that they have been since fire is coming in their direction.

The tanks can make a path through hostile wire and antipersonal mine fields through which the infantry can pass without casualty. The infantry, on the other hand, can spot antitank guns and concealed enemy tanks and thus greatly assist the tanker.

In the pursuit north of Rome it was practice to carry infantry on the backs of the tanks, and when the tanks came to turns in the mountain roads, the infantry would dismount and reconnoiter around the turn to discover the presence of antitank guns or hostile tanks. Many tanks and guns were thus discovered, saving our own tanks from ambush and permitting a concerted plan of attack to remove the resistance and allow the column to proceed.

Our light tank was used to great advantage in moving with the infantry forward line to assist them in mopping hostile resistance which had been passed over by the heavier leading tanks.

The maneuverability of our tanks can be greatly enhanced by wider tracks. Increased maneuverability of tanks across country at the expense of speed is highly desirable, and above all, our tanks should carry the highest velocity and heaviest gun that can be carried consistent with other considerations, such as weight and power. Armor should be sacrificed for firepower and maneuverability on every occasion. Tanks must be withdrawn from the line after two or three days of continuous fighting but can be put into battle again after a short rest of twenty-four to forty-eight hours.

The tank crew fights all day and spends a large part of the night on maintenance and supply of gasoline and ammunition. Consequently, they get little rest. The service of the crew in the tank is most fatiguing due to the foul air, heavy jolting, and hammering.

A high explosive shell is the best type of artillery fire to be used in front of tanks. This type of artillery fire enables the tank commander to keep his head out of the turret, thereby giving the tank about fifty percent more efficiency than it would have if the tank were completely buttoned up. Our tankers in the Armored Division insist on the tank commander keeping his head out of the turret and won't serve under a commander who hasn't the courage to do this. However, the Germans know this, and we lost quite a few tank commanders by sniping fire. Time

fire by the artillery can be placed directly on top of the tank formation when the tanks are buttoned up but has the disadvantage that the tank is blind and is only about twenty-five percent efficient.

Artillery fire can be placed within fifty yards of the tanks without any undue damage. This requires careful adjustment of fire by the artillery and perfect coordination and teamwork.

The three great enemies of the tank are terrain, which restricts their maneuverability, the antitank gun, which can be concealed and destroy the tank at close range, and the mine, which can disable the tank temporarily. The ordinary mine usually blows the track which can be replaced very quickly. However, it must be remembered that a tank once it hits a mine will never operate with the same mechanical efficiency again because, although the track and bogies may be replaced, certain stresses and strains are set up in the driving mechanism due to the sudden stopping of the machinery. A tank that has hit a mine never operates at more than seventy-five to eighty percent of its original mechanical efficiency.

## 12. Mines.

The extensive use of mines, both antitank and antipersonnel, by the German is one of the greatest menaces of the present war. No area, either forward or back, is safe from the mine. The most effective enemy mining was the sporadic mining of long stretches of road, road shoulders, craters, and areas upon withdrawal. Heavily mined fords strewn with metal fragments to render detectors useless were also effective delays. In general, the enemy's mine technique and mine equipment were superior to our own.

During the later phases of the African campaign and throughout the Italian campaign the Germans employed a box mine made of wood and having practically no metal which made it almost impossible to detect with a mine detector. Also, there was introduced the shoe mine which was a small wooden box hidden in the grass or under the leaves and used as an antipersonnel mine.

Late in the Italian campaign a new type of antipersonnel mine appeared made entirely of plastic except for the detonating device. The Germans strewed these freely along the ditches and roadways. The German positions around the Anzio Beachhead were thoroughly covered with mine fields. They presented a great problem to the passage of tanks, a problem which was not solved. A large proportion of the heavy losses of tanks in the breakthrough at Anzio were caused by going through these mine fields. The antitank mine has no sure antidote except the slow, painful process of picking up the mines by detectors or by charging through the mine fields at great loss to vehicles.

