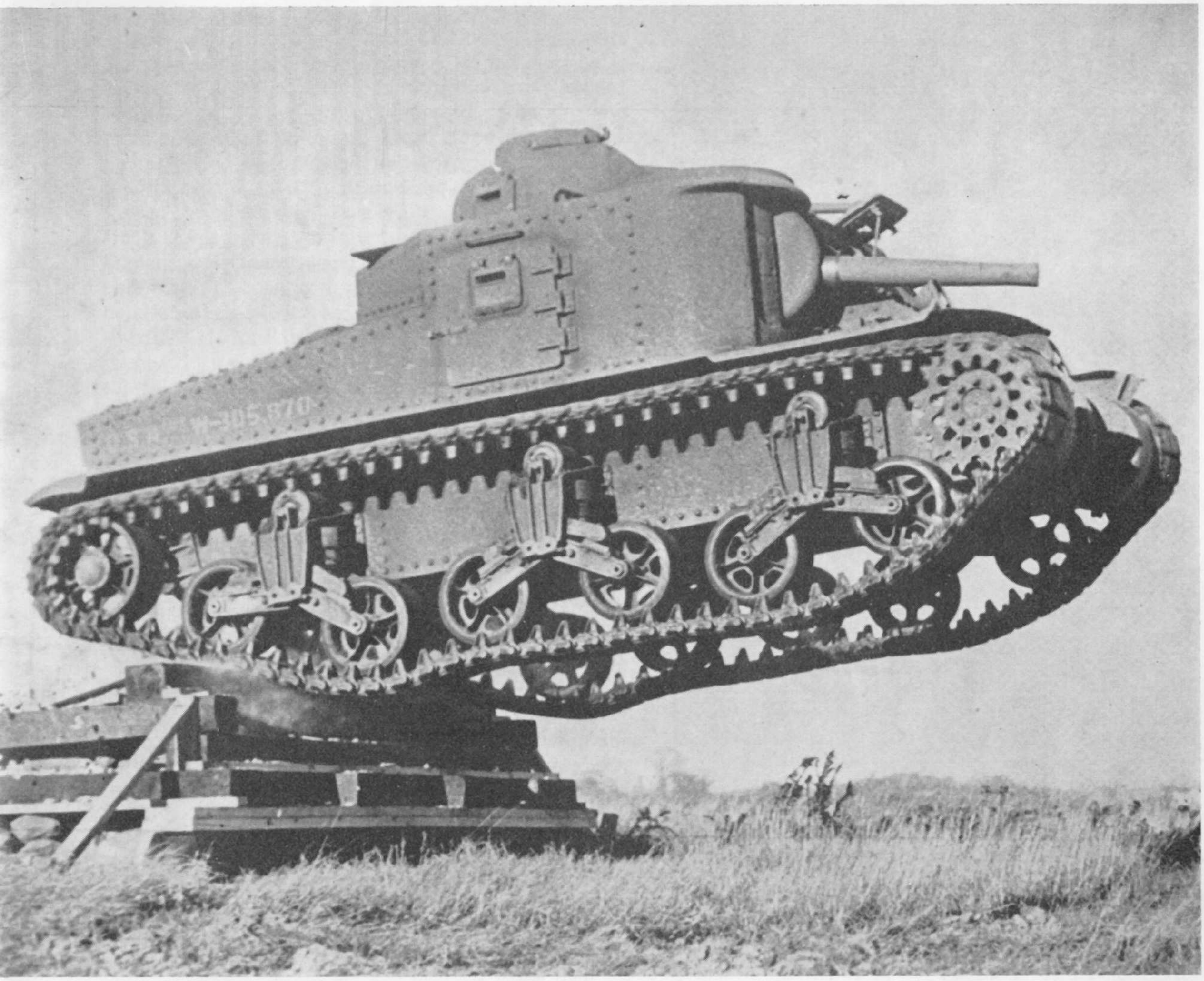
AFV 11

M3 MEDIUM (LEE/GRANT)

~~FIVE SHILLINGS~~

Cover Photograph: *M3s of a U.S. tank battalion in England on exercises in December 1942. Nearest vehicle has the counterweight on its M2 gun.* (U.S. Official)



An early production M3 being put through its paces at Aberdeen Proving Ground in 1941 shows to advantage the flexibility of the simple vertical volute spring suspension. (U.S. Official)

