CHAPTER TWO

M4 SERIES TANKS

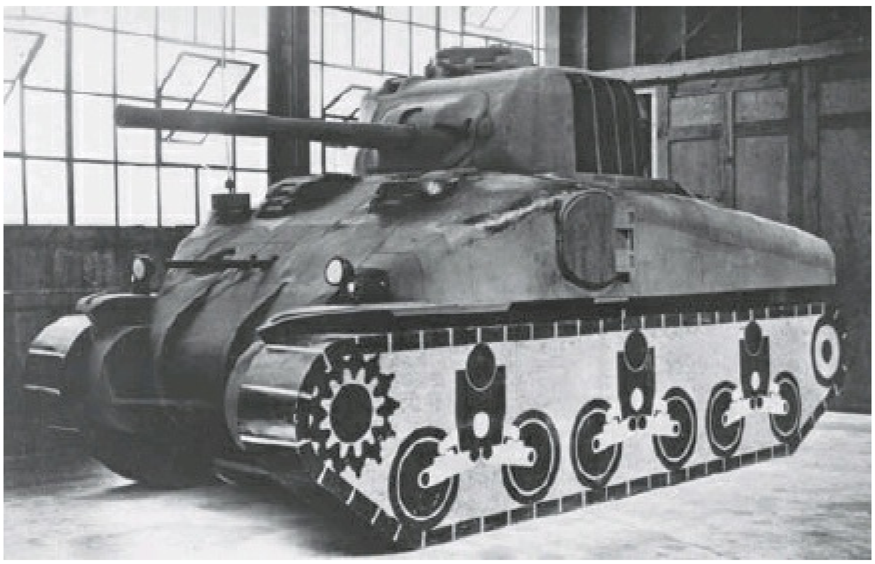
Presentation Day, September 3, 1941. Major-General Jacob Devers, head of the Armored Force, poses with the medium tank T6, the prototype of the M4 series medium tanks. Devers played a significant role in the development of American medium tanks. The T6 was armed with the short-barrel M2 75mm main gun. (National Archives)

On August 31, 1940, the Armored Force released detailed characteristics for its desired new medium tank to be armed with a turret-mounted 75mm gun M3. However, the new tank design team brought together at APG by the Ordnance Department was then still working on the production drawings of the medium tank M3 and had no time to spare until that project was completed at the end of January 1941. On February 1, 1941, the Ordnance Department directed that its tank design team begin work on the medium tank M3 replacement as quickly as possible.

There was a conference regarding the new tank held at APG on April 18, 1941. Out of that conference the key features of the new tank were confirmed, one of the most important being the retention of the basic chassis of the M3 powered by a nine-cylinder, Continental Motors gasoline-powered, air-cooled radial engine. This would speed up the design and eventually production of the new tank, while not disrupting the existing production of the M3 series tanks.

It was also decided at the April conference that the upper hull of the new tank would be made out of either cast or welded armor. The lower hull on all of the new tanks would be made of welded armor. The cast-armor turret of the proposed new tank would be surmounted by the same machine-gun-armed cast-armor vehicle commander's cupola seen on M3s built for the U.S. Army.

In place of the seven-man crew of the M3 tank series, the new medium tank would have a crew of only five men, with the vehicle commander and gunner sitting on the right side of the turret and the loader on the left side of the turret. The driver and bow gunner sat in the vehicle's front hull, with the driver on the left side and the bow gunner on the right side. The bow gunner had a manually operated .30 caliber machine gun mounted directly in front of his seat, as well as two remote-controlled, fixed forward-firing .30 caliber machine guns to his left. To allow the crew to talk to each other, an interphone was to be installed.



The wooden mockup of the medium tank T6 is shown at Aberdeen Proving Ground in August 1941. It inherited the hull side access doors and the machine-gun-armed commander's cupola from the M3. Both of these features were dropped from the vehicle before it was standardized. (Patton Museum)

Thinking outside the box, the designers of the next-generation medium tank envisioned that various turret cast-armor gun shields could be made to mount a variety of different weapons besides a 75mm main gun and a coaxial .30 caliber machine gun. These would include a 105mm howitzer with a coaxial .30 caliber machine gun, two 37mm guns M6 with a coaxial .30 caliber machine gun, a British 6-pounder (57mm) gun with a coaxial .30 caliber machine gun, or three .50 caliber machine guns for antiaircraft purposes.

MEDIUM TANK T6

In June 1941, the Ordnance Committee ordered the building of a full-sized wooden mockup and a pilot model of the new tank, designated the medium tank T6. Upon completion of the wooden mockup followed by a few design changes, APG started to construct a pilot tank with a cast-armor upper hull and turret, with a riveted welded lower hull. The cast-armor turret on the T6 built by APG resembled nothing more than a scaled-up version of the cast-armor turret on the M3 series tank. Rock Island

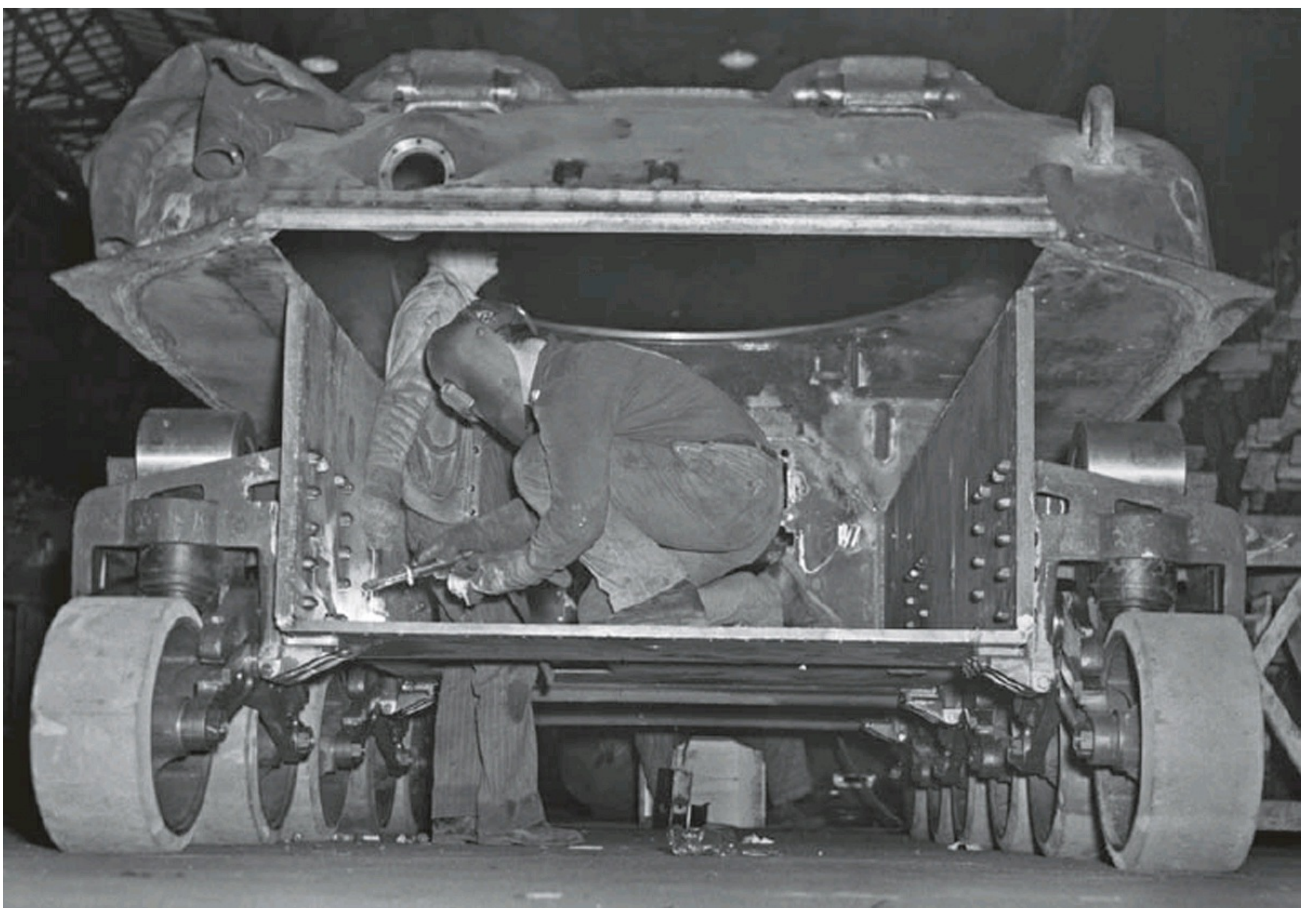
Arsenal built a T6 pilot tank with a welded-armor upper hull, but without a turret.

Like the M3 series tanks, the T6 differential and final drives were contained within a large, three-piece cast-armor housing that bolted together to form the lower front of the vehicle hull. The T6 also appeared with the original M3 series tank suspension system that is identified by the track return roller being located on the top of the VVSS assemblies.

APG rolled out its 30-ton T6 pilot tank on September 2, 1941. The vehicle's turret was armed with the 75mm gun M2, as the intended 75mm gun M3 was not yet ready. Because the elevation gyrostabilizer system for the tank's turret was supposed to be for the 75mm gun M3, it proved necessary to add counterweights to the muzzle end of the 75mm gun M2 to permit the elevation gyrostabilizer system to work properly. The elevation gyrostabilizer in the turret of the T6 was a modified version of that fitted to the 37mm gun M6 in the turret of the M3 series tanks.

VEHICLE DETAILS

The T6 turret could be rotated manually by the vehicle's gunner by squeezing a lever on a vertical drive handle located on the top of a gear mechanism to the right of his seated position. It could also be turned by the gunner with a pistol-grip control handle that operated an electro-hydraulic power traverse unit that could rotate the turret 360 degrees in just 17 seconds. On the roof of the T6 turret was a cast-armor cupola armed with a .30 caliber machine gun for the vehicle commander. The height of the tank with the vehicle commander's cupola was 9 feet 6 inches.



Welders are pictured at work in the unfinished hull of a medium tank M4A1 at Lima Locomotive Works in Ohio. At this point the vehicle's hull is being moved from station to station around the factory floor on its bogie wheels. When completed the tank weighed 33 tons combat loaded. (Patton Museum)

The turret traverse system offered the innovation of speed control, by which turret speed was determined by how far the vehicle's gunner turned his control. Only a few tanks of the day offered powered operation, which usually featured ON/OFF power, to be followed by fine adjustment using manual control. To stop the turret from turning, the gunner needed only to release the control handle and the turret stopped automatically. Vision for the gunner on the T6 came from an overhead fixed forward-facing periscope device that sat on the upper front slope of the turret and was referred to as the "protectoscope." It had an adjustable armored shutter to protect the upper prism of the periscope.

There was a pistol port on either side of the turret fitted with a protectoscope and armored doors on either side of the vehicle's upper hull. The tank's driver had a direct vision slot protected by an armored visor in the front of the upper hull and the bow gunner a protectoscope, later replaced by a direct vision slot protected by an armored visor.

There was an adjustable seat for the driver on the T6 that allowed him to operate the tank with the overhead hatch closed, or when the overhead hatch was open he could drive the vehicle with his head projecting out from the top of the front upper hull. Strangely enough, there was no overhead hatch for the bow gunner on the T6, or for the loader in the turret.

The second medium tank M4A1, built by the Lima Locomotive Works in March 1942, was shipped to England bearing the name "MICHAEL" in honor of Michael Dewar, head of the British Tank Mission to the U.S. It is seen here on display at the Tank Museum in Bovington, England. The first ten M4A1s made by Lima were built with non-ballistic (unarmored) steel, for test purposes. This tank is one of the ten, with the other nine transferred to APG. (Tank Museum)

SUGGESTED CHANGES TO THE T6

After representatives of the Armored Force and the Ordnance Department inspected the T6, some major and minor changes were ordered. The first major change to the revised T6 was to do away with the armored doors on either side of the upper hull, as they were a serious weak spot in the tank's armor protection. In their place, a single escape hatch was installed in the bottom of the hull floor just behind the bow gunner's seat.

The second major change requested to the revised T6 was the elimination of the cast-armor vehicle commander's cupola. It was replaced with a rotating, two-piece flat circular split hatch with one of the hatches fitted with a 360-degree rotating periscope, designated the M6. This brought the revised T6's height down to 9 feet.

Also asked for on the revised T6 was an overhead hatch for the bow gunner in the front hull. Instead of a pistol port fitted with a protectoscope on either side of the T6 turret, there was only a single pistol port, minus the protectoscope, on the left side of the turret.

NEW DESIGNATIONS

On September 5, 1941, the Ordnance Committee recommended that the revised T6 be standardized as the medium tank M4. That recommendation was approved a month later by the Ordnance Department, with a couple of added requirements for the new tank that included a ball mount for the manually operated .30 caliber machine gun in the front upper hull, and if possible, the addition of a .50 or .30 caliber machine gun on the turret for antiaircraft purposes. Eventually, it was decided in February 1943 that the .50 caliber machine gun was a better choice.

By November 1941, the manufacture of M4 pilot tanks had begun. The following month, the Ordnance Committee decided to attach slightly different designations to the new medium tank M4. Those built with a cast-armor upper hull were referred to as the medium tank M4A1, and those with an upper hull constructed of welded armor were designated as the medium tank M4. APG continued to operate and test the pilot T6, now classified as an M4A1, for further development.

Cast-armor upper hulls were quicker and cheaper to manufacture for the M4 series tank than welded-armor upper hulls. However, warships and aircraft were at a higher priority than tanks and there was not enough leftover foundry capacity in the United States to construct a sufficient number of cast-armor upper hulls for all of the M4 series tanks being ordered.

The fixed machine guns were eliminated from the M4 series medium tank design almost immediately, and this early medium tank M4A1 has had the holes covered over. The gunner's sight rotor was also eliminated early on, and was replaced by an overhead periscope as seen on this example. This vehicle has the original M34 gun mount that featured a very narrow rotor shield. (TACOM Historical Office)

The Ordnance Department took delivery of the first M4A1 from the Lima Locomotive Works in February 1942. The second vehicle went to Great Britain, bearing the name "MICHAEL" on its side, in honor of Michael Dewar, head of the British Tank Mission in the United States.

A very early-production medium tank M4A1 can be identified by a number of features. These include the direct vision slots for the driver and bow gunner, the two fixed .30 caliber machine guns in the front hull, and the sight rotor in the top-right front of the turret. (Patton Museum)

In March 1942, the Pressed Steel Car Company started building M4A1s, with Pacific Car and Foundry Company following in May of that same year. Production of the M4A1 continued at the three firms until December 1943, with 6,281 units built.

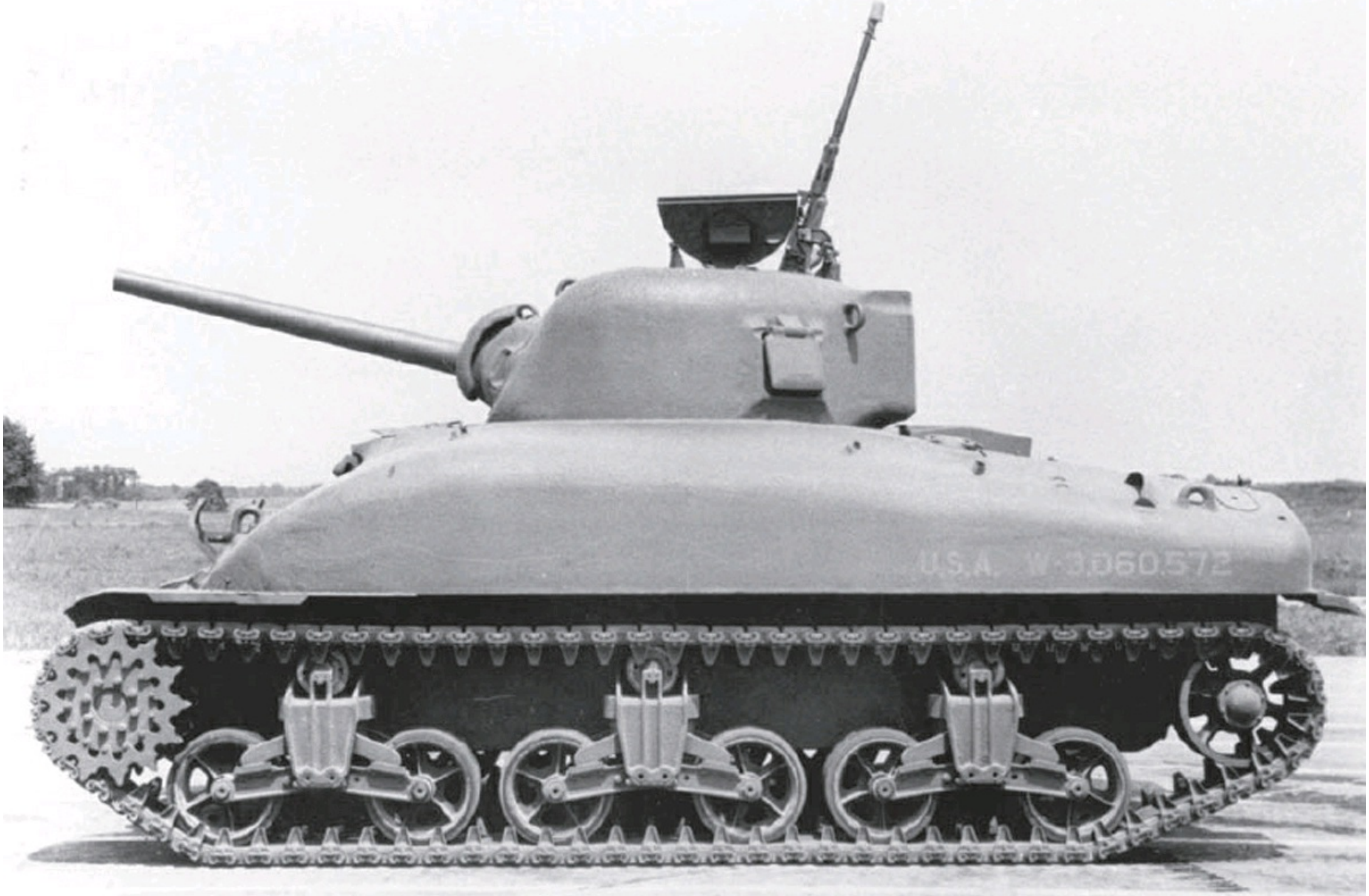
Following the production of 30 M4A1s by the Lima Locomotive Company, and ten units by the Pressed Steel Car Company, the overhead gunner's protectoscope, inherited from the T6, was replaced by a forward-looking periscope, designated the M4. The M4 periscope sat further back on the very top of the turret, making it far less vulnerable to direct projectile strikes than the protectoscope. Unlike the protectoscope, the M4 periscope could be retracted into the turret if damaged and replaced if the need arose. There was only a simple unarmored lid to cover the opening on the top of the turret roof when the M4 periscope was removed.

In July 1942, the Pressed Steel Car Company started production of the M4. Four other manufacturers soon joined in, including Baldwin Locomotive Works, the American Locomotive Company, the Pullman Standard Car Company, and the government-owned Detroit Tank Arsenal.

By the time production of the M4 ended in January 1944, a total of 6,748 units had been completed. A directive issued in March 1942 had dropped the two fixed, forward-firing hull-mounted .30 caliber machine guns from the M4 and M4A1. During World War II, the M4 and M4A1 were the types most widely employed by the U.S. Army.

Due to the more angular shape of the M4 welded-armor upper hull, it had room for 97 rounds of 75mm main gun ammunition versus only 90 rounds of main gun ammunition in the more rounded cast-armor upper hull of the M4A1. It was not uncommon for some units to increase the onboard main gun ammunition storage arrangement in their M4 series tanks during World War II.

An April 27, 1944 War Department document titled *Report of the New Weapon Board* details the U.S. Army's impression of the ammunition storage arrangement in the M4 series tank in the Italian Theater of Operations: "When going into combat, the crews invariably put a full complement of ammunition in the floor of the turret basket because they are anxious to carry a very large quantity of ammunition. Tank crews are very little concerned with protection of ammunition and consider accessibility and quantity [main gun rounds] of primary importance."

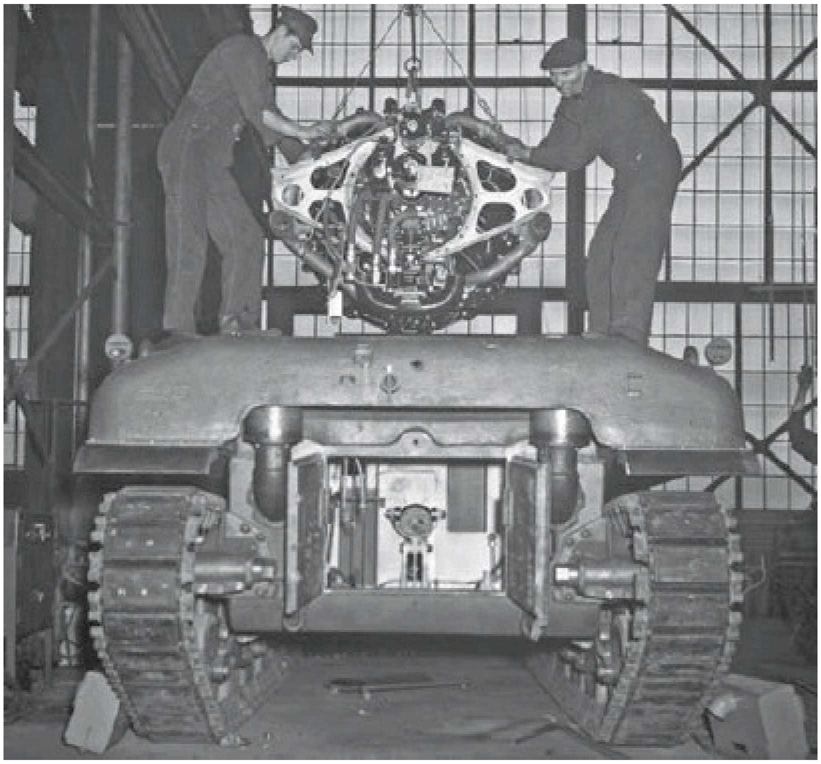


Pictured is the first medium tank M4A1 made by Pacific Car and Foundry. The VVSS was inherited from the M3 medium tank and can be identified by the return rollers mounted on the top of the bogie assemblies. Notice the pistol port on the left-hand side of the turret. (TACOM Historical Office)

There are many M4 series medium tanks on display as monuments throughout Europe. The

M4A1 shown above rests in Patton Square in Ettelbruck, Luxembourg. The vehicle was 19 feet 2 inches long with the main gun forward, and 8 feet 7 inches wide. Its height was 9 feet. (Pierre-Olivier Buan)

Other than a few minor differences resulting from the welded-armor upper hull of the M4 and the cast-armor upper hull of the M4A1, the two tanks were almost identical. The engines, power trains, and suspension systems were the same. They both featured a nine-cylinder, Continental Motors gasoline-powered, air-cooled radial engine that generated 400hp at 2,400rpm. The engine in the M4 and M4A1 was designated the R975 C1 as it had a slightly lower compression ratio than found on the R975 EC2 engine in most of the M3 series tanks and the T6.



Being installed in the rear hull of a medium tank M4A1 is an air-cooled, gasoline-powered, Continental R975 C1 radial engine, which weighed 1,137 pounds. The maximum sustained speed of the M4A1 on a level road was 21mph. It could reach a top speed on a level road of 24mph for short periods. (Patton Museum)

Both the M4 and M4A1 inherited the differential and final drives arrangement from the T6, which was contained within a large three-piece cast-armor housing that bolted together to form the lower front of the vehicle's hull. Eventually, a one-piece cast-armor housing was produced for the entire M4 series of tanks, which could vary in contours and thickness based on the foundry that made it.

MACHINE GUNS

Authorized storage for the .30 caliber machine-gun ammunition on the M4 series tanks was 4,750 rounds. Many tank crews loaded their vehicles with additional .30 caliber machine-gun ammunition. A rationale for this behavior appears in the "After Action Report" (AAR) of the 741st Tank Battalion. They expended approximately 100,000 rounds of .30 caliber machine-gun ammunition during a single day's combat engagement near Etouvy, France, during the breakout from the Normandy beachhead.