The "snake" was successfully used in the breakthrough at Anzio and has possibilities where the mine field can be located ahead of time and where conditions are favorable for approaching with a tank to push the "snake" through the field. Several lanes were blown through mine fields with a great demoralizing effect on the enemy. However, the danger with the "snake" is its susceptibility to being set off by artillery and causing heavy casualties by our own troops in the immediate vicinity.

There was also developed a primer cord which was shot out of an infantry mortar and when detonated, cleared a path about 20 inches wide through the grass exploding the antipersonnel mines.

Tanks are impervious to the antipersonnel mine and can go through wire entanglements, which are usually strung with antipersonnel mines, clearing a way for the infantry. However, the solution to the problem of locating mines and mine fields is yet to be found.

Intensive mine training must be given to every officer and man, regardless of his duties. This should include detection, disarming, where mines are mostly likely to be found, etc. Our own mines proved to be a great menace. Many local operations were conducted during the siege of the beachhead such as raids on enemy strong points, etc., and in almost every case we had as much damage done by our own mines as we did by hostile mines. The sectors were occupied by different divisions, each one putting in more mines, and a careful record was not kept, as it should have been, as to location of the mines installed. Troops frequently place mines in front of their positions at night as a protection and go off forgetting to raise them or mark them properly. The result is heavy casualties to other troops which pass over the same ground later. Much more drastic discipline and training in the handling of mines and the use of mines by our own people has got to be employed.

### 13. Miscellaneous.

One of the most important items of equipment is the armored bulldozer. It played an important part in the pursuit of the Germans in Italy. Without it we couldn't have advanced as all bridges and culverts were blown, and houses were often blown into the streets. A greater proportion of armored bulldozers should be set up.

In the early days of the war we dissipated a great many 50 calibre machine guns and also 30 calibre machine guns by placing them on peeps, trucks, and vehicles for anti-aircraft defense. This has been partially rectified but we still are wasting too many machine guns for this purpose. It is absolutely unnecessary to install machine guns on peeps and individual passenger vehicles. 30 calibre machine guns are practically useless against air, and it is a grave question whether men will remain in their vehicles and fire any type of machine gun against a low flying hostile airplane.

The 37 millimeter gun is another weapon that has been built in large quantities and which has no practical use except in small quantities in the infantry to operate against machine gun nests.

In pursuit in rough country, column commanders must be well forward. Where only the first few leading tanks are engaged, a column commander should have his tank not more than six vehicles from the front, and the infantry commander should be right with him.

The Cub airplane has proven to be one of the greatest assets for artillery fire and, contrary to expectation, has been able to survive on the battlefield in spite of hostile air.

For liaison communications between infantry-tank-tank destroyer teams it is essential that a sufficient number of radio sets SCR-300 be available to permit distribution down to and including infantry companies, tank platoons, and tank destroyer gun sections.

All artillery should receive training in direct fire over the sights in addition to their normal indirect fire training. All tanks and tank destroyers should receive indirect fire training for use as artillery in addition to their normal direct fire training and should be equipped with the necessary sighting apparatus for indirect fire.

During a pursuit the use of reconnaissance elements, as the leading element in a force, merely because contact has been lost locally, is not justified in most circumstances. Where the nature of the expected next resistance can be in any way deduced - and it usually can - appropriate composition of the column should be made ahead of time to overcome it; usually time is saved in the long run if medium tanks lead. If demolitions, only lightly defended, are to be expected, light tanks in front work well. Putting a reconnaissance element in front is advisable only when it can be used deployed; in a situation wherein nothing more serious than undefended demolitions are expected or where a route reconnaissance appropriate to armored reconnaissance is expected to be the first operational problem to be met. In pursuit situations, liaison missions are so frequent that there is ample work for available reconnaissance without seeking opportunities for its employment otherwise. In a pursuit the three most habitual and most profitable uses of the armored reconnaissance platoon have been:

- a. Contact patrols to contact flank units.
- b. Flank observation posts.
- c. Reconnaissance of alternate routes parallel to axis of advance.

Motorcycles again proved their worth in the last operation. Because of the ability of the cyclist to get through heavy traffic quickly, the carrying of written communications was greatly expedited. Because of the single axis of communication available to the battalion throughout the operation, traffic was always congested, and during one phase, it took a motorcycle fifteen minutes to deliver an important message over a route that took a "peep" one hour and twenty minutes to travel.