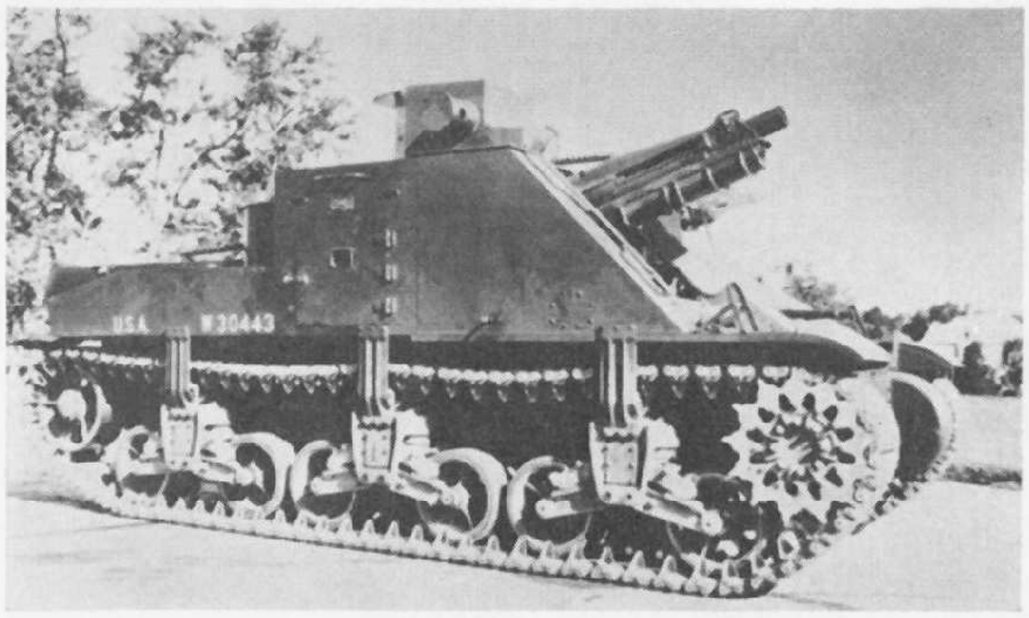
M3 Medium (Lee/Grant)

by Peter Chamberlain and Chris Ellis

BETWEEN the two world wars no great nation made less progress with the development of the tank than the United States. Germany, Russia, and even France, all built up considerable armoured forces in the 'thirties, while Britain was rich in ideas for tank warfare if not in material. America had entered World War I late, however, and the Armistice of November 1918 put an end to the expansion of her promising Tank Corps long before it could be established on its planned war footing. There was thus all too little time for any senior American officers to be "schooled" in the value of tanks and hardly anyone, other than the tank men, raised a whimper when the U.S. War Department abolished the Tank Corps in 1919. In 1920 the National Defense Act made tanks an Infantry responsibility which effectively relegated tanks and tank development to the lowest priority in the meagre defence budgets of America's lean years. For twenty years relatively little progress was made in building up tank forces, though light tanks fared better than other types. It was not until the German invasion of France and Flanders in May 1940 that impetus was given to the production of bigger tanks on a large scale and the result was the immortal M3 Medium tank, variously remembered as the Grant and Lee, which went from drawing board to battlefield in under two years and played a major part in restoring Allied fortunes when at their lowest ebb in the Western Desert fighting.

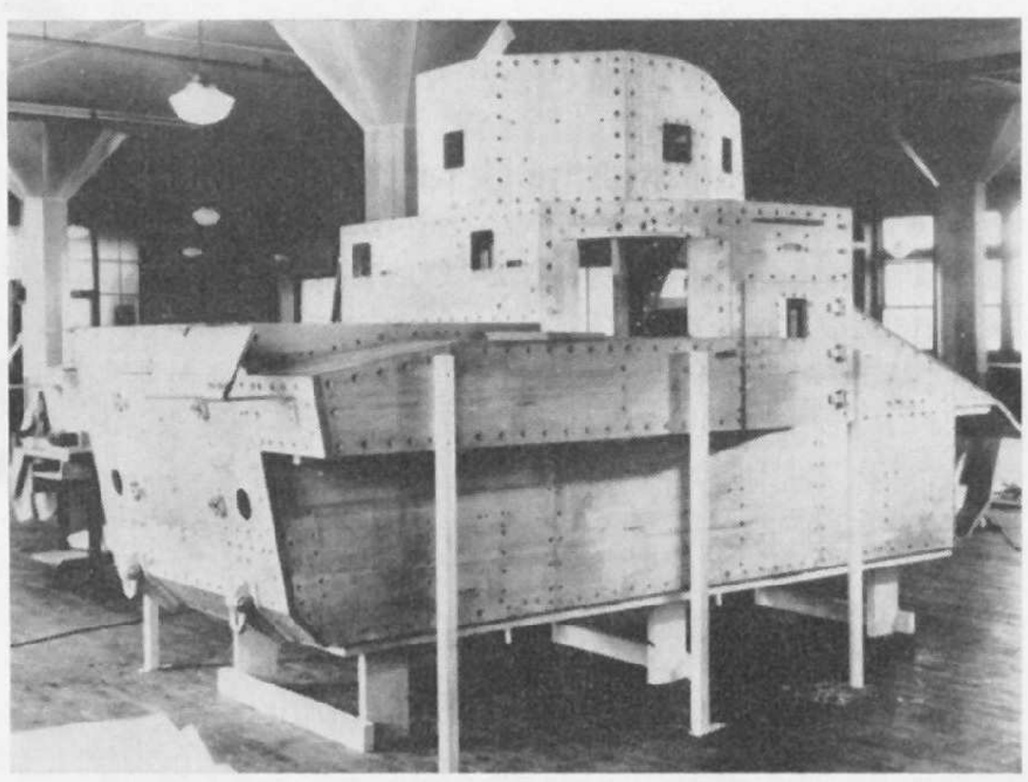
BETWEEN THE WARS

The origins of medium tank development in the U.S. Army dated back to 1919, just before the abolition of the Tank Corps. To plan for future tank development the Chief of the Tank Corps asked one of his staff officers, Major R. E. Carlson, to make a study of



The experimental T5E2 was a conversion in 1939 of the T5 Phase III (the M2A1 prototype) and inspired the actual layout with hull-mounted gun adopted for the M3. Note the optical range-finder. (U.S. Official)

Medium Tank M2 (and its similar but improved successor the M2A1) were the designs which formed the mechanical basis for the M3 Mediums. Note the numerous machine-guns, the single 37 mm. gun in the turret, and the deflector plates for enfilading trenches in line with the rear-firing machine-guns.
(Imperial War Museum)



The full-size wooden pattern model for the M2A1 built by Chrysler in anticipation of mass-production of this vehicle before the M3 was substituted in August 1940. (U.S. Official)

future requirements and prepare a paper on the subject. Carlson had been a member of the Anglo-American Tank Commission, which was responsible for the development of the Mk. VIII tank, so he was well placed to be familiar with British ideas on the future of tanks. Carlson's "Paper on the Development of Tanks" suggested that light tanks in the five ton class and medium tanks in the 20-30 ton class should be produced in future, the latter with a 6-pdr. (57 mm.) gun and machine-gun armament. These requirements were passed to the Ordnance Department's Rock Island Arsenal which accordingly produced a prototype medium tank, the M1921, to meet the ideas formulated by Carlson. An improved model, the M1922, subsequently produced, was similar but was based in shape much more on Johnson's Medium D tank built in Britain and superficially the two had a family resemblance. With a speed of 12 m.p.h., the M1922 was half as fast again as the M1921.

By this time, however, (1922) the Tank Corps had long been abolished as a separate arm but in 1921 the Infantry and Ordnance Department had asked the General Staff to approve a future policy for tank development based on Carlson's original paper. After much deliberation, in April 1922 the General Staff did at last make a formal decision and published an outline directive. This document started with the statement: "The primary mission of the tank is to facilitate the uninterrupted advance of the rifleman in the attack. Its size, armament, speed, and all accessories . . . must be approached with the above mission as the final objective . . . ." While this decisively established a future (if conservative) policy based on the earliest World War I ideas for the employment of tanks, the rest of the paper went on to water down Major Carlson's original ideas very considerably. The entire emphasis was on saving money and resources even if this meant sacrificing technical and tactical progress at the same time. The two classes of tanks commended by Carlson were retained, the light tank and the medium tank, but the medium tank was not now to exceed 15 tons, the weight limit of existing Engineering Corps bridging equipment. Speeds of medium tanks were not to exceed 12 m.p.h., machine-guns were to be arranged to enfilade enemy trenches as the vehicles crossed, and a heavier calibre gun was to be carried to engage enemy tanks. Two particular statements emphasize the financial parsimony of the period: ". . . for the present funds and effort will be applied principally to development purposes rather than to the construction of complete tank units;" and "Expenditure of funds on existing tanks will be limited to the amount necessary to keep those in actual service in repair and those in storage from deterioration."

As a result of the General Staff's ruling, the M1921 and M1922 prototypes were outside the new 15 tons limit so these were held in abeyance and work started on other designs. In 1926 the General Staff allowed another 23 ton vehicle (the T1) to be made but concentration on 15 ton types continued. Efforts were diverted to Christie vehicles of about 13 tons weight which were, of course, "commercial" designs, while the Ordnance Department had, by 1930, developed the T2 Medium tank which was designed to the 15 ton limit and was based in shape and layout on the British Medium Mk. II. The T3 and T4 vehicles which followed

this were Christie designs once again. Until the T4 all these tanks had existed as prototypes only but in 1935 16 of the Christie T4 Medium tanks were built at Rock Island, the first medium tanks (as opposed to combat cars and light tanks) to be built in quantity since 1919. These T4s were not scrapped, incidentally, until mid-1940 when they were still in use for training at Fort Benning. Prior to 1935 only 35 tanks of all kinds had been built in America since 1920, and American tank forces were smaller than those of any other of the major nations.

Christie's designs never found favour in the U.S. Army, however, particularly with the Ordnance Department, and the next type of medium tank was designed by Rock Island Arsenal in 1937-38 on more conventional lines. Designated T5, this new vehicle conformed almost to the letter with the General Staff's original 1922 outline for medium tanks. It was within the 15 tons weight limit—though this was exceeded very early on in development—it had an all-round machine-gun armament and even featured angled plates on the rear fenders so that bullets could be deflected down into the trenches as the vehicle crossed. The main armament was a 37 mm. gun, matching the calibre of most contemporary foreign tanks, and for economy and standardization as many components and features as possible were utilized from the existing M2 light tank. Among these were the same Continental 7-cylinder 250 h.p. engine, vertical volute suspension, sprockets, similar track, and similar transmission. The Continental engine was a radial air-cooled unit adapted from an aero engine. This had

The first M3 completed was built by American Locomotive Co. and was tested at Aberdeen Proving Ground in April 1941 where it is here seen. (U.S. Official)

been adopted in the design of the light tanks to avoid expenditure in developing special high-power motors for tanks, another result of the economic stringency of the 'thirties.

The T5 pilot model was completed at Rock Island Arsenal in 1938. With its eight machine-guns—two firing forward, four in the barbette, and two on the turret sides—plus its 25 mm. armour it exactly fitted the General Staff conception of a tank for infantry support. Tests of the vehicle showed it to be under-powered, however, and it was decided that a bigger engine was necessary. One proposal—not carried out at the time—was to fit a Guiberson diesel motor, in

A standard early production M3 (Lee I) with the short M2 75 mm. gun and M5 37 mm. gun. (Imperial War Museum)

which form the vehicle was designated (on paper) T5 Phase II. The alternative proposal was to fit a larger Wright Continental engine, the 9-cylinder R975 350 h.p. unit, and in this form the prototype was actually rebuilt, being then designated T5 Phase III. Trials of the modified vehicle were completed in early 1939 and the design was standardized as the M2 Medium Tank.

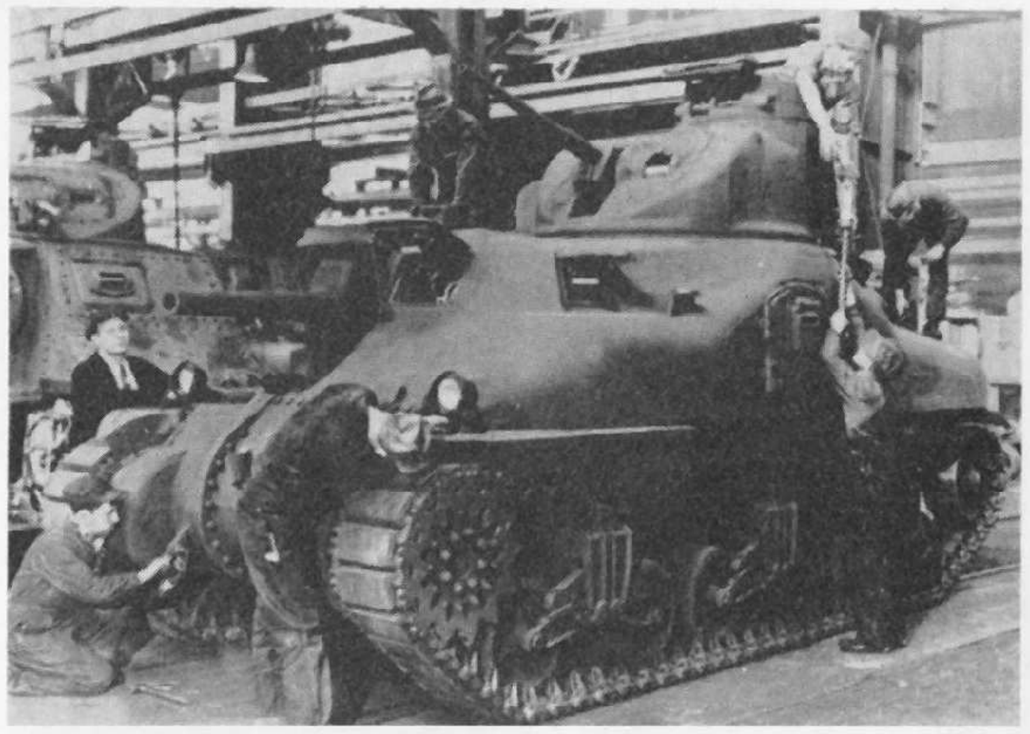
With the new engine and other detail changes, including wider tracks, the weight of the T5 Phase III had crept up to 19 tons but by this time bridging limits had, in any case, been raised. A production order for 15 M2 Mediums was given to Rock Island Arsenal in August 1939 and, with the addition of two more development vehicles, the total M2 output amounted to 18 vehicles. At the time of the German invasion of France in May 1940 these were the only up-to-date medium tanks in the U.S. Army. By the time the first M2s were in production war had started in Europe and work was put in hand to produce an improved model. This was designated Medium Tank M2A1. Compared to the original M2 it had an uprated (400 h.p. supercharged) engine, armour maximum increased from 25 mm. to 32 mm., strengthened bogie units, slightly wider tracks, splash rails added on the glacis plate, and an enlarged turret. These changes increased the overall combat weight to just over 23 tons.

Experimental work carried out with the original T5/M2 vehicles included the installation of a Guiberson diesel engine and twin 37 mm. gun in one vehicle (T5E1) and the conversion of the original T5 Phase III vehicle to an experimental self-propelled carriage. In this guise it was designated T5E2, being converted between March and May 1939 to mount a standard 75 mm. pack howitzer in its suitably modified hull front. The turret was removed and a new small offset turret was fitted which held an optical rangefinder for the howitzer. This conversion was merely an idea by the Ordnance Department to test the feasibility of producing a self-propelled gun on the medium tank chassis should such a vehicle be required in future. In the event, the T5E2 was to become the vital design on which the M3 Medium Tank was later based.

THE MEDIUM TANK PROGRAMME

When Germany invaded Poland in September 1939 the U.S. Army possessed no modern medium tanks and

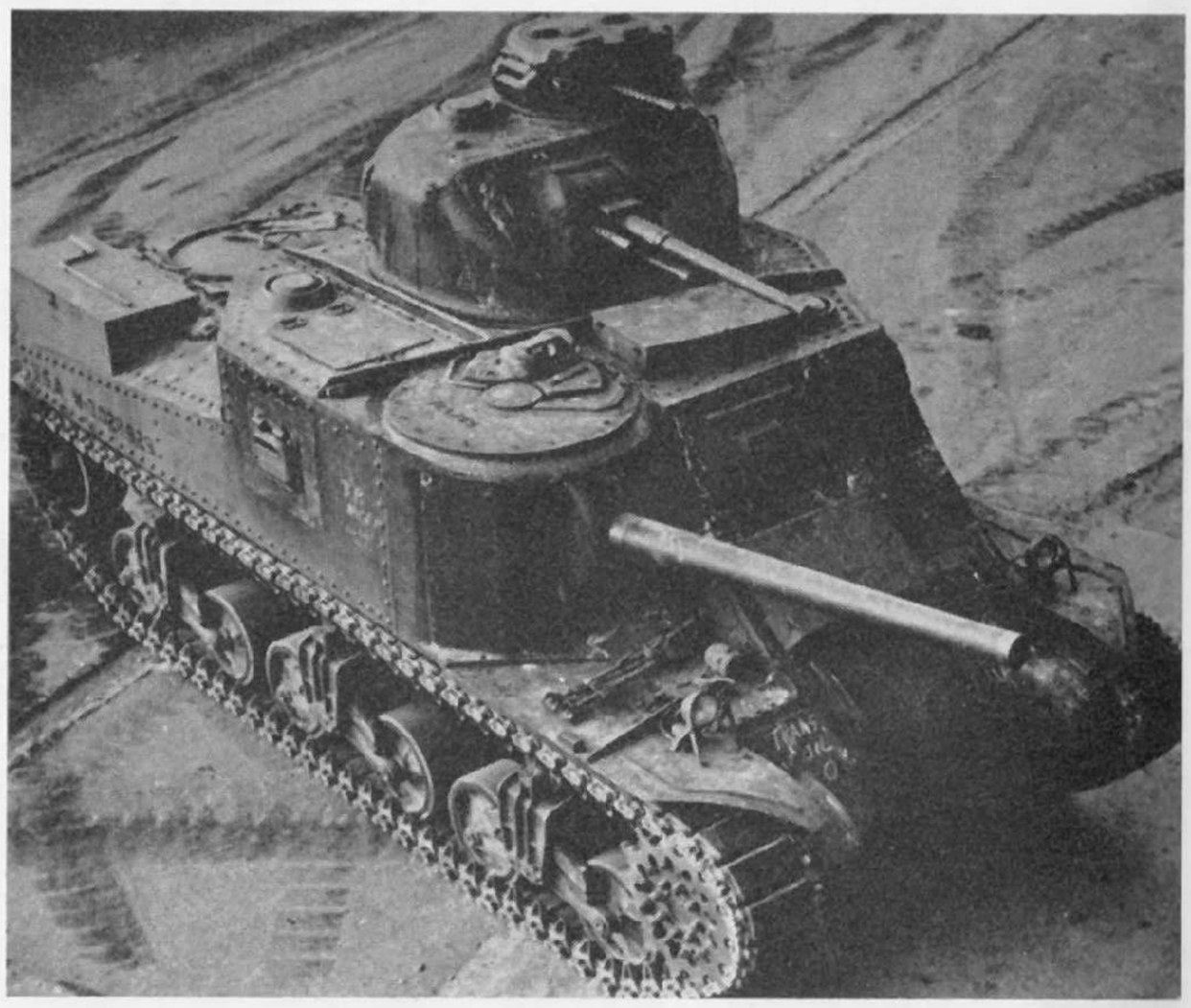
The M3 built for British use as the Grant I. Note the lower turret with pistol ports and no cupola. (Imperial War Museum)

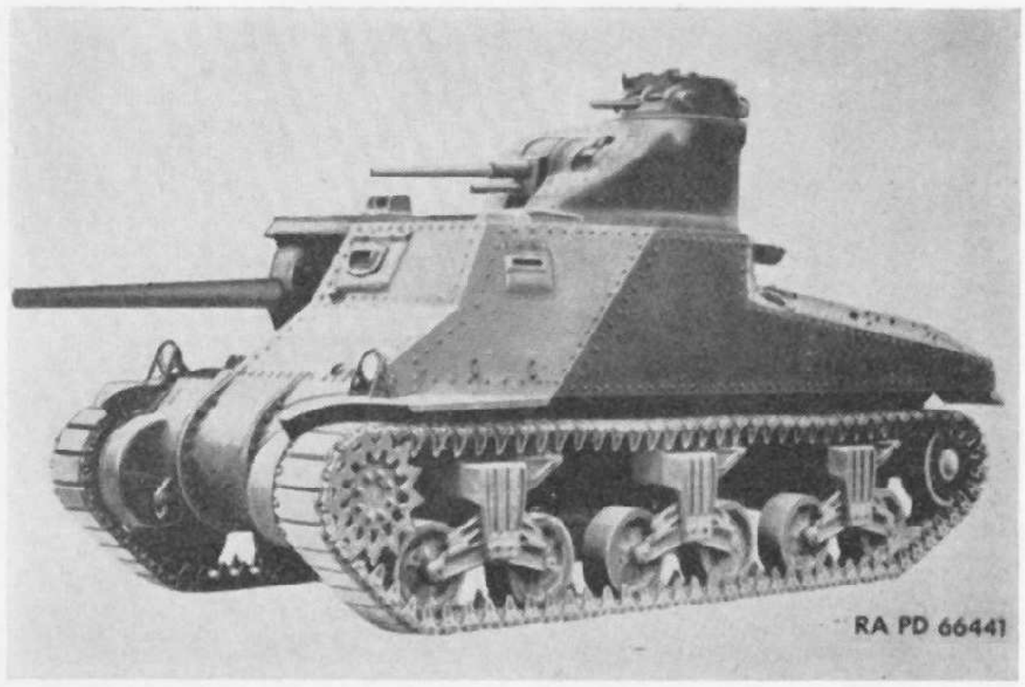


The M3A1 was distinguished by its cast hull. Here the pilot model is seen being completed at American Locomotive Works in February 1942. (U.S. Official)

only a few new light tanks. No facilities for producing tanks on a large scale existed at all. Though Rock Island Arsenal had built most of the tanks produced in the 'twenties and 'thirties, this was primarily an artillery plant and there was no space for large tank production lines. Plans existed, however, to place contracts with heavy engineering firms should the need for tanks in quantity arise, the view being that this sort of firm would be adept at the heavy casting and assembly work involved in tank building. Accordingly the first big contract, for M2A4 light tanks, went to one such firm, American Car & Foundry, in October 1939 on the basis of competitive tendering. "Educational" orders went at the same time to two other heavy engineering plants, Van Dorn and Baldwin, again for light tanks. In the fall of 1939 the improved medium tank design, the M2A1, was still being worked out and the "Phoney War" in Europe gave valuable breathing space.

The late production M3 had the long M3 75 mm. gun and the M6 37 mm. gun. In addition the side doors were eliminated. Note also the stowage boxes on rear decking and hull front. Tripod on hull front is for use with the ·30 cal. machine-guns which could be unshipped for ground firing.
(Imperial War Museum)





A very late production M3A4 which has the M3 75 mm. gun, the M6 37 mm. gun, side doors eliminated, and Sherman-type bogies with trailing return rollers. (U.S. Official)

The M3A1E1 was one of many project test vehicles. It was tried with triple Lycoming aero engines in May 1942 when alternative power plants were being sought for M3 series vehicles. (U.S. Official)

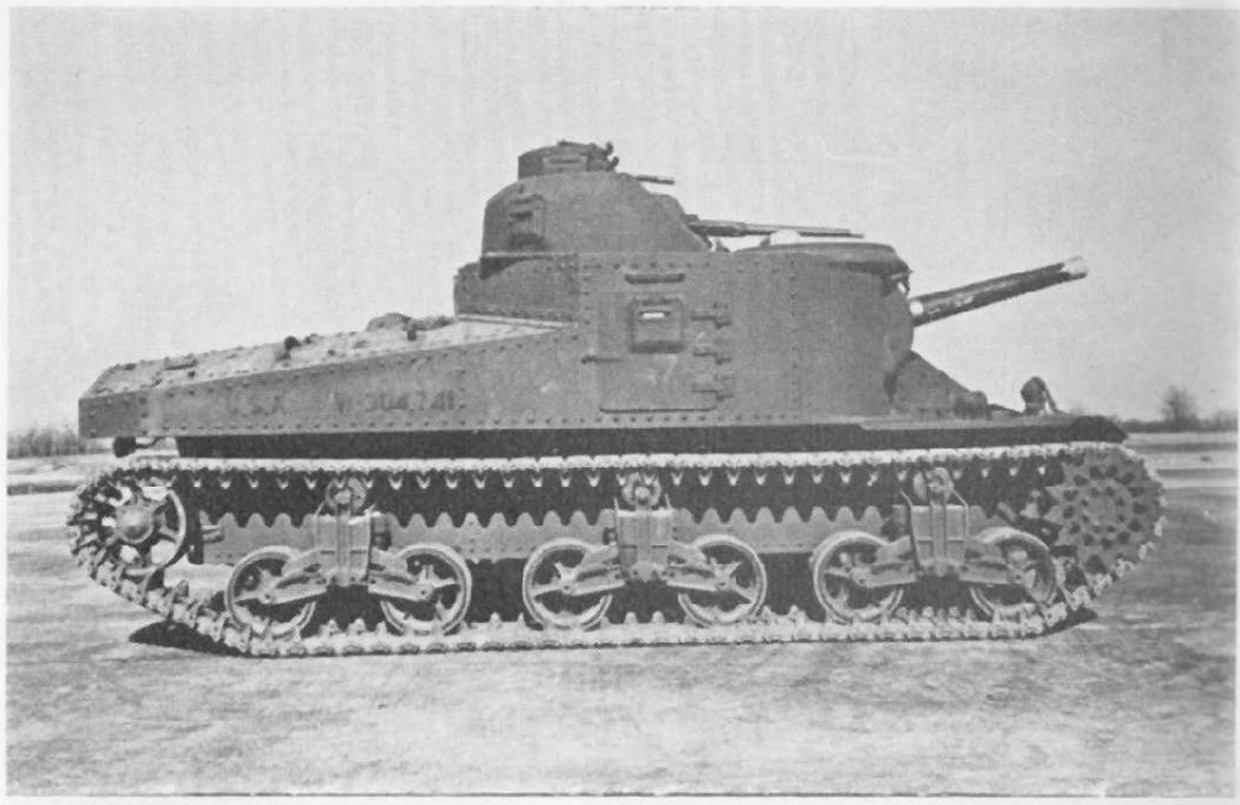
In May 1940 the M2A1 was ready. Almost simultaneously the German panzers were sweeping all before them in the advance into France and Belgium, and America's grave shortage of tanks suddenly became a cause for political concern. In the Senate, Henry Cabot Lodge, who had just witnessed military manoeuvres at Louisiana said: "I have recently seen all the tanks in the United States, about 400 in number*, or about one finger of the fanlike German advance about which we have read, or about the number destroyed in two days of fighting in the current European War. The Germans have a rough total of 3,000."

*All but about 25 were M2 light tanks or M1 combat cars.

Criticism from press, public, and politicians alike at America's general unpreparedness for war led to the introduction of the National Munitions Program on June 30, 1940, by which time France had capitulated and Britain was almost defenceless and seemingly about to be invaded herself. The plan covered all aspects of defence, of course, but included a requirement for 1,741 medium tanks to be produced in the next 18 months. On July 10, 1940, a new Armored Force was formed under General Adna R. Chaffee, to take over all responsibility for tanks from the existing infantry and cavalry commands. The scene was now set for an expansion of America's tank forces on a dramatic and urgent scale.

Standard production M3A1, known to the British as the Lee II. (U.S. Official)

The M3A5 had twin GM diesel motors. This view shows the M2 gun with added counterweight, welded up side doors, and the deeper rear housing for the engines. (U.S. Official)

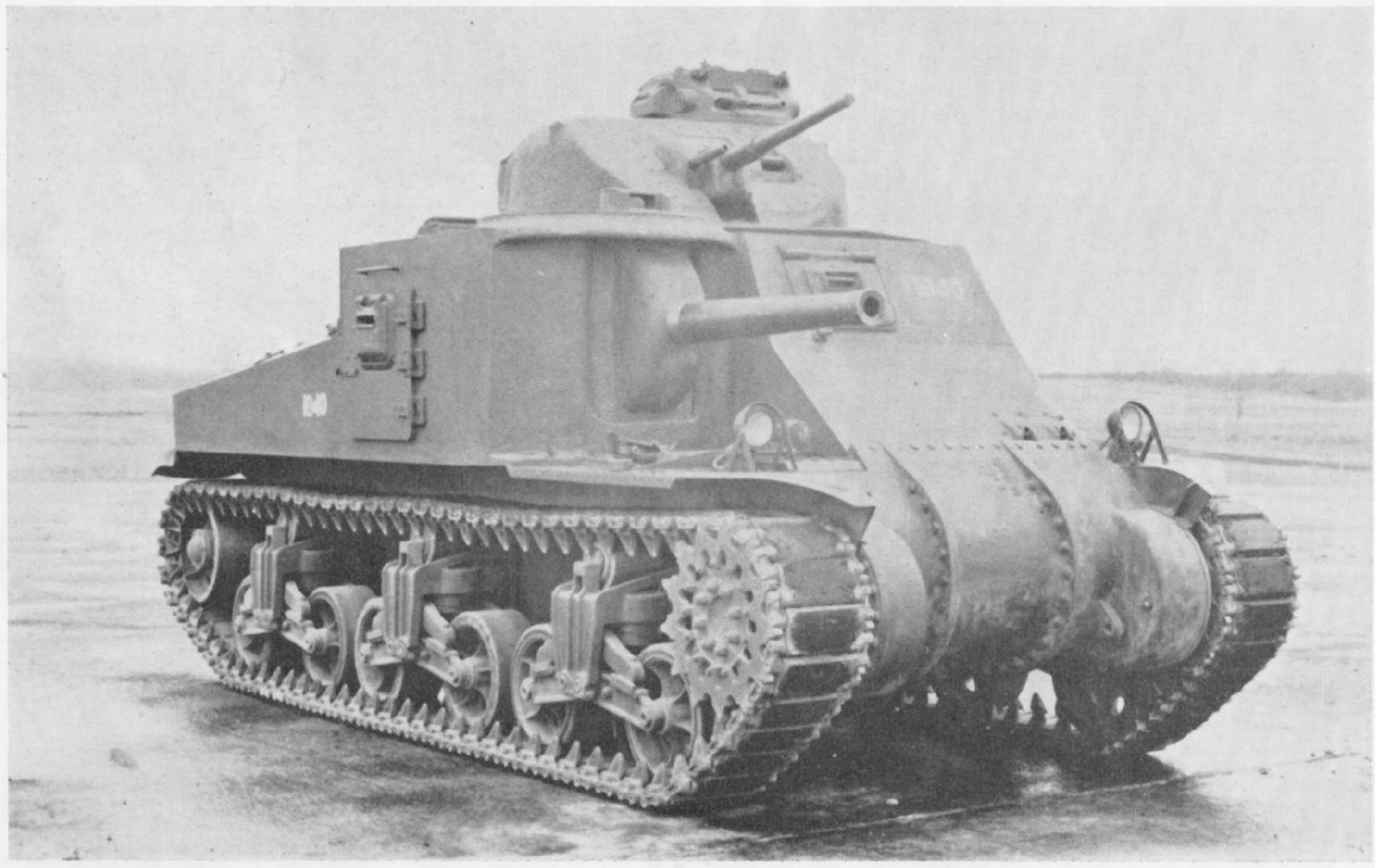


The M3A4 had the Chrysler Multibank engine which necessitated lengthening the hull and chassis to accommodate it. Wider spaced bogies and the extended rear can be seen clearly in this view. British designation was Lee VI. (U.S. Official)

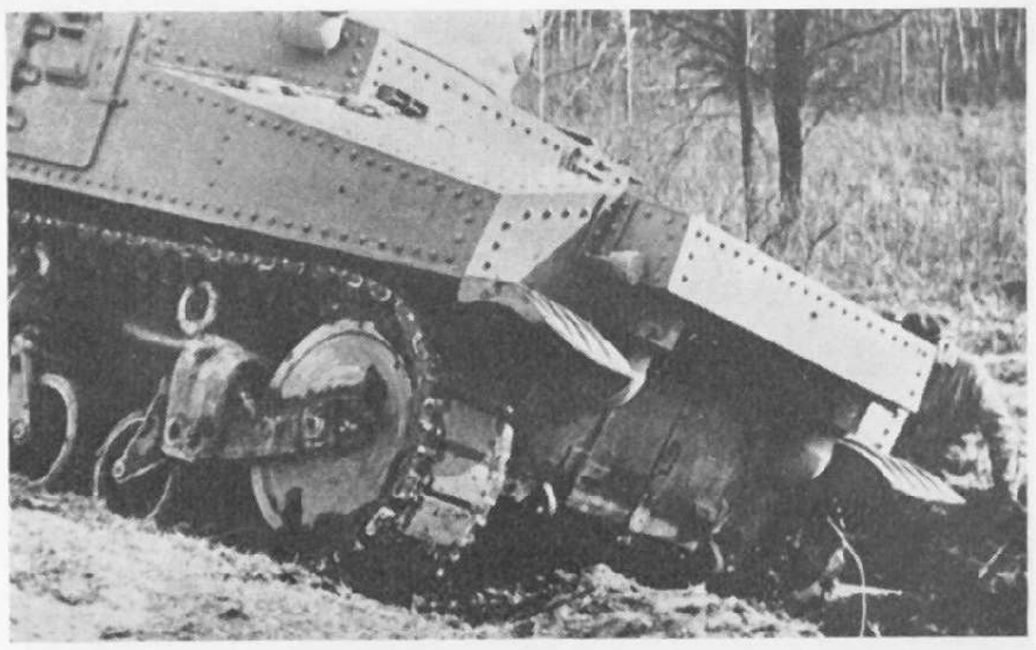
The Ordnance Department had earmarked American Locomotive Co. and Baldwin Locomotive Co. as possible builders of medium tanks since these firms had spare capacity for the task. However, such plans were soon revised. Early in June a National Defense Advisory Commission had been formed to help prepare the new Munitions Program and among its members, one of several leaders of industry, was William S. Knudsen, President of General Motors, whose special task was to advise on matters concerning mechanized equipment. Knudsen considered that tanks on the vast scale now required could not be produced quickly enough by heavy engineering plants. He argued that such firms were mainly used to small "bespoke" orders for locomotives, cranes and the like which did not necessarily give them the necessary expertize for turning out tanks by the hundred*. He maintained that the answer to the tank problem was to harness the resources of the mighty Detroit automobile industry and suggested that a purpose-built plant should be erected at Detroit specially to build the new medium tanks which were required. Existing automobile factories could not be used because the production plant needed was different and these factories

*The heavy engineering firms engaged in tank production did, however, disprove this theory very quickly with an excellent war output record.

M3A2 had an all-welded hull. Only 12 were built after which the power plant was changed to twin GM diesels and the designation was changed to M3A3. (U.S. Official)



The M3A5E1 was yet another trials vehicle, this time to test the possible installation of Hydramatic transmission. Note the extended rear hull to house it. (U.S. Official)