A War Department document titled *Report of the New Weapon Board*, dated April 27, 1944, describes the U.S. Army's impression of the usefulness of the .30 caliber machine gun located in the front glacis of the M4 series tank: "The bow machine gun is much used in combat operations, although all crews agree that this weapon is extremely hard to fire accurately and would like some means of sighting to be provided. As it is known that the tanks draw fire and that the bow machine gun is never used unless the position of the tank is known to the enemy, it was suggested that, to improve accuracy of fire, the percentage of tracers be increased to fifty or one hundred percent."

Early combat experience in the Pacific Theater of Operations quickly demonstrated to the U.S. Marine Corps that light tanks lacked the bulk to push through jungle undergrowth, or the needed firepower to penetrate Japanese bunkers. This realization encouraged the Marine Corps to ask the U.S. Army for a supply of M4 series medium tanks to supplement their inventory of light tanks. What the U.S. Army had available at the time was the first-generation M4A2 medium tanks, armed with a 75mm main gun. Pictured is a Marine Corps first-generation M4A2 named "China Gal" of Company C, of the 1st Tank Battalion (Medium), on Tarawa in November 1943. The vehicle is in olive drab, with the registration numbers in blue drab. There is no national symbol on the tank pictured. (© Osprey Publishing Ltd.)

A Grizzly I medium tank on display at Base Borden in Canada. The Grizzly was essentially an M4A1 medium tank assembled by the Montreal Locomotive Works, and factory equipped to Canadian/British requirements. Due to production cutbacks in the M4 series medium tank program, only 188 units were produced from October through December, 1943. (Paul Hannah)

Authorized storage for .50 caliber machine-gun ammunition on the M4 series tank was 600 rounds. The .50 caliber machine gun mounted on the turret roof of the M4 series tanks was far less popular with American tankers than their onboard .30 caliber machine guns, as is evident in this March 1945 U.S. Army report titled *United States vs. German Equipment*: "The American .30 cal. MG is considered one of the best weapons we have. Its rate of fire is sufficient. It is a well-built weapon and very dependable under the toughest conditions. The American .50 cal. MG is excellent for the same reasons. It is a good weapon for aircraft defense, but the mount on tanks makes its use for ground targets impractical."

U.S. Army tanker Tom Sator remembers that it normally fell to the loader to operate the .50 caliber machine gun on his M4 series tank, as the tank commander was typically too busy to perform that job. Tom believed it was certain death to expose himself outside the confines of his tank to fire the .50 caliber machine gun in the face of stiff enemy resistance. He only did it once and swore he would never do it again.

The late Jim Carroll (a Marine Corps tanker) remembered that they never bothered to even mount their .50 caliber machine gun on their M4 series tank as it was not safe to expose oneself to Japanese fire for even a moment in the close-in fighting that was so characteristic of combat in the Pacific

Theater of Operations (PTO).

The vehicle pictured is a welded-hull medium tank M4, probably made in September or October 1943 by Alco Production of the welded-hull M4 medium tank began in July 1942. It differed only slightly from the medium tank M4A1 in its interior arrangements, as its more angular-shaped hull allowed for an increase in main gun ammunition storage. The vehicle crew is bombing up with main gun ammunition, smoke grenades, and their small arms. (Patton Museum)

ARMOR PROTECTION LEVELS

Armor thickness on the welded armor glacis of the M4 was 2 inches (51mm) with a 56-degree slope. The armor thickness on the glacis of the M4A1 was also 2 inches; however, due to its more rounded upper cast armor hull, the slope varied from 37 to 55 degrees. The steep slope on the welded armor glacis of the M4 and M4A1 inherited from the T6 caused the designers of the tanks to come up with very narrow overhead hatches for the driver and bow gunner that made ingress and egress difficult. This was a design feature that made everybody unhappy and wasn't corrected until the introduction of the second generation of M4 series tanks that received a new, larger hatch design.

The steep slope of the welded armor glacis on the M4 accounted for the driver's and bow gunner's hatch protrusions on the vehicle, which were not as pronounced on the M4A1 due to its smoother cast armor contours. Both the driver's and bow gunner's overhead hatches featured a 360-degree rotating replaceable periscope designated the M6. Eventually, the direct vision slots (protected by armored visors) in front of the driver and bow gunner positions were eliminated from the entire M4 series of tanks, because they proved to be ballistic weak spots, and were replaced by replaceable, fixed forward-looking M6 overhead periscopes. Baldwin Locomotive Works continued to build M4s with the direct vision slots until production ended in 1944.

Armor thickness on the upper hull sides of the M4 and M4A1 was 1.5 inches (38mm). The cast-armor turret that was the same for both vehicles had an armor thickness of between 3 inches (76mm) and 3.5 inches (89mm) on the cast-armor gun shield, which was not sloped. The side walls of the rounded cast armor turret were 2 inches (51mm) thick with little or no slope. The turret roof was an inch thick (25mm).

Late-production medium tank M4s built by the Detroit Tank Arsenal differed from those made by other firms. A single-piece cast-armor front hull section that extended past the driver's position was combined with a welded-armor hull as is seen on this medium tank M4. Such vehicles are now commonly referred to as having a "composite hull." The example pictured is on display in southern California. The vehicle was heavily damaged as it was previously used as a range target, thus the penetration holes in its armor. (Chris Hughes)

In August 1943, the Chrysler Corporation began production of M4s. In an effort to save welding time and labor, their tanks consisted of a cast-armor front end married to the rear two-thirds of a typical M4 welded-armor hull. This somewhat unusual arrangement was generally referred to as the "composite hull" variant.

Of the 1,676 units produced of the M4 composite hull variant, perhaps 70 of the early examples featured armored front castings with small hatches, while the majority were equipped with large hatch castings very similar in shape to the second-generation M4A1.

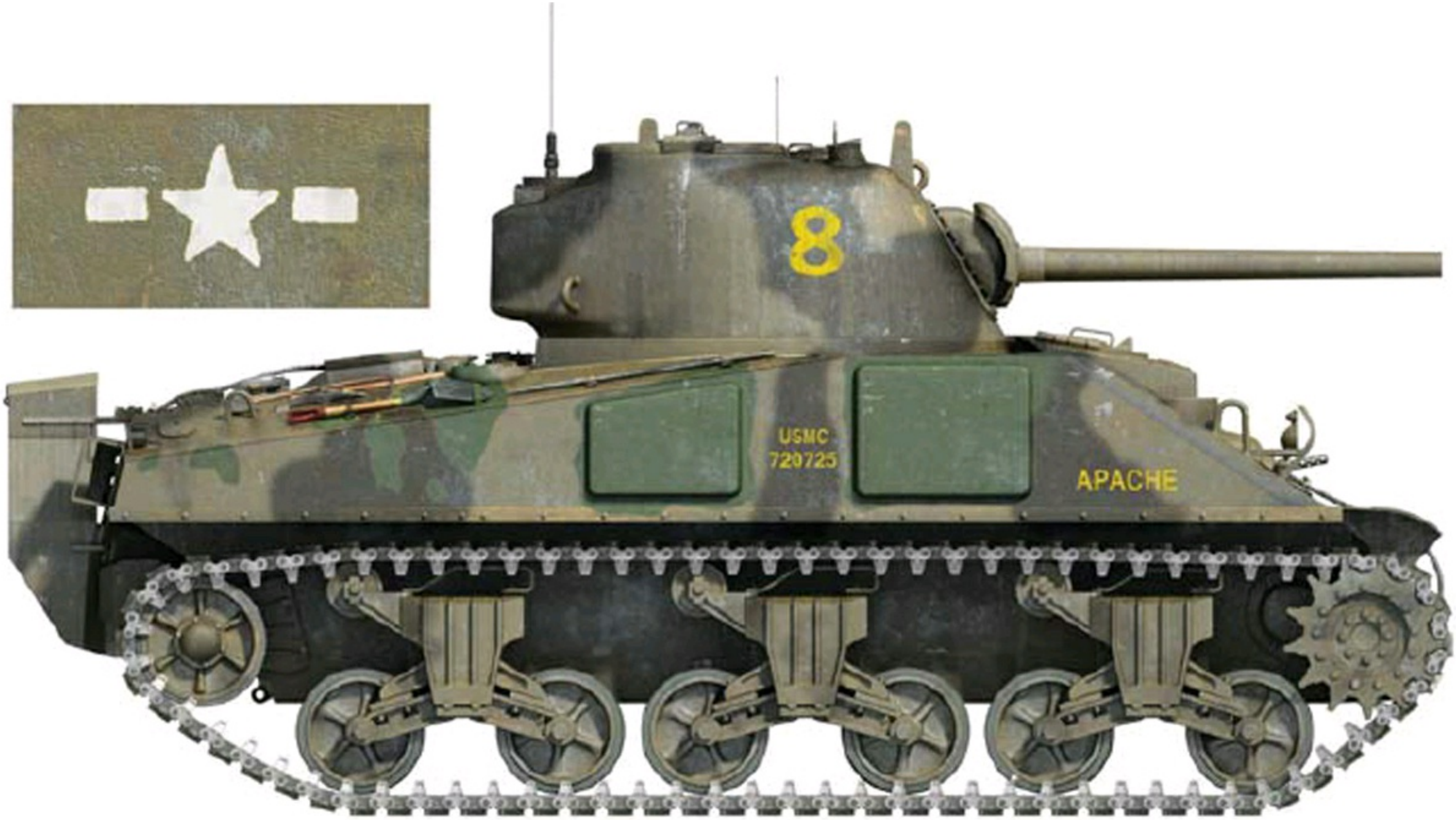
MEDIUM TANK M4A2

As with the M3 series, the lack of enough gasoline-powered, air-cooled radial aircraft-type engines proved to be a serious problem for the M4 series tanks. The Ordnance Department was forced to use whatever motive power was available and therefore took the twin, liquid-cooled GM diesel truck engine arrangement designated the 6046 and installed it in the M3A3 and M3A5, and mounted it in a welded-hull M4. Reflecting the various modifications made to the tank, primarily in the engine compartment, they designated it the medium tank M4A2. Production began in April 1942 at a number of different manufacturers and continued until May 1944, with 8,053 units built.

Pictured is a late-1943-production medium tank M4A2 powered by the General Motors 6046 diesel engine. This tank is equipped with just about every modification that had been added to the original design by fall 1943. Note the later M34A1 gun mount that featured a full-width rotor shield that provided protection to both the new direct telescopic sight on the right side and the coaxial .30 caliber machine gun on the left. (Ordnance Museum)

U.S. Army testing of the M4A2 resulted in both some positives and some negatives. Everybody liked the vehicle's excellent horsepower to weight ratio as well as its low fuel consumption. The maximum operational range of the M4A2 tank on roads was about 150 miles as compared with the M4 and M4A1 being approximately 120 miles due to the greater thermal efficiency of diesel fuel. However, everybody felt that the twin-diesel arrangement was too sensitive to dirt, which would result in shorter engine life and poorer reliability than the other types of engines used in the M4 series tanks.

In March 1942, the U.S. War Department issued a policy which stated that only gasoline-powered M4 series tanks would go to American forces serving overseas. This would ease the burden on the logistical units as only one type of fuel would be required for both the U.S. Army tanks and its massive inventory of unarmored, gasoline-powered wheeled vehicles.



Pictured is a first-generation M4A2 of Company A, 3rd Tank Battalion, on Iwo Jima in February 1943. The base color of the vehicle is olive drab. However, in this case, it has been over-painted with irregular patches of black. As factory-built add-on armor kits for the first generation of M4 series medium tanks arrived in the field, they were quickly welded onto the hulls of the vehicles and painted in whatever was available at that moment, in this case a dull green. The tactical and registration numbers on the tank shown are in yellow. The lusterless (flat) olive drab paint applied to American tanks and AFVs in World War II actually dated back to official use with the U.S. Army beginning in 1917. It consisted of black and ochre mixed together. U.S. Army tanks and AFVs often employed a gloss (shiny) olive drab during the 1930s. (© Osprey Publishing Ltd).

Diesel-powered M4 series tanks were employed for training purposes within the United States only, or for supplying under Lend-Lease to Allied nations also fighting the Axis. Despite this ban on sending the M4A2 overseas with American fighting men, when the Marine Corps initially requested gasoline-powered M4 series tanks, they eventually ended up with an inventory of about 200 M4A2s in late 1943, as that was what the U.S. Army could spare from its inventory.

The M4A2 was initially disliked by some Marine Corps tankers as can be seen from this November 1942 quote from a memo written by Lieutenant Colonel William R. “Rip” Collins, commanding the Marine Corps Tank Battalion School at Jacques’ Farm, located near San Diego, California: “From all that I can gather the M4A2 is a stinker which is probably the reason why the Army is so liberal with them.” However, combat use of the M4A2 soon convinced the majority of Marine Corps tankers of the desirability of their diesel-powered, twin-engine tank. When informed they had to trade in their M4A2 tanks for single-engine, gasoline-powered, M4 series tanks in March 1944, they strongly objected.

The Marine Corps tankers’ fondness for the M4A2 came about for a couple of important reasons. Combat use had quickly demonstrated to all that having two engines meant that damaged tanks could make it to safety even on one engine. Disembarking from a damaged tank in a combat zone is always fraught with danger and is never relished by any tanker. Watching gasoline-powered tanks quickly turn into raging infernos after being struck in combat by enemy weapons, Marine Corps tankers saw with their own eyes how diesel fuel was less flammable compared with highly volatile gasoline.

The advantages of the twin-engine, diesel-powered arrangement of the M4A2 is seen in this extract from a letter written by Marine Corps Major Richard Schmidt and his 4th Tank Battalion staff after the Tinian operation concluded on August 1, 1944:

> On at least three different occasions on Saipan, tanks of Company "C" were partially damaged when magnetic mines exploded over the engine compartments. In each instance the result was one engine destroyed and several fuel lines shattered with fuel [diesel] blown over the hot engines. But on neither of these occasions did a tank catch fire. Never was a vehicle destroyed or a crew lost. And always the damaged tank was able to return to safety powered by its one good engine.

Among the many different types of M4 series tanks supplied to the British Army during World War II, the M4A2 was the preferred version due to its twin-engine arrangement since it was the easiest to work on. In total, the British Army would receive 5,041 units of the M4A2. They would refer to the M4A2s they took into service as the "Sherman III." The Red Army received via Lend-Lease a total of 1,990 units of the M4A2 during World War II. Almost 400 M4A2s went to the Free French Army.

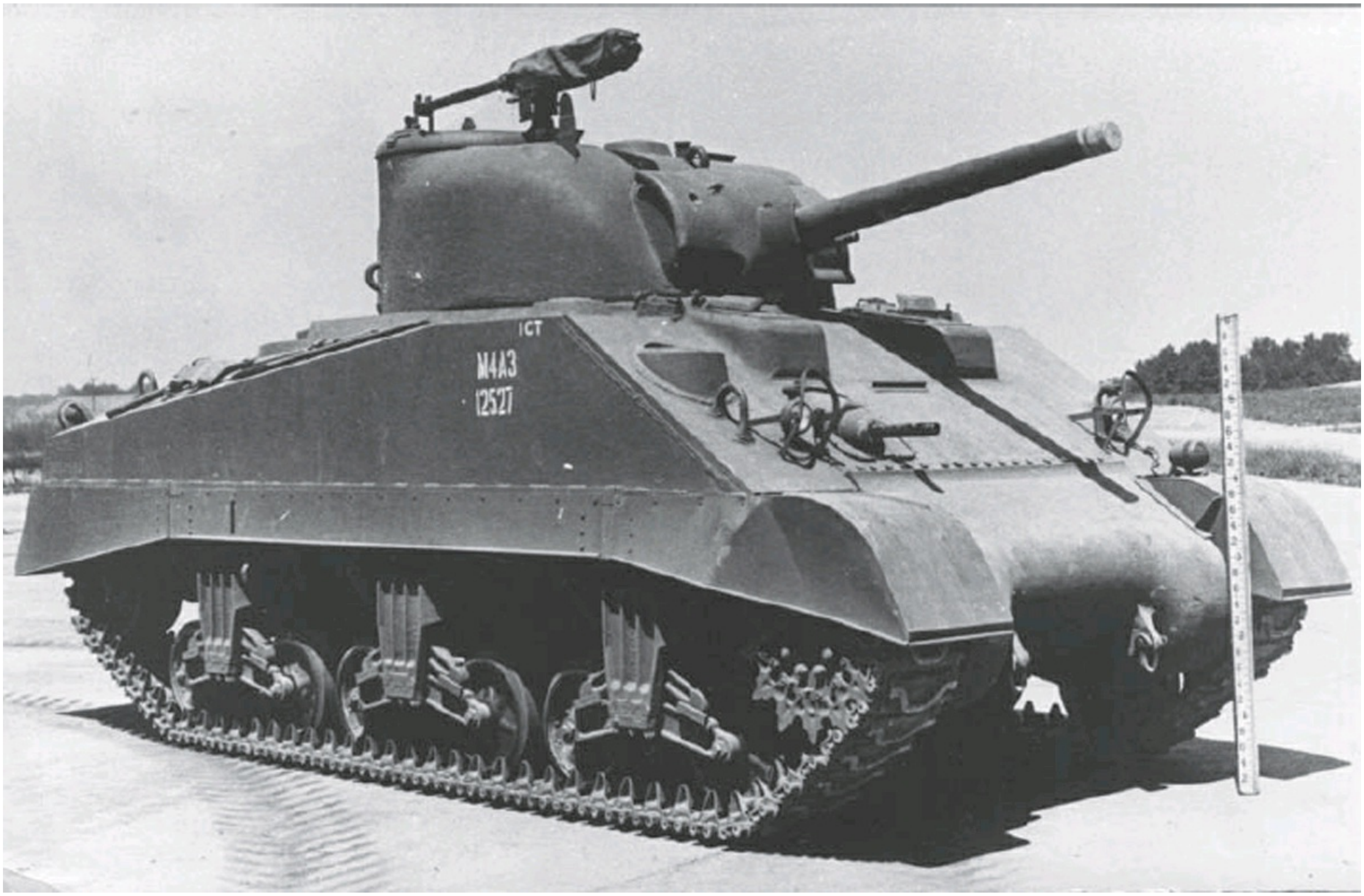
The majority of medium tank M4A2s were provided to the British and Soviets as Lend-Lease. Pictured is a restored example in British Army markings taking part in a yearly event held at the Tank Museum, Bovington, referred to as "Tankfest." The Free French Army also received a great many M4A2s under Lend-Lease. (Christophe Vallier)

Pictured is the Ford Motor pilot of the medium tank M4A3. This was made using a medium tank M4A2 hull. The angle of the upper-rear hull plate as well as the configuration of the engine deck does not accurately reflect the standard appearance of the production medium tank M4A3. (TACOM Historical Office)

"Sherman" was the official British designation for the M4 series tanks. The name was in honor of the American Civil War general, William Tecumseh Sherman. It was never an official U.S. Army designation, although it did become popular with some American tankers fighting in Europe during World War II, and shows up in some U.S. Army reports from the period. In the decades after the war, it became the primary name for the tank, which continues to this day.

Under Lend-Lease, the British received a total of 2,096 M4s, which they designated as the "Sherman I." A good number of their M4s were of the composite hull type which they designated "Sherman I Hybrid." A total of 942 units of the M4A1 entered into British and Commonwealth service during World War II, and were referred to as the "Sherman II."

While the production of M4 series tanks in the United Kingdom was contemplated in 1942, it was never implemented, most likely for political reasons. The only foreign manufacturer of the M4 series tanks was Montreal Locomotive Works in Canada. Using over 90 percent American-made components, they assembled a slightly modified version of the M4A1, outfitted to suit Canadian and British preferences (different internal storage arrangements). Officially designated the "Grizzly I," only 188 units were completed between October and December 1943, when production was terminated, as it was then thought that American factories had sufficient capacity to meet all future requirements.



Shown is a late-production M4A3 with the full-width M34A1 gun mount. The sand shields fitted to this vehicle seldom appeared on M4 series tanks employed by the American military during World War II. As with the M4 and M4A2, the glacis plate on the M4A3 was composed of both cast and welded armor. The .30 caliber bow machine gun in the tank's front hull was normally assigned to the lowest-ranking member of the crew. Since there was no sights for the bow machine gun, unlike their German medium tank counterparts, the bow machine gunner, or BOG, was forced to employ the fall of the weapon's tracers to direct his fire onto a target or targets. Many tankers thought it was a useless position, while other felt that it was useful in keeping enemy infantry at bay. (Patton Museum)

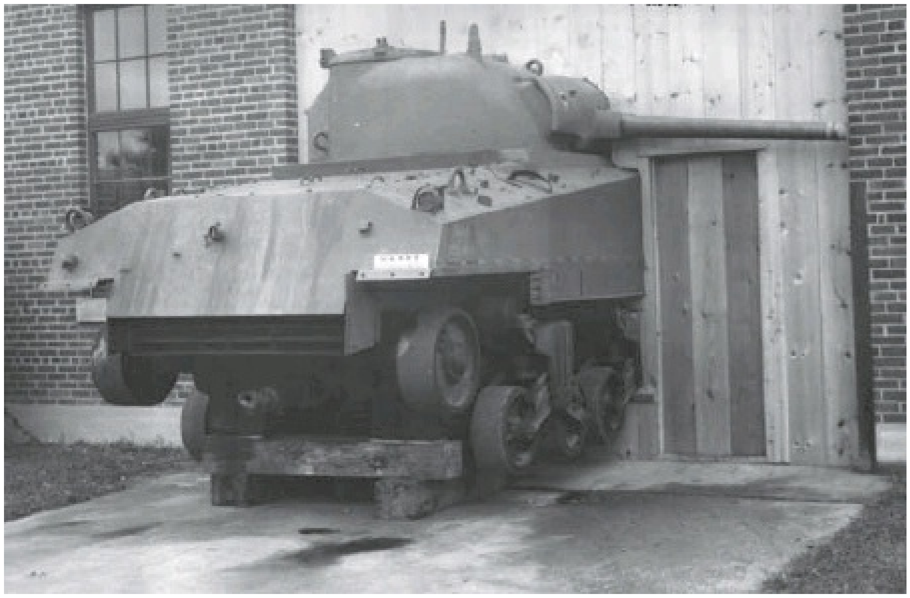
MEDIUM TANK M4A3

In August 1941, the U.S. government asked officials of the Ford Motor Company if they would be willing to manufacture tanks. Ford agreed to produce medium tanks, and for a power plant, offered a liquid-cooled, gasoline-powered V-8 design it had developed in-house. Ford-engine M4 series tanks were designated the "Medium Tank M4A3." In outward appearance, the welded-armor hull M4A3 differed from the welded-armor hull M4 only in its rear engine compartment arrangement and some other minor features. As with the M4 and M4A1, the M4A3 weighed about 33 tons. Production of the M4A3 began at Ford in June 1942 and continued until September 1943 with 1,690 units built.

More must be said about what was designated the "Ford GAA engine." It started out in June 1940 as an experimental 12-cylinder aircraft engine with a very high output power for its size and weight. Reduced to eight cylinders as a tank engine, maximum gross power was 500hp at 2,600rpm. The net power as installed in the M4A3 was 450hp at 2,600rpm.

A memorandum titled "Subject: Medium Tanks, M4A3," addressed to the Commanding General, Army Ground Forces Washington, DC, June 1943, shows that the Ford engine exceeded the performance of other medium tank engines at the time: "Based on experience in operations and after exhaustive comparative tests, the Armored Force considers the Ford tank engine superior to any other medium tank power plant now available. It is therefore recommended that the Ford-powered medium tank be declared suitable for overseas supply and placed in active theaters of operation at the earliest practicable date."

Belonging to the Virginia Museum of Military Vehicles is this medium tank M4A3. As seen here, a modification was introduced in which armor plates were welded to the front of the driver's and bow gunner's protruding hatch hoods in an attempt to increase the protection levels on the front of the vehicle's glacis. (Michael Green)



Pictured is a production medium tank M4A3 undergoing a dynamometer test at APG. The M4A3 can be distinguished from the earlier medium tank M4 by the squared-off upper-rear hull plate, which extended below the level of the upper track run. To reduce the amount of dust thrown up by the two engine exhaust vents, a deflector grill was fitted as seen here. (National Archives)

It was at that point, if sufficient production capacity had existed, that the U.S. Army would have completely replaced the Continental Radial engine with the Ford GAA engine. As it was, the decision was to reserve M4A3s for U.S. Army armored units, while progressively replacing all other types of M4 series tanks with the M4A3 both at home and overseas.

Ford was the only automobile company dropped from the M4 series tank program in the production cutbacks of late 1943. Reasons cited were to free up Ford facilities for other war work, as well as high cost and low productivity. However, Ford continued to produce engines up until the end of World War II. Most of these were supplied to Chrysler and Fisher Body, who took over the manufacture of M4A3s (and M26 heavy tanks) in 1944 and 1945. All told, Ford's Lincoln Plant produced 26,954 GAA engines.

During World War II, most of the M4A3s actually produced by Ford served as training tanks in the United States. However, period photos and historic documents from 1945 show that a small number served in both Europe and the Pacific. On the other hand, with progressive replacement, Chrysler and Fisher-built second-generation M4A3s made up over half of the U.S. Army's inventory of the tank by the end of the war.

While the M4A3 entered into Marine Corps service in late 1944, only a very small number were Ford-built. The British Army received six Ford-built M4A 3s as Lend-Lease, and used them only as test vehicles. They were designated the "Sherman IV."

MEDIUM TANK M4A4

The Ordnance Department eventually approved the mounting of an improved version of the Chrysler A57 Multi-bank gasoline-powered engine that had been installed in the M3A4 medium tank into the M4 series. This configuration of the M4 series tank was designated the M4A4. Like the M3A4 medium tank with the same engine arrangement, the large and bulkier power plant mandated a lengthened hull and suspension system for the M4A4. Ordnance Department tests showed the A57 Multi-bank was the least satisfactory of the engines selected for the M4 series tanks and recommended that when a sufficient number of other types of engines became available, production come to an end.

An early-1943-production medium tank M4A4 is shown on display in France. To make room for the larger and bulkier Chrysler A57 Multi-bank engine, the M4A4 hull had to be lengthened 11 inches. Note the increased distance between the road wheels as compared with other M4 series medium tanks. The approximate operating range of the M4A4 on level roads was 150 miles. (Pierre-Olivier Buan)

With no interest in the A57 Multi-bank engine-powered M4A4 except for stateside training purposes, the U.S. Army decided to give most of them to the British Army. Automotive engineers from the British Tank Mission initially looked with absolute horror on the complex A57 Multi-bank-powered M4A4 tanks being offered to them. However, they took them into service anyway and eventually rated them as being more reliable than the nine-cylinder Continental Motors gasoline-powered, air-cooled radial engines in the M4 and M4A1. This was partly accomplished by doing away with the individually mounted carburetors on each of the five engines and combining them into one bank on top of the power plant for easier access by the crew.

Chrysler completed 7,499 units of the M4A4 between July 1942 and September 1943. Of that number, 7,167 units went to the British Army under Lend-Lease. In British military service, the M4A4 became the "Sherman V." Of the remaining M4A4s, two went to the Red Army and 274 to the Free French Army in North Africa in 1943. Of the remaining 56 M4A4s remaining, 22 went to the Marine Corps, who employed them for training duties only. The tank was reclassified as limited standard in May 1945.

The lengthening of the M4A4, and the larger and heavier power plant, drove the vehicle's weight to almost 35 tons. Due to a serious U.S. Army shortage of M4 series tanks during the Battle of the Bulge (December 1944 through January 1945), the British Army returned a number of M4A2 and M4A4 tanks to the U.S. Army. Most went on to see service with the American Third Army, under the command of Lieutenant-General George S. Patton.

THE M4A6 TANK

The only other M4 series tank to see the mounting of an alternate power plant was the composite-hull M4A6, which featured a Caterpillar Tractor Company modification of a Wright G200 air-cooled, gasoline-powered radial turned into a diesel engine with a fuel injection system. Originally referred to as the Caterpillar D200A, it later became the Ordnance Engine RD-1820. Unlike the other engines in the M4 tank series, the new power plant in the M4A6 could operate on a variety of petroleum products ranging from crude oil to gasoline, making it the first example of a multi-fuel tank power plant.

The medium tank M4A6 was fitted with a Caterpillar Tractor Company radial diesel engine designated the RD1820. Due to the size and bulk of the engine, the rear ¾ hull of the M4A4 was mated to the front-hull casting used on the late-production composite hull M4 medium tank. Only 75 M4A6s were produced before the project was terminated due to production cutbacks. (TACOM Historical Office)

Chrysler began production of the M4A6 in October 1943. However, the Ordnance Department decided to discontinue production of the vehicle in February 1944 after only 75 units were completed. The reason for this cancellation had to do with changing military requirements and a decision to concentrate on building more of the gasoline-powered M4A3 tanks. The M4A6 tanks all came with the same unusual combination of a cast-armor hull front mated to a rear welded-armor hull, as did late-production M4 tanks built at the Detroit Tank Arsenal. The tank was reclassified as limited standard in May 1945.

BRITISH ARMY COMBAT DEBUT

The British Army suffered some serious battlefield reverses in North Africa in June 1942, which included the loss of a great many tanks. Unable to make up those losses quickly, British Prime Minister Winston Churchill asked American President Franklin Roosevelt if he could make available as many of the new M4 series tanks as possible to help stem the German advance in North Africa.

Originally, it was envisioned that an entire American armored division under the command of then-Major-General George S. Patton would be sent to Egypt to assist the British Army. However, the logistics of such a move would have taken too long to be of much use to the hard-pressed British Army then fighting for its life. Instead, it was decided to take 300 M4 series tanks out of the U.S.

Army inventory and ship them by sea directly to the British Army in Egypt.

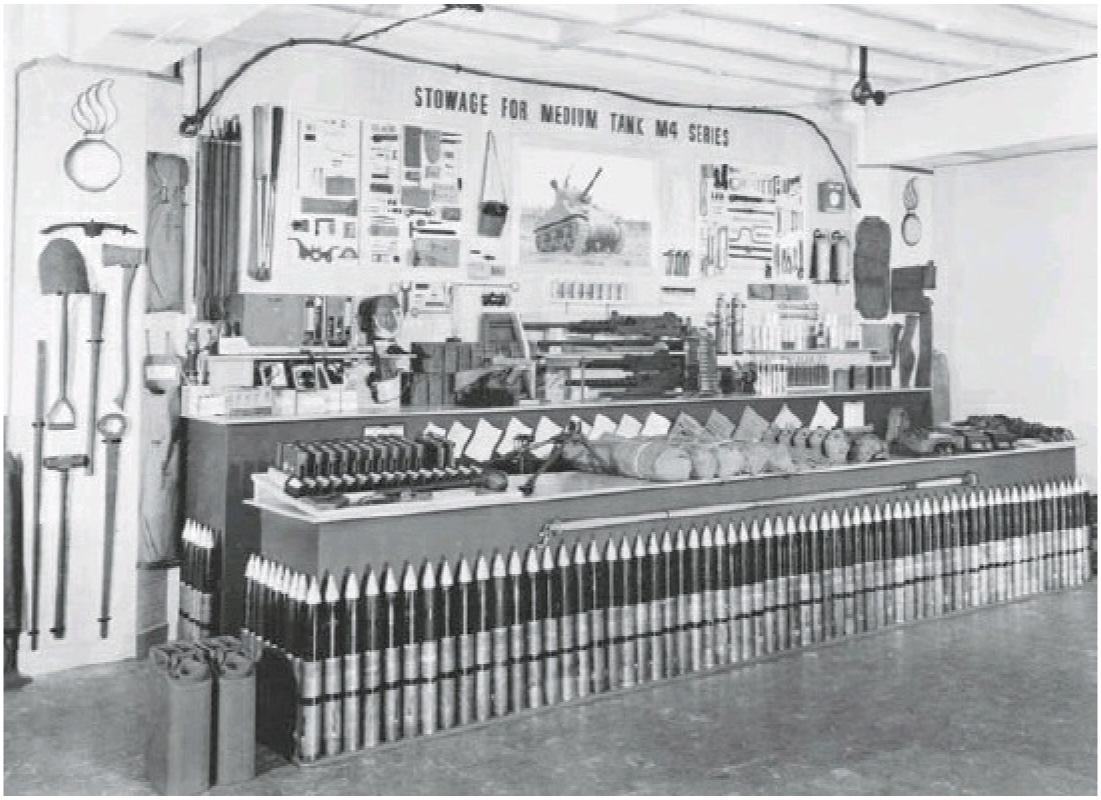
Despite one transport ship carrying tanks being sunk en route to Egypt, by September 1942 almost 300 M4 series tanks had arrived in that country, with most of them being M4A1s and a smaller number of M4A2s. Modified by the British Army for use in a desert environment, which included the addition of sand shields and British stowage arrangements, these tanks would play an important role in helping the British Army eventually stop the German advance toward Egypt. As time went on, additional deliveries of M4 series tanks to the British Army in North Africa made it their most commonly used tank in that theater of combat.

British Army opinion of the M4 series tank ran very high during its time in combat in North Africa. That sentiment appears here in a statement from a senior British Army officer that showed up in a July 1943 U.S. Army report titled *Tankers in Tunisia*: "In my opinion the Sherman is the finest tank in the world, better than anything else we have and also better than anything the Germans have. It will be the best tank for the next five years."

The M4 series medium tanks first saw combat with the British Army at El Alamein in October 1942. Its U.S. Army combat debut was in November 1942 with Operation *Torch*, the invasion of Northwest Africa. This camouflaged M4A1 of the 1st Armored Division was photographed in Tunisia in February 1943. (Patton Museum)

U.S. ARMY COMBAT DEBUT

Various units of the U.S. Army were employed in the invasion of French North Africa (which includes the current countries of Morocco, Algeria, and Tunisia) in November 1943. The endeavor was referred to as Operation *Torch* and was spearheaded by the U.S. Army's 1st and 2nd Armored Divisions. The inexperienced American tankers had their first encounter with the more experienced German forces in North Africa in December 1942, when a platoon of five M4 series tanks from the 2nd Armored Division went up in flames from a combination of accurate German tank and antitank gunfire.



Pictured is an Ordnance Department display of the onboard stowage of the M4 series medium tank showing the many items carried within the vehicle. Many tankers blamed the gasoline fuel used by most M4 series tank as the primary cause of tank fires. However, battlefield studies revealed that the main gun rounds were the primary culprit. Ammunition stowage was positioned high in the hull and poorly protected. (Ordnance Museum)

Being winched onboard a semitrailer, designated the M15, is a trackless, burned-out medium tank M4A1. The tractor truck with the armored cab was referred to as the M26. By summer 1944 it was clear to all American tankers in the ETO that they were vulnerable to almost every antitank weapon in the German arsenal. (Patton Museum)

On February 19, 1943, American tankers felt the full wrath of the German Army in North Africa when its tank-led spearhead punched a 2-mile-wide hole through American lines at Faid Pass in Tunisia, pushing them back 50 miles in what is best described as a rout. In the process, German Army units inflicted heavy losses on the still inexperienced U.S. Army units in their path during a series of engagements known as “the battle of the Kasserine Pass.” Over 100 American tanks, most of them belonging to the M4 series, littered the barren North African landscape in its aftermath. It took until February 25, 1943, before the American lines were restored to their original positions.

Despite their losses in North Africa, many American tankers considered the M4 series a fine tank and more than sufficient for any job at hand. In the U.S. Army report *Tankers in Tunisia*, Sergeant Becker, who saw combat in North Africa, remarked, “I like the M4. I look at the German tank and thank God I am in an M4.”

Not everybody who served on M4 series tanks in North Africa considered the tank free of flaws. Sergeant James H. Bowser, a tank commander in the 1st Armored Division, is quoted in the same report: “Yes sir, this is my third tank, but I’ve still got all my original crew with me. We were burned out of our other two tanks under fire. If they were diesel, it wouldn’t have happened, but these gasoline jobs blaze up on the first or second hit and then you’ve got to get out. None of us like ’em, sir. We’d rather have the diesels.”

Despite the belief of many American tankers who served on M4 series tanks during the fighting in Northwest Africa that it was the gasoline fuel their vehicle used that burned so easily, this was not the case. Instead, it proved to be the main gun ammunition stored within them that caused the fires. A British officer commented in *Tankers in Tunisia*: “Self-sealing gasoline tanks for tanks are nice, but they are not vital. It is the ammunition, not the gasoline that burns. German tanks burn too if ammunition is hit. I think that the Germans aim to hit our ammunition. In one battalion fifteen tanks were penetrated; eleven of them burned, ten because of ammunition… In another battle fifteen tanks were penetrated; seven burned, all but one by ammunition fire.”

Another U.S. Army report, *Observations on Problems in Armored Units*, dated June 6, 1945, from the Office of the Chief of the Commanding General Army Service Forces, confirms the British officer’s opinion on the cause of tank fires: “Fires in Tanks: Recent experience reinforces earlier data, from sixty to ninety percent of M4-75mm go by burning and almost all burn when hit by a *Panzerfaust* [German late-war infantry single-shot antitank weapon firing a shaped-charged warhead]. The greater proportions of fires originate in the ammunition, a few slow fires in oil of power train, and stowage the remainder in the engine compartment.”

ARMOR PROTECTION ISSUES

Once a projectile of almost any type penetrated the armor of an M4 series tank upper hull, it would often strike the main gun ammunition racks primarily located in the sides of the upper hull (referred to as “sponsons” in the American military and “panniers” in the British Army), igniting the propellant charges contained within the metal cartridge cases, which would begin to burn within a few seconds. In many cases, this happened before the crew could evacuate their vehicle. On the original M4 series tanks, the majority of the 75mm main gun rounds were stored within light-sheet steel boxes, with another 12 rounds stored vertically in clips along the inside wall of the turret basket for easy access by the loader.

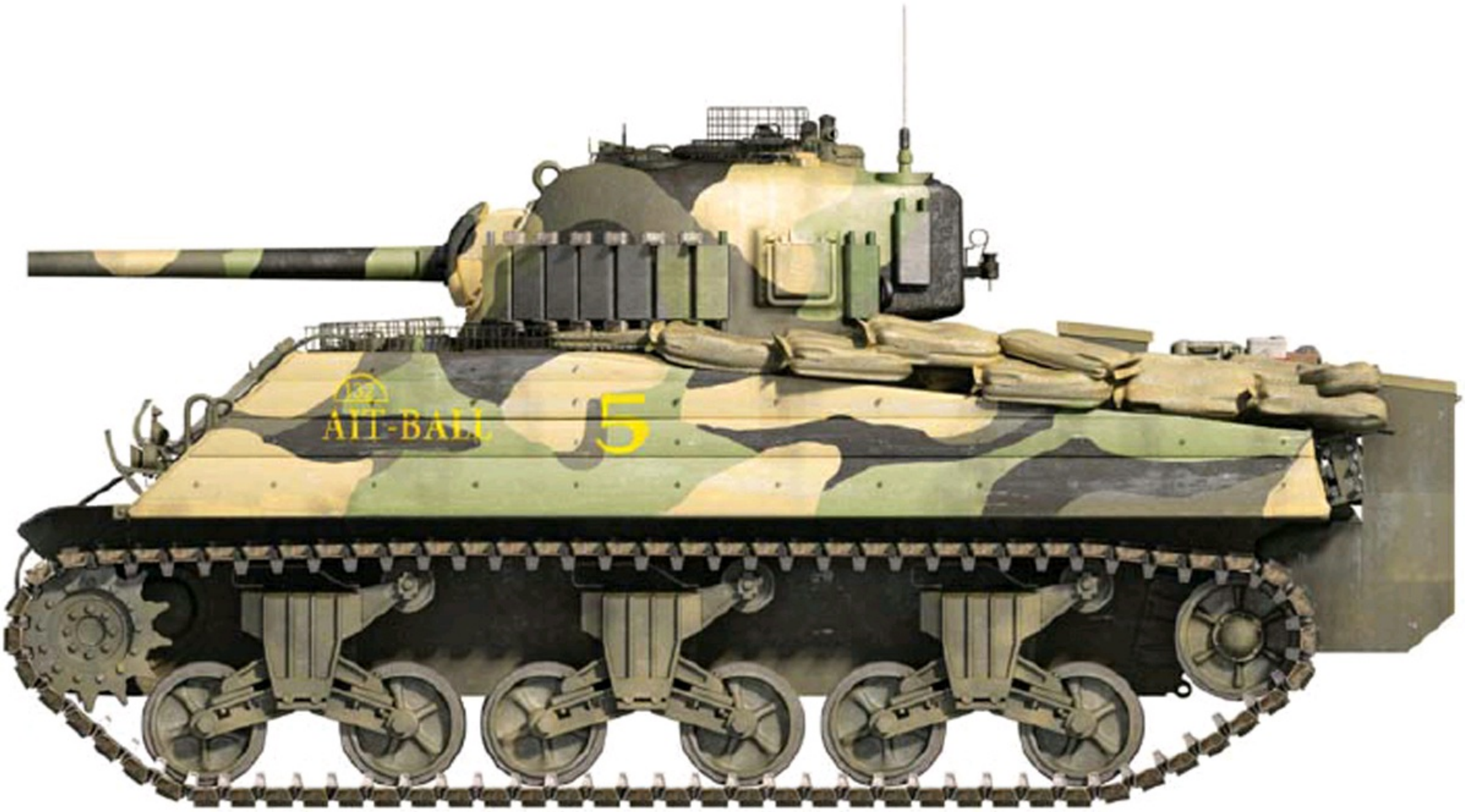
There were numerous reasons for the lack of heavier armor not appearing on the M4 series tanks. Armor is the heaviest element of any tank design. Steel armor plate 1-inch thick weighs 40 pounds per square foot. When the M4 series tanks came about, the engineers designing the vehicle were constrained because existing cranes fitted to the majority of transport ships could not load or unload anything heavier than 35 tons. Portable bridges employed by the U.S. Army in the early days of the war also had an upper weight-bearing limit of no more than 35 tons.

Due to the need to produce a tank with a turret-mounted 75mm main gun as quickly as possible, the M3 chassis and engine became the basis for the M4 series tanks. While this decision certainly sped up the M4 series tank design and production, it saddled the engineers with a number of design problems, such as figuring out the minimum amount of armor protection needed by the tank to carry out its intended battlefield roles.

To increase the armor protection on their M4 series medium tanks, it was common for crews to weld spare track links onto the hulls as seen here. Sometimes the spare track links would also be welded onto the turret sides. (Patton Museum)

The Ordnance Department looked to see what the main antitank weapon of the German infantry was in 1941. That turned out to be a towed 37mm antitank gun, designated the 3.7cm PaK 35/36 L/45, which fired an AP-T projectile with a muzzle velocity of 2,444ft/sec. In theory, it could penetrate 1.34 inches (34mm) of armor sloped at 30 degrees at a range of 109 yards. At 546 yards, it could only penetrate 1.14 inches (29mm) of armor. These penetration figures illustrate that the M4 tank series was well protected against this weapon.

What the American tank designers failed to foresee when laying out the armor protection levels on the M4 series tanks were the amazing advances in antitank weapon technology made by the German military prior to, and during, World War II. These weapon advances quickly left the M4 series tanks badly under-protected for the roles they assumed during the conflict. While many stopgap measures appeared, both officially and unofficially as field modifications, none could really meet the expectations of the American tankers who served in the M4 series tanks.



As the Marine Corps inventory of M4A2 medium tanks was depleted, they returned to the U.S. Army for a resupply of additional M4 series medium tanks. Available at that time was the second-generation M4A3 medium tanks. The vehicle pictured in this artwork belongs to Company A, 4th Tank Battalion on Iwo Jima in February 1945. It has a very elaborate camouflage scheme consisting of a combination of the base olive drab, with field-applied splotches of black, sand, and dull green. The vehicle also has raised wire mesh screening on the crew hatches, and sandbags on the rear engine deck, to reduce the effectiveness of enemy hand-placed explosives. The wooden planking on the hull side was intended to counter the use of magnetic mines by Japanese infantry tank-hunting teams. (© Osprey Publishing Ltd.)

While some M4 series tankers believed that cast-armor upper hulls were superior in deflecting armor-piercing projectiles than their more box-like, welded-armor upper hull counterparts, tests between the two types of hulls showed without a doubt that the welded-armor hull M4 series tank was better at deflecting projectiles.

In the ETO, a widely used method of adding extra protection was placing sandbags on the front, as seen here on this medium tank M4A1. To prevent the sandbags from sliding off the sloped glacis of the tank, they have been secured by a steel crossbeam at the bottom of the glacis. In reality, the sandbags did little, other than add weight, straining the drivetrain components. (Patton Museum)

The high losses suffered by American tanks, such as the M4 series, is addressed in Belton Y. Cooper's book *Death Traps: The Survival of an American Armored Division in World War II*. In his book, he states the 3rd Armored Division had 648 tanks completely destroyed and another 700 knocked out, but eventually repaired and placed back in service again. This took place between the time they went ashore in France in late June 1944 and the end of World War II in Europe.

THE SHAPED-CHARGE THREAT

Besides the threat from German kinetic energy rounds, a new danger for the M4 series tanks and other armored fighting vehicles came late in World War II from the widespread employment in the German military of hand-held rocket launchers equipped with shaped-charge warheads. These included the *Panzerschreck* ("tank terror") and *Panzerfaust* ("tank fist"). Kinetic energy refers to the energy an object has in motion.

To counter the threat from German kinetic energy rounds and shaped-charge-armed rocket launchers, American tankers began covering the outside of their vehicles with a variety of materials, including spare track links. Other items employed included sandbags followed by cement. Initially, the most common method of holding sandbags onto the tanks was with communication wire or common chicken wire. As time went on, some units built elaborate metal brackets to support the sandbags in place.

Some units would apply as many as 170 sandbags to each of their tanks. It was felt that the application of these materials to the exterior of tanks might deflect kinetic energy projectiles and prematurely detonate shaped-charge rocket warheads, thereby reducing their penetrative abilities. The actual effectiveness of these field expedient modifications varied depending on whom you talked to. The commanding officer of the 756th Tank Battalion noted in an After Action Report (AAR) of his unit that “sandbagging the front of the tank greatly improves the morale of the crews.”

Some M4 series tankers decided to take the add-on protection to the next level by covering the sandbags on their vehicle’s glacis with a layer of cement as seen in this photograph. Other tankers dispensed with the sandbags and added only a layer of cement to the glacis of their tanks. (Patton Museum)

Some units swore that the addition of sandbags to their tanks was worth the effort, while other units dispensed with them altogether due to the strain placed on the vehicle’s automotive components. Lieutenant-General George S. Patton frowned on the use of sandbags in his Third Army due to the toll they took on suspension system components. This belief often caused problems with armored divisions being temporarily assigned to his command, coming in from either the First or Seventh Armies, whose commanders had no objections to the use of sandbags on tanks.

The addition of cement to the exterior of M4 series tanks was not as common as the application of sandbags in the European Theater of Operations (ETO). To verify the effectiveness of cement in repelling rockets armed with shaped-charge warheads, the U.S. Army’s 709th Tank Battalion conducted a test that involved firing a number of rockets from a *Panzerschreck* at the cement-covered glacis of an M4 series tank. The cement did not stop the shaped-charge rocket warheads from penetrating the glacis of the vehicle, but it did reduce the damage inside the tank. Depending on the point of entry, shaped-charge warheads can ignite fuels, fluids, and ammunition within a struck vehicle.

A popular answer to the threat from hidden German soldiers armed with the *Panzerschreck* or the *Panzerfaust* was referred to as “reconnaissance by fire.” A description of the merits of that practice appears in an article by an unnamed American tanker, titled “Technique of the Tank Platoon as the Point in an Exploitation,” in *Armor in Battle*, a March 1986 publication by the U.S. Army Armor School:

> We come to that highly controversial subject: reconnaissance by fire. On this subject the writer had two complete changes of opinion. During his first days in combat, he employed it extensively. Later it seemed distracting, to destroy the element of surprise. Then he gaily rode into a neat ambush just across the Rhine. From there on he fired on everything remotely suspicious on the ground that it was German in any case. Of course, the life span of tractors and other farm vehicles of suspicious silhouette

was short indeed.

More seriously it should be said that reconnaissance by fire is almost a necessity if moving steadily. It is sometimes a waste of ammunition, but it has a decided morale factor. It is good for your morale and decidedly disturbing to the other fellows. However, it should be carefully controlled and done intelligently.

THE JAPANESE ANTITANK THREAT

The threat in the PTO to the M4 series of tanks was different from that found in the ETO. The Japanese Army deployed very few tanks and self-propelled guns against the American military during World War II. What they did have was an excellent towed 47mm antitank gun that was introduced into field service in 1942. It was a scaled-up copy of the German-towed 37mm antitank gun. It could penetrate 2 inches (51mm) of armor at 1,000 yards. This meant it could punch a hole through the M4 series tank in any area except the glacis or the front of the turret most of the time.

A Marine Corps document dated May 1945, titled *Iwo Jima, 4th Tank Battalion Report*, describes Japanese antitank measures involving their 47mm antitank gun:

> Antitank gunnery was generally excellent. The gun positions were usually well constructed and well concealed. Guns had good fields of fire and good alternate fields of fire. Most guns had alternate positions, in some cases several, and this allowed the enemy to shift guns, so that located positions would be empty the next day, and our tanks were surprised by fire from previously undetected guns. Fire discipline of 47mm gun crews was excellent, and few erratic or waste rounds were observed.

To make up for the shortfall of tracked and towed antitank weapons to deal with American tanks, the Japanese Army often depended on the fighting spirit of their infantrymen. Lacking the hand-held anti-armor rocket launchers provided to the German infantry in the latter part of World War II, the Japanese infantrymen evolved their own method of tackling enemy tanks.

During one combat encounter on the Japanese-occupied island of Saipan on July 8, 1944, a Japanese soldier tossed a hand grenade onto the turret of a Marine Corps tank commanded by Sergeant Frederick Grant Timmerman who was operating the .50 caliber machine gun on the roof of the vehicle. Rather than allow the grenade to drop within the turret and no doubt kill his crew, according to his Medal of Honor citation, “Sergeant Timmerman unhesitatingly blocked the opening with his body holding the grenade against his chest and taking the brunt of the explosion.”

This passage from the U.S. Army Center of Military History publication, The Technical Services, *The Ordnance Department: On Beachhead and Battlefront,* describes how Japanese infantrymen dealt with tanks:

> The Army’s 193rd Tank Battalion noted a pattern of Japanese infantry attacks in 1945 on Okinawa. Japanese squads of three to nine men attacked individual tanks. Each man in the squad filled a role. One man threw smoke grenades to blind a targeted tank. The next man threw fragmentation grenades to force the tank’s crew to close their hatches. Another man placed a mine on the tank’s tracks to immobilize it. A final man placed a mine or explosive charge directly on the tank to attempt to destroy the tank.

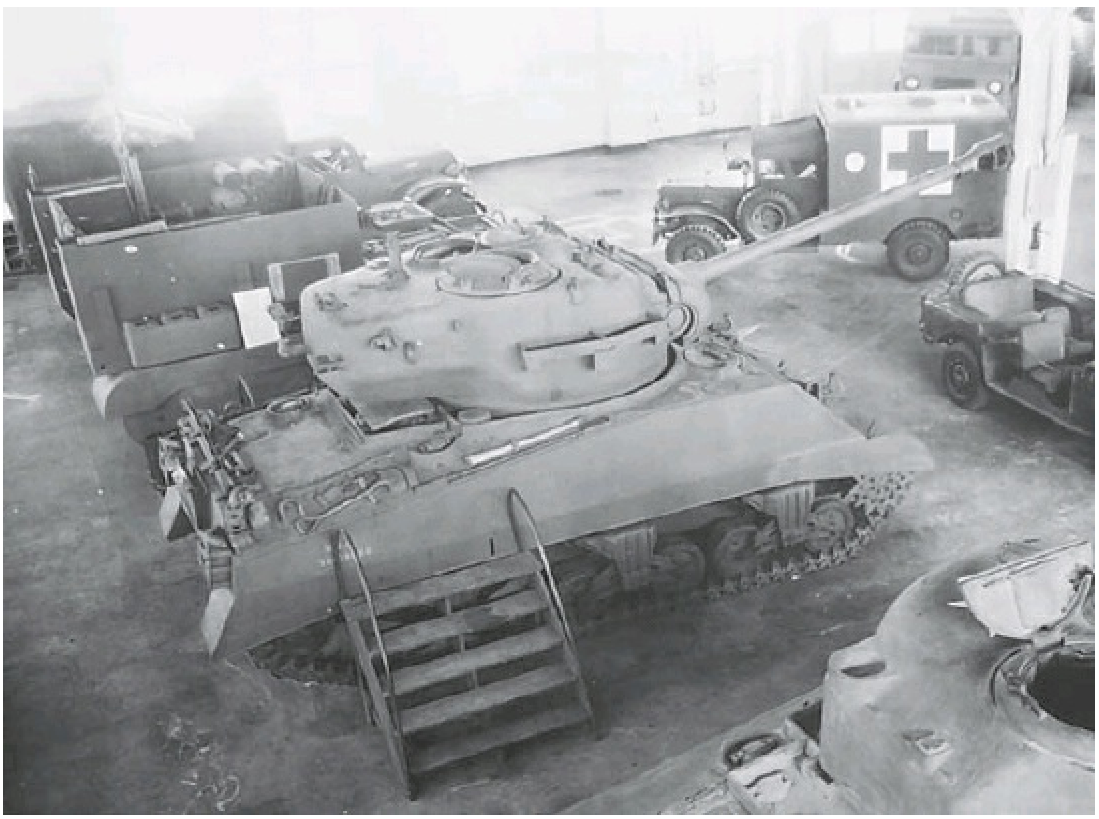
AMERICAN COUNTERMEASURES

To counter Japanese towed antitank guns and infantry tank-hunting teams armed with satchel charges, magnetic mines, regular mines, and on some occasions, with explosives strapped to their bodies, American tankers in the PTO would adopt some of the same countermeasures employed by their counterparts fighting in the ETO. This included adding spare track links, sandbags, or cement to the exterior of their vehicles. The downside of this extra protection meant an increase in weight and sometimes vehicle width that would cause problems for the U.S. Navy when attempting to transport these vehicles by landing craft.

As Japanese infantrymen would often attempt to set off explosives over the engine deck of tanks in order to immobilize them, Marine Corps tankers would sometimes place a layer of sandbags over that portion of their vehicles. Because Japanese infantry tank-hunting teams would also target the hatches on M4 series tanks with hand-emplaced mines or explosive charges, some Marine Corps tankers installed steel mesh covers over their hatches or even went as far as welding on nails face up on the hatches of their tanks.

The Marine Corps tankers of C Company, 4th Marine Tank Battalion, attached 2-inch by 12-inch wooden boards to the sides of their vehicles with a 4-inch gap between them and the vehicle's exterior hull in which they poured cement. The intention was that the wooden planks would defeat magnetic mines, and the cement would reduce the effectiveness of the AP round fired from Japanese-towed 47mm antitank guns.

American tankers in the Pacific discovered that canvas or neutral materials applied on the tanks made the magnetic mines slide off. The U.S. Army's 713th Flame Thrower Tank Battalion mixed sand with paint to stop magnetic mines from adhering to the surface of their vehicles, in a manner similar to that of the German's *Zimmerit*. However, since they did not encounter any magnetic mines in combat, the 713th's concept remained unproven.



In summer 1944, Chrysler Engineering, part of the Chrysler Corporation, did a trial installation of the heavy tank T26E3's 90mm main-gun-armed turret onto the hull of a second-generation M4 medium tank as shown here. Had this been available for immediate shipment in quantity, it might have been accepted. However, the powers-that-be in the U.S. believed that this arrangement would not be ready for delivery before January 1945. In their minds it therefore made more sense to await the production of the heavy tank T26E3, which later became the M26 heavy tank. (National Archives)

In response to the threat from enemy infantry tank-hunting teams, a number of countermeasures were explored by the Ordnance Department. These included everything from a special flame-thrower device mounted externally on the four corners of an M4 series tank, to a variety of explosive devices, be it antipersonnel mines or hand grenades on the exterior of the tanks. It was intended that these devices be detonated from within the vehicle by the driver when enemy tank-hunting teams approached. Due to the danger of these devices going off accidentally around friendly troops, none of these proposed arrangements was adopted.

As with the German Army, the Japanese Army employed standard antitank mines to stop enemy tanks. The Japanese Army would also use improvised antitank mines. Some comments on the use of antitank mines by the Japanese Army appear in a U.S. Marine Corps report titled *Armored Operations on Iwo Jima*, dated March 16, 1945:

> The enemy practice of tying aerial bombs to a yard stick mine is an expensive method of mining. Their policy is to completely demolish the tank with the mine as distinguished from the German policy of merely stopping the tank with the mine and destroying it by gunfire.
>
> Japanese mining was erratic. In one case the mines were marked with stakes. In another case a complete field beside a road was mined while the road was left untouched. Tanks on the beach were able to pick their way through [mine] fields because the mines were spaced too far apart.

FIREPOWER ISSUES

Following the U.S. Army landings in France on June 6, 1944, there was a quick push inland after the German defensive positions along the French coast were overcome. It was shortly thereafter that the American soldiers had a shock when they discovered what an incredible terrain obstacle the Normandy farmers' hedgerows created. The thick and tall centuries-old hedgerows began right behind the American landing beaches, codenamed "Omaha" and "Utah," and extended up to 50 miles inland in some areas. They provided excellent cover and concealment for the defending German units.

To make matters even worse, U.S. Army M4 series tankers who were assigned to assist the infantry in overcoming the Normandy hedgerows began encountering the 50-ton German Pz.Kpfw. V Panther medium tank in ever increasing numbers beginning in July 1944. The frontal armor on this tank proved impervious to the M61 APC-T projectiles fired by the 75mm gun M3 even at pointblank range.

The welded-armor glacis on the Panther tank was 3.15 inches (80mm) thick and sloped at 55 degrees, with the front of the Panther tank welded-armor turret being 4 inches (100mm) thick, fitted with a rounded cast-armor gun shield also 4 inches thick. How was it that the U.S. Army did not have an M4 series tank in service that possessed a main gun that could penetrate the Panther tank's frontal armor?

While the primary effectiveness of main guns on modern tanks comes from their ability to defeat the armor protection of other tanks, when the M4 series tank first appeared in 1942, its main purpose was envisioned by the U.S. Army as a deep attack (exploitation) weapon and not as a tank-versus-tank combat vehicle. This flawed concept is seen in a memorandum by Lieutenant-General Lesley J. McNair, commander AGF, dated January 23, 1943, in which he states the following: "It is believed that our general concept of an armored force – that it is an instrument of exploitation, not greatly different in principle from horse cavalry of old – is sound."

To allow the M4 series tanks to fulfill their primary mission as a weapon of exploitation, the U.S. Army fielded highly specialized vehicles for combating enemy tanks, known as tank destroyers, supposedly mounting weapons of sufficient power to penetrate any opposing armored vehicle. The idea that it took a specialized vehicle to destroy enemy tanks was championed by McNair, a man who had a great deal of influence with the then-U.S. Army Chief of Staff, General George C. Marshall, who had appointed him to the job.

American tankers engaging late-war German tanks in Northwest Europe beginning in the summer of 1944 and into early 1945 soon saw the fallacy of McNair's strong belief in the value of tank destroyers. Colonel S. R. Hinds, of Combat Command B of the 2nd Armored Division, stated in the March 1945 report *United States vs. German Armor* that "[i]n spite of the often quoted tactical rule that one should not fight a tank versus tank battle, I have done it almost invariably, in order to accomplish the mission."

Lieutenant-Colonel Wilson M. Hawkins, commanding the 3rd Battalion, 67th Armored Regiment of the 2nd Armored Division, was quoted in the same report: "It has been stated that our tanks are supposed to attack infantry and should not be used tank vs. tank. It has been my experience that we have never found this an ideal situation for in all our attacks we must of necessity fight German tanks. Therefore, it is necessary for a tank to be designed to meet adequately this situation."

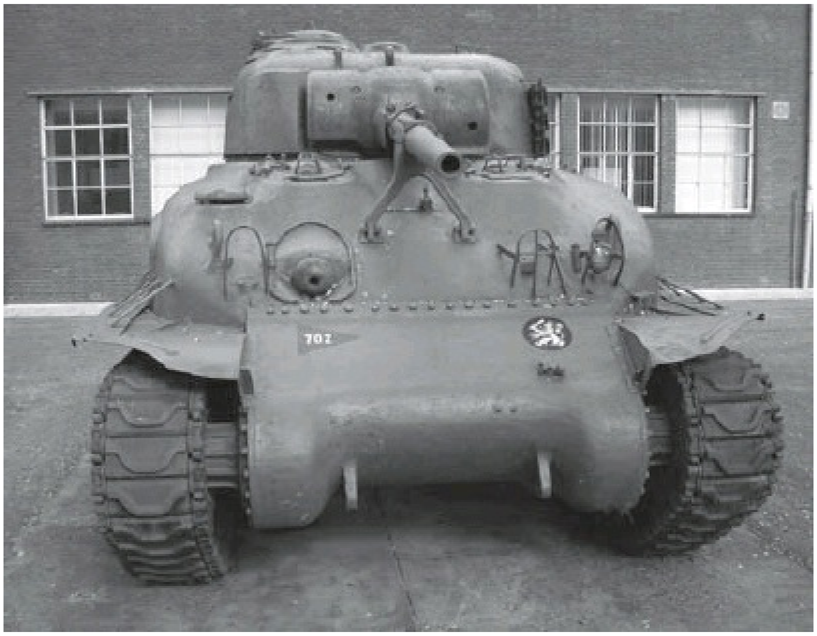
PROBLEMS IN OVERCOMING THE PANTHER TANK

The Panther medium tank was first confronted by the U.S. Army during the fighting in Italy in early 1944. Its 75mm main gun was designated the 7.5cm Kw.K. 42 L/70 and fired an APC-T round known as the Pzgr. 39/42, which had a muzzle velocity of 3,035ft/sec. The projectile portion of that round could penetrate 3.5 inches (89mm) of armor at a range of 2,187 yards. Despite the outstanding attributes of the Panther tank's 75mm main gun, the vehicles did not make much of an impression upon the American frontline forces fighting in Italy because they were used in small numbers and restricted by poor terrain.

Unfortunately, the Italy experience led to the false belief among the U.S. Army senior leadership that the Panther tank, like the Pz.Kpfw. VI Tiger Ausf. E heavy tank, was only going to be fielded in small numbers. Hence, there was no need to spend the time and effort in developing tank or tank-destroyer main guns able to destroy these late-war German vehicles. At the lower levels of command, not everybody was convinced the Panther tank would only be deployed in small numbers. However, their voices would not be heard.

The M4 series tank problems with the Panther tank caused General Dwight D. Eisenhower (Supreme Allied Commander of the Allied Expeditionary Force) to send one of his subordinates back to the tank designers in the United States in July 1944 to look for a quick solution.

Eisenhower's subordinate was shown an M4 mounting a 90mm gun M3 armed turret from the future heavy tank M26. This arrangement seemed to be the answer to the Panther tank problem. However, he was told it could not be made ready for at least six months and it made more sense to wait for the M26 supposedly due out in that time frame. Sadly, while the M26 did make it to Northwest Europe in February 1945, it was fielded in such small numbers initially that it would have no real influence on the battlefield before the war in Europe ended in May 1945.



The Chrysler Corporation was requested to design a spacer system that would allow extended end connectors to be attached to both the inner and outer track links of M4 series medium tanks to improve off-road mobility. The modifications kits were not available until early 1945, too late to see much service during World War II. The M4A1 tank pictured might be referred to informally as the “M4E9,” although it lacks the extended end connectors that would normally be fitted in this configuration, but the space for the inner connectors between the track and the hull side can be seen here. (Michel Krauss)

THE BRITISH ARMY SOLUTION

The British Army did not make the same mistake the U.S. Army did regarding the widespread fielding of the Panther tank. They had grasped right away that the vehicle was not going to be formed into a small number of independent battalions like the Tiger Ausf. E heavy tank, but was intended as a replacement for the Pz.Kpfw. IV medium tank in the Panzer Divisions.

The British Army therefore set out to field a tank main gun that could penetrate the frontal armor of anticipated German late-war tanks and had it in service before the Allied invasion of France on June 6, 1944. As a tank main gun, the weapon was designated the 17-pounder (76.2mm), quick-firing Mark IV. It was mounted in the M4 or M4A4 and became known as the “Firefly.” It began appearing in British Army service in early 1944. By the time the British and American armies had landed in France there were almost 350 in British service. When the war in Europe ended in May 1945, 2,200 units of the Firefly had been constructed.

The 17-pounder main gun on the Firefly possessed the penetrative abilities to punch holes in the frontal armor array of late-war German tanks at normal combat distances. This ability was not appreciated by the U.S. Army until after the invasion of France, and large numbers of Panther tanks were encountered in June and July 1944. Desperation drove American General Omar N. Bradley to inquire in August 1944 from his British Army counterpart if some Fireflies could be made available to the U.S. Army. This request was denied as the British Army felt that they did not have enough Fireflies in service at the time to spare.

In September 1944, the British Army informed their American comrades in arms that they could now spare at least enough 17-pounder quick-firing Mark IV tank guns to re-arm up to 100 M4 series tanks for them. This time it was the U.S. Army which declined, as there was then a temporary shortage of 75mm main-gun-armed M4 series tanks in the ETO due to extremely high combat losses.

The program to up-arm U.S. Army M4 series tanks with the 17-pounder, quick-firing Mark IV tank gun bore no fruit until near the end of the war in Europe when 100 units out of 160 planned were completed. Twenty were transferred to the British Army, with the other 80 vehicles never issued to units in the field. The ultimate fate of these vehicles is lost to history.

On display at the Tank Museum, Bovington, is a Sherman VC “Firefly” based on the medium tank M4A4. It is armed with a 17-pounder (76.2mm) main gun that proved to be one of the few Western Allies’ tank-mounted weapons that could penetrate the frontal armor of the German Panther tank at combat distances. (Tank Museum)

Belonging to the Belgian National Military Museum is this Sherman VC "Firefly." Due to the recoil length of the 17-pounder main gun in the Firefly turret, the radio, normally mounted in the rear of the turret bustle, was relocated to an armored box at the rear of the tank, as seen on this vehicle. (Michel Krauss)

UPGRADING EARLY-PRODUCTION M4 SERIES TANKS

Beginning in spring 1943, the turret armor of the M4 series tanks was thickened. The original M34 combination gun mount, which included a 3-inch-thick cast-armor gun shield and a narrow 2-inch-thick cast-armor rotor shield in front of it, was replaced in production by the M34A1 combination gun shield that had a 3.5-inch-thick cast-armor gun shield and a full-width, 2-inch-thick cast-armor rotor shield behind it.

Experience gained by American tankers in North Africa convinced them that the German Army adoption of telescopic sights for their tanks was a superior arrangement than the periscope gun sight mounted in the early-production M4 series tanks. The addition of the telescopic sight M55 for the gunner, who sat on the right side of the 75mm main gun, created a small opening for the telescopic sight on the front of the tank's cast-armor turret that introduced a ballistic weak spot and was compensated for by the wider M34A1 cast-armor rotor shield.

Prior to the introduction of the telescopic sight, the M4 series tank gunner relied solely on an overhead, fixed forward-looking periscope designated the M4, or the improved M4A1, both of which incorporated the telescope M38 fitted with a ballistic reticle.

A modification was conceived in early 1943 to have early-production M4 series tanks with the original M34 cast-armor rotor shield upgraded to approximately the M34A1 standard by the addition of a welded-on cast-armor section on the right side of the rotor shield. However, as best as researcher Joe DeMarco can determine, something went wrong and the contractors tasked with the project were unable to obtain the necessary parts to complete the work until early 1945, with none making it into the field before World War II ended.

FIRE-CONTROL IMPRESSIONS

The War Department's *Report of the New Weapon Board*, dated April 27, 1944, describes the U.S. Army's impression of the effectiveness (or lack thereof) of the M4 series tank fire-control system:

> Because of the excessive dispersion which occurs with the M4 periscope, firing of the main guns is confined almost entirely to the artillery method of sensing and locating burst and giving corrections in mils to the gunners. The average dispersion which occurs as a result of slack in the periscope holder and linkage extends four mils in both planes. This dispersion is so great that guns do not stay bore-sighted with the telescope after any operation… There is very little use of the coaxially mounted telescope; the dispersion which results from its use is even greater than that experienced with the M4 periscope. In addition, the optics of the M55 telescope are unsatisfactory, resulting in unsatisfactory light-transmission characteristics. Furthermore, most gunners report that it is very difficult for them to get their heads into proper position for sighting through the coaxial telescope.

The March 1945 report *United States vs. German Armor* mentions further problems with sighting, as First Lieutenant Coulter M. Montgomery of the 66th Armored Regiment points out:

> Our sight reticle is okay, but our sights are not nearly powerful enough. These new telescopic sights are an improvement over the old periscope sight, but are still not powerful enough. The Germans seem to have better glass in theirs. Couldn't a ten or twelve power scope be devised to fit in the periscope? We shouldn't want to sacrifice the field of vision that our periscope gives us, but the telescope in it isn't nearly powerful enough. The position of the telescope is not satisfactory. The gunner has to cramp himself too much to use it.

Tom Sator of the 4th Armored Division remembers looking through the gun sight of an abandoned Pz.Kpfw. IV during his time in the ETO and swears he could see blades of grass a mile away. While he admits that might be a bit of an exaggeration, the obvious superiority of the German gun sight he examined that day compared with that found in his tank was extremely depressing and made him want to take the next boat back to the United States.

MORE MODIFICATIONS

In spring 1943, the Ordnance Department embarked on a program to upgrade the thousands of very early-production first-generation M4 series tanks then employed as training vehicles in the United States. During the rebuilding process, the tanks went through a modernization program, which incorporated the addition of many of the improvements developed after they first rolled off the assembly lines. These upgraded first-generation M4 series tanks then went off to various war zones with both the American military and other countries under Lend-Lease.

Combat experience had shown that the pronounced driver's and bow gunner's hatch hoods, which protruded from the glacis of the welded-armor M4 series tanks, were a ballistic weak point. To correct this problem, the vertical surfaces on the front of these hoods had 1.5-inch-thick welded armor plates welded onto them at an angle of approximately 35 degrees from the vertical. This armor-upgrading process occurred both on the assembly line and in the field and brought the protection afforded by the two hatch areas up to approximately the rest of the welded hull glacis.

While M4A1s were not officially specified as needing the addition of welded-armor plates on the driver's and bow gunner's hatch hoods, period photographs show that some had the plates added to their less-pronounced hatch protrusions.

In early-production M4 series tanks, part of the cast armor interior turret wall had been machined away in front of the gunner's position to make more room for the gunner when operating his electro-hydraulic power traverse unit control or electric turret power traverse system. Combat experience in North Africa had quickly demonstrated that this had been a serious mistake. As a result, early M4 series tanks were refitted with add-on armor plates on the right front of their cast armor turrets beginning in spring 1943 through summer 1943.

In summer 1943, new cast armor turret castings entered the production pipeline. On them, the pistol port was eliminated, and the area of the "thin spot" was thickened, so that the welded-on armor turret patches were no longer required. This thickening can be detected in close-up pictures of M4 series tanks so modified.

So as not to interrupt the production flow, in early 1943 the Ordnance Department came up with a "Quick Fix" to the problem of main gun ammunition fires in earlier and then-current production M4 series tanks. The 12 75mm rounds clipped to the wall of the turret basket were eliminated. The thin steel ammunition containers were retrofitted with 0.25-inch (6.35mm) armor plates. One-inch (25.4mm) welded armor plates were welded to the exterior of the upper hulls opposite the 75mm ammunition racks, one on the right side and two on the left side.

Both the welded-hull M4A2 and M4A3 medium tanks were adapted to mount the new "T23 turret." Reflecting the changes to these second-generation tanks, the M4A2 was designated M4A2(76)W, and the M4A3, as seen here on display in Luxembourg, became the M4A3(76)W. The "W" in the vehicle's designation is shorthand for "wet stowage," which featured ammunition bins that included liquid-filled inserts intended to extinguish propellant fires in the event the bins were penetrated. (Pierre-Olivier Buan)

In the case of very late-production M4A1s, the upper hull armor casting was thickened by an inch in the necessary areas, obviating the need for the welded-on appliqué plates. Finally, the thin perforated sheet metal that originally enclosed the vehicle's turret basket was removed to improve access between the vehicle's fighting compartment and turret. More importantly, this provided the crew with more avenues of emergency escape.

The necessary components began to enter the pipeline in mid-1943, and manufacturers began installing the various modifications in new production tanks as they were able to procure them. Tank depots were also mandated to install modifications when the supply of the various kits became available to them. The U.S. Army desired to bring the 1,300 odd M4 series tanks in the United

Kingdom up to the latest standards. Thus a sufficient number of modification kits were shipped to Great Britain, so that just about every U.S. Army M4 or M4A1 already there that needed modifications had them retrofitted before D-Day (June 6, 1944). The troops training there could not spare the time, such that the upgrade program was contracted out to British firms.

MOBILITY IMPROVEMENTS

Field reports had indicated that the existing 16.56-inch-wide tracks on the VVSS of early-production M4 series tanks did not always provide sufficient off-road flotation. To rectify this situation it was decided to use duckbill-shaped devices referred to as “extended end connectors” to increase the track’s ground contact area and thereby lower the tank’s ground pressure. As there was no space between the inside of the suspension system and the lower hull on M4 series tanks to attach extended end connectors, Chrysler was tasked by the Ordnance Department in February 1944 to design a spacer system for the sprockets and other suspension components in order to provide the necessary room for the addition of extended end connectors on the inside of the track.

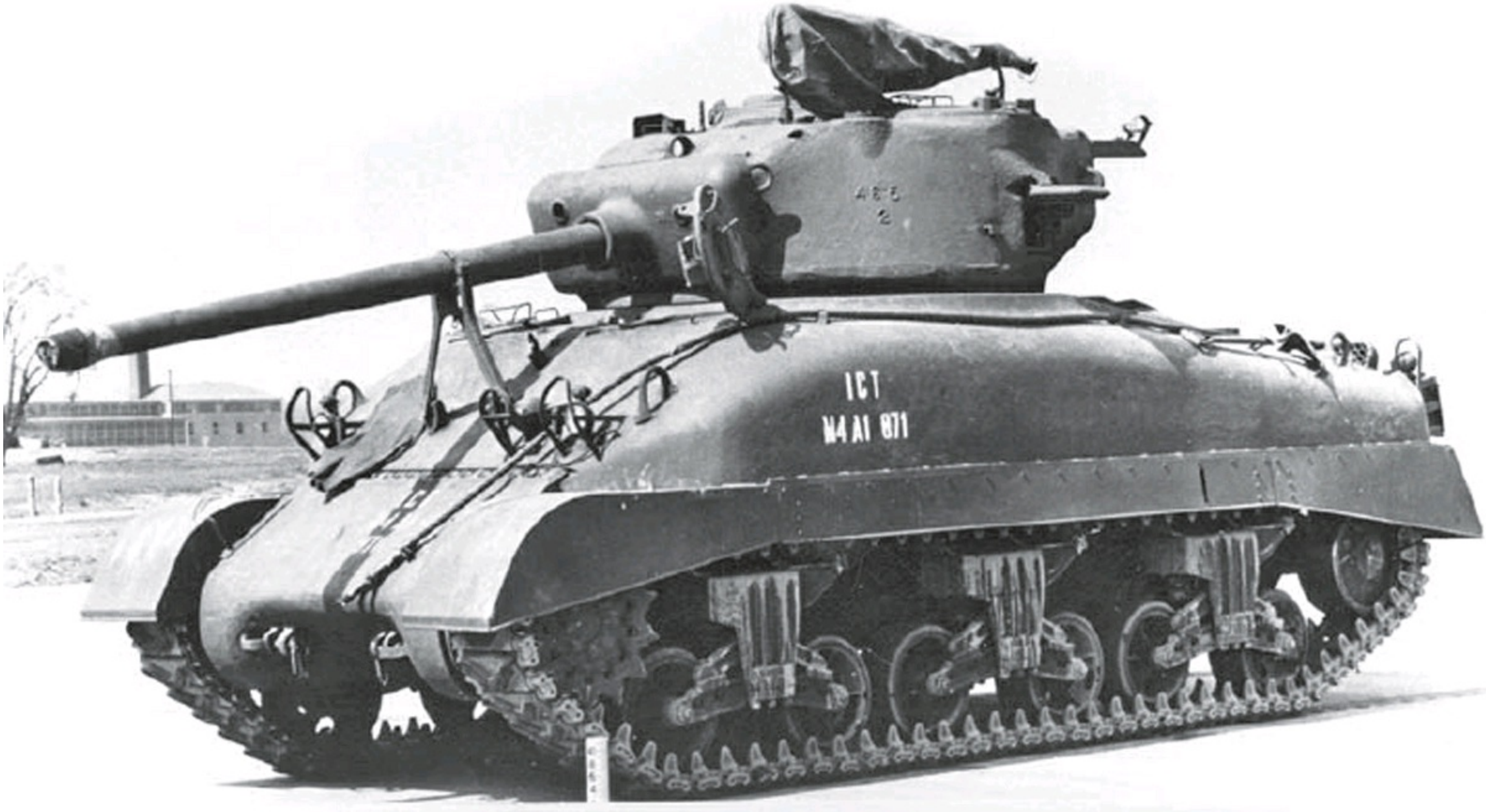
Testing of the Chrysler-designed spacer arrangement proved successful, and the Ordnance Department ordered 1,000 units for fitting on remanufactured early-production M4 series tanks. They also ordered another 1,000 units of the Chrysler-designed spacer arrangement in kit form to be added to selected M4 series tanks in the field. With the extended end connectors fitted to both the inside and outside of the tracks, the total width was just a bit over 23 inches and lowered the vehicle’s ground pressure to 10 pounds per square inch. Vehicles equipped with the Chrysler-designed spacer arrangement had “E9” added to their designation to reflect the upgrade.

NEW HATCHES AND PISTOL PORT ISSUES

Beginning in November 1943, a small overhead oval hatch was fitted in the roof of M4 series tanks to assist the loader in entering and leaving the vehicle. Combat experience had shown that it was extremely difficult for the three men in the turret to exit their vehicle in a timely manner when forced to use only the vehicle commander’s overhead hatch. This loader’s hatch was provided with a hatch lock and featured counterbalanced springs to make it easier to open and close.

The driver’s and bow gunner’s hatches on the early-production and then-current production M4 series tanks were also fitted with hatch locks and counterbalanced springs beginning in 1943. In place of the original circular split hatch for the vehicle commander of the M4 series tanks, the remanufactured tanks sometimes received a newly designed vehicle commander’s cupola that was developed for an improved second generation of M4 series tanks.

Because the Ordnance Department felt that the pistol port on the left side of first-generation M4 series tank turrets was a ballistic weak spot, it ordered the factories building the tank to delete it from production units of the vehicle beginning in April 1943. Those vehicles on the assembly line when the decision was made would retain the casting impression of the pistol port but would never have it installed. Those M4 series tanks that had already rolled off the assembly line with the pistol port and not yet been issued to field units had their pistol ports welded shut.



Efforts by the Ordnance Department to keep the M4 series medium tanks viable on the battlefield led to a fairly significant redesign of the hull front sections, along with the introduction of numerous improvements. Most "second-generation" M4 series medium tanks were armed with a more powerful 76.2mm main gun mounted in the turret developed for the abortive T23 medium tank. The first units were produced in January, 1944 and designated M4A1(76)W, an example of which is seen here. (TACOM Historical Office)

Strong user feedback on the usefulness of the pistol port resulted in the Ordnance Department backing off on its original decision. New turrets with pistol ports, as well as loader's hatches, were introduced into production starting in November 1943.. Despite its misleading name, the pistol port was actually used by crews to pass ammunition into the tank during resupply. This method required one less man, because no one was needed to stand on the hull to pass ammo down through the loader's hatch. Ammunition could be passed by a man standing on the ground directly into the turret. Photo research by Joe DeMarco and Pierre-Olivier Buan have led them to conclude that the majority of M4 series tanks used in the ETO in 1944 had no pistol ports or had them welded shut.

THE SECOND GENERATION OF M4 SERIES TANKS APPEARS

Even before the M4 series tanks began rolling off the assembly lines of American factories in early 1942, the Ordnance Department was considering ways of improving it. By early 1943, the Armored Force concluded that it would have to make do with the M4 series tanks for the rest of the war and set out to modify the vehicle's existing design to improve its combat effectiveness. The M4A4 and M4A6 would not be part of this upgrading process.

To improve the off-road mobility of the second-generation M4 series medium tanks, many were built with a greatly improved suspension system incorporating tracks widened to 23 inches. This was referred to as the Horizontal Volute Spring Suspension (HVSS) system. Pictured is an M4A3(76)W HVSS at the former Patton Museum of Cavalry and Armor. (Michael Green)

Very soon, however, the number of changes requested for inclusion on the M4 series of tanks had grown to such an extent that a major redesign of the entire series became apparent. This effort began in July 1943, and would result in a much improved second generation of M4 series tanks.

Chrysler received permission in September 1943 to build a number of pilot models incorporating numerous second-generation changes to M4 series tanks. These vehicles included the latest manufacturing modifications. However, due to delays in acquiring drawings necessary to begin the project, actual work did not start until December 1943, with the completed and semi-completed second-generation pilots showing up in February 1944.

SECOND-GENERATION MODIFICATIONS

The biggest change to the majority of second-generation M4 series tanks would be the addition of a more powerful 76mm main gun, designated the M1A1, M1A1C, or M1A2, which was mounted in a new, larger, cast-armor turret. Rather than take the time to design a new turret with space for a larger 76mm main gun, the Ordnance Department decided to use the pre-series production version of a cast-armor turret originally developed for the never-fielded T23 medium tank.

Unlike the first-generation M4 series tank with a cast-armor rotor shield mounted in front of the cast-armor gun shield, the second-generation M4 series tank armed with a 76mm main gun did away with the rotor shield and relied solely on a full-width vertical cast-armor gun shield for protection, designated the combination gun mount M62, which was 3.5 inches (89mm) thick. Not everybody was pleased with the new gun mount. Many tankers felt the mount was too light for the 76mm gun and the extra play in the mount caused inaccuracy in firing.

Another major modification for the second-generation M4 series tanks included the incorporation of a new vehicle commander's cupola developed by the Libby-Owens-Ford Glass Company. It was fitted with six laminated bullet-resistant glass vision blocks uniformly spaced around a central 21-inch diameter hatch. There was also an M6 periscope installed in a 360-degree rotating mount in the overhead hatch cover. Due to production shortfalls, some second-generation M4 series tanks left the factory with the original rotating two-piece circular split hatch from the first-generation M4 series tanks at the vehicle commander's position.

A key identifying feature of the second-generation M4 series medium tanks was the redesigned, slightly thicker (2.5-inch) glacis plate shown here on an M4A3(76)W HVSS. It was sloped at 47 degrees as opposed to the 60 degrees of first-generation M4 series medium tanks. The modified angle permitted the designers to do away with the protruding driver's hatches of first-generation M4 series medium tanks. (Michael Green)

The loader on the second-generation M4 series tank armed with a 76mm main gun was originally provided with the same rotating two-piece circular split hatch for the vehicle commander from the first-generation M4 series tanks. Eventually, this hatch was replaced by the same small oval hatch applied to the modernized first-generation M4 series tanks beginning in November 1943.

An important improvement to the second generation of the M4 series medium tanks was the addition of a new raised commander's cupola, as seen here. It featured six laminated glass vision blocks around its circumference, and an overhead periscope in the hatch cover. It was also retrofitted to some first-generation M4 series medium tanks as a field modification or during remanufacture. (Michael Green)

An easily noticed exterior spotting feature that identifies second-generation cast- and welded-armor upper hull M4 series tanks is the disappearance of the very pronounced driver's and bow gunner's hatch protrusions seen on first-generation upper hull M4 series tanks. This came about because the slightly thicker 2.5-inch-thick (64mm) welded armor glacis of the second-generation M4 series tanks (M4, M4A2, and M4A3) was set at a less steep angle of about 47 degrees compared with the approximately 57-degree slope seen on the first-generation cast- and welded-armor upper hull M4 series tanks.

The reset of the glacis on second-generation M4 series tanks allowed for the inclusion of new larger, counterbalanced, angled overhead hatches for the driver and bow gunner, which made ingress and egress for the driver and bow gunner a much easier process. These new overhead hatches were designed by the Fisher Body Corporation of General Motors and were copied from those developed for the M10 tank destroyer.

As with the original first-generation small, narrow overhead hatches, the new, much larger overhead hatches contained a 360-degree rotating M6 periscope. Both the cast- and welded-armor front upper hulls of the second-generation M4 series tanks also retained the fixed forward-facing M6 periscopes. Rather than having the fixed forward-facing periscopes directly in front of the periscopes in the driver and bow gunner overhead hatches, they were offset to the center of the front upper hull.

With the introduction of the larger overhead hatches for the driver and bow gunner on the second-generation M4 series tanks, there also appeared in the design a slightly raised rear turret bustle.

These new high bustle turrets can be recognized in pictures because there is almost no downward slope on the top portion of the turret bustle, whereas the low bustle turrets for first-generation M4 series tanks has a pronounced downward slope on the top of the turret bustle.

The raised turret bustle's intended purpose was to clear the new, larger upper hull hatches that appeared with the introduction of the second-generation M4 series tanks armed with the 75mm main gun. However, when 300 surplus early-production first-generation M4 series tank turrets became available because the chassis of the tanks were being converted into tank recovery vehicles, Fisher Body was granted permission to mount them on the chassis of second-generation M4A3 tanks after upgrading them with the raised vehicle commander's cupola and an overhead oval hatch for the loader. To make sure that the low bustle turret would clear the new, larger driver and bow gunner hatches, Fisher Body flame-cut some of the lower rear corners of the recycled turrets, which can be seen on some close-up pictures.

SECOND-GENERATION SUSPENSION IMPROVEMENTS

The first-generation M4 series tanks rode on the VVSS combined with 16.56-inch-wide (42.1cm) tracks. The shortcomings of this system were apparent to all. As early as December 1941, the Ordnance Department looked at other types of suspension systems. The system showing the most promise was the Horizontal Volute Spring Suspension (HVSS) system first considered for fitting on the medium tank M2. While the HVSS never appeared on the M2, it did make it onto the medium tank M3 for test purposes only.

In early 1943, the Armored Board began testing two first-generation M4 series tanks fitted with the HVSS system that retained the 16.56-inch-wide tracks of the VVSS currently in use. While it showed promise, there was insufficient improvement to warrant the costly retooling needed to change over the first-generation M4 series tanks from the VVSS to the new, narrow track HVSS. Work, therefore, began on designing an improved HVSS system in September 1943 utilizing more bogie wheels and wider tracks. Tests proved this new wide track HVSS system to be far superior to the VVSS and the earlier narrow track HVSS system in durability, flotation, riding qualities, and bogie wheel life.

As the name indicates, the volute springs in the HVSS system were mounted horizontally on the bogie assembly instead of vertically. Elimination of friction from sliding shoes, improved geometric design, addition of shock absorbers (VVSS-equipped M4 series tanks did not have shock absorbers) and bogie wheels, and, together with the use of center-guides instead of outside track guides, decreased the possibility of track throwing. The wide track required the use of dual bogie wheels, doubling their number and distributing the wear more uniformly than in the VVSS design.

In September 1943, the Ordnance Committee recommended development of the improved HVSS system with 23-inch-wide center-guided tracks for application to a first-generation M4 pilot vehicle, which was designated the M4E8. As other M4 series pilot tanks underwent conversion to the new type of suspension system, they also saw their designations change. The M4A1 became the M4A1E8, the M4A2 the M4A2E8, and the M4A3 became the M4A3E8.

Early testing showed that the 23-inch-wide version of the HVSS system improved performance of the pilot tanks, but needed some additional refinement. In November 1943, the Ordnance Committee recommended acquiring ten more sets of the HVSS system to be mounted on M4A3E8 pilot tanks. These vehicles were completed in early summer 1944 and sent out for testing to a variety of military bases.

HVSS IS APPROVED

Even before the testing of the M4A3E8 pilot tanks was completed, the Ordnance Committee recommended in early March 1944 that the HVSS system be fitted onto 500 second-generation M4A3 tanks equipped with a 76mm main gun and having the "Wet" main gun ammunition storage arrangement. On tank data plates this arrangement is abbreviated to "M4A3 76 Gun, Wet." For the sake of brevity the author will convert this to M4A3(76)W.

In total, Chrysler would build 4,542 units of the M4A3(76)W between March 1944 and April 1945. They began construction of these tanks fitted with the HVSS system in August 1944. As they were the only firm that kept track of how many second-generation M4 series tanks they built with the HVSS system, we now know courtesy of researcher Joe DeMarco that 2,167 of the 4,542 units built of the M4A3(76)W were equipped with the HVSS system.

Most U.S. Army documents from World War II do not distinguish between a second-generation M4 series tank riding on the original VVSS or having the HVSS system. A few documents mention "wide tracks" or "twenty-three inch tracks." There are also a few period documents that list the M4A3(76)W incorrectly as the "M4A3E8," which was intended solely for designating the pilot tanks, although it might have been adopted for the sake of brevity in documents or by the tankers and supporting troops in the field.

The addition of the HVSS system increased the weight of the second-generation M4 series tanks somewhere between 3,000 to 5,000 pounds depending on the type of track used. It also increased the tank's width to 9.8 feet with sand shields fitted. The first-generation of M4 series tank without sand shields were 8.7 feet wide. On the positive side, the increased width of the new tracks that came with the HVSS system reduced ground pressure from 14.5 pounds per square inch to about 10 pounds per square inch.

Belonging to a private collector is this M4A1(76)W HVSS. The effectiveness of the "wet" system is somewhat doubtful. That the ammunition bins were armored, and moved from the sponsons to the floor of the tank, were the real factors that increased crew safety. (Michael Green)

M4A3(76)Ws with the HVSS system fitted reached Northwest Europe in December 1944. Experience had already shown U.S. Army tank units that a track 23 inches wide was still not enough to keep a tank from bogging down in deep mud. In response, the Ordnance Committee approved production of kits for field installation with 39-inch grousers. These were still in development when World War II ended and therefore never went into production. The M4A3(76)W with the HVSS system fitted also eventually reached U.S. Army armored units fighting in Italy near the end of the war in Europe.

A total of 3,426 units of the M4A1(76)W were built between January 1944 and July 1945 by the Fisher Body Corporation of General Motors. Research at the National Archives undertaken by Joe DeMarco showed that 1,255 units were built with the HVSS system. Additional findings uncovered by DeMarco showed that out of a total of 2,915 units of the M4A2(76)W that rolled off the assembly lines between May 1944 and May 1945, 1,321 units were fitted with the HVSS system.

The American First and Third Armies received an allotment of M4A1(76)Ws with the HVSS system starting on April 6, 1945. Efforts by many tank history buffs have yet to uncover any pictorial evidence showing them in troop service before the war in Europe officially ended in May 1945. The majority of M4A2(76)W tanks, with or without the HVSS system, were reserved for Lend-Lease shipment to the Soviet Union. Pictorial evidence shows that the Red Army used the M4A2(76)W with the HVSS system in combat against the Japanese Army in Manchuria in June 1945.

MAIN GUN AMMUNITION RELOCATION

One of the most important, though not externally visible, second-generation modifications to the M4 series tank involved the placing of most of the main gun rounds in the tank's lower hull in storage racks located below the rotating turret basket. The purpose of this arrangement was to reduce the potential for fires caused by projectiles penetrating the tank's exterior armor and puncturing the metal cartridge cases formerly stowed high up in the hull sponsons and the turret basket.

Along with the relocation of the main gun rounds to the bottom of the tank's lower hull, second-generation M4 series tanks came with provisions for protecting those same rounds by placing liquid-filled metal insert containers called "Ammudamp" within the main gun storage racks. The rounds themselves sat in liquid-free cavities that formed part of the storage racks. The liquid within the metal inserts only engulfed the main gun rounds when penetrated by a projectile. On top of the liquid-filled metal inserts were removable plugs used to refill them if the need arose.

Second-generation M4 series tanks equipped with these liquid-filled metal inserts were designated "wet" stowage. Tests generally showed that wet stowage did not effectively quench the ignition of the propellant charges within tanks struck and penetrated by overmatching weapons. Realizing that the wet stowage system was not the perfect solution, some in the U.S. Army recommended that armored containers of higher ammo stowage capacity take its place. There was, however, no follow-through of this recommendation on the M4 series tanks before World War II ended.

U.S. Army tanker Tom Sator recalls that nobody ever informed him that his M4A3(76)W had water-protected main gun ammunition storage racks in the hull bottom of his vehicle or how it was supposed to work.

SECOND-GENERATION DESIGNATION CONFUSION

According to an Ordnance Department report, the term "wet" represented not only the fitting of liquid-protected main gun ammunition racks, but also indicated that the tanks so designated incorporated all the other second-generation modifications as well. This report is somewhat misleading, as the incorporation of features found on second-generation M4 series tanks was phased in at different times and with different manufacturers over the course of their introduction into field service. This meant that many so-called M4 series "wet" tanks did not have all the second-generation features, such as the HVSS system.

It was the early-production units of the M4A1(76)W tanks without the HVSS system that first reached U.S. Army units stationed in Great Britain in April 1944. However, those tanks didn't make it to Northwest Europe until July 1944. Their first combat employment would take place with Lieutenant-General Omar Bradley's First Army during Operation *Cobra*, which lasted from July 25 to July 31, 1944.

It took until September 1944 for the first of the M4A3(76)W tanks without the HVSS system to show up in Northwest Europe. They would see action with Lieutenant-General George S. Patton's Third Army that same month. Other than the original shipment of M4A1(76)W tanks minus the HVSS system that arrived in Great Britain back in April 1944, the bulk of the second-generation M4 series tanks shipped to Northwest Europe without the HVSS system consisted of M4A3(76)W tanks. One hundred and forty M4A3(76)W tanks without the HVSS system fitted were allocated to U.S. Army armor units fighting in Italy. They first went into the field in August 1944. Another 70 of the vehicles were provided to the U.S. Seventh Army that invaded Southern France on August 15, 1944.

The British Army eventually received 1,330 units of the M4A1(76)W without the HVSS system fitted under Lend-Lease. These tanks were designated the "Sherman IIA" and were supplied in lieu of first-generation M4A4s. The British Army was also provided five units of the M4A1(76)W tanks with the HVSS system, which they designated the "Sherman IIIAY." None saw operational use with the British Army. The British Army was never supplied the M4A3(76)W with or without the HVSS system.

Not impressed with the armor-penetration abilities of the 76mm main gun fitted to the M4A1(76)W they were supplied under Lend-Lease, the British Army decided to ship them off to British and Commonwealth armor units fighting in Italy, as there was a less serious threat from late-war German tanks in that theater of operations. The British Army would also supply the 1st Polish Armored Division fighting in Northwest Europe with about 180 units of the M4A1(76) W without the HVSS system. The Free French Army in the ETO were supplied with the M4A1(76)W and the M4A3(76)W without the HVSS system from U.S. Army stockpiles during the latter portion of World War II.

SECOND-GENERATION TIMELINE

Upon standardization of second-generation M4 series tanks with the 76mm main gun and the wet ammunition storage racks into the armored force, production of vehicles armed with the 75mm main gun was limited to just the M4A3 tank. These M4A3 tanks, which also had wet ammunition storage racks and other improvements, would be designated M4A3(75)W. At this point in the war, those first-generation M4 series tank without the wet storage system, such as the M4 and M4A2, came to be called "dry" stowage tanks. For example, the original M4A3 tank was now referred to officially as the M4A3 75mm, Dry Stowage.

In February 1944, the Fisher Tank Arsenal began building the first of the M4A3(75)W tanks. Production of this tank would continue until March 1945, with 3,071 units completed. The second-generation M4A3 tank was not fitted with the cast-armor turret from the T23 medium tank as were all the second-generation M4 series tanks armed with a 76mm main gun. Rather it retained the original cast-armor turret from the first-generation M4 series tank. However, it was eventually upgraded with the new raised vehicle commander's cupola common to most second-generation M4 series tanks armed with a 76mm main gun. None of the M4A3(75)W tanks would be exported under Lend-Lease during World War II.

The need to up-arm the M4 series of medium tanks was realized early on by the U.S. Army Ordnance Department. The result of their labor was a second generation of M4 series medium tanks fitted with a new turret design, mounting a 76mm main gun. The artwork shows a second generation M4A1(76) belonging to Company D, 66th Armored Regiment, 2nd Armored Division. It is taking part in Operation *Cobra*, launched in France in July 1944. To better blend in with the surrounding foliage, the base olive drab has been over-painted with splotches of black. The vehicle's tactical number, the registration numbers, and the tank's nickname appear in white, yellow having been discontinued by the U.S. Army in December 1942. Blue drab registration numbers would last on some vehicles into the postwar era. (© Osprey Publishing Ltd.)

A feature not found on the first-generation M4 series tanks, but incorporated into some second-generation M4 series tanks armed with either the 75mm or 76mm main gun, was a hydraulic traverse control joystick mounted on a bracket on the inner turret wall next to the tank commander's position. By repositioning a control lever, the tank commander could automatically disable the gunner's turret traverse control handle, allowing the tank commander to point the turret in the direction he chose with his joystick.

WET AMMUNITION STORAGE DETAILS

With the change to liquid-protected main gun ammunition stowage on second-generation M4 series tanks, a partial turret basket, which occupied only about one-third of the space, replaced the full turret basket. The partial basket permitted access to the main gun ammunition stowed under the sub-floor on the loader's side of the tank.

In second-generation M4 series tanks equipped with the 76mm main gun and wet storage, the majority of the 71 main gun rounds were stored on either side of the drive shaft enclosure under or behind armored hatches. Thirty-five of the main gun rounds sat in vertical racks on one side, and 30 sat in horizontal racks on the other side of the interior behind the bow gunner's seat. The remaining six main gun rounds, referred to as "ready rounds," resided in an armored box upon which the gunner's seat perched.

With the second-generation M4A3(75)W, the ammunition storage arrangement was somewhat similar to that on the 76mm main-gun-equipped tanks, except for an additional 29 rounds stored within the vehicle, for a total of 104 main gun rounds. Like the 76mm main-gun-equipped tanks, the M4A3(75)W had an armored box on the turret floor with a number of ready rounds.

The second-generation M4A3(75)W main gun ammunition storage arrangement retained the full turret basket that equipped the older first-generation M4 series tanks. Under the turret basket (in the sub-floor) were ten vertically oriented ammunition storage racks, each containing ten main gun rounds. There were another four ready rounds in an armored box on the turret basket floor.

The only access for the loader to the 100 main gun rounds stored in the sub-floor of the M4A3(75)W came from opening two armored hatches in the bottom of the turret basket floor (located directly under his feet). In prolonged firing of the main gun, this storage arrangement called for turning the tank's turret every so often to allow the loader to access all the main gun round ammunition storage racks.

World War II Tank Production (acceptances) M4 Series Tanks

Manufacturer	1941	1942	1943	1944	1945	Total
American Locomotive			126	2,174		2,300
Baldwin Locomotive		12	1,190	43		1,245
Detroit Arsenal Tank Plant		2,432	6,611	5,338	3,369	17,750
Federal Machine (M4A2)		21	519			540
Fisher Body		1,540	2,240	5,627	2,148	11,555
Ford (M4A3)		514	1,176			1,690
Lima Locomotive (M4A1)		820	835			1,655
Montreal Locomotive	31	1,113				1,144
Pacific Car & Foundry (M4A1)			266	660		926
Pressed Steel		1,174	3,526	2,171	1,276	8,147
Pullman Standard		1,112	2,314			3,426
Totals	31	9,130	21,245	13,179	6,793	50,378

A SOLUTION TO A PROBLEM

One of the biggest problems with the 76mm tank gun fitted to the second-generation M4 series tanks was the weapon's muzzle blast and the resulting target obscuration from smoke and dust. This is seen in a postwar U.S. Army staff memorandum titled "Characteristics for Tank Guns": "Also the muzzle blast from the 76mm was increased so that it was practically impossible to observe fire from the tank. The net result was that when the 76mm gun fired at an enemy tank the crew was temporarily blinded. They could not observe the strike, and if they had missed, were subject to being destroyed before they could try another shot."

This issue was of such serious concern to then Major-General Alvan Cullom Gillem, Jr. (commander of XIII Corps of the Ninth Army in the ETO) that he felt it was important to retain the 75mm main gun on the M4 series tanks as it presented a far less serious problem with muzzle blast.

To correct the problem of target obscuration, the Ordnance Department came up with a two-part solution: first, a longer primer in the 76mm cartridge case that improved the burning rate of the propellant, and second, a redesigned combination muzzle brake and blast deflector to be fitted to the 76mm gun M1A1.

Those 76mm tank guns equipped with the threaded barrels for the fitting of a muzzle brake were designated the 76mm Gun M1A1C, while a later model having rifling with a tighter twist became the 76mm Gun M1A2. The tighter rifling improved projectile stability in flight, which in turn produced a slight increase in penetration at longer ranges. When no muzzle brake was available for fitting on threaded 76mm guns, a protective ring was installed to protect the threads from damage.

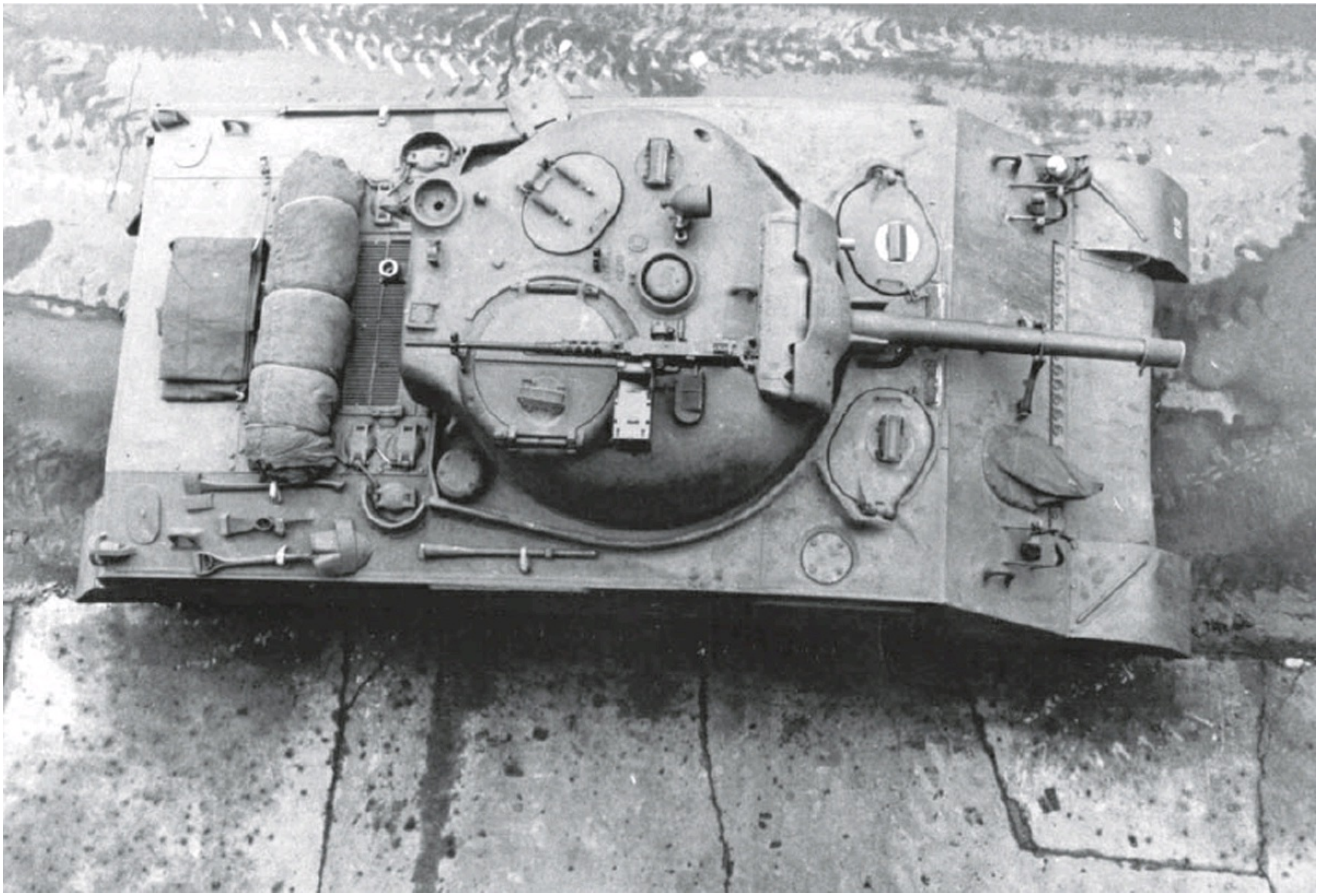
Major Paul A. Bane, Jr., of the 2nd Armored Division, discussed tank muzzle brakes in *United States vs. German Equipment*, a March 1945 U.S. Army report: "Recently we have received a few M4A3E8 tanks equipped with muzzle brakes. Test firing and combat operations have proven the muzzle brake to be a great help. We consider muzzle brakes an essential part of the tank gun."

DRUMMING UP INTEREST IN THE 76MM TANK GUN

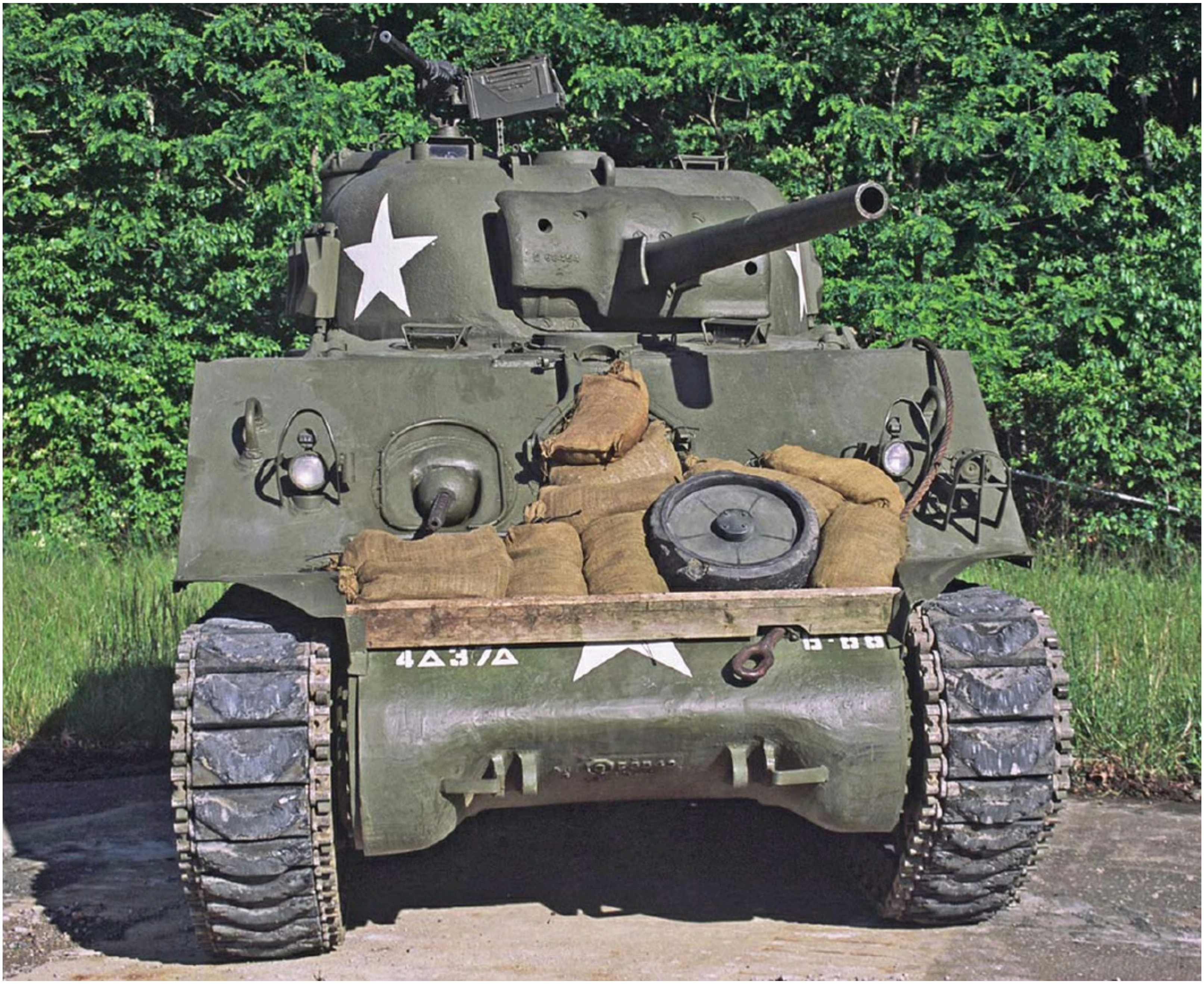
Prior to the invasion of France in June 1944, a number of demonstrations of the new M4A1(76)W tanks occurred in Great Britain for senior U.S. Army officers. Everyone who saw the firepower demonstrations came away impressed with the 76mm cannon. Yet, most high-level armor commanders decided that they would rather stick with the familiar 75mm main gun on their existing first-generation M4 series tanks than retrain their troops to use a new tank main gun. They were also concerned with introducing a new gun and ammunition into the already complex logistical problem of keeping thousands of tanks up and running.

In the April 1944 memo "Conference Notes: Distribution of medium tank M4 Series (76mm. gun)," from Brigadier-General Joseph A. Holly (in charge of the Armored Fighting Vehicle and Weapons Section of the ETO) to the G-3 (in charge of operations) of the ETO, the feeling of senior officers who initially rejected the perceived troublesome 76mm gun on the M4 series was summed up: "an excessive price for the additional inch of armor penetration obtained."

This lack of interest in a bigger, and supposedly better, gun for the M4 series tanks seems strange for those who look back in hindsight. At the time, though, the Army Ground Forces (AGF), under the command of Lieutenant-General Lesley J. McNair, still had complete faith in the 75mm gun-armed M4 series tanks. McNair was still the champion of the tank destroyer concept, and felt that improvements in the armor-defeating capabilities of tank guns would encourage unit leaders to plan on tankers engaging German tanks instead of creating tactical strategies leaving them to his tank destroyers. In addition, the HE round of the 75mm gun was better than that of the 76mm, which further suited those officers who believed the primary role of U.S. Army tanks was infantry support.



The 75mm-gunned M4A2 series medium tanks were also built with second-generation or large hatch hulls. However, these tanks retained the earlier ammunition stowage arrangement, with the ammo bins positioned in the sponsons. Ordnance retrofitted the designation "dry" to any current or earlier production M4 series medium tank made without wet stowage. Thus, the large hatch vehicle shown was designated M4A2(75)Dry. (TACOM Historical Office)



The US Army wanted to discontinue the use of the 75mm gun on the M4 series by the end of 1943. However, the British Army and the U.S. Marine Corps stated that they did not want the 76mm gun-armed M4 series tanks, and would require 75mm gun-armed versions into 1945. As a consequence, it was decided to continue production of a single model. This picture shows an example of the only second-generation M4 series tank built that was armed with a 75mm gun and designated M4A3(75)W. Units of this type built in 1944 featured a VVSS suspension system, while those produced in 1945 were equipped with HVSS. (Michael Green)

Even then, Lieutenant-General Patton, who witnessed a demonstration of the M4A1(76)W six days after the invasion of France took place, decided he would take the new gun only if first placed into separate tank battalions for a combat test. Patton changed his tune after the Battle of the Bulge (December 1944 through January 1945), when his Third Army made plans to make up for the shortage of second-generation 76mm gun-armed M4 series tanks by mounting 76mm main guns in first-generation M4 series tanks. Pictorial evidence indicates some of these vehicles saw combat at the end of the war in Europe with Third Army.

76MM MAIN GUN ROUNDS

The standard complete APC-T round for the 76mm main gun was the approximately 25-pound M62. The projectile portion of the round weighed about 15 pounds and attained a muzzle velocity of 2,600ft/sec, which could penetrate armor about 1 inch (25mm) thicker than the M61 APC-T projectile fired from the 75mm main gun, which had a muzzle velocity of only 2,030ft/sec.

At a range of 500 yards, the 76mm tank gun firing the M62 APC-T round was supposed to be able to penetrate 3.7 inches (93mm) of armor, and at 2,000 yards 3 inches (75mm) of armor. Late-production examples of the M62 APC-T round came with an HE filler and a base-detonating fuze, earning it the designation M62 APC-HE-T.

In the field, the M62 APC-T round's performance was a big disappointment to most. Second Lieutenant Frank Seydel, Jr., of the 2nd Armored Division, described a combat action in the March 1945 U.S. Army report *United States vs. German Equipment*, in which the M62-T APC round saw use:

> On March 3rd at Bosinghoven, I took under fire two German Mark V [Panther] tanks at a range of 600 yards. At this time, I was using a 76mm gun, using APC for my first round. I saw this round make a direct hit on a vehicle and ricochet into the air. I fired again at a range of 500 yards and again observed a direct hit, after which I threw about ten rounds of mixed APC and HE, leaving the German tank burning.

At pointblank range

An encounter between a second-generation M4 series tank armed with a 76mm main gun and German antitank gunners is described by First Lieutenant Chauncey C. Lester in a book published in Germany shortly after the war in Europe ended titled *Dare Devil Tankers: The Story of the 740th Tank Battalion*:

> An 88 opened up at point blank range. I could see the powder blast blow its way through the bushes when he fired but couldn't see the gun. I judged him to be about 100 feet to my left front, so swung the gun there and at the same time told my driver to back up and give it hell. He did just that, and my gunner was doing the same with the 76. I counted five shots from the 88, but all were high. I could almost see them going by in front. They seemed close enough to touch, and it took all the guts I could muster to keep my head outside the tank. The Jerry was a very poor shot, thank God, because we backed up 150 feet before he hit us. I don't think he would have hit us then if I hadn't hit a building that I was trying to back behind. As we hit the building he hit us, but the angle was such that the round bounced off. The instant we were hit I told the boys to bail out, and I dropped inside to let my gunner out. It took them about one second to vacate, and then I followed. I went back down the street and found that my platoon sergeant had stopped an AP with the final drive of his tank. Neither of the crews were hurt, except for their feelings, so we felt pretty lucky. After the infantry had cleared the trouble, we found two 88s, the crew of one having been blown to bits. Think maybe I got them.

There was also another AP round for the 76mm gun designated the M79 Shot AP-T. The complete round weighed 24 pounds. While the 15-pound projectile featured the same muzzle velocity of the M61 APC-T, the lack of a ballistic cap affected its armor penetration performance at longer ranges. At 2,000 yards it could only penetrate 2.5 inches (64mm) of armor. At 500 yards it should have been able to penetrate 3.7 inches (93mm) of armor.

Besides firing a smoke round designated the M88, the up-gunned second-generation M4 series tanks with the 76mm main gun fired a 22-pound HE round, designated the M42A1. The projectile portion of the round weighed approximately 12 pounds and left the muzzle of the gun tube at 2,700ft/sec.

The use of HE was much more common than APC-T during World War II for American tankers in all theaters of operation. As an example, the U.S. Army's 13th Tank Battalion, which formed part of the 1st Armored Division in Italy between August 3, 1944 and December 31, 1944, expended 19,634 rounds of HE and only 55 rounds of M62 APC-T. Typical targets for American tankers late in the war in the ETO were enemy antitank guns and enemy infantry armed with hand-held antitank weapons firing shaped-charge warheads.

IMPROVED TANK AMMUNITION

To increase the penetrating ability of the 76mm gun, the Ordnance Department developed a new main gun round, designated the M93 hypervelocity armor-piercing tracer (HVAP-T) solid shot. It was nicknamed "Hyper-Shot" by the tank crews. While the complete HVAP-T round weighed 18.9 pounds, the lightweight 9.4-pound projectile consisted of a dense core of tungsten carbide with an aluminum outer body, nose, and windshield.

With a muzzle velocity of 3,400ft/sec, the projectile portion of the M93 HVAP-T could penetrate 6.2 inches (157mm) of armor at 500 yards (almost double that of the M62 APC-T main gun round). It was supposed to penetrate up to 5.3 inches (135mm) of armor at 1,000 yards. At 1,500 yards, penetration was 4.6 inches (116mm) of armor, and at 2,000 yards, 3.9 inches (98mm) of armor.

As soon as the first M93 HVAP-T rounds came off the production line, they were transported by air to Northwest Europe around August 1944 and then to the tankers in the field. Each 76mm gun-armed M4 series tank was supposed to have a small supply of this special ammunition because priority for this tank-killing round went to McNair's beloved tank destroyers.

Major Paul A. Bane, Jr., of the 2nd Armored Division, commented in the March 1945 U.S. Army report *United States vs. German Equipment*: "Our tank crews have had some success with the HVAP 76mm ammunition. However, at no time have we been able to secure more than five rounds per tank and in recent actions this has been reduced to a maximum of two rounds, and in many tanks all this type has been expended without being replaced."

A POSSIBLE M4 SERIES TANK REPLACEMENT

In spring 1942, an Ordnance Department developmental program began that was intended to come up with a possible replacement for the M4 series tanks (that were just entering into production) that would address the continued improvements in firepower and armored protection seen on German tanks during the fighting in North Africa and expected in the future. It was desired that the possible successor to the M4 series tanks would incorporate both combat experience gained during the fighting in North Africa, as well as any new technical advances conceived since the M4 series tanks were first designed.

The point men in this developmental project were Major-General Gladeon Marcus Barnes, from the Chief of the Ordnance Department Research and Development division, and Colonel Joseph Colby of the Tank-Automotive Center. They proposed a state-of-the-art design that kept the five-man layout of the M4 series tanks, but did away with the upper hull and the sponsons that projected out over the vehicle's tracks. In their place would be a simple box-like lower hull upon which the tank's turret was mounted. All of the nonessential equipment stored within the hull of the M4 series tanks was to be kept in storage bins located on top of the fenders that extended out from the hull over the tracks on either side of the vehicle.

A wooden mockup of the proposed new medium tank design was presented in May 1942 and was a great hit among all the senior officers attending. It offered a better armed tank, possibly mounted a more powerful 76mm gun M1 in place of the 75mm gun M3 in the first-generation M4 series tanks, as well as 0.5 inches (13mm) more armor and a possible automatic transmission. This was all being accomplished without exceeding the weight of the first-generation M4 series tanks. The vehicle was quickly approved and was designated the medium tank T20 by Action of the Ordnance Committee that same month.

Reflecting the fact that many different components were being considered for inclusion in the final design of the T20, a number of designations were added to distinguish between the various versions of the vehicle. Two pilot vehicles to be fitted with a modified version of the synchromesh transmission in the first-generation M4 series tanks were designated the medium tank T22, and two pilot vehicles to be fitted with an electric transmission and steering system developed by General Electric (GE) were designated the medium tank T23. These vehicles would also be further subdivided into various models by the armament fitted.

The T20 series of medium tanks was developed to replace the M4 series medium tanks. Pictured is the T20E3 pilot vehicle in July 1943. It was armed with a 76.2mm main gun and rode on a torsion bar suspension system. (TACOM Historical Office)

THE TESTING PROCESS

The first T20 pilot appeared in May 1943 with an early type of HVSS system. Another T20 pilot equipped with a torsion bar suspension system was designated the T20E3. Due to problems with the T20's transmission, it and the T20E3 were canceled in December 1944. The engine, Torqmatic transmission, and controlled differential steering units on the T20 and T20E3 were all located in the rear hull of the vehicle and could be removed as a single unit.

Coming off the factory floor in June 1943, the T22 pilots also demonstrated serious power train problems. The T22E1 boasted a turret armed with a 75mm gun M3 hooked up to an automatic loader. Although this gun featured a phenomenal 20 rounds per minute rate of fire, the technology was not mature enough to work properly and the gun itself was considered inadequate by that time. The project was suspended and then canceled in February 1944.

The first T23 pilot was completed in January 1943, and appeared with the GE electric drive that worked with the liquid-cooled, gasoline-powered Ford V-8 Model GAA engine. The vehicle rode on a VVSS. In contrast to the other pilot vehicles in the T20 series that featured cast-armor turrets, the first T23 pilot had a turret constructed of welded armor. An improved cast-armor turret was mounted on the second T23 pilot that featured the 76mm gun M1A1.

Early testing of the T23 pilots was so successful that 250 series production units were eventually ordered. However, testing of the first ten series production units led the Army Ground Forces (AGF) to conclude that the complexity of the GE electric transmission and steering system was beyond the skill set of the typical U.S. Army mechanic and the vehicle was therefore unsuitable for use in the field. The vehicle was also offered informally to the ETO in February 1945, but the offer was rejected as it would have involved retraining maintenance personnel and acquiring a new inventory of spare parts.

Three of the T23 pilots were fitted with the late-model HVSS as seen on second-generation M4 series tanks and designated as the T23E4. There was also another version of the T23 that rode on a torsion bar suspension system and was designated the T23E3. Like the T23, the T23E3 and T23E4 would never enter into field use. The one claim to fame of the T23 series was that its cast-armor turret armed with the 76mm gun M1A1 formed the main feature of the majority of second-generation M4 series tanks.

There was another version of the T23 built that was fitted with the 90mm gun M1 and designated the T25. A more heavily armored version of the T23 armed with a 90mm gun M1 was designated the T26. As events unfolded, the T25 would never be built, as U.S. Army interest in the summer of 1944 turned to more thickly armored tanks. A version of the T26 that rode on a torsion bar suspension system was designated the T26E3 and would eventually become the heavy tank M26 that saw service in World War II and the Korean War.

Pictured is the T22E1 pilot vehicle which generally followed the same basic hull design of the T20 pilot vehicle. The modified 75mm first-generation M4 series medium tank turret included an automatic loader. The vehicle rode on an early, narrow track version of the HVSS system. (TACOM Historical Office)

Pictured is the T23 pilot number 2 vehicle. A dramatic departure within the design of the various versions of the T20 series was the use of an electric drive transmission. Despite the advantages promised, the concept was dropped as it was found to be overly complex and difficult to maintain. (TACOM Historical Office)

M4 SERIES TANK VARIANTS

In March 1943 the number of M3 series medium tanks available for conversion into the tank recovery vehicle M31 was dwindling. It was decided to convert surplus early-production first-generation M4 series tanks into tank recovery vehicles. This program called for the fielding of the tank recovery vehicles M32, M32B1, M32B2, M32B3, and the M34B4, based respectively on the M4, M4A1, M4A2, M4A3, and M4A4. All versions of the M32 series entered production except for the M32B4, which was based on the M4A4 tank.

The M32 series of tank recovery vehicles all came equipped with the same 30-ton Gar Wood winch that was driven by a power takeoff from the vehicle's propeller shaft. The winch was located inside the front hull just behind the driver's seat on all versions of the series. The winch cable was fed out through a tow winch dragline roller located on the lower front upper hull of the vehicles. All versions of the M32 series also featured a crane type boom that could be used for lifting or towing purposes and a fixed superstructure on top of the upper hull. In total, 1,582 units of the M32 series would be built or converted between June 1943 and May 1945.

Not everybody was thrilled with the M32 series as is seen in this extract from a postwar research report, *Armor in Mountain Warfare* , prepared at The Armored School in Fort Knox, Kentucky: "The M32 series tank retriever has such obvious limitations as a recovery vehicle that it seems unnecessary to mention more than two of the most serious limitations: (1) the narrow tracks prohibit its use in soft terrain: and (2) the open turret prohibits the use of the vehicle under fire."

In British Army service the M32 series was referred to as the "ARV III." The prefix "ARV" stood for "armored recovery vehicle" in British military terminology. The British also converted a number of standard first-generation M4A2s into ARVs by removing their gun-armed turrets and providing them with a 3.7-ton jib crane for removing engines or power trains from tanks and drawbars for towing disabled tanks if the need arose. These makeshift ARVs were referred to in the British Army as the "Sherman ARV I."

The Sherman ARV II was a more advanced ARV and was fitted with both a jib crane and a winch. To fool the enemy, the vehicle's box-like superstructure, fitted on the top of the upper hull, sported a dummy 75mm main gun.

The British Army converted 52 of its ARV Is into Beach Armored Recovery Vehicles (BARVs) prior to the Allied invasion of France on June 6, 1944. Their intended role was to rescue any tracked or wheeled vehicles that became stuck in the surf during the beach landings. With a waterproofed hull and superstructure, the vehicle could wade through 9 feet of water to push or pull stranded vehicles out of the surf onto a beach.

Reflecting the eventual switch to second-generation M4 series tanks, the Ordnance Committee decided to field new tank recovery vehicles riding on the HVSS system. There were a number of modifications made to the second-generation M4 series tank recovery vehicles. These included adjustable rod-type stabilizers employed to lock out the springs on the front and rear bogies when lifting operations were being conducted.

The initial batch of 80 units of the M32 riding on the HVSS system was constructed by the Baldwin Locomotive Company and International Harvester and rolled off the factory floor by the end of 1945. They were originally designated as the T14E1. Reflecting the various changes to the second generation tank recovery vehicles riding on the HVSS system, the M32, M32B1, M32B2, and M32B3 became, respectively, the M32A1, M32A1B1, M32A1B2, and M32A1B3.

An M32B1 tank recovery vehicle on display at the annual "War and Peace Show" held in England every July. The 81mm mortar on the vehicle's glacis would have been employed in wartime to lay smoke to mask its location while performing recovery operations. (Christophe Vallier)

For the invasion of France, the British Army decided there was a requirement for a full-tracked recovery vehicle able to assist others in transiting from their landing craft onto the beaches of Normandy. In response, a number of M4A2 medium tanks were converted to Beach Armored Recovery Vehicles, as seen here. (Christophe Vallier)

FLAME-THROWER TANKS

The U.S. Army Chemical Warfare Section (CWS) had been studying the installation of flame-thrower guns in medium tanks prior to America's official entry into World War II. The initial project began when the CWS installed an experimental E2 flamethrower gun in the turret of a medium tank M2. This was followed by a shortened version of the E2 flame-thrower gun mounted in the turret of the medium tank M3 in August 1942. Maximum range of the flame gun was only about 35 yards. User interest was nil at that time, as it was hard to conceive of any practical purpose for this short-range weapon in the wide open desert wastes of North Africa.

There was a dramatic peak in interest in flame-thrower gun equipped tanks after fighting against the Japanese infantry in the jungles of Guadalcanal in fall 1942 demonstrated that such a vehicle could be extremely useful. Initially, light tanks would be converted, but their thin armor protection made them vulnerable to enemy return fire as they attempted to close to within the short effective range of their flame-thrower guns. To rectify this problem, it was decided to modify first-generation

M4 series tanks to serve as carriers for the new E4-5 auxiliary flame gun.

The new E4-5 auxiliary flame gun was not mounted in the turret of the first-generation M4 series tank, but mounted in place of the front hull-mounted .30 caliber machine gun. In this arrangement, the weapon had a range of about 60 yards. A half-dozen E4-5 auxiliary flame guns were installed on M4A2s and saw service with the Marine Corps during the fighting for the island of Guam between July and August 1944.

A small number of M4s equipped with the bow-mounted M3-4-3 flame gun would see limited use in Northwest Europe during the latter stages of World War II. It was not a popular vehicle with users for a number of reasons. Crews felt it made their M4 series tanks even more susceptible to vehicle fires, the range of the flame thrower was shorter than that of the German hand-held rocket launchers, and it was not a mechanically reliable device. Furthermore, the arrangement of the device inside the M4 series tanks blocked the escape hatch located under the bow gunner's seat, making it more difficult for him to leave the vehicle via his overhead hatch, and the limited fuel capacity of the E4-5 required frequent refueling.

Also developed during that same time period were a couple of other auxiliary flame guns designated the E6R3 and E12R3. They were also referred to as periscope-type flame guns because they were configured to fit alongside the bow gunner's overhead hatch M6 periscope. These were employed during the fighting for the islands of Iwo Jima and Okinawa that took place between February and June 1945. Like the E4-5, the E6R3 and E12R3 were not that highly valued due to their short range and limited fuel capacity of only 24 gallons, which provided them with 20 to 30 seconds of flame time before the fuel tanks were empty.

What the Marine Corps and U.S. Army really wanted was a turret-mounted flame-thrower gun arrangement with a larger onboard fuel capacity. A composite group from the U.S. Army CWS, Marine Corps, and U.S. Navy set about fulfilling that requirement as is described in an extract from an article by Captain John W. Mountcastle in the March–April 1976 issue of *Armor* magazine, titled "Inferno: A History of American Flamethrowers":

> Working around the clock in late 1944, this group succeeded in fabricating a very effective flame-thrower which was mounted in the gun tube of the standard M4 medium tank. Tanks of this type participated in the Iwo Jima invasion… and were so successful that many more were requested by the Marine Corps for the upcoming Okinawa campaign. The Army too wanted flame tanks. A [U.S. Army] medium tank battalion [54 tanks] was converted completely to flame and performed magnificently on Okinawa. The 713th Armored Flamethrower Tank Battalion was in combat for 75 days and was credited with killing 4,788 Japanese. Approaching enemy positions in caves and bunkers, the flame tanks threw long (100 yards) jets of flaming napalm at the Japanese. Those who escaped death by burning or suffocation were machine gunned as they ran screaming from their holes.

On display at the U.S. Army Chemical Corps Museum at Fort Leonard Wood, Missouri, is this POA-CWS-H5 flame-thrower tank, based on a first-generation medium tank M4A1. This concept allowed for the use of the 75mm main gun, as well as the flame gun contained within the upper barrel. (Lorén Hannah)

The M4 series tanks modified to accommodate the turret-mounted flame guns were designated as the POA-CWS-H1. The troops nicknamed them "Zippos," the brand name of a popular cigarette lighter renowned for its reliability. The POA-CWS-H1 carried 290 gallons of fuel in four tanks located below the vehicle's turret.

The first batch of POA-CWS-H1 tanks consisted of eight first-generation Marine Corps M4A3s. Four were issued to the 4th Tank Battalion, 4th Marine Division, and the other four to the 5th Tank Battalion, 5th Marine Division. All eight would see action during the conquest of Iwo Jima between February and March 1945. Results were mixed, according to a Marine Corps report titled *Armored Operations on Iwo Jima*, dated March 16, 1945:

> This weapon gave excellent results when it worked and could reach the target. In rubble brush and defiladed positions it caused casualties where no other weapon could reach the target… A combination of mechanical trouble and poor fuel reduced the efficiency of these weapons about 75 percent. The average length of flame produced was about 30 yards while the potential range of the same gun is over 100 yards farther than this… Unfavorable winds completely rendered the weapon useless on several occasions.

The 54 POA-CWS-H1s employed by the U.S. Army during the fighting for Okinawa between April and June 1945 were based on late-model M4 tanks referred to as composite hulls.

An extract from First Lieutenant Patrick J. Donahoe's article "Flamethrower Tanks on Okinawa," in the January–February 1994 issue of *Armor* magazine, sums up the effectiveness of the POA-CWS-H1s:

> A key to the flame tank's success was the mounting of the weapon in the sturdy M4 medium tank, which was survivable enough to take the fight directly to the enemy's position. Also, the inclusion of the armored flamethrower as an intrinsic part of the tank-infantry combined arms team was instrumental to it use [sic]. Had the main armament flamethrower been perfected earlier in the war, American casualties could have been reduced and the tank infantry team could have been more effective in the Pacific War.

Some within the U.S. Army and Marine Corps felt that the POA-CWS-H1 would be better off if the 75mm main gun was retained for self-protection. In response to this desire, starting in late 1944 all newly converted M4 series tanks would have their flame guns mounted alongside the vehicle's main armament, be it a 75mm main gun or a 105mm main gun. In this configuration the tanks were designated the POA-CWS-H5. Due to the space taken up by the fuel tanks for the flame gun inside the hull, their main ammunition storage was greatly reduced.

The Marine Corps wanted 72 units of the POA-CWS-H5 for the planned invasion of Japan, which fortunately never happened. The U.S. Army had hoped to employ ten of the POA-CWS-H5s during the fighting for Okinawa, but they arrived after the fighting concluded. A number of other projects to mount flame guns on the M4 series tanks were in the pipeline for use by the American military. However, none would reach the field before World War II ended and they would all be eventually canceled.

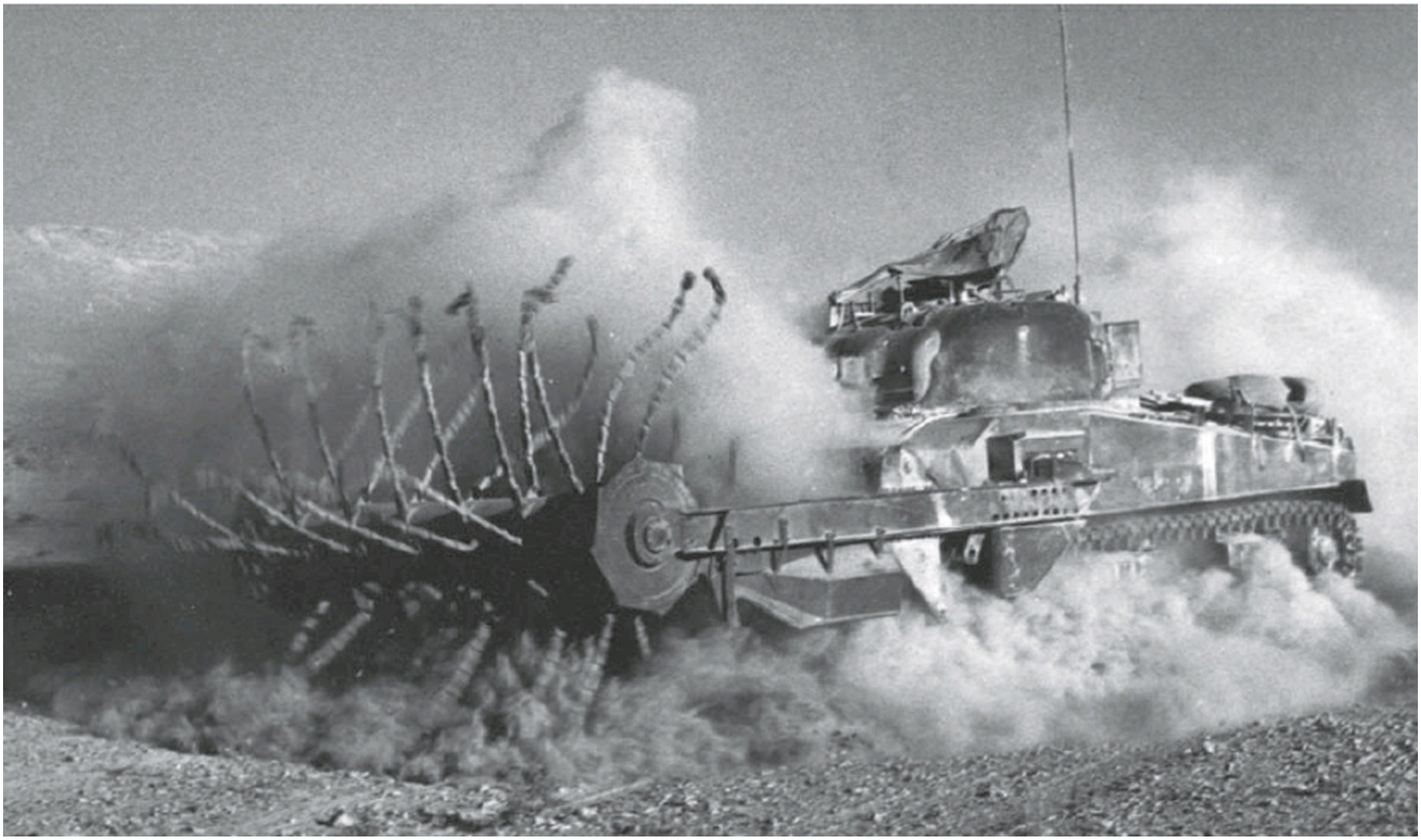
There was some early interest before the invasion of France by the U.S. Army in modifying the M4 series tanks to accommodate the British-developed and built Crocodile flame-thrower system, which included a two-wheel towed trailer that held the fuel for the vehicle's front hull-mounted flame gun. In the end, only four would be built and go on to see action with the U.S. Ninth Army in the ETO. They proved very useful, and a request for additional units was made; but it was rejected as it was felt that American-designed and built medium tank-mounted flame-thrower guns would soon be available.

ACCESSORIES

There would be a number of accessories designed for use by the M4 series tank during World War II to allow it to perform roles for which it was not originally intended. The largest number of these accessories proved to be for clearing enemy minefields and could be broken down into two major types of mine exploders: pressure-type mine exploders and concussion-type mine exploders. Pressure-type mine exploders activated mine fuzes with pressure applied by a mechanical device such as a flail, roller, disc, or plunger. The second type of mine exploder activated mines fuzes by sympathetically detonating mine charges with the force of a concussion or blast from a nearby explosive charge.

A pressure-type mine exploder developed and fielded by the British Army was a rotary flail system nicknamed the "Crab." It consisted of a cylindrical rotor with 43 large chains attached to the front of a first-generation M4 series tank that beat the ground in the hope of detonating any mines in its path during the breaching process. The cylindrical rotor was turned by a power takeoff from the vehicle's main engine. Due to the amount of dust generated by the Crab when in operation, visibility proved to be a serious issue. To assist the crews of the Crabs in maintaining the proper direction when breaching minefields, they were fitted with both a directional gyro and a magnetic compass.

There were two versions of the Crab fielded by the British Army during World War II, the "Crab I" and "Crab II." With the Crab I, a hydraulic ram on either side of the vehicle's front hull was employed to raise and lower the rotor assembly. Once locked into position it could not be adjusted for terrain deviations. On the Crab II, the rotor assembly was balanced by an adjustable weight mounted on one side of the vehicle's front hull that maintained a constant height of 4 feet 3 inches in spite of terrain variations.

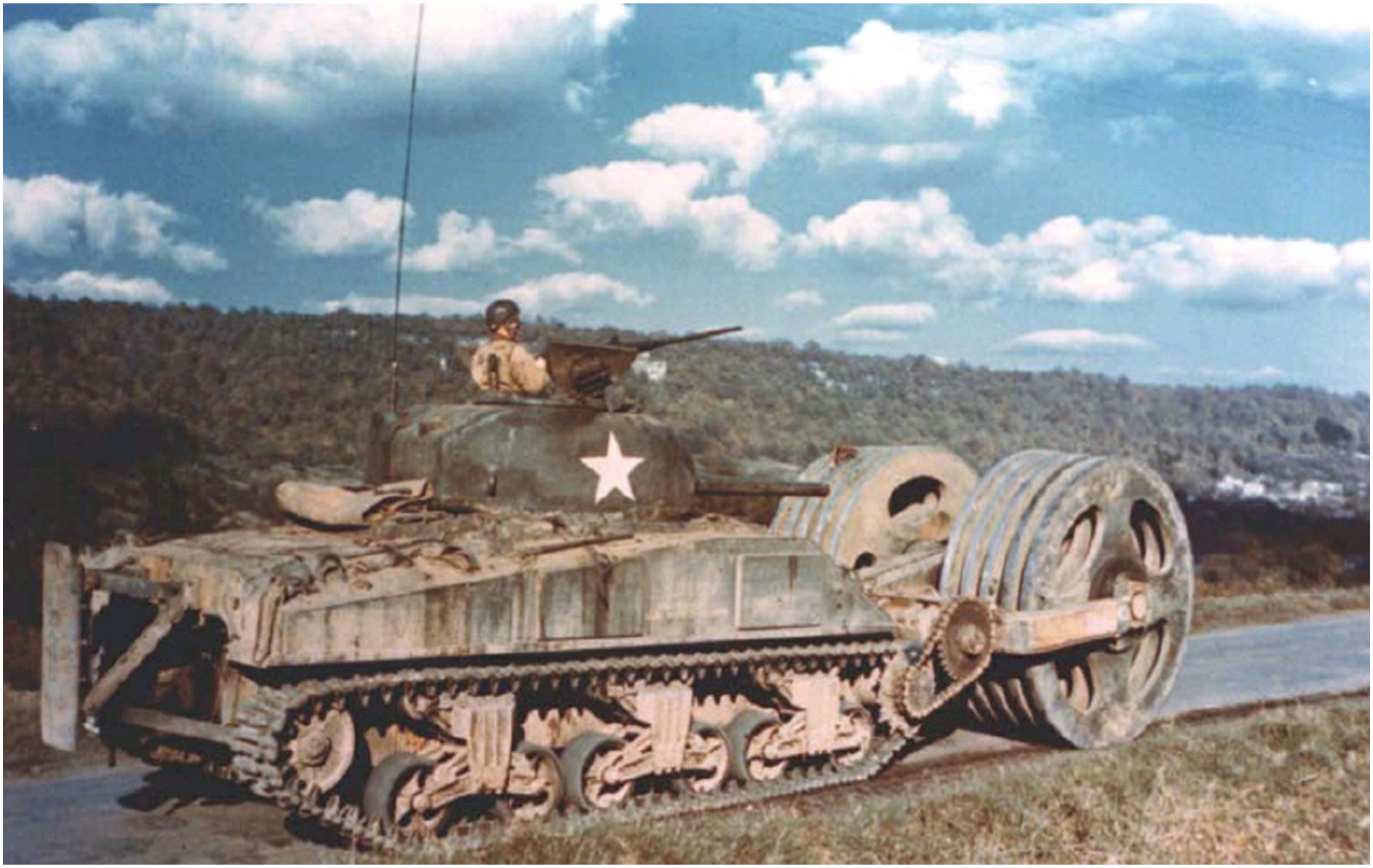


A medium tank M4A4 is seen here in postwar Israel Defense Forces service mounting a British-designed flail-type mine exploder, referred to as the “Crab II.” When flailing, the Crab could only be operated at a maximum speed of 1.25mph. (Patton Museum)

On a number of occasions, small numbers of Crabs were transferred to the U.S. Army by the British Army for use in the ETO during World War II. The Crabs made a favorable impression on the U.S. Army units that employed them in combat, who liked the fact that the vehicle could be employed as a standard tank when not involved in breaching minefields and that they provided the quickest breaching method available. Several disadvantages of the Crab identified by the U.S. Army included being vulnerable to off-set mines, delay action mine fuzes, and large explosive charges.

AMERICAN MINE-CLEARANCE DEVICES

The simplest mine-clearing device fielded by the American military during World War II was designated the mine excavator T5E3, of which 100 were constructed by La Plante-Choate between March and May 1945. Designed to be mounted on the front of first-generation M4 series tanks, it consisted of a V-shaped plow arrangement with scarifying teeth to extract mines without detonating them and, using a moldboard, to cast them to either side of the vehicle’s tracks. To prevent the extracted mines from running up over the top of the moldboard it had a curved upper lip. The T5E3 weighed approximately 4.5 tons.



The medium tank M4 pictured is equipped with the T1E3 mine exploder. The drive chains attached to the tank's drive sprockets drove the roller assemblies. The large plate at the rear of the tank served as a bumper to allow the vehicle to be pushed by another tank if the need arose. (Patton Museum)

The Ordnance Department had also developed a rotary flail system, designated the mine exploder T3, and nicknamed the "Scorpion." Unlike the Crab's cylindrical rotor, which was powered by a takeoff from the vehicle's engine, the Scorpion's cylindrical rotor was turned by an auxiliary engine. Forty-one of the T3 devices were adapted to fit on the front of first-generation M4 series tanks by the Pressed Steel Car Company between April and July 1943. Once completed, the modified tanks were rushed to the Italian Theater of Operations. They did not impress the users due to their weight and lack of off-road mobility and were quickly removed from service.

There were also two improved rotary flail systems developed by the Ordnance Department following the Scorpion; however, neither would see field service. The first was referred to as the T3E1, and the second as the T3E2, which was also nicknamed the "Rotoflail." There were also some improvised rotary flail systems developed in the field for fitting onto the front of U.S. Army and Marine Corps first-generation M4 series tanks.

The U.S. Army Ordnance Department favored pressure-type mine exploders consisting of large steel rollers/discs in various configurations that mounted on the front of the tank recovery vehicle T32 or first-generation M4 series tanks. Those eventually fielded in the ETO in very small numbers included the original T1E1 and improved versions. The T1E1 consisted of three sets of steel rollers mounted on the front of the recovery vehicle T32 that had a combined weight of 18 tons. Gar Wood Industries would complete 75 units of the T1E1 in April 1944, which were nicknamed "Earthworm."

The improved T1E3 was intended to be mounted on the front of first-generation M4 series tanks, with the first four pilot examples of the T1E3 being shipped overseas in May 1944, two going to England and two to Italy. The T1E3 consisted of two large sets of steel rollers with a combined weight of 29.5 tons. The Whiting Corporation built 200 units of the T1E3 between March and December 1944.

The Ordnance Department never stopped tinkering with the design of its pressure-type mine exploders, and came up with another variation, designated the T1E4. It consisted of a single roller fitted with 16 serrated steel discs that fitted to the front of first-generation M4 series tanks and weighed 24 tons. The T1E4 was followed that same year by the T1E6, which was slightly wider with 19 serrated steel discs and was designed to be mounted on the front of second-generation M4 series tanks.

All the Ordnance Department-developed pressure-type exploders that employed roller/discs rendered their carrying vehicle generally road-bound. They also proved vulnerable to relatively large explosive charges as well as off-set mines and delayed-action mine fuzes. The large and bulky roller/disc assemblies also proved extremely difficult to move from one location to another. This meant they had to be constantly assembled and disassembled – a very time-consuming process.

A description of the effectiveness of German minefields appears in this passage from a late-1944 report by Major-General E. N. Harmon titled *Notes on Combat Experience during the Tunisian and African Campaigns*:

> The extensive use of mines, both antitank and antipersonnel, by the Germans is one of the greatest menaces of the present war. No area, either forward or back, is safe from the mine. The most effective enemy mining was the sporadic mining of long stretches of road, road shoulders, craters, and areas upon withdrawal. Heavily mined fords strewn with metal fragments to render detectors useless were also effective delays. In general, the enemy's mine technique and mine equipment were superior to our own.

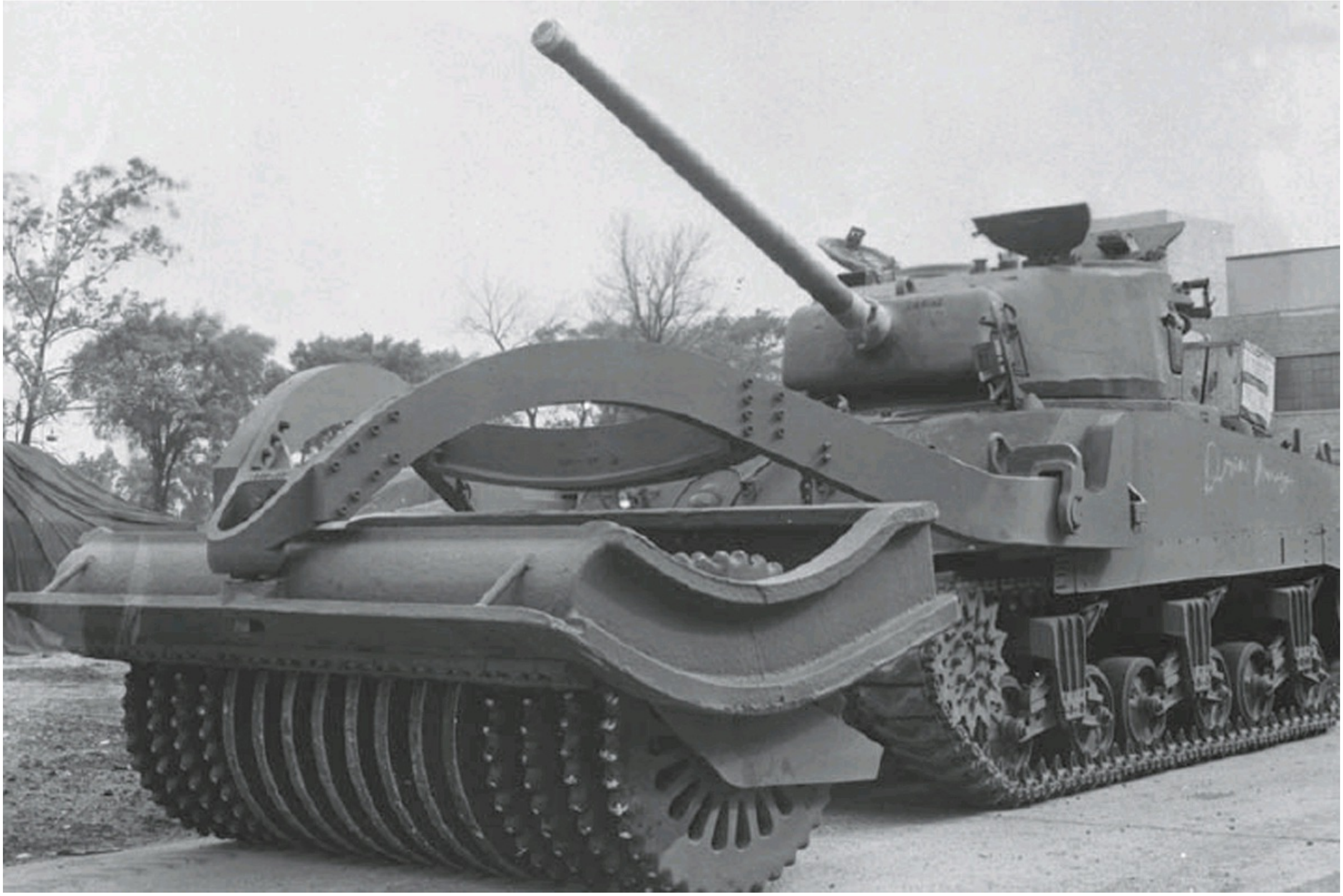
CONCUSSION-TYPE MINE EXPLODERS

Besides the pressure-type exploders developed by the Ordnance Department, a number of concussion-type mine exploders were developed by the U.S. Army Corps of Engineers. Most would not see field service during World War II. One of those that did see use in combat with mixed results was the 400-foot-long demolition snake M2. Based on a Canadian design, it was built by the Armco International Corporation and pushed into firing position by M4 series tanks.

The M2 weighed 6.25 tons and consisted of a double row of explosive cartridges fitted inside corrugated steel plates. It was followed in production by the lighter weight M2A1 and M3 fitted inside lighter aluminum plates. Once emplaced in their firing position, the various types of snakes were detonated by machine-gun fire aimed at an impact-sensitive fuze or, in an emergency, by a direct hit from a tank's main gun.

A description of the single operational use of the demolition snake in Northwest Europe appears in a postwar U.S. Army report titled *Armored Special Equipment*, prepared for the General Board U.S. Forces, European Theater:

> The only tactical employment of snakes on record was in the Third U.S. Army assault of Fort Driant of the Metz defense works on 31 October 1944, and this attack was unsuccessful. One dummy snake was assembled on 1 October and used for training, and four "live" snakes were ready the night of 2 October for movement to the fort. The snakes had to be moved approximately one mile to the fort by tanks of the 735th Tank Battalion. One tank was to tow each snake to the approximate site of detonation, and another tank was to follow, maneuver the snake into the exact location desired, and detonate it.



The T1E3 mine exploder was not a full-width device and had very poor off-road capabilities due to its size and weight, and proved extremely unpopular with the user community. Work continued on refining the concept, with the next step being the smaller and lighter full-width T1E4 mine exploder, seen here mounted on an M4A3(76)W with VVSS. (TACOM Historical Office)

Unfortunately, the plans using the M2s for the assault on the German-held Fort Driant quickly fell apart as two of them broke up when the tanks towing them into position had to make sharp turns on the approach to the enemy fort. Another M2 was lost a half mile from the fort when the towing tank drove over some logs. The remaining M2 was dropped just short of the enemy fort by the towing tank, but it buckled and twisted when another tank attempted to push it into its firing position. The accompanying U.S. Army assault on the enemy fort was beaten back by the German defenders.

A description of the effectiveness of the M2 during the breakout at the Anzio beachhead in Italy in May 1944 appears in this passage from Harmon's *Notes on Combat Experience during the Tunisian and African Campaigns*:

> The "snake" was successfully used in the breakthrough at Anzio [May 1944] and has possibilities where the mine field can be located ahead of time and where conditions are favorable for approaching with a tank to push a "snake" through the field. Several lanes were blown through minefields with a great demoralizing effect on the enemy. However, the danger with the "snake" is its susceptibility to being set off by artillery and causing heavy casualties by our troops in the immediate vicinity.

Another pressure-type exploder developed by the Corps of Engineers was the projected-line charge M1. It consisted of up to four plywood pallets towed behind an M4 series tank. Each pallet had a 300-foot-long charge containing plastic explosives that were launched from the edge of a minefield by a rocket propulsion unit mounted on the same pallet. Upon crossing a minefield the plastic explosives carried within the line charges were detonated in the hope of successfully breaching a path wide enough for vehicles and personnel to cross safely.

The Corps of Engineers also experimented with using liquid explosives for breaching minefields. It was intended that three 150-foot-long hoses, 3 inches in diameter and filled with liquid explosives (desensitized nitroglycerine), be launched from a modified M4 series tank and propelled over a minefield by a turret-mounted rocket launcher. Once emplaced, the three liquid explosive-filled hoses would be detonated to breach a path through a minefield for friendly forces to pass through.

Using the turret-less chassis of an M4 series tank, the Corps of Engineers developed the mine exploder T12. In place of the vehicle's turret was a platform level with the tank's upper hull that was fitted with 25 spigot mortars capable of launching 115-pound T13 HE shells in a long narrow impact pattern intended to breach a suitably wide enough path through a minefield. Three pilot examples of the T12 were built for testing. However, superior results obtained with rocket-propelled charges for breaching minefields led to the termination of the T12 project.

ENGINEER-ARMORED VEHICLES

It did not take long for the American military to conclude that unarmored bulldozers were not suitable for use in combat areas. As a short-term fix, a number of improvised armor kits were constructed by units in the field to offer the vehicle operators a measure of protection from enemy fire. The Corps of Engineers determined in January 1942 that the optimum solution would involve the fielding of a bulldozer kit that could be attached to the front of first-generation M4 series tanks. The end result of this line of development appeared during the second half of 1943 and was designated the bulldozer, tank mounting, M1. It would be widely distributed wherever U.S. Army or Marine Corps armored units served.

The straight toothless blade on the M1 was 10 feet 4 inches long and mounted on side arms that pivoted from the center bogie assemblies of first-generation M4 series tanks. A redesigned version designated the M1A1 had an 11 foot 6 inch wide straight toothless blade and could be adapted to mount on the front of both first-generation M4 series tanks and second-generation M4 series tanks riding on the HVSS system. It could also be adapted to mount on the front of first-generation M4 series tanks featuring the E9 spaced-out suspension system. By early 1945, a new bulldozer kit appeared that could be attached to the front hull of any M4 series tank. Known as the bulldozer, tank mounting, M2, it did away with the side bracket arms seen with the M1 and M1A1.

The U.S. Army in the ETO evaluated the various tank-mounted bulldozer kits for the M4 series tanks on the conclusion of the war in Europe. They proved to be a valuable addition to tank battalions as they could be readily employed to reduce obstacles in their path or prepare defensive positions if the need arose. It was also favored because it was a simple device that was reliable, with few maintenance needs. The big disadvantage of the various kits was that they overloaded the front of the M4 series tanks and caused suspension system problems.

A description of the effectiveness of the tank-mounted bulldozer appears in this extract from Harmon's *Notes on Combat Experience during the Tunisian and African Campaigns*: "One of the most important items of equipment is the armored bulldozer. It played an important part in the pursuit of the Germans in Italy. Without it we couldn't have advanced as all bridges and culverts were blown, and houses were often blown into the streets. A greater proportion of armored bulldozers should be set up."

One of the most useful M4 series medium tank accessories was the tank-mounted bulldozer M1, seen here mounted on the front of a first-generation medium tank M4A1. Field expedient dozers had been used in 1943, but the M1 was first employed in Italy in spring 1944. (Patton Museum)

A U.S. Marine Corps medium tank M4A2 fitted with the sheet metal deep water fording kit is being directed to its beach staging area. In combat conditions, the top section of the wading trunks could be dropped immediately upon reaching shore. However, de-waterproofing stations were directed to be set up as soon as possible, in order to remove sealants and tapes that might interfere with the proper operation of the vehicle. (Patton Museum)

FLOTATION DEVICES AND FORDING EQUIPMENT

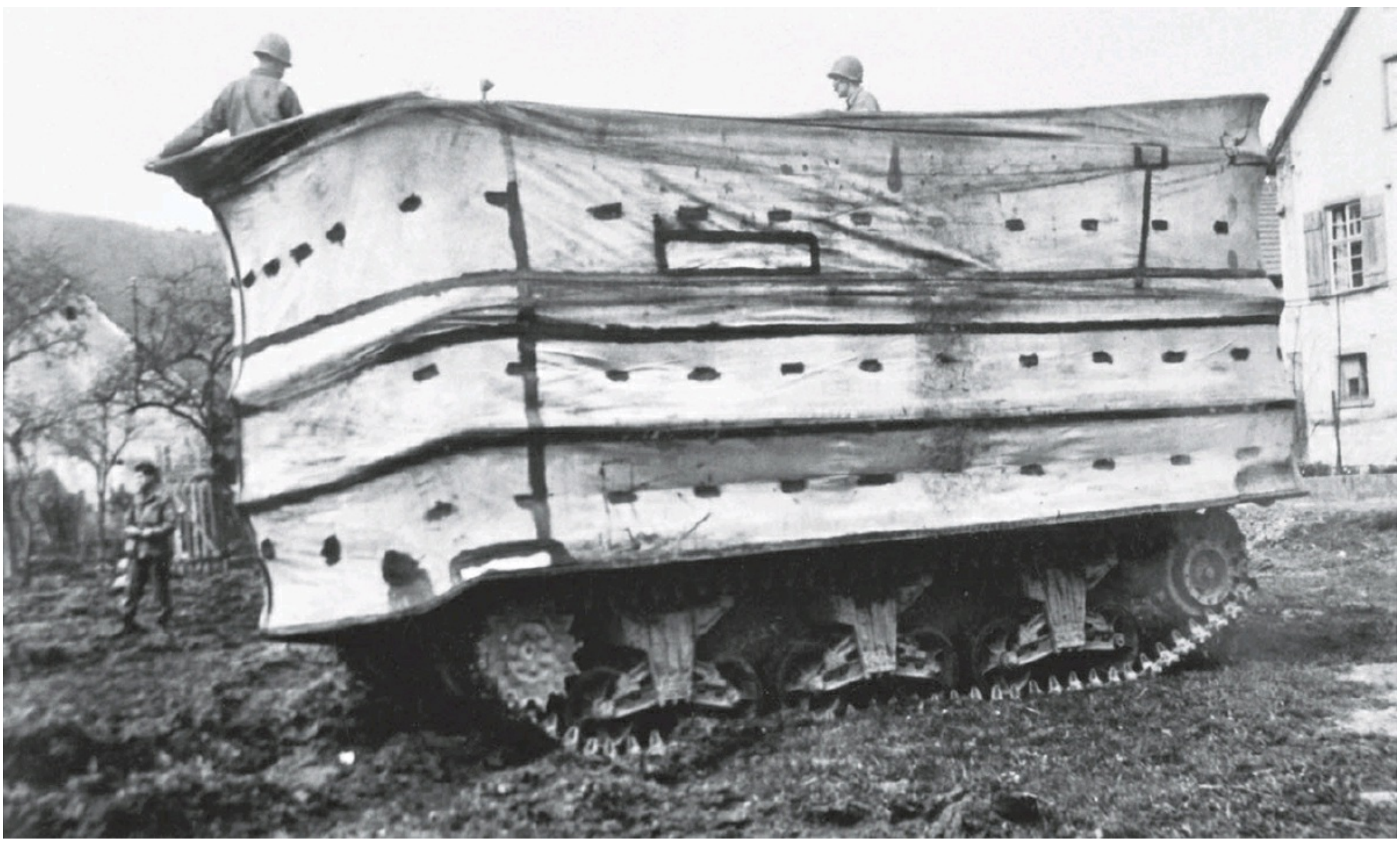
The planned Allied invasion of France in summer 1944 called for a method to assist tanks in getting ashore during the initial assault wave to provide much-needed fire support to the infantry coming in on naval landing craft. What was eventually acquired by the U.S. Army and the British Army for use on their tanks was a flotation device developed by Nicholas Straussler, a prolific inventor of Hungarian descent who became a British citizen in 1933. He came up with an inflatable, rubberized, waterproof canvas screen that could be erected around the upper hull and turret of first-generation M4 series tanks. In the water, the vehicles were powered by two propellers temporarily mounted to the rear hull and connected to the tank's tracks. Straussler's flotation device was referred to as "Duplex Drive" or "DD tanks."

Once on land, the inflatable canvas screen on the DD tanks could be lowered, allowing for use of the tank's turret-mounted weapons. At the same time, the rear hull-mounted propellers were raised so as not to interfere with the vehicle's mobility on land. The debut of the DD tanks took place on June 6, 1944, (D-Day) with the Allied invasion of France. Three U.S. Army tank battalions (the 70th, 741st, and 743rd) had been trained in their use along with three British and two Canadian armor battalions.

Of the two U.S. Army tank battalions assigned to Omaha Beach (the 741st and 743rd), the 741st lost 27 of their 29 DD tanks when swimming ashore due to rough water swamping the vehicles. The 743rd had their DD tanks delivered to the landing site by naval landing craft for fear that the same fate that befell the 741st might happen to them. Losses among the other DD tank-equipped units on D-Day were not nearly as high, as the seas were generally calmer at their landing locations.

DD tanks would continue to see employment by the U.S. and British Armies during the fighting in the ETO. Forty-eight of them would take part in Operation *Anvil*, the U.S. Army invasion of Southern France, in August 1944. With calm seas and little enemy resistance, 20 of the DD tanks safely transitioned from sea to shore, with the remainder delivered to shore by naval landing craft.

U.S. Army and British Army DD tanks would next see use in the Allied crossing of the Rhine River in March 1945, codenamed Operation *Plunder*. As the U.S. Army had a shortage of DD tanks in early 1945, they borrowed a number from the British Army inventory. All the U.S. Army DD tanks that attempted to cross the Rhine did it successfully. A British Army unit used DD tanks to cross the Po River in Italy on August 24, 1944 and the Adige River in Italy on August 28, 1944. The last use of DD tanks in the ETO occurred on April 29, 1945, when a British Army unit used them to cross the Elbe River in Germany.

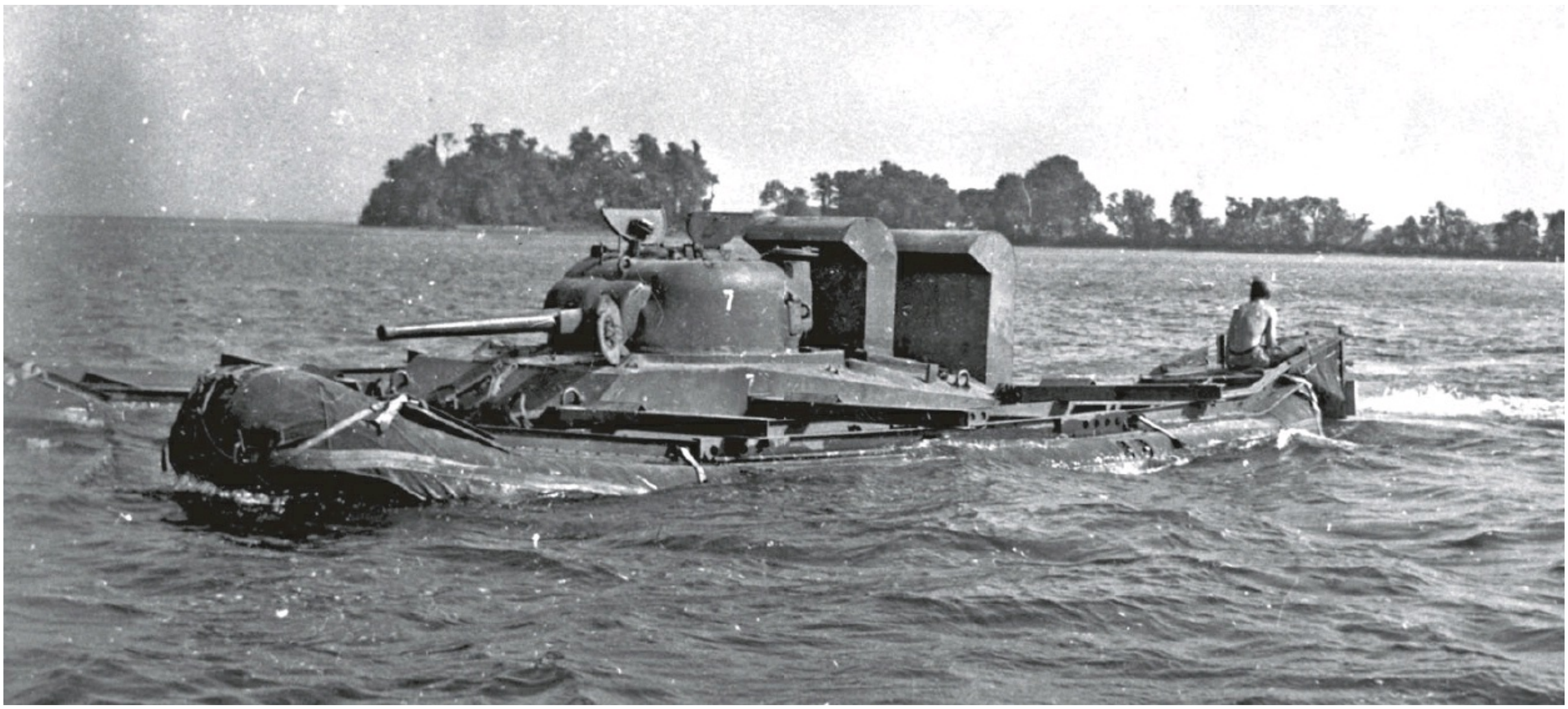


Developed for the invasion of France was a British-designed swimming device referred to as "Duplex Drive" or "DD." It consisted of a canvas screen with a supporting structure that could be erected around the hull for flotation. Power takeoffs attached to the tank's idler wheels rotated a pair of propellers for propulsion. (Patton Museum)

DD tanks never saw service in the PTO during World War II. The only flotation device employed by the American military in that part of the world was originally referred to as the T6, and was later standardized as the device M19.

The M19 consisted of large compartmented steel floats attached to the front, rear, and sides of M4 series tanks. The steel floats were filled with plastic foam encased in waterproof cellophane to lessen their vulnerability to damage from enemy fire and natural obstacles. Propulsion in the water for the M19 was by the turning of the tank's tracks. The biggest drawback of the M19 was its size, which was 11 feet by 47 feet 8 inches. In spite of this drawback, the U.S. Army employed a few of them in the invasion of Okinawa in April 1945.

Another flotation device tested by the Ordnance Department was the T12, which consisted of two 15-ton engineer pontoons strapped on either side of an M4 series tank. Propulsion was provided by outboard motors fitted to each pontoon. The T12 would not see use in World War II and was considered only as a field expedient method of moving a tank across a water barrier.



Pictured is a late-production M4A3(75)W swimming with the T12 flotation device. This consisted of a pair of 15-ton engineer pontoons attached to the sides of the hull. Propulsion in the water was provided by outboard motors attached to the rear of each pontoon. (Patton Museum)

The most widely employed piece of equipment used to assist M4 series tanks in moving from ship to shore through a surf line came from an idea generated by the Fifth Army Invasion Training Center (5AITC) located in Algeria in early 1943. They conceived the concept of waterproofing first-generation M4 series tanks, and then two tall sheet metal trunks were fitted on top of the rear hull engine compartment – the forward trunk to provide air for the engine or engines, and the rear trunk to vent the engine exhaust. This deep water fording arrangement would allow a suitably equipped tank to cross a surf line 6 feet deep.

Improvised deep water fording kits were first employed during Operation *Husky*, the invasion of Sicily in July 1943. By the time the invasion of France occurred in June 1944 standardized deep water fording kits had been developed. The fording kits would also be used during the U.S. Army invasion of Southern France, in August 1944, codenamed Operation *Anvil*. Both improvised deep water fording kits and factory-produced examples would see use in the PTO with the U.S. Army and Marine Corps.