Recent actions involving much combat reconnaissance have revealed the necessity for the following modifications in the Armored Car M-8:

- a. Added protection on the floor to protect the crew from mines; designing the floor to permit heavy sandbagging would be of some value.
- b. Better protection for the radiator. A regimental reconnaissance company had twelve (12) cars knocked out of action due to shell fragments through the radiators during a period of less than one month.
- c. Add a .30 Cal MG bow-gun to be operated by the assistant driver.

The hatches for the driver and assistant driver on light tanks should be redesigned to permit unrestricted movement of the gun when hatches are open. On many occasions the gun is fired when it is not advisable for the tank to button up.

In operations in mountainous or otherwise difficult terrain, the M-4 tank dozer proved to be the most valuable vehicle in the entire force. It is capable of working under artillery fire and the speed with which these vehicles were able to repair obstacles was not approached by any other method. They were kept well forward in the column at all times as they could rapidly reach the head of the column when needed.

Present camouflage nets are very inflammable. Many have been set on fire by shells or bombs causing great vehicular damage and loss. The garnishing material is not dyed fast and must be replaced in a few months.

When TDs are firing in artillery roles, it is highly desirable to have a large size fire extinguisher placed in a hole to rear of M-10.

Sights, both direct and panoramic, should be equipped with night lighting devices. Makeshift lighting devices are not satisfactory. In direct fire at night, hits simply will not be obtained without such devices.

At the present time all members of the armored car crew in reconnaissance elements are armed with the carbine. It has been found that an automatic weapon similar to the Thompson Sub-Machine Gun must be the arm of one of the occupants of the turret of the armored car particularly when operating in close areas infested with enemy infantry. The enemy will watch the traverse of the turret and move towards the armored car when the turret guns are not pointed directly at them. This automatic weapon provides necessarily rapid close in fire against these individuals who attempt to disable the vehicle by approaching from blind spots.

The "Bazooka" would be more effective if the ammunition was more sensitive to detonation. Its effect on houses and fortified strong points would be doubled if it did not take such a direct hard blow against a very solid substance to detonate it.

The packing of mortar ammunition should be improved. A wood chest, 3 rds per chest, with a handle for carrying, is suggested.

Combined infantry-tank training cannot be stressed too much. Recent intensive training of the armor of this division with infantry elements of another division proved to be of great value. This was shown by closer cooperation, better understanding of capabilities and limitations of troops, weapons of other units. However, it is felt that while close support of tanks, medium or light, is desirable, it was found not to be always practicable. In most instances it has moved forward faster than foot troops can advance. By lingering and waiting for infantry to mop up, the tanks expose themselves unduly, and if the tanks continue on, enemy infantry will rise up and a regular infantry battle ensues, thereby breaking up the tank-infantry team play. This situation was remedied by using medium tanks for the assault punch and attaching light tanks to the infantry to

assist in mopping up operations. It is believed that semi-permanent tank-infantry teams, trained together and used together whenever possible in combat will alone insure the accomplishment of a tough mission.

More training must be devoted to the meaning and requirements of one's combat missions. This will require commanders of all echelons to be more careful and concise in the assignment of the mission, to question the subordinate commander carefully to avoid all possible misunderstanding of the mission. It will also require the subordinate commander to devote more care to the complete understanding of his mission. Then, he must be allowed full independence of action within the scope of his mission. With the full knowledge of what is to be required of him, the subordinate will be able to conduct himself and his command more intelligently, with the long term requirement in view. It will also render the constant repetition of orders, which are dependent on perfect radio communication (often lacking), much less necessary.

More emphasis must be placed on training of combat and reconnaissance patrols. Use of prescribed routes, reports of where, when and what, and the necessity for the accomplishment of the mission cannot be too strongly impressed on combat personnel.

As this has been a discussion mainly on training, details as to recommendations on changes in equipment and tables of organization, particularly as pertain to an Armored Division, will be covered separately.

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