SUMMARY

Reenactors have overwhelmingly accepted an infantry impression, but armor is growing as a part of the WWII living history experience. This is a summary of what reenactors will need to know, along with things they might want to know, as the presence of combat vehicles increases at events. This guide covers the role of armor in World War II, the technical evolution of Armor and how it influences its part in victory, the principles of tactics and gunnery for armor and how they fit in with the "big picture" on the reenacted battlefield, and—as a necessary part of understanding the challenges—how to coexist safely with large combat vehicles during field exercises.

Most living historians who operate large combat vehicles will be familiar with the principles and practices described here. The guide is written primarily for reenactors who are familiar with the role and details of infantry combat.

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SECTION I. INTRODUCTION

Most reenactors embrace an infantry impression. It makes sense. Who can afford a tank? How many living historians have a healthy enough bank account, a large enough garage, and a strong enough marriage to support an M4? You can love animals more than life itself, but it's easier to be a cat person than to bring a water buffalo into the house.

Besides, being infantry is easy with only a few people. Being a tanker requires four or five friends who will show up at an event and risk suffocation, hernia, hemorrhoids, and bladder problems. A grunt just has to show up with his personal kit and an attitude.

"Hullo, glamorous."
"Howdy, Blitzkrieg."

Now, however, combat vehicles are showing up in ever greater numbers.

Sure, we've had wheeled vehicles—jeeps, WC's, the occasional deuce and a half—for years. The odd greyhound or half track shows up. But jeeps and trucks are not combat vehicles. They're combat support vehicles. They carry stuff. Sure, a truck might have a Ma Deuce on a ring mount over the cab, but that's there for air defense. Use a truck or a jeep for combat and bullets will turn it into a blackened engine block and frame and a bunch of shredded tinfoil.

Ah, but when the big tracks roll off their flatbeds, it's a whole new world. They're here, and more are coming, so let's get used to it and try to learn about them.

NOTE: Most people who own armored combat vehicles are tread heads by experience. No one else (except, notably, the federal government) is brain-damaged enough to buy a self-propelled environmental disaster, rust factory, and magnetic anomaly. They generally know not only how to keep the things running, but also are likely to know a lot of the material in this guide. I am writing for the instruction of infantry guys and the amusement of the clankers.

References: FM 100-5; FM 100-15; FM 17-5; FM 17-10; FM 17-20;FM 17-30; FM 17-33; FM 17-42; FM 18-5;

SECTION II. THE ARMORED FORCES

ESSENTIALS

- **"The armored forces" are the outcome of a long philosophical debate concerning the role of the tank: is it an infantry support weapon, a firepower backup for horse cavalry, or does it fit into a separate, independent category? This debate ended when the Wehrmacht rolled over France in 1940.**
- **The armored forces reflect a combination of arms that have in common the ability to move swiftly in vehicles: tanks, armored infantry, and self-propelled artillery.**
- **The armored forces were to be used in exploitation and pursuit in the offense, and as a counterattacking force in the defense. Tanks were to be used offensively, and would engage other tanks only as the situation demanded. Mobile antitank defense was the task of the tank destroyers.**
- **Most of the tank resources were assigned to the armored divisions, which were independent combined arms packages of mobile whupass. Additional separate tank and TD battalions were available at GHQ and field army reserve, and were parceled out as needed to reinforce infantry divisions.**
- **German armored force doctrine was very similar to the US philosophy.**

■ **1. General**. It's not just about tanks. This calls for a little background. This may be confusing, but it is important to bear in mind that the armored forces were more than just tanks, although the development of the tank in WWI started the ball rolling.

When tanks were first used in WWI, they were there to provide mobile protected fire support for the infantry attacking across no man's land. The original German term for a tank was something terrifyingly Teutonic like *Schützengrabenvernichungsauto*, implying an ugly, smelly monstrosity that could cross and demolish trenches, barbed wire, antipersonnel mines, and other familiar infelicities associated with trench warfare.[1]

■ **2. The development of armored doctrine**. After the armistice in 1918, armies took a brief coffee break, then (without much publicity or funding) started planning for WWII. It's what we do. Anyway, tanks had enjoyed some success and were here to stay, but there was disagreement over their purpose. Infantry wanted them to provide infantry support, à la 1918, which meant they did not have to move faster than the doughfeet. Cavalry wanted tanks to support (not supplant) horses, providing fire support at the speed and mobility of mounted troops.

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[1] The first tanks were British, and they were designed and built under strict secrecy. When they were shipped over the channel to join the fun in Flanders, the crates were labeled "TANK" as a security measure. The name stuck. It is the common name used in English, Russian, and Korean. The French don't like foreign words, and use the term *char*. The Germans, perhaps still resentful of the TANK prank, use *Panzer* (from *gepanzerte Kampfwagen/ armored fighting vehicle*).

While that fight was going on, a third group of conspirators wanted to make the tanks the centerpiece of a new, independent branch—what would someday be called the "combat arm of decision." This heresy (which is what infantry and cavalry traditionalists considered it) was international—men like Chafee and Boudinot in the US, Liddell-Hart in England, Tukhachevskii and Pavlov[2] in the Soviet Union, and de Gaulle in France—did the groundwork. But it was slow going. The old guard was hostile and suspicious, which is what Old Guards are paid to be. Stingy legislatures

Figure 1. Pioneers of armored force doctrine. r-l, top to bottom: Sir Basil Henry Liddell Hart; Adna N. Chaffee; Mikhail Tukhachevskii; Dmitry Pavlov; Charles de Gaulle; Heinz Guderian.

and parliaments didn't want to spend a bunch of money on iron monsters that tore up country lanes and polluted the air.

[2] Both these officers were on the money with respect to tank employment. Tukhachevskii was purged and shot in the late 1930's for the crime of "being there". Pavlov carried on, and was in the process of reorganizing the Red Army's armored forces when the Germans attacked in 1941; he was shot for the crime of not being finished. However, his reforms continued on an accelerated schedule.

It is wisely said: "any fool can learn from his mistakes. The wise man learns from *other* peoples fuckups." And so it was. In 1940 France fell in record time to the concentrated German armored forces. Heinz Guderian had been doing some work on this problem, too, and he read what Chaffee and Liddell Hart and Tukhachevskii et al. were writing. He ultimately bypassed the *Wehrmacht* Old Guard to go straight to the top—yeah, *him*. The French actually had more and better tanks, but the German employment of coordinated and swift-moving forces of tanks and armored infantry decided the battle. Now the uneasy powers not yet involved started playing catch-up. One consequence was that the armor-as-a-separate-branch theorists won, the hard way and almost too late to matter.

The armored forces were organized on a basis similar to the foot-propelled or air dropped forces. They need the full range of capabilities for land combat, including infantry, tanks, and artillery. The difference is that all these have to move with the mobility of the tank. By *mobility*, I mean the combination of where it can go and how fast it can go. A Maserati can be fast and furious on a paved highway, but it isn't "mobile" because it can't operate off the road.

Infantry in the armored force. *Infantry* operating as part of the armored force was called—wait for it—*armored infantry*. (Nowadays it's called "mechanized infantry", but it's the same idea.) Armored infantry was organized just like regular straightleg heavy infantry, but it was carried around in half tracks. Its internal fire support (mortars, AT assets, etc.) are also mounted.

Artillery in the armored force. *Artillery* operating with the armored forces was and is self-propelled, which means it was not towed behind something. Early in the war it usually consisted of 105mm howitzers bolted onto cramped half tracks, later the 105's and 155's were mounted on converted M4 chassis. The point is, they could go where the tanks go. Infantry is called the Queen of Battle; artillery is the King of Battle because, as some anonymous gun bunny once put it, "it puts the balls where the Queen wants them."

Reconnaissance. *Reconnaissance* elements in the armored force are—again, wait for it—armored. Each armored division had a recon outfit that was lighter and more mobile than the main tank and armored infantry units. Each corps was generally assigned an armored cavalry group (later called an armored cavalry regiment), a formation large enough to cover and screen a corps front. These units were endowed with light tanks, armored cars, and half tracks. The difference between an armored cavalry unit and an infantry mounted scout unit was that the cav group was supposed to find the enemy *and* fight the enemy (usually to delay).

■ 3. Important elements of armored doctrine.

Rather than launch a major discussion of armored force doctrine (which you can find by going to **FM 17-33**; I've prepared a digital annotated version for those interested) we will just examine some basic WWII principles.

a. Tanks are used to exploit infantry breakthroughs in the *offense*. We are not to waste these precious and expensive resources slogging through enemy defenses. Armored forces should pour through gaps in the enemy's front and run wild in the rear, exploiting and pursuing the enemy.

b. In the *defense*, armored forces are held in the rear as a mobile reserve to counter attack. Tanks are wasted on the line, where their firepower is limited by a lack of mobility.

c. Tanks are to be used in mass, not scattered here and there on the battlefield. In general, the very smallest unit for tank operations is the platoon (4-5 tanks). Anything smaller replaces shock effect and firepower with a good target for the enemy. Of course, there is that unfortunate principle of war: **the enemy always gets a vote**. You do what you have to do, and if that means splitting tanks, you do it.

d. Tanks are never used alone. They are always accompanied by infantry. Infantry accompanying tanks should be armored or motorized infantry (that is, carried by halftrack personnel carriers or on trucks, respectively). The reason for this is that tanks can't take advantage of their mobility if they can only move at an infantry marching pace. But: see *c*, above.

e. When using tanks, always remember that *they require hours of maintenance for each hour of operational use*. Unlike infantrymen, a broken-down tank (is there any other kind?) will not respond to encouragement or kicks or appeals to patriotism. *Corollary*: the faster and farther you push tanks, the farther they get from their fuel and ammo and spare parts supply.

f. On a route march (that is, not within range of enemy observation), move in a column, using the most trafficable route (usually an unmined road), as this usually affords the best control and fastest pace.

g. When you cross the line of departure and move into approach march (the enemy is close), don't move one behind the other. It will allow an enemy to your front to engage you with everything he's got, while your tanks in back are unable to fire back without hitting tanks in front. Approach march may be in line, echelon, wedge or "V", depending on which formation will afford maximum unmasked fire (fire is masked if there are friendlies in the line of fire). *Corollary*: friendly fire is just as hostile as enemy fire.

h. Think of a tank as a very overweight infantryman capable of firing huge-assed bullets. Like doughfeet, tanks should never attack in the open when cover and concealment are available. Steel is dandy, but dirt is even better. Pop up in defilade (see figure 6) and take a shot, then shift and do it again.

■ **4. How the US armored forces were organized and why.** A lot of thought went into the organization of the armored forces. Unlike the Infantry, there was not a long history of theory and practice in how this combat arm was to be organized and used. Starting with a clean slate is good and bad. You are spared the unyielding resistance of traditional experts who are always ready to cite the War of 1812, but the doctrine writers and thinkers didn't have a lot to work with other than their own imaginations and a couple of years' vicarious analysis of German practice. Here is what they took away from the *Blitzkrieg*:

a. The forces designated to strike the main blows should be fast and self-contained. the genius of the Blitzkrieg was that it could be used to "get inside the enemy's decision loop." This is a modern term that captures the essence of the Blitzkrieg: *move with speed and flexibility, fast enough that by the time the enemy figures out what you're doing you've already started doing something else. Corollary*: This philosophy is best used with a slow-witted enemy, but international politics is not within the scope of this monograph.

b. There are several essential rules for Blitzkrieg, but the first we consider is *use of combined arms*. This generally refers to the combination of tanks and armored infantry, supported by combat engineers and mobile artillery and used in coordination

with close air support. As noted earlier, all of it must move quickly—there is no point in attaching dismounted infantry to attacking tank formations, because coordinated employment would require the tanks to move at the speed of marching infantry.[3]

c. Don't waste tank resources battering down prepared defenses. Hit them where they are weak, and if there are strong antitank defenses, hit them with infantry and artillery, then send the armor through the smoking hole.[4] Keep on the move. "Bypass and haul ass", as we say. Let follow-on troops mop up. That's why God made National Guard divisions.

■ 5. The armored division

The original concept for the armored division—which was applied to the 2nd (Hell on Wheels) and 3rd (Spearhead) divisions was a force with two heavy armored regiments that in fact included large (3x battalions) armored infantry forces along with battalions or medium and light tanks. These divisions fought through the war with the "heavy" structure.

All other armored divisions were of the "light" organization, designed to provide flexibility of task organization. This division consisted of a division base (HQ, plus reconnaissance, engineer, medical, supply, and other standard supporting structures, plus six maneuver battalions (3 tank, 3 armored infantry). In addition, there were three "combat commands"—tactical headquarters to which battalions were to be assigned on a changing basis depending on the mission needs. There were no regiments, just the combat commands, called Combat Command A, Combat Command B, and Combat Command Reserve. The last (CCR) was a holding structure for a small tactical reserve and a place where battered units could pull back from active combat for a quick rest and refit.

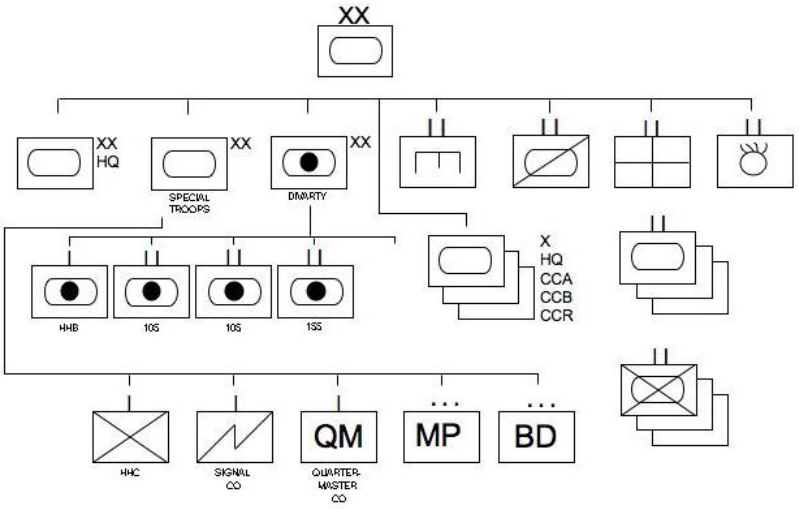

Figure 2. The armored division. The "light" armored division ("Hell on Paper") consists of a division base (headquarters, combat support such as artillery, engineers, and recon and combat service support (medical, ordnance, quartermaster, signal, military police, and the division band (which provided music on

[3] This was achieved in the armored divisions by assigning only armored infantry battalions. Elsewhere, the answer was typically American: turn a leg infantry RCT or division into a motorized division by assigning separate truck battalions from the huge theater reserves.

[4] This sounds good, but we should consider the most annoying principle of war: *the enemy always gets a vote*. Don't depend on him to leave you a convenient point to attack.

special occasions, but generally provided stretcher bearers in combat)); three tactical headquarters called *combat commands*, which are really brigades; and six maneuver battalions, three each of tank and armored infantry, to be assigned as the situation dictated, to the CC's. The division was almost entirely self-sufficient, though it was usually reinforced by an attached AAA battalion and, if necessary, additional truck assets to haul ammo and fuel for extended operations.

A couple of things to understand about this seemingly unfamiliar idea:

a. **The battalions were all separate numbered organizations,** not part of any regiment. Most tank and armored infantry (and tank destroyer) battalions were separate, the only exceptions being those in the 2nd and 3rd "heavy" armored divisions. Some were permanently assigned to the light armored divisions, but many were simply separate battalions that could be assigned from theater reserve to bolster infantry divisions. This was supposed to allow higher commanders to concentrate the armored force resources at the critical points instead of scattering them all over the battlefield (the result of the interwar debate about infantry support versus concentrated armored formations). In practice, separate nondivisional tank battalions were assigned early on to infantry divisions and seldom sent elsewhere. For example, the 29th Infantry division entered Europe with its skinny all-rifle organization reinforced by the 747th Tank Battalion (Separate)—plus the 821st Tank Destroyer Battalion and the 554th Antiaircraft Artillery Battalion. These battalions stayed with the 29th to the end.

b. **The combat commands, as noted earlier, were "tactical headquarters"—**they had no troops of their own, just the battalions assigned, and a battle staff but no administrative or logistical responsibilities or capabilities. These were provided by division.

c. If you're going to specify six maneuver battalions (that is, battalions of infantry or armor), why not just assign one tank battalion and one armored infantry battalion to each CC? This would provide "two up and one back", a basic part of mobile warfare. The answer is, the armored division was designed for two specified purposes: exploitation and pursuit, which involves taking advantage of a penetration of the enemy's line, and counterattack on enemy units that manage to get through your line. Neither mission calls for much reserve—maximum combat power is going to be up front.

So why have CCR at all if you don't want to waste combat power on a sissy reserve? One critic suggested that would call for a Combat Command C (CCC), which might sound like stuttering or be confused with the Civilian Conservation Corps. The real reason was to provide a way of rotating battalions during an offensive when they become weakened by constant contact. They could be assigned to CCR to recover, and elements of CCR sent forward to take their places. Using CCR as a separate maneuver element was theoretically a bad idea.

But theory has to deal with reality. In fact, the Allies invaded Europe on the cheap, and most combat power was constantly employed forward because there was so much front to cover. The armored division is not designed to defend a sector of the line, but sometimes a division's got to do what a division's got to do.

"War is hell," the saying goes, but "actual combat's a motherfucker" as we used to add in my youth. You do what is necessary, and doctrine can take a ten-minute break. As the 4th Armored Division approached Bastogne from the south to relieve the 101 and "Team Snafu" defending the perimeter, CCA and CCB ground to a halt a few miles

short of linkup. The only force left was CCR, which consisted of one tank battalion (37th) and one armored infantry battalion (3rd), both shot up and understrength. But the job had to be done, and so it was done. CCR made the linkup, depleted or not, and Creighton Abrams earned his rep.

d. How do we form combined arms teams? We can't just send in a battalion of tanks followed by a battalion of armored infantry. The answer is: *cross-attachment*. Let's say CCA is a tank battalion and an armored infantry battalion. For the operation, one company of armored infantry is assigned to the tank battalion, which gives up a company of tanks in trade. Companies then exchange platoons, to provide tank-infantry teams.

Since the teams are no longer pure and their composition is not permanent, but done to complete a particular task, the formations are given temporary names, often using the name of the senior officer (Team Desobry, Team Cherry).

e. Commanders of combat commands (and armored task forces in general) were allowed considerably more leeway for maneuver and on-the-fly modification of plane than are dismounted infantry maneuver units. The reason is, the armored force "packages" are supposed to be grinding around ahead of everybody else causing mischief and destroying everything in sight. An offensive force on the move has to make decisions in a timely manner, and is often so distant from division or corps decision-makers that everything submitted for permission is old news by the time it circles back to the leader on the spot. Sometimes this can cause problems, but these rolling messages of bad news are ruled by the principle of calculated risk. The only restriction is to stay within the mission and execute the commander's intent, which is usually a frag order something like "drive east to BIDONVILLE. Blow stuff up on the way and occupy the town. Let me know how it's going."

In late December 1944, advance elements of Third Army approached the Bastogne perimeter from the south, seeking to link up with the defenders and establish a clear corridor for resupply and reinforcement. The 4th Armored Division led the pack, but by Christmas Day CCA and CCB had stalled only a few miles from the positions of the 327th GIR, 101st. The only resources left were in CCR miles to the south. Comprising CCR at this time were two beat-up battalions—the 37th Tank and 3rd Armored Infantry—led by a new commander. A task force was formed from these battalions and sent north to bypass the CCB position. wheel north and west to secure the town of SIBRET, and then push through to the besieged US forces.

Senior officer of this force (TEAM CHARLIE) was the 37th tank battalion commander, LTC Creighton Abrams. Intelligence arrived indicating that SIBRET was heavily defended. Abrams made the choice to change the mission and drive north and east through ASSENOIS, led by a tank-infantry team commanded by his S-3. The move was successful, and 4th AD linked up with the 101st.

This illustrates a difference between mobile war and foot-speed war: things happen fast, decisions must be made on the spot, and trusted commanders are given latitude. It doesn't always work, but sluggish decisions are usually wrong, win or lose. *L'audace, l'audace—toujours l'audace!*

■ 6. German doctrine and practice

The new German Wehrmacht was created from the wreckage of WWI which left the country with only the weak *Reichswehr* and a small *Truppenamt* in place of the banned general staff, hemmed in by austere treaty restrictions and economic poverty. The transformation of German arms in two decades into a powerful force was

astonishing for a country with no "good will equity" and limited supplies of critical resources. Despite the formidable ambitions of the Nazi regime, Germany was obliged to wage a poor man's war. That they were able to do so for so long with so many successes owes largely to the aggressive facade and bluff that characterized Axis policy.

Armor and the offensive doctrine. The emphasis on armored forces came late in the approach to war, and the result was that the material and doctrinal resources were thrown together in a rather haphazard way. The technical features of German armor were actually rather unimpressive. French armor technology was superior to Germany's in many ways in 1940, as was that of the Soviet Union. All the major powers, as noted earlier, were struggling with the question of how to put it all together into a coherent and effective doctrine. Germany managed to find the answer, though at the last minute, almost as the Wehrmacht was deploying for the invasion of France. The result of that swift campaign underscores a critical point: having the resources is only the first step. You must have the will to use them and a realistic and bold idea of *how* to use them. Germany had both; France had neither.

Part of Germany's strength was its tough and aggressive doctrine. But that sufficed only as long as the war was going well. In 1942, things started to break bad for Germany. A doctrine based on the endless offensive became a rubber crutch when the offensive started to fizzle out. The German armored force was able to remain as effective as it was due to two mitigating factors:

a. Flexibility and toughness of leadership and flexibility of tactics. Interestingly, one of the principle lessons of WWI the German military leadership considered during the rebuilding was that rigid Prussian leadership was sufficient to make troops perform. The model used by the postwar *Truppenamt* was the American model of leadership, which stressed initiative at the unit level as a counterbalance to the terrible confusion of the modern battlefield. In the new Wehrmacht, there was special emphasis on small unit leadership and tough reactions to problems that could not be handled by awaiting orders.[5]

The *Kampfgruppe*. The tactical problems in the East were particularly vexing. Terrain seldom favored the defense on the endless steppe, so it was hard to find something on which to anchor a flank; this meant extremely long front lines that had to be continuously manned with forces numerically inferior to the enemy's, and limited reserves. The answer to this problem was to receive an attack, accepting the breaks in the lines, but keep the tactical situation from deteriorating into chaos by forming ad hoc units from the remnants of the forward elements. (This was abetted by the Russian doctrine of bypassing strong points and maintaining the offensive momentum.) These ad hoc units were designated *Kampfgruppen*, or battle groups. The word can mean a formally constituted combined arms team assembled for a particular mission (in US usage, a *task force*). But out in Russia it often mean a sort of coalition of what pieces of units were still together, organized on the fly by the senior or most creative officer still standing. Long experience with tough discipline, unit cohesion, and reluctance to be killed or captured by the Russians provided the glue that held Kampfgruppen together until they could find a defensible position and, eventually, reorganize into their old units to receive resupply and replacements.

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[5] Rommel is supposed to have said something like "In absence of orders, go find something and kill it."

The "backhand blow." If your organization and psychology are relentlessly oriented to the attack, defending can be a bitch. The German answer in the East was what von Manstein famously called the *Schlag aus Nachhand*, a tennis expression for striking the ball with a backhand swing. This was a way of defending . . . offensively. The backhand blow was delivered with whatever mobile reserve you could muster when the enemy has disclosed his direction of attack and tactical objective. The *Schlag* was used to break the enemy's offensive momentum and give your own forces time to reconstitute a continuous defense. It was a Hail Mary play, granted; but it worked for quite some time—actually, it worked until the German forces were stretched too thin to keep anything like an effective mobile reserve.

SECTION III. THE TANK

ESSENTIALS

- **A tank is a high-speed, full-tracked vehicle with a large-caliber direct-fire gun mounted in a revolving turret, with a crew and operating space protected by heavy armor. It is designed for use in the offense.**
- **A tank destroyer differs from a tank in that it is high-speed and fully tracked and mounts a large-caliber direct fire gun, but lacks the heavy armor. It is designed for mobile antitank defense.**
- **The basic M4 design served throughout WWII, with product improvements over time that improved its mobility and firepower.**
- **The M4 series was powered by a gasoline engine (some later models used diesel) in the rear of the hull that transmits power to front sprockets through propeller shafts to the transmission placed in the bow of the tank.**
- **The M4 uses a simple system like a commercial tractor, employing three bogies on a side with horizontal volute springs.**
- **The M4, like all weapon systems, was a compromise between technological perfection, tactical performance, and mass production. While it was inferior in many ways to comparable later enemy tanks, it was produced in huge numbers and employed to take advantage of its strong points.**

■ **7. General**. A tank is something very specific. It is a high speed, full-tracked vehicle with a direct fire main gun of large enough size to dominate the battlefield (just how large evolved fast in the war, so it's a changing standard limited only by the boundaries of engineering and physics). The gun is mounted in a revolving turret[6], and gun and crew are protected by just enough armor to afford sufficient survivability unless struck by large armor-piercing rounds.

[6] This is a twitchy definition. The Swedish STRV-103, fielded in the 1960's, had a 105mm main gun but no turret, and it was classed as a tank. However, its suspension and transmission allowed the entire vehicle to pivot almost as smoothly as a turret. The idea did not catch on.

We will use the basic Sherman design to illustrate US tank principles, since this concept endured throughout the war, extended by one product improvement modification after another, and by 1967 the ever-creative Israeli Defense Force had even found a way to mount a 105mm main gun. But the M4 was rather retro by 1944; it was the US war industry's first quick and dirty design, and it used technology that was available at the time. Once we started churning these tanks out, there was a lot of resistance to constant product improvements that would slow production. The Germans, by contrast, constantly fiddled with new ideas and new inventions, producing impressive results now and then (and quite a few stinkers in the process), but the constant turmoil in design reduced the numbers that could be fielded. Which approach was right? Well, both, in a way. But option 1 produced victory, option 2 produced rusted hulks of fancy tanks.

■ **8. Tanks and tank destroyers.** Tank destroyers, like the US M10, M18, and M36, were deliberately "non-tanks"—they looked like tanks, walked like tanks, and shot big bullets from a turret, but they were lightly armored. The reason for having them are found in Army doctrine of the 1940's, which we'll examine later. As a practical matter, they provided large-caliber direct fire, most important in defending against enemy tanks, and were best fired from covered positions. In short: tanks are offensive weapons, while TD's were supposed to be used to concentrate fire in defensive situations. See Section IV on tank destroyers for details.

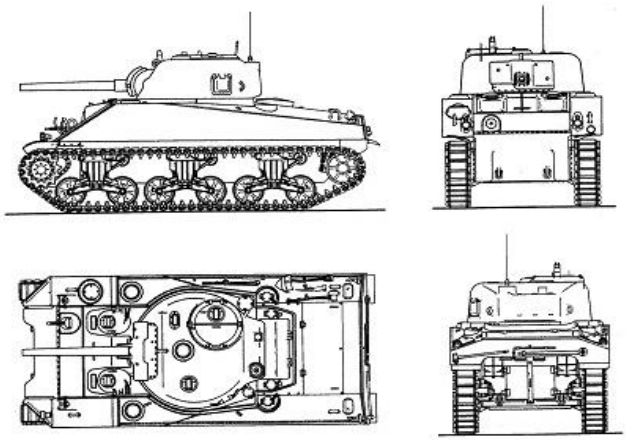


Figure 1. **A tank.** The M4 series was widely produced in WWII; most examples were typical tanks like the one above, but the carriage was modified for use in other applications. The original M4 was easy to produce, using a gasoline engine and a tractor-style vertical volute spring suspension (late models used a horizontal volute spring system, HVSS, which provided a smoother ride).

■ **9. How tanks work: tracks, drive, and suspension**. Tanks are invariably tracked vehicles. What is a tracked vehicle? It's basically a wheeled vehicle that carries its own road in the form of a linked track. This feature allows it to move more effectively off-road than standard wheeled vehicles because the ground pressure is spread to more surface area. This does *not* mean that tanks or other tracked vehicles can go anywhere—a tank can get just as stuck as a jeep[7], but if the crews of the tracked

[7] Longer ago than I care to remember, I found my entire tank company (seventeen tanks and three personnel carriers) mired in mud to their sponsons in a fire support base motor pool at the top of a hill called Nui Con Thien (Vietnamese for "place even Marines won't defend"). If they had been on low ground, I guess only the tips of their whip antennas would have been visible.

vehicle uses good sense it can generally maneuver across country without a lot of drama. By good sense, I mean avoiding errors like moving in a single column over unsuitable soil (the first few tanks churn up the surface and create soft mud that may more the vehicles that follow). Driving down alleys that are narrower than the width of the tank is discouraged as well. Simple stuff.

■ 10. Moving the tank: basics.

Drive system. The M4 uses a full track design with the engine in the rear and the drive sprocket in front. The drive sprocket is cast and milled with radial teeth that engage the track between blocks to drive it forward. This requires a complex power train of universal-jointed propeller shafts projecting from the engine in the rear of the hull forward to the dual transmission and final drive gears that turn the sprockets. This is a seemingly clumsy arrangement, and takes up quite a lot of space on the turret floor, cramping the crew and fighting space.

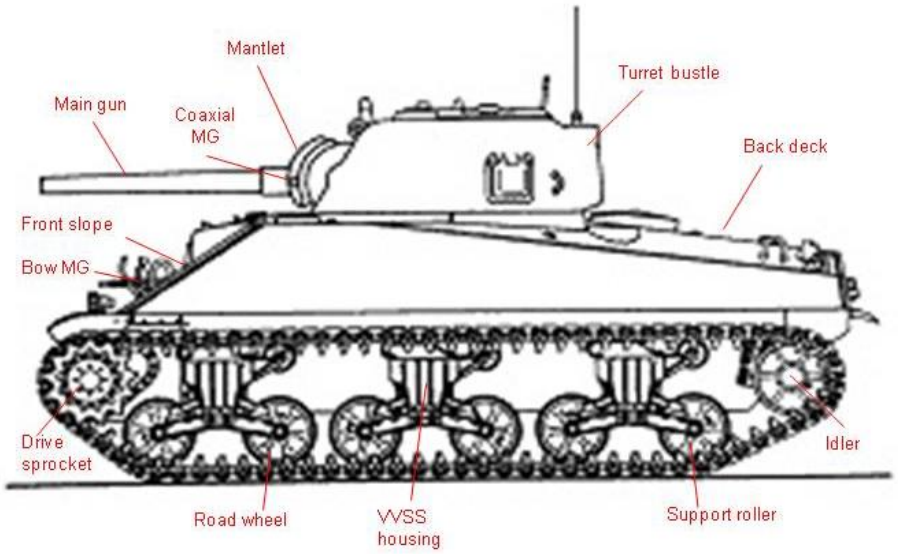


Figure 2. Features of the M4. This is a view of critical features and the correct tread head usage. Note the three bogies (the Brits and railway geeks call them "trucks") composed of a volute spring housing and two road wheels. The support rollers on top opf the bogies let the upper part of the track roll smoothly over the suspension housings. The turret bustle is actually a counterweight to the main gun on the front of the turret, since an unbalanced turret would cause wear on the gears and rollers of the turret ring on which the structure rotates. The drive sprocket actually drives the track. The engine and transmission are at the back of the tank, which means the drive shafts must go all the way from the rear end of the tank to the bow.

The mantlet is a wide, thickly armored collar around the main gun the protects the aperture on the front of the turret that must be open to allow the gun to elevate and depress. The coaxial machine gun (so called because it is slaved to the main gun and elevates on the same axis on the trunnion; you aim and fire the coax through the main gun controls). The bow MG is on the right of the tank's front slope, and generally uses a ball mount to provide elevation and traverse (moving side to side); the driver sits on the left side of the front slope.

Over time, user modifications tended to be made standard, like grab handles on the side of the turret to provide a grip when crew walts on the top deck (and offering a place to the crew to hang various gear) and the famous hedgerow-cutting rhino blades. The back deck is taken up with the engine grills. The tank engine is air cooled, and gear can only use a small part of the back deck for storage or the lack of cooling flow will cause the engine overheat.

Why not drive the sprockets from the rear and save all this crank case, propeller shaft complexity? The reason is easy to demonstrate. Cook a single spaghetti noodle until soft, then remove it from the pot and stretch it out on the counter top. Try to move it by pushing it from the rear. Then try pulling it from the front. Easier, right? Pushing a limp track from the rear would cause any slackness to make the power impulse uneven and might dislodge the track, while pulling it from the front keeps the upper travel of the track taut. So, why not just place the engine in the front of the hull? Because you need space for the driver and bow gunner.

[**Note:** Nowadays, most tanks are rear-sprocket designs. This is due to the development of "live" track, which has a natural curl in its design (cut a sturdy rubber band and observe that it tends to keep its shape instead of lying flat like the spaghetti noodle in the first experiment). Old-fashioned "dead" track is like the noodle.]

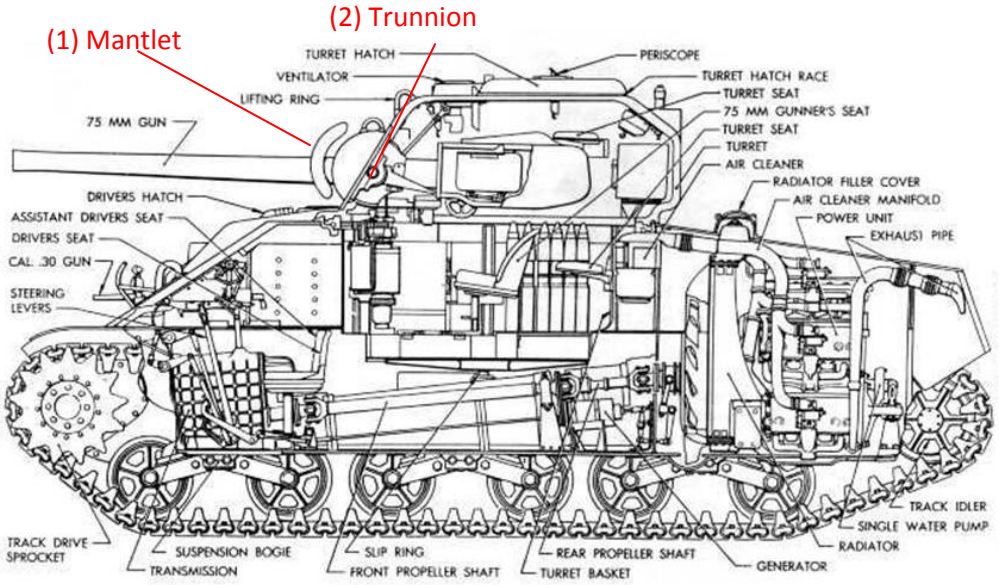


Figure 3. M4 cross-section. This shows the interior arrangement of the basic M4 medium tank. The "assistant driver" serves as bow machine gunner. The tank commander sits on the upper turret seat below the hatch on the top of the turret, the gunner in a seat below and to the right of the main gun breech and facing the telescopic sight. The loader can sit on the lower turret seat or stand on the floor of the turret basket. Note that the main (75mm) gun projects through a heavy cast steel mantlet (1) and swivels vertically on trunnions (2). Main gun rounds (90 in this model) are stowed around the turret basket and forward between the driver and assistant driver/bow gunner.

The suspension. A couple of design notes: The M4 basic approach used a tractor suspension system using *bogies*. A bogy (and the word is often misused) is a complete volute spring suspension unit: two road wheels and the spring suspension, with a return/support roller on the top to help the upper part of the track loop return smoothly. An M4 had three bogies on a side. The volute springs allowed limited up and down travel of road wheels across country. The latest version, which barely made it to

ETO, used a horizontal volute spring system, a limited improvement. Most tanks since have used torsion bars.

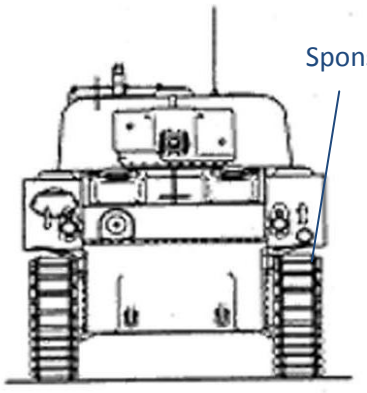
A tank steers by using the two tracks. The transmission and braking system allow the driver to increase or decrease power to each track separately. The driver also has the option to "pivot steer", driving one side forward and the other in reverse, making the tank spin on its center of mass. The more advanced German tanks could not pivot steer.

■ **11. Design compromises.** The M4 was not on the technical edge of tank design when it was fielded. It was rushed from prototype into production from to replace the transitional M3 tank, which was to prove unsatisfactory early in the war. The Sherman was designed for mass production, and there was general resistance to major modifications that might interrupt the flow of M4's to the combat theaters. This ensured that the M4 would be "adequate but obsolescent" by the last year of the war. Surety of stopping a German main gun round from the Tiger or Panther would require something like 10" of homogeneous steel, which was not practical; training and courage would have to make the difference.

A problem with any tank, M4 included, is *field of view*. The commander (in the turret) and the driver (in the hull, left front), could crank up their seats so the head was above the armor and the hatch (naturally) open, which made driving easy. You could see where you were going. It was also easier to see threats. The problem: it's easier to detect the enemy when your head is exposed, but it's also easier for the enemy to shoot you with small arms or pepper you with shrapnel. Under fire, you had to "button up"—slam down the hatches and look at the world through the various periscopes. Searching for targets and threats with a narrow field of view is hard, and there is also the threat of small infantry units with AT launchers creeping up to hit you from close range. This is one reason for never employing tanks without infantry.[8]

The M4 also has a very high silhouette. This creates comfortable crew and ammo storage space at the cost of making it a larger target. US tanks until the appearance of the M1 series tended to have higher silhouettes for a variety of reasons, not least of which is anthropometric—the height of the average American soldier is somewhat taller than that of most potential enemies.

The armor on the M4 series was adequate. The first model had cast hull and cast turret, which improved integrity; some later models had welded plate hulls, some models reinforced (example being extra plates welded on the flanks to provide extra protection for ammunition storage).



The M4 engine was gasoline powered, and the flammability of gasoline caused many catastrophic vehicle losses. Diesel engines would have reduced that risk (as well as using more efficient fuel), but changing the engine would have created significant delays in

[8] It's also a reason tanks never operate buttoned up in reenactments. It's a great hobby, but it's not worth ending up looking like a frozen pizza.

production. Some later models had diesel power packs, but this caught hold slowly.

The biggest source of catastrophic kills was ammunition storage, which on the Sherman was in the sponsons (hull flank overhang) and in the rear of the turret, both exposed and susceptible to problems if the hull were penetrated.

■ 12. Tank armament

The M4 series carried a 75mm main gun for most of the war, replacement with the more powerful 76mm arriving in France beginning in July 1944.

The 75mm L40 was more than adequate for its range and penetration until numbers of Panther tanks began appearing in France and Belgium. Replacement of the 75 with the 76 was not immediate, and by the end of the war most battalions were about half and half (which complicated ammo resupply).

The main gun. The "main gun" or "main armament" is the largest gun on a tank. It is the reason for having the tank. You pick a main gun, then build a tank around it. If the main gun lacks the power to defeat an enemy, the rest of the tank is just useless hardware. First, some definitions and ordnance[9] vocabulary:

The main gun consists of a tube of steel made from cast or extruded round stock (a solid cylinder). The gun is bored through the center from end to end in the desired diameter. This tunnel down the center is called, naturally enough, a "bore." The gun tube is then turned on a huge metal lathe to produce precise thicknesses of steel surrounding the bore. The end of the tube into which the round (projectile and

[9] Learn this if you learn nothing else. An ord*i*nance is a law or regulation ("City Ordinance #120.1 prohibits keeping farm animals larger than a cape buffalo within city limits"). Ordnance refers to matters pertaining to weapons. Watch that *i* when you use the word.

propellant) will be fitted for firing is called the *breech*. The end from which the projectile will emerge on its rendezvous with destiny is called the *muzzle*.

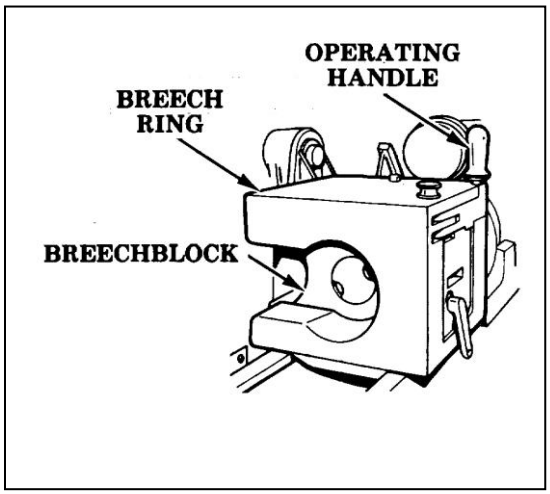


Figure 4. Sliding wedge breech block. This is a typical design. There are two main components: the breech ring, through which the loader rams the round to be fire, and the breechblock, which closes behind the round (cartridge case) to seal the breech so combustion gases do not escape. The laws of physics produces a recoil when the gun fires, driving gun tubs and breech to the rear (buffered by shock absorbers). As it travels, camming action drops or opens the breech block, ejects the cartridge case, and leaves the block open so the next round can be loaded. The operating handle allows the loader to open the breech manually if necessary.

When the round is fired, the conflagration of propellant creates a sudden expansion of gases in the breech; the pressure caused by that expansion is called the *breech pressure*. The pressure drives the projectile down the bore; as the projectile travels inside the bore, it creates volume for the gases to expand, reducing pressure. Thus, the pressure at the breech is highest, and the pressure at the muzzle (*muzzle pressure*) is lowest. Since we want to use the smallest safe thickness of steel, the lathe turns the tube so that the thickness at the breech is larger than the thickness at the muzzle. This is what gives the tube its tapered appearance.

Most large guns were rifled to impart a spin to the projectile, a dynamic that stabilizes the round and keeps it from tumbling out of control.[10]

But we can't just shove a round in the big end and shoot it out the muzzle, because the cases would escape out the back. So we use a breech block, a movable plug that seals off the bore when we fire the round. There are two common breech blocks: the *interrupted screw*, which is of interest mostly to artillerymen, and the sliding wedge. Tank guns use the sliding wedge. (The only exception I can think of was the old M60A2, which was an odd contraption with special needs.)

The basic M4 main gun was the M2 75mm L40. "M2" is the model number, so you won't think it's an M3 or whatever. The designation "75mm" is the diameter of the bore (and hence of the projectile it fires). The "L40" is the "caliber" of the gun. This is not the same as the caliber of small arms. A large gun caliber is the length of the bore in bore diameters. The M2 therefore has a bore length of approximately 40 bore diameters.

Main gun ammunition. Tank main gun rounds in WWII were generally limited (US) to antitank, HE (high explosive) and smoke. The main antitank round was the 75mm **HE/APC-T M61.** This is commonly called "shot". Since it does have a small high

[10] Most tank main guns today are smooth bore, and rounds are fin-stabilized. The reasons can be found online, but are beyond the scope of this guide. Note also that spinning a projectile introduces a drift called *precession*; this is corrected by firing tables.

explosive component, it is designated "HE". The code APC-T means "armor piercing cap with tracer." It was the most common AT round used by the M4.

The shot round. This round consisted of a hardened steel penetrator with a small HE charge in the base just forward of the tracer element, with a "cap" attached to the front. The reason for the cap was the tradeoff in penetrators between hardness and brittleness. A hardened carbide steel penetrator will shatter at high velocity, and penetration is reduced at low velocity because of that pesky $E_k=mv^2$ rule. The answer was the APC round's aerodynamic front cap that included a mild steel core to absorb the shock of hitting armor without shattering and allowed the hard steel penetrator to work its evil spell. It also reduced the tendency of the penetrator to ricochet off a sloped steel plate like that on the Panther. With luck the shot would penetrate and the HE core would explode to finish the job.[11]

Why do these rounds carry tracers? Simple: it's much easier to see where the round went, which is sometimes hard because of the dust and smoke and other crud kicked up by the muzzle blast. This was a particular problem with the later 76mm guns, which was one reason their introduction was delayed. When they finally appeared, the boasted muzzle breaks that diverted blast to the left and right. Without this modification it would have been extremely difficult to sense and adjust rounds. A gunner and TC should be able to see how the first round missed (usually incorrect range estimation) and adjust to kill the target on the second round. This is important because almost hitting an enemy tank often reveals you presence and location and annoys the enemy crew.

The HE round: This is just a shell with high explosive (TNT fill) and a fuze[12] adjustable to "quick", "super quick" or "delay" depending on the target type. This was a disadvantage to the 76mm gun that began to replace the M2 75 L40 near the end of the war. The 76 HE round was not very effective compared to the 75. For this reason, battalions had mixed 75 and 76 rather than doing a wholesale conversion.

The canister round: A big shotgun round to confound attacking infantry at close range.

The smoke round: Similar to the HE except that the fill consisted of a burster charge and a smoke-generating compound (in those days white phosphorus, useful at marking targets for other tanks or for close air support).

US tanks has a flex-mounted cal. .50 M2 heavy machine gun on the turret top, positioned for firing by the TC or the loader. This was designed for antiaircraft defense, but the venerable ma deuce (which is still around, still blowing away the enemies of our country all over the world) has a good antipersonnel effect, not only by impact but also because it is so terrifying it discourages unprotected troops from doing anything useful.

There is also a coaxial machinegun, cal. .30, that is fired from the gunner's sight to stack up any exposed enemy trying to maneuver for a better *Panzerfaust* shot.

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[11] HEAT (high explosive antitank shaped charge) rounds that were range-independent—that is, the distance from launch to target did not affect the penetrating power because the penetrator uses chemical energy instead of kinetic *were* used in WWII, but effectively only in infantry AT rounds like the bazooka, PIAT, and Panzerfaust. There are technical problems with shooting a HEAT round through a conventional tank gun that were not cracked until late 1945.

[12] Attention geeks! A "fuse" uses a powder train timing device. A "fuze" is mechanical.

The bow gunner ("Bog" in the fire command) sits to the right of the driver behind a ball turret of limited elevation and traverse. I don't believe any modern tanks have bow gunners.[13]

■ 13. Blowing stuff up 101: Tank gunnery

What's the deal with these "big bullets?"

Hitting and destroying a target in direct fire is complicated, but it's ever so important if your intended target is also trying to hit and kill *you*. This means that tank gunnery has to be simple and fast. But the process involves math and physics. We have to make it simple and intuitive.

First, we need to look at the main gun ammo types available then. The most important for us are *shot* and *HE*.

HE (high explosive) depends on *chemical energy* to cause the case of a round to shred and disperse as shrapnel. It is useful mostly against "soft" targets—thin-skinned or lightly armored (like half tracks) vehicles, infantry, and emplacements. Important: its *terminal effect* (effect on the target) is not range dependent. An exploding shell explodes just as well at maximum range as it does at point blank range.

Shot depends on *kinetic energy*. A shot round is basically a big, solid bullet that punches through armor. Note that the amount of armor it can punch through is largely dependent on kinetic energy, and kinetic energy is:

$$E_k = mv^2$$

or "kinetic energy equals the mass of the moving object (shot round) multiplied by the square of its velocity." Mass is just mass, but velocity here is squared. That means the "punch" ability is heavily dependent on how fast the round is traveling when it strikes the target.

This means that a shot round is most effective against armor, but only if you are close enough and the projectile is fast enough to generate enough kinetic energy.[14]

So the tank commander has to set up a shot for maximum effect before handing it over to the gunner. The gunner is the number two man in the crew; he sits in the hull

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[13] I am sometimes asked why we use the puny cal. 30 (or 7.72mm) MGs for coax and, in those days, the Bog. I can answer that one from personal experience. While assigned to the US Army Armor and Engineer Board in the early 70's I was the designated "weird projects officer", and was tasked to get with the engineers and see how well the ma deuce worked as a coax. The answer is: very well indeed. It sprayed accurate terror and destruction, AP and AT, at much longer ranges than the smaller MGs, and the muzzle was actually outside the turret armor, which made it extremely quiet for the crew. Great, huh? There was one drawback. After about 30 seconds of joy firing it, the crewmen in the turret basket were up to their genitals in hot, spent casings that had to be removed frequently by shoveling them out the loader's hatch or dropping the escape hatch in the hull floor (of an M60A1), neither of which is advisable in combat. *Learn something new every day*, I say, preferably at the expense of the government.

[14] Late in the war, HEAT (high explosive anti-tank) rounds started to be available. These are shaped charge rounds, like the ones used by the bazooka or the *Panzerfaust*. They penetrate armor using chemical energy, and penetration is not affected by velocity. So why keep shot at all? Answer: it is much easier to defeat HEAT rounds than shot rounds, particularly nowadays when shot wounds have been replaced by long subcaliber fin-stabilized penetrators of ultrahard steel and filled with depleted Uranium for weight. See section 21.

below the turret and tank commander, to the right of the main gun breech.[15] He has a telescopic gunner's sight inscribed with a special reticule. For now, let's say the enemy tank is within 400-500 meters.

Why is that important? Because the trajectory of the round is not flat. It leaves the muzzle going like a bat out of hell, but as soon as it is on its way, gravity starts pulling it down at an acceleration of **9.8 m/sec²**.[16] This means it starts dropping. If its muzzle velocity is very fast, there won't be much drop at first; but after a second of flight (a second is an eternity for a shot round), the projectile will have dropped almost ten meters.

Now let's do an experiment. We will drop the breech block and look through the bore of the main gun. We can make the aim more accurate by taping two pieces of string on the muzzle to make crosshairs. If we place the center of the cross right on the target, the drop of the round will be so slight that it will still hit the target—at some maximum range (*we call this boresight range*). Beyond boresight range, the round will fall short of the target if we just point the gun directly at center. To correct for this range drop, we add a little elevation to the "lay" of the gun tube. This is an angular correction called *superelevation*. The longer the range to the target, the more superelevation we have to add.

So, how does this work?

A tank advances (with other tanks—*Fury* notwithstanding, we never send a tank out by itself) against the enemy. The tank commander (TC) sees an enemy tank in a tree line to the left front. He quickly finds a place to halt that provides cover, concealment, and observation of the target and field of fire (room to fire (without hitting friendly tanks, nearby trees, etc.). When the tank is in position he announces HALT over the intercom. If the intercom isn't working, which it frequently is not, he can just kick the back of the driver's seat.

He now estimates the range to the target. This has to be an estimate based on practice—the M4 did not have a stereo or coincidence (optical) range finder, and the laser had not been dreamt of. The target is a stationary enemy tank, he estimates about 700 meters distant. He issues a fire command:[17]

GUNNER! This alerts the crew that there will be an engagement by fire.
TANK! This tells the gunner the type of target.
SHOT! This tells the loader the type of round to be fired.
TRAVERSE LEFT; STEADY; ON! By this simple method, the TC has the gunner rotate (traverse) the turret to the left until approximately aligned with the target ("approximately" meaning within the field of view of the gunner's telescopic sight).
RANGE SEVEN HUNDRED! This tells the gunner to add superelevation for a target seven hundred meters away.

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[15] The breech (not *breach*) is the end of the gun into which you stuff a round to be fired; once fired, the round travels down the *bore* and exits the *muzzle*.

[16] A quibble here. First, there is a slight aerodynamic effect when a conical round leaves the muzzle that makes it rise just slightly at first. This effect is so minor that we can generally ignore it.

[17] The fire command has changed slightly since WWII.

LEAD ZERO! If the target is moving left or right relative to the gunner's line of sight, we would apply lead to make the shot and the target occupy the same space. Since the tank is not moving, lead is zero.

By this time the gunner will have slammed a shot round into the breech of the main gun and verified the block has closed. When the round is ready to fire, he says **UP**.

FIRE! Tells the gunner to shoot the round as soon as he has a solution.

Just before shooting, the gunner signals with **ON THE WAY!**

How does the gunner apply superelevation? This is simpler than it sounds, and does not involve the gunner in trigonometry. He just looks through the telescopic sight, which is slaved to the main gun. He will see the reticule below superimposed on the target area:

Of course, the round may miss because (*a*) the TC has estimated the range wrong, (*b*) the gunner placed the reticule wrong, or (*c*) it was a funky round. Producing ammo is not as precise a process as we like, and constant quality testing and proof firing is required before the rounds are crated and shipped. There is a procedure for adjusting the next round and, if necessary, the round after that based on the gunner and TC sensing of where the round went (left, right, over, short) and adjusting. But that's beyond the scope of knowledge for most infantry reenactors.

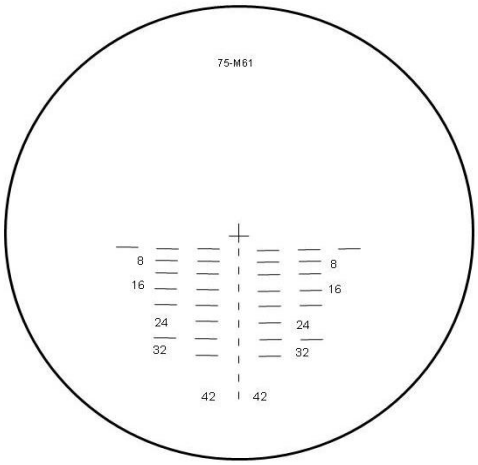


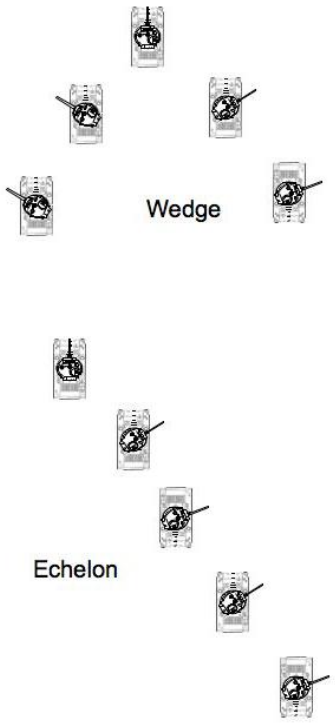
Figure 5. Gunner's sight reticule for the M4's 75mm gun. If the target is within boresight range (600m or less), the gunner can simply place the center cross on the target and blaze away. At a longer range, the gunner can simply elevate the gun (which will move the center cross up) until the target is on the dashed vertical line close to the estimated range. If the target is moving, the gunner has to respond to the TC's estimate of how much lead to apply. The horizontal tic marks to the sides of the center dashed index line are calibrated in *mils*. A *mil* is 1/6400 of a full circle (remember a degree is 1/360 of a circle). A little arithmetic is involved here, but with a lot of practice a gunner can do the calculation of lead in his head. (The trick is to live long enough to get a lot of practice.)

■ 14. How tanks were used

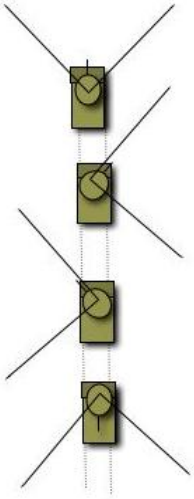
Here it gets a little more murky, because armored doctrine in those days was not what most people, reenactors included, think. Here are some things to remember:

a. Tanks do not operate below platoon level (no matter what you saw in "Fury"). Tanks operate together because a tank alone is too vulnerable. Formations (see FMs 17-5 and 17-10) are designed to provide all-around observation and fire. Even on a road in column, tanks alternate observation to the left and right.

b. Tanks are not supposed to be used to break through defended positions. This was seen as a waste of mobile power. Infantry and artillery were to establish the breakthrough, and the tanks were supposed to pour through the gap and run wild in the rear.

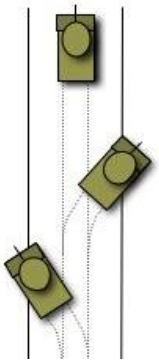


When moving in road column, turrets can be oriented to provide all-around coverage.



When momentarily halting on a road, tanks may pull off in alternating directions to form a “herringbone” pattern of all-around observation and orientation.

c. Tanks are to be used in mass, not scattered here and there on the battlefield. Anything less replaces shock effect and firepower with a good target for the enemy.



d. When using tanks, always remember that *they require hours of maintenance for each hour of operational use*. Unlike infantrymen, a broken-down tank (is there any other kind?) will not respond to encouragement or kicks or appeals to patriotism. Corollary: the faster and farther you push tanks the fewer you will have when you get there and the farther they get

from their fuel and spare parts supply.

e. On a route march (that is, not within range of enemy observation), move in a column using the most trafficable route (usually an unmined road), as this usually provides the best control and the fastest pace.

f. When you cross the line of departure and move into approach march (the enemy is near), don't move one behind the other. That will allow an enemy to your front to engage you with everything he's got, while your tanks in back cannot effectively return fire without hitting friendlies in front. Approach march may be in like (skirmish line), echelon, wedge, or "Vee" depending on the location of possible threats. And avoid masking fire. Remember: friendly fire is just as hostile as enemy fire.

g. It is usually a good idea to attack in two echelons: *assault* and *support*. One maneuvers to carry the objective while the other provides supporting fire to reduce the effectiveness of the enemy's defense. You can also alternate the assault and support elements if you are advancing into enemy positions in depth; this avoids having one part of your force engaged and exposed too long.

h. Think of a tank as a very overweight infantryman capable of firing huge-assed bullets. Like doughfeet, tanks should avoid attacking in the open when cover and concealment are available. Steel armor is dandy, but dirt is even better. Pop up in defilade (Figure 6) and take a shot, then shift and do it again.

i. Use everything you've got. Hell, the government is paying the bills (which might not comfort a reenactor, but work with me). Use artillery support whenever it's available (which means requesting simulated fires through the umpires in our case). And never give the enemy a break. *Knock 'em down, then stomp on 'em.*

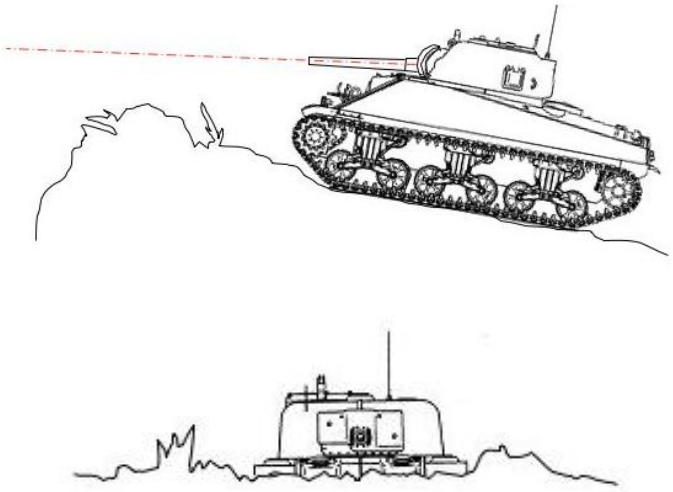


Figure 6. Defilade. To assume a position in defilade, examine the surrounding terrain and find a position on the reverse (away from the enemy) slope of a rise. Pull up carefully and take a position that blocks everything below the turret (hull defilade) or, if possible, lets you just peep over the slope exposing only as much of the turret as may be necessary to have a field of fire (turret defilade).

SECTION IV. TANK DESTROYERS AND OTHER VARIATIONS
(FM 18-5)

ESSENTIALS

- **A tank destroyer is a high-speed, lightly armored self-propelled gun capable of engaging enemy tanks in the defense.**
- **Because of design considerations that guide the production of tanks, tank destroyers are capable of carrying larger guns than tanks of equivalent size.**
- **Tank destroyers are organized into separate battalions, and are assigned as needed to infantry divisions to provide antitank support.**

■ **15. General.** Tank destroyer battalions, as they came to evolve 1937-1943, were self-propelled direct-fire guns of sizes that increased during the war in proportion to the increased armor on German tanks. They might have medium or light tank chassis, but the turrets were not as heavily armored as "real" tanks.

TD's were a way of supplying commanders mobile, large-caliber antitank assets for defense. Tanks were not to be wasted defending against other tanks—they were supposed to be pouring through breaks in the enemy's line and exploiting and pursuing.

■ **16. TD Design features.**

a. A TD, since it was to be used in defense, could dig in, pile sandbags, employ defilade, and generally use the battlefield for protection. They would often be placed in primary firing positions, with an alternate position or two where they could scurry when the Germans found their range, and a supplementary position in case the enemy attacked from a less likely direction. Because of that, they didn't need heavily armored turrets.

b. In any case, sticking a large-caliber gun inside a heavily armored turret is an engineering challenge that causes delays in mass production. Installing a larger gun in a tank turret requires changes in design to allow for the larger size of the gun from trunnions to breech block, plus increased recoil travel, plus room to store larger rounds (one thing you don't want to do in a knockdown battle is climb out of the turret to reload!). Installing a longer, heavier gun could cause mechanical wear problems on the gears of the turret ring because of imbalance; to counteract this, it was necessary to lengthen the overall turret, and often to add counterweight to the turret bustle (the rear projection) to balance the weight of that long gun tube.

The first US TD's were half tracks with a gun stuffed in the cargo space. These were just an interim gesture, and proved inadequate in North Africa. Later versions were built on a standard M4 chassis with a turret (usually without overhead protection). The models evolved from the M10 to the M18 to the M36, with successively better engineering and superior guns.

c. The TDs were still in service in Korea, where their guns were useful in knocking out T-34's. However, the late-war M4A3E8—the "easy-eight"—carried a gun just as effective and had the additional armored turret to improve survivability. The Army decided to get rid of the TDs and admit that "the best tank killer is another tank."

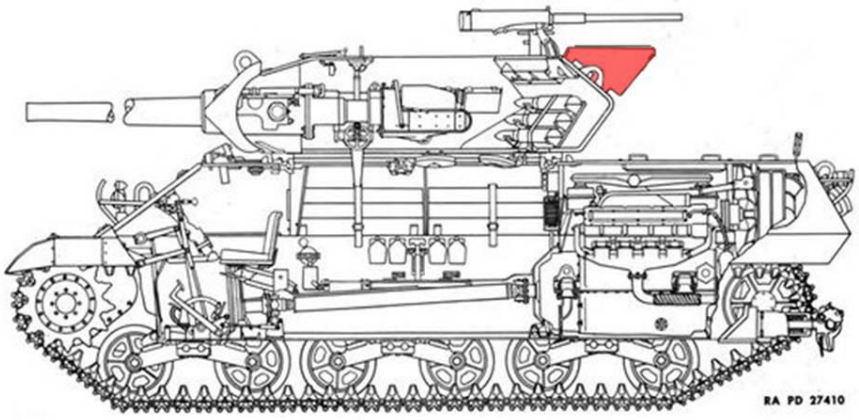
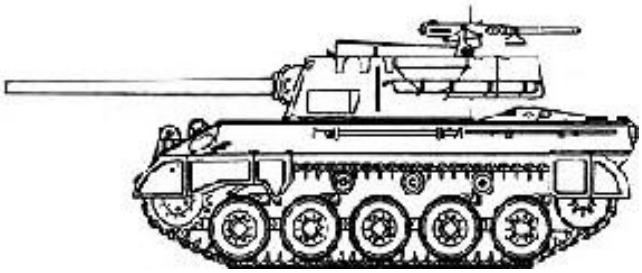


Figure 7. Tank Destroyer (M10A1). This cutaway shows a typical TD design. Note that the power train is essentially the same as that of the M4 tank series, as is the 3-bogy suspension with VVSS. The hull is lightly armored, as is the open-top turret. The red highlighted area on the turret bustle is a solid steel counterweight. The main gun is a 3-inch (76.2mm) standard antitank gun. This was the first US TD design in mass production, and was used in large numbers through the end of the war. Subsequent models (M18 and M36) had improved armament, but were in most ways similar to the M10.



Tank destroyer, M18: This model was produced in 43-44 until production of the M36 was established. The M18 did not use a Sherman chassis, but a unique design with torsion bar suspension and a 450 hp aircraft radial engine, a combination that allowed a road speed of 60mph. The main gun was the 76mm that was being developed for newer Sherman models.

Tank destroyer, M36: This model, introduced in the Fall of 1944, carried a powerful 90mm gun. The M36 was basically an M10 chassis with an enlarged and improved turret with power traverse and a large counterweight to accommodate the larger, longer gun. Vehicles after November 44 were fitted with muzzle brakes to prevent blast from making it impossible to sense and adjust rounds.

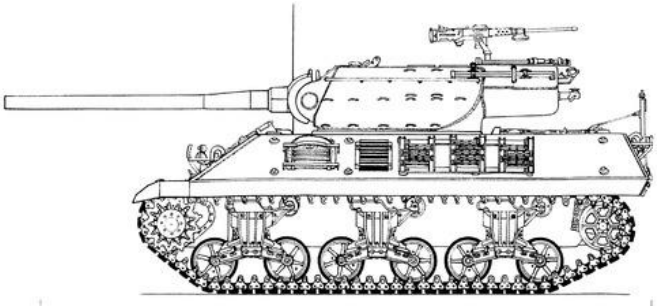
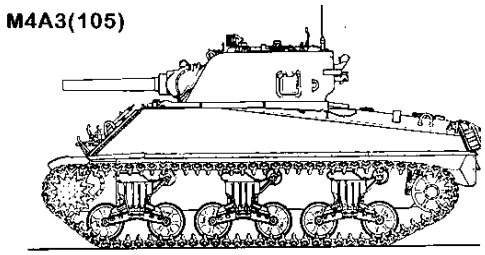


Figure 8. Later tank destroyer designs.

■ **17. The assault gun** (FM 17-25)

Tank units included a certain number of vehicles configures as *assault guns*. The name is essentially identical to the German *Sturmgeshütz,* but the design and employment of US assault guns were different.



The M4 has a main armament designed to take out hard point targets. Soft targets can also be smacked, but usually by wasteful overkill, and with little ability to handle area targets.

So a lot of M4's (and M3/5 light tanks) were modified by replacing the 75mm L40 gun with a stubby 105mm. This gave the tank battalion the capability to deal with targets that can't economically be killed with a shot round. It also created a problem because the 105mm round was larger by far than the 75, and turret storage was limited. It's usually easy to pick out the M4 assault guns because of the ammo trailers they hauled around for reloads.

SECTION V. ARMORED INFANTRY

(FM 17-42)

ESSENTIALS

- **Armored infantry is heavy infantry carried in light armored vehicles (half tracks) to allow it to move at the same speed as the tanks it supports.**
- **When engaging the enemy in close combat, armored infantry dismounts from its carriers and exercises fire and maneuver as normal infantry. Armored infantry does not engage the enemy from the carrier, but uses the carrier to support the squad's action.**

■ **18. General.** Armored infantry was not "armored"; it was equipped to accompany tanks as part of the combined arms armored force.

■ **19. Role of armored infantry**. Armored infantry was *transported* in lightly armored half tracks, but fought on foot. Note that using a half track as a mobile Alamo is a bad idea. The armor will not stop caliber .50 AP at any range, and is designed to provide protection from light shrapnel. If your squad fights from the vehicle, the best you can do is die together.

■ **20. Vehicle-infantry coordination**. The best way to understand the role of the half track (except as a battle taxi) is to imagine it as a very large and noisy member of the squad. If the track carries a .50 and a .30, these weapons can provide covering fire from defilade and the squad maneuvers. the sound of fifties firing over your head can be very comforting.

☞ **Here is an important piece of news for reenactors who hang around in half tracks. *Armored infantry engage the enemy dismounted*. Their half tracked battle taxi will support with cal .50 fire and whatever else they might be able to fling at the enemy over the heads of the dismounted passengers. But infantry does not fight from a self-propelled Alamo. The armor on a half track is designed to stop some small arms and stray shrapnel; anything more serious will hardly slow down when it hits, and a squad of infantry huddled behind flimsy rolled steel can be killed in efficient groups. Think of the carrier as transportation to the place of battle, after which it becomes a large and noisy member of the squad.**

SECTION VI. HOW TO ENGAGE A TANK

ESSENTIALS

- **Tanks are heavily armored, but cannot carry enough armor to be invulnerable. Any tank can be defeated with training, materials, and courage.**
- **Methods for engaging a tank depend on the type of type, the type of weapon available, and the range to the target.**
- **There are three categories of tank solutions: mobility kill, armament kill, and catastrophic kill.**
- **Tanks are most vulnerable to a kill when engages from the flank or rear, particularly with infantry antitank weapons.**
- **Some German tank designs include heavy armor; however, trained infantry has a chance against even Tiger and Panther models.**
- **The best aim points are (1) thinner armor on sides and rear; (2) track and suspension components; and (3) "shot traps."**

■ **21. General.** Tanks are designed to be hard to knock out. As in the popular auto insurance ads, "it's what they do." The approach used depends on situational factors, like

a. **What are you shooting?** The weapon used must be capable under favorable conditions of scoring a kill. We will be examining three kinds of "kills": mobility, armament, and catastrophic. Note also that "favorable conditions" vary with the type of weapon being used and the tactical situation. We will look at two options:

—*Direct-fire gun firing an antitank round* (tank, tank destroyer, towed AT gun, etc.)

—*Infantry close-range antitank weapon* (bazooka, PIAT, etc.)

Forget about magnetic charges and "sticky bombs". They are possible tactics, but not safe for living history purposes.

b. **How far away are you?** If you are firing a shot round from a gun, the range of engagement has two factors:

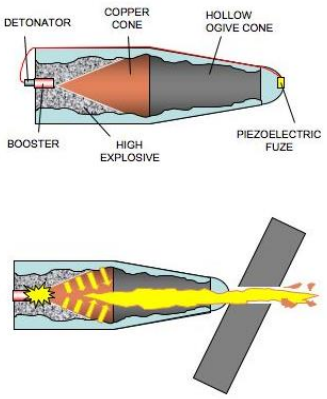
—*Probability of scoring a hit.* No matter how carefully we set up a firing solution (aiming, estimating range, calculating lead), there will always be some error in the result. Nothing is perfect. When a round leaves the muzzle, it will carry that error with it to the bitter end, and the error is expressed as an angle of deflection from the true gun-to-target line. Trigonometry takes command. The angular error might remain constant over the flight of the round, but the longer it flies the greater the actual distance from the intended aiming point. So: The longer the shot, the larger the error. The shorter the range, the higher the probability of hitting the "sweet spot."

—*Probability of defeating the tank (scoring a kill).* With a shot round, this means amount of armor penetrated. If the shot does not go through the armor, a complete kill is not likely. (Yes, a spent shot round may break a track, but the tank will still be able to shoot back.) The longer the range, the less penetration (physics). A close shot is not only more likely to hit the target, but also more likely to punch a hole in it.

If you are carrying a bazooka, the odds and tactics change. First, the maximum range of an M1 or M1A1 bazooka is 400 yards, but the max effective range is around 150 yards with the grace of God. The effective range in this case is purely probability of a hit. Why? Because the bazooka uses a shaped charge that penetrates armor using chemical energy, not kinetic, and so the effect on hitting the target is the same (presuming it hits the target) no matter what the range.

c. **What is the tank doing?** Is it moving? Is it in defilade? Has it improved protection (*e.g.*, piled sand bags on the front slope)?

d. **How important is it to you (is it worth dying for)?** I leave this to the reader.



Rifle grenades, bazookas, Panzerfausts and similar weapons use HEAT (high explosive antitank) penetrators instead of shot. A shot projectile (like the 57-mm) is usually solid steel with a softer cap, and simply punches a hole in armor with kinetic energy. A HEAT round uses a combination of kinetic and chemical energy.

In the top drawing above is a cross-section of a typical HEAT penetrator. The HE compound (often Tetryl) is shaped or molded into a hollow cone (hence “shaped charge). The hollow part is usually lined with a copper cone. At the tip of the round is a piezoelectric element (“lucky piece”) that responds to pressure with an electrical impulse. This travels by wire to a detonator and booster in the base that sets off the HE. Surface waves from the explosion are focused at the axis of the cone, melting the copper and blasting it through the armor.

Unlike KE shot, the velocity of the round has little effect on penetration (in fact, the slower the better).

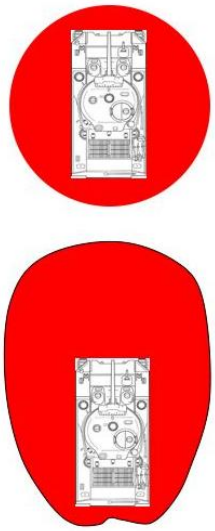
■ 22. How do you kill a German tank?

It depends on the kind of tank, the terrain, and your personal attributes. Even the biggest of them can be killed if you rely on knowledge, skill, cunning, and luck. If luck is all you have to work with, I really can't help you.

Tanks have armor, but no tank's armor is perfect. Bear in mind the following: *a. Most tank armor is on the front.* Why? Because that's usually where the enemy is. Dumb ass question. Experience shows that probability of being hit in a tank is closely related to direction, and is described by what we call the

cardioid frequency of hit distribution.[18] Memorize this expression and amaze your friends. Most rounds will hit a tank from the front (usually expressed as a "sixty degree frontal arc") because tanks and other elements typically arrange themselves and maneuver to reduce the probability of a flank or rear shot.[19] So tank designs tent to load most armor to guard against hits from that direction.

The relationship between direction of fire and likelihood of fire is called the *frequency of hit distribution*. Here are two informative examples:



The top distribution shows the situation in towns and operating among guerrillas: the distribution is circular (that is, shots are more or less equally likely from all directions. The bottom distribution is that for tanks in normal combat situations, a distribution we call the *cardioid* ("heart-shaped"). Shots are most likely to come from the front. This is one reason tanks should not be frittered away in urban combat.

But why not just armor the hell out of every part of the tank? Another dumb ass question. It would make the tank too heavy. You have to economize somewhere or the thing will sink out of sight in the soft ground, make railroad flat cars collapse, or just burn out engines, transmissions, and final drives.

So, if possible avoid the frontal shot unless you have a close-range shot with a large main gun. Go for the flank or the rear, where there is usually much thinner armor. The enemy will usually make an effort to see that you don't get a favorable shot, but combat means never playing it completely safe. Surviving is not the same thing as winning.

b. There are three ways to knock out a tank:

—*The mobility kill.* Shoot off a sprocket or an idler or just break the track. The tank can't move, or, if you break one track, only move in a tight circle until the crew gets out and tries to fix the track, which crews don't like to do under fire (trust me, I've done it). Of course, it can still shoot, so we can try for

—*The armament kill.* Knock out the main gun (usually by making it impossible to traverse or elevate the turret, the first being ideal). He can sit there cussing and shaking his fist and peppering you with MG fire, but he's not event a good pillbox. Best of all, hope for

—*The K (catastrophic) kill*, the outcome of which is a tank that can't move or shoot. This may result in crew death, but the real objective is to turn the tank into an inert, impotent lump of iron.

Okay, let's look at the absolute worst case: the enemy tank is larger than yours, the gun outranges yours, and you can't get a good flank shot. What do you do?

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[18] "Cardioid" means "heart-shaped." If you collect huge amounts of data (like "where was the hole in the hulk of a burned-out tank?") and count up the frequency of hits by direction in different kinds of engagements, the distribution is large in front, diminishes on the flanks, and drops to near zero in the very rear. The diagram is heart shaped. So this affects the likelihood the tank you're shooting at will be your Valentine.

[19] In city fighting (or "rubble fighting") the distribution is more nearly circular. Think about it.

First, find a good firing position. Best is defilade (see figure 4: behind—the "reverse slope"—high ground so you can pop up with only the top of your turret showing and expose yourself only long enough to get off a shot). Nothing protects a tank, even a Tiger II, like a bunch of dirt.[20]

c. Know your enemy, his strengths and weaknesses. What kind of tank are you engaging and how do you engage it? Examples:

—*Tiger I.* Pull into defilade. Eat a complete K ration. Take a 30-minute nap. In that time the Tiger will probably break down, saving you the aggravation of actually engaging it. If that fails and you have only a frontal shot, try for the turret ring (where the turret meets the hull). The turret ring can't be completely covered by armor because the turret wouldn't turn. The ring itself is a huge band of steel gear teeth turned by a much smaller gear in the turret. A good hit might knock it out. A very good hit might even dislodge the turret. Shooting at the frontal armor or the very thick turret mantlet (the housing that surrounds the breech of the main gun outside the front of the turret) isn't worth a shot, as it will just annoy the crew and disclose your position. Go for a mobility kill if the track or engine compartments are exposed.

Get as close as you can by cunning. The penetrating effect of a shot round, as noted earlier, is range dependent. The closer the better.

—*The Tiger II.* Well, *uh* . . . try to break a track from the front and score a mobility kill. He can still shoot, but you might be able to find a way past him; and in any case, he is fairly useless in the general sense until he can move again. Forget the front slope (what we call the "upper glacis"). Behind that armor is ammo, fuel, and the crew, all of which are needed and perishable. For that reason, the front slope is a huge, well sloped plate of "RHA" (rolled homogeneous armor). Even if you get close, a 75mm L40 shot round will likely cause a dusty patch and an annoying ringing sound.

But there aren't that many Tiger II's around, and most of them at any given moment are being repaired. That's where luck comes in.

—*The Panther.* Okay. . . After D Day the Germans transferred a lot of Panthers from the Eastern Front, where they had their hands full engaging countless T-34's, to France where they were suddenly needed. The Panther was arguably the best tank on the planet. It was "over engineered"—hey, the Germans built it, and they tend to be obsessive-compulsive—and broke down a lot, but it was lighter than a Tiger and used the same engine, so it was fast; it had wide tracks, so it was better off-road; frontal armor was well sloped. The main gun was a high-velocity pisser. This was the Germans' "main battle tank", and the only good thing was that their heavy industry was overtaxed and overbombed and they could never produce as many of these sweeties as they needed.

But if you're facing them, this is all academic.

Okay, let's say you're stuck with the lease. The Panther does have one armor weakness: its mantlet.

If you can move around the flank (tough, as the enemy will do whatever he can to make that difficult, but sometimes do-able), hit him at the center of the turret ring.

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[20] Why is earth more effective armor than homogeneous steel? Simple: homogeneous steel is, well, homogeneous. When a shot hits, the shock wave is tremendous through the armor. If a shot hits dirt, which is a nonhomogeneous pack of particles of various sizes, the shock wave is quickly absorbed. Use defilade, my friends.

Note that if you're carrying a bazooka, try hard for a flank or rear shot. The bazooka can theoretically penetrate 3-4 inches of homogeneous steel, but the front slope of the Panther is thick and angled to the point that the bazooka's shaped charge will just poke a little hole in the first couple of inches.[21]

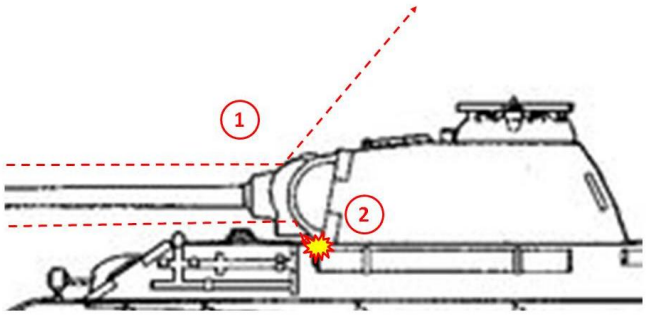

Figure 9. Panther shot trap. German engineering is sometimes awesome, but no matter how hard a design team tries, we try we occasionally experience an "oopsie." The mantlet of the Panther is a transverse cylindrical casting through which the main gun projects. The steel is tough and very thick, which is something the crews appreciate. However, it also presents a problem, though you would call it an "opportunity." A shot round striking the front of the mantlet will ricochet off into the sky if it hits on the upper surface. However, if it strikes the undersurface of the cylinder, it ricochets down onto the top of the hull (not so thickly armored) or, worse, into the turret ring. This is called a "shot trap." If you absolutely, positively have to have a close-in frontal urinating contest with a Panther, try to hit him with shot on the underside of the mantlet. The Germans did recognize this flaw, and began casting the mantlets with a "chin" that reduced the probability of a shot trapped at the turret ring.

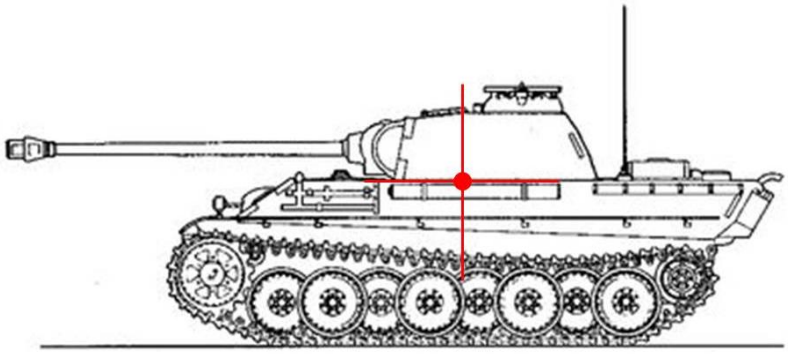

Figure 10. Turret ring shot. Pop him right at the center of mass, which (for engineering reasons) is usually right there where the turret sits on the hull. You may just jam his turret, or (with a lucky shot) you may penetrate into the ammo storage and blow the whole turret off.

[21] Note that the Panther's front slope was patterned after that on the Soviet T-34. The US was still carrying a product improved bazooka in 1950 when troops first engaged the T-34 in Korea. The bazooka was useless. This led to the design of an improved launcher with a 3.5" round which was till around when I as a cadet. It was replaced by the high-tech "light antitank weapon" (LAW) which was light, disposable, and generally useless due to low penetration and poor sealing which made it difficult to fire in wet weather.

SECTION VII. GERMAN ARMOR

ESSENTIALS

- **The German Army produced a wide range of armored fighting vehicles that evolved and improved over the course of the war. The quality of these weapons varied widely.**
- **German design and production policies and limitations resulted in great variety of design and many innovations, but never achieved the kind of mass production of standard designs necessary to achieve victory.**
- **Faced with a rising challenge in the war against the Soviet Union, the German Army responded with flexibility and technical savvy; however, limits in its industrial base were never able to overcome the flood of allied armor beginning in 1942.**
- **Ambitious designs for heavy tanks produces formidable machines in small numbers that were further reduced by maintenance problems.**
- **Sound designs like the Panther medium tank had superb qualities, but could be overwhelmed by sound tactics and courage.**
- **Obsolete models were frequently converted to other uses when they could no longer serve as first-line tanks; these included a variety of self-propelled guns.**

■ **23. General.** For most of WWII the robustness of German tactical doctrine masked a tank fleet with surprising weaknesses. German designs at the beginning of hostilities in 1939 were somewhat primitive and very conservative, reflecting the initial engineering philosophies of the 1930's, and were technically outclassed by many foreign designs. Armor was fairly thin, armament was rendered inadequate in the first two years of war, and it took many months for Germany to rise to the challenge. Part of this may have been the expectation that hostilities would soon end with the accomplishment of strategic objectives; however, the extent of strategic ambitions was enlarged with every success until the armored force establishment was approaching obsolescence.

Germany had neither technical nor numerical superiority over France in 1940, but French doctrine was muddled and tentative. Part of this was due to conservatism—the French high command, for example, mistrusted radio communication, and preferred to rely on motorcycles to carry written dispatches. The course of combat resulted, predictably, in roads choked with military and civilian traffic, resulting in a cycle of response that was critically slower than the Germans'. There was also the debate ongoing on infantry support that had prevented the armored forces from enjoying a concentration of power at critical points.

In 1941, the Germans tackled the Red Army, which was then in the process of reorganizing based on the theories of Tukhachevskii and Pavlov and on the problems highlighted by the Winter War with Finland. Most of the changes were healthy; however, it is difficult to handle a sudden invasion when you are busy reorganizing.

Russian armor was concentrated in separate tank brigades whose mission was shifting from infantry support (backed by aging veterans of the Russian Civil War who

clung to the principle of massed infantry assault) to concentrated mobile assets. This resulted in dozens of tank "packages" scattered across a very wide front being confronted by coordinated army-sized combined arms forces that were able to enjoy local superiority due to communications, mobility, and sound doctrine. For example, the pure tank brigades of the Red Army were supported by large numbers of dismounted infantry, and so the tanks' mobility was wasted. Having infantry cling to the upper decks of tanks was a poor compromise.

But by 1942, Red Army doctrinal reorganization was well underway, an effort that took time paid for by countless Russian lives. Soon a stream of lend lease equipment provided the army thousands of the trucks it needed. In addition, much improved tank designs began to emerge from war industries moved to the Urals in the early days of the German invasion: the heavy KV-1 and KV-2 models that trickled in as the Germans approached Moscow in the winter of 1941, and the start of a flood of T-34's that were technically superior to any tank the Germans possessed.

These were the problems the German effort faced: a revitalized Soviet industry supported and augmented by massive lend-lease and superior tank designs based on experience rather than theory. The German response was complex and ultimately beaten down; the comments in this guide hit only the most important aspects of the arms race.

■ 24. German weaknesses.

Industrial base limitations. By late 1941, the German industrial base (which included that of nations conquered early in the war) was unequal to the demands of a two-front conflict. With respect to tank design, Germany started the war with an imposing collection of automotive production consortia (*Maschinenfabrik Augsburg-Nürnberg* (MAN), Krupp, Daimler-Benz, Henschel, Porsche) used to mass production techniques. These concerns battled over contracts, and sometimes slowed down the process of acquisition and wasted resources by turning out too many prototypes that went nowhere. They were also most experienced in manufacturing automobiles, trucks, and buses; heavy vehicles were a sideline (in the tractor-crazy Soviet Union the reverse was true). Under pressure to supply the armed forces with fighting vehicles, the German produces tended to rely on what they knew best rather than what was needed.

The industry also needed to ramp up its ability to produce ever-thicker and heavier armor as the threat evolved. Tank armor is either riveted/welded plate or cast. Germany used both (as did the USSR and the United States), but it is not easy to revamp or repurpose industrial plants to do new and more demanding things when they are already overburdened doing the old stuff.

Conceptual limitations. The American and Soviet design philosophies were similar: leverage the advantages of mass. Find a workable design and make as many as possible, as fast as possible. If change is necessary take the conservative course and improve incrementally. The Germans took the same approach in some ways, but frequently tried to engineer the game-changer that would restore the strategic and tactical initiative.

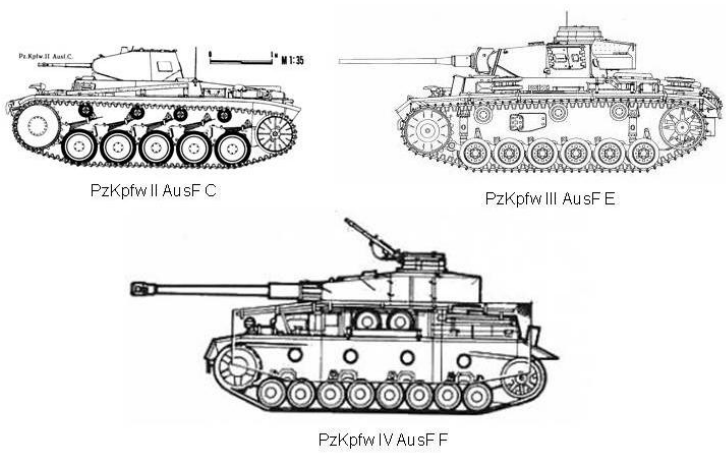

Figure 11. Basic German tank thread. The PzKpfw II, at less than 9 tons and armed with a 20mm gun, was by1943 reduced to a light reconnaissance role as the *Luchs* (Lynx). The PzKpfw III, which weighed in at 23 tons with a 37mm gun, was rarely seen in the East and reduced to a backup role elsewhere. The PzKpfw IV in various modifications lasted the entire war.

Germany started the war armed with the Mk I, Mk II and Mk III designs.[22] These were light prewar designs and were obsolescent before the shooting started. The early Mk IV was present in small numbers. From mid-1940 on, emphasis was placed on the Mk IV series, with various modifications based on field experience: improved main gun, additional armor, steel side plated, and other improvements.

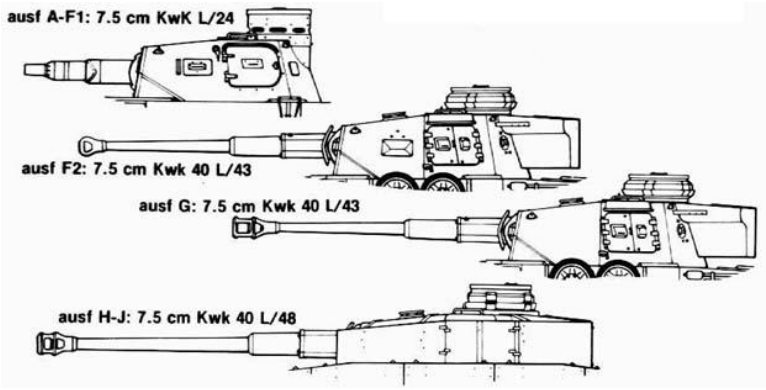

Figure 12. Evolution of the PzKpfw IV. The Pz IV was the heaviest tank in Germany's fleet in 1940, and began its active combat with a short 75mm L24 That eventually grew to an L48. There was a drive to add appliqué and bolt-on armor plates as well.

But there was pressure, much of it from Adolf Hitler, to leapfrog ahead to innovative and ambitious designs that could tip the balance—particularly in the East—and

[22] "Mk" (mark) is a British usage, meaning "model". The German designation was *PzKpfw* (*Panzerkampfwagen*, or "armored fighting vehicle"). This was sometimes rendered simply *Panzer*. From the Mk IV on, the basic designs were product improved to meet changing requirements. A modified version of a certain type was given a "derivation" (Ausführung) indicator: for example, "*Ausf H*."

restore momentum. This was of particular importance when the T-34 appeared in greater and greater numbers, and outclassed the standard German equipment. One shift was to heavier armor, resulting in the Tiger I.

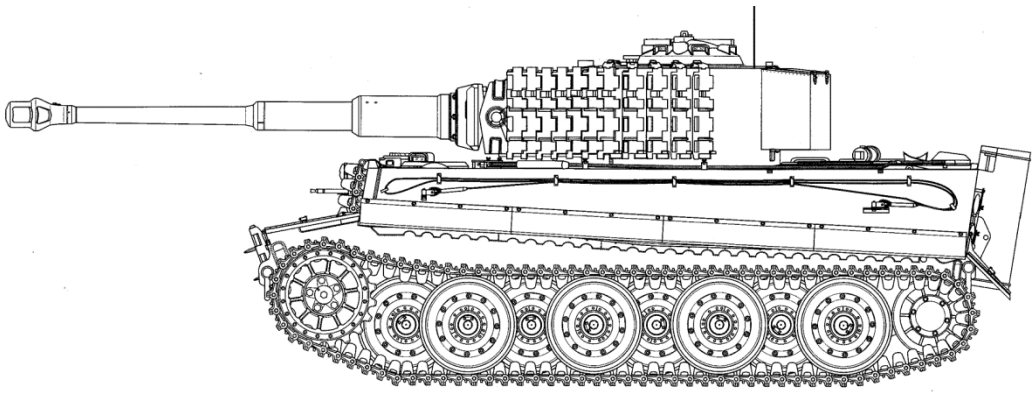

Figure 13. The Tiger I. This is officially *PzKpfw VI Ausf. H.* This version was the result of a competition of prototypes designed by Henschel and Krupp; the "H" indicates Henschel. The Krupp/Porsche consortium produced a number of chassis for their tank that were converted to heavily armored guns (the *Jagdpanzer Elefant*). The Tiger I was a 54-tom heavy packing an 88mm L56 gun, heavy armor, and the uniquely German interleaved road wheel suspension that provided a very smooth ride and some extra flank armor protection, but it was extremely heavy and difficult to maintain. Armor in front and sides was not effectively sloped. Maintainability and reliability were very low; the Tiger has the reputation of a hangar queen.

The Panther. The famous PzKpfw V was Germany's answer to the T-34, designed to be mass produced, but of higher technical qualities than the Russian tank. The Panther's frontal armor was well sloped, much like the T-34, so shot rounds would often ricochet off instead of penetrating (see **22** *c* for a more detailed discussion). The Tiger II was essentially a heavy version of the Panther.

■ **25. Waste nothing**. The German war industry had too few resources to let matériel go to waste. This was particularly true with combat vehicles. If a particular tank design became obsolete in the original role, it would usually be reconfigured for some other role. The rule was: "if it can move, slap a gun on it." Many older chassis were converted into self-propelled guns of various types. These included casemated guns (larger tank guns mounted behind heavy armor that afforded protection at the cost of limited traverse);a design dedicated to engaging enemy tanks were designated a *Jagdpanzer* ("hunting panzer"). Others were multipurpose direct fire guns with more limited protection (like the *Marder* series). The advantage was in reusing chassis and engines and reducing the number of spare parts needed by keeping proven designs.

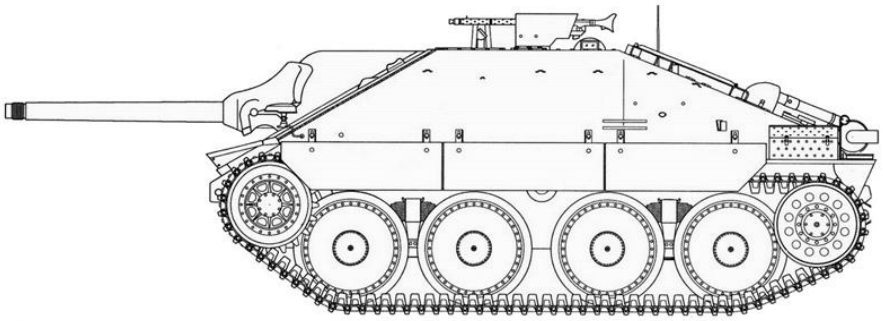

Figure 14. Hetzer (*Jagdpanzer* 38(t). This is a typical and numerous example of vehicle reuse. The Hetzer began life as a Czech tank mass produced by the Skoda Works. When Czechoslovakia joined the Reich, the model 38 (the (t) stands for "tschechisch") became the German Army's Pz 38(t). When it became obsolete, many chassis were converted to other uses, including this tank destroyer. The PzKpfw III and especially the IV were also converted to special combat functions.

The all-time champion of this philosophy was the *Marder* series of self propelled AT guns. When the tank guns in use in 1942 had difficulty dealing with the T-34, Germany started mounting the 75mm Pak 40 ("Pak" stands for *Panzerabwehrkanone* or antitank gun) on every carriage available, starting with the captured French Lorrain tractor, moving then to the ubiquitous Skoda 38(t) and various other chassis that were outdated or too lightly armored for other roles. As an alternative, the vehicles carried captured Soviet 76mm field guns. These had the overall name *Marder* (marten, a large weasel with a sort of personality disorder).

The assault gun. Many available chassis were also converted into assault guns (the German term *Sturmgewehr*, or "Stug", has that literal meaning. These vehicles were used in direct infantry support. They were relatively cheap to make, since they had casemated guns instead of turrets. Their mission was to provide direct-fire support to knock out bunkers and other hard targets during infantry assaults. Quite a few Pz III's were converted to Stug III's when the tank version became obsolete.

■ **23. Final assessment.** The German tanks were mixed in quality and limited by urgent needs on the battlefield. Because of political decisions, the Wehrmacht found itself outgunned by early 1942, and spent the rest of the war playing catch-up. Some later models were impressive, but were not suitable for mass production and probably prevented larger numbers of more practical models like the Panther from reaching the battle in sufficient numbers.

Some German designs, most notably the Panther, were distinctly superior to the comparable models of the M4 series; however, the Shermans were produced in such large numbers that the outcome was not changed, only made more unpleasant.

SECTION VIII. THE INEVITABLE "WHAT ABOUT *FURY?*" QUESTIONS

Okay, it was a great *flic*. I enjoy watching even Brad Pitt get old.

It's a good depiction of the interactions of a tank crew, 4-5 guys trapped inside an iron monster and facing existential questions like "do I go outside and get blown away or just say fuck it and piss in my coveralls?" It gives some taste of how much fatiguing maintenance time is necessary to stay in combat.

I've only been shot at by a tank once, and that was friendly fire. Obviously it missed. Yes, a large tank round sounds like that when it breezes by. Yes, the terminal effect is gruesome. Yes, the choice of exposing yourself so you can see nearby threats and getting shot and buttoning up, missing close-in threats, and getting shot anyway is always there. There is always the Quartermaster Corps.

It implicitly evokes some other truths, like the endless fight to keep the crew space clean when you have to get out again and again and it's muddy and the TC speaks rudely to you if you track in the dirt (which is why you often see those rubber galoshes stuffed in the turret grab rail). There are no secrets in a tank crew. Your whole world is shrunk to those few guys, of which, due to God or central casting, one will inevitably be educated, one will be a refugee from the penal system, one surrounds himself with an endless verbal aerosol of profane complaints (in war, profanity stops being emphasis and becomes punctuation), one talks endlessly about sex; the remaining one will take perverse pride in farting, though the inside of a tank has so many characteristic smells one hardly notices.

Inaccuracies: Only one I can think of offhand. The Allies pushed into Germany with over 30,000 tanks. Yes, casualties were high even at the end of the war, but it stretches our faith in the screenwriter to imagine that a single tank would be sent off by itself to guard a critical avenue of approach. It's dramatic, but contrary to basic and accepted doctrine and practice, and very, very dumb.

I sat through it without flashbacks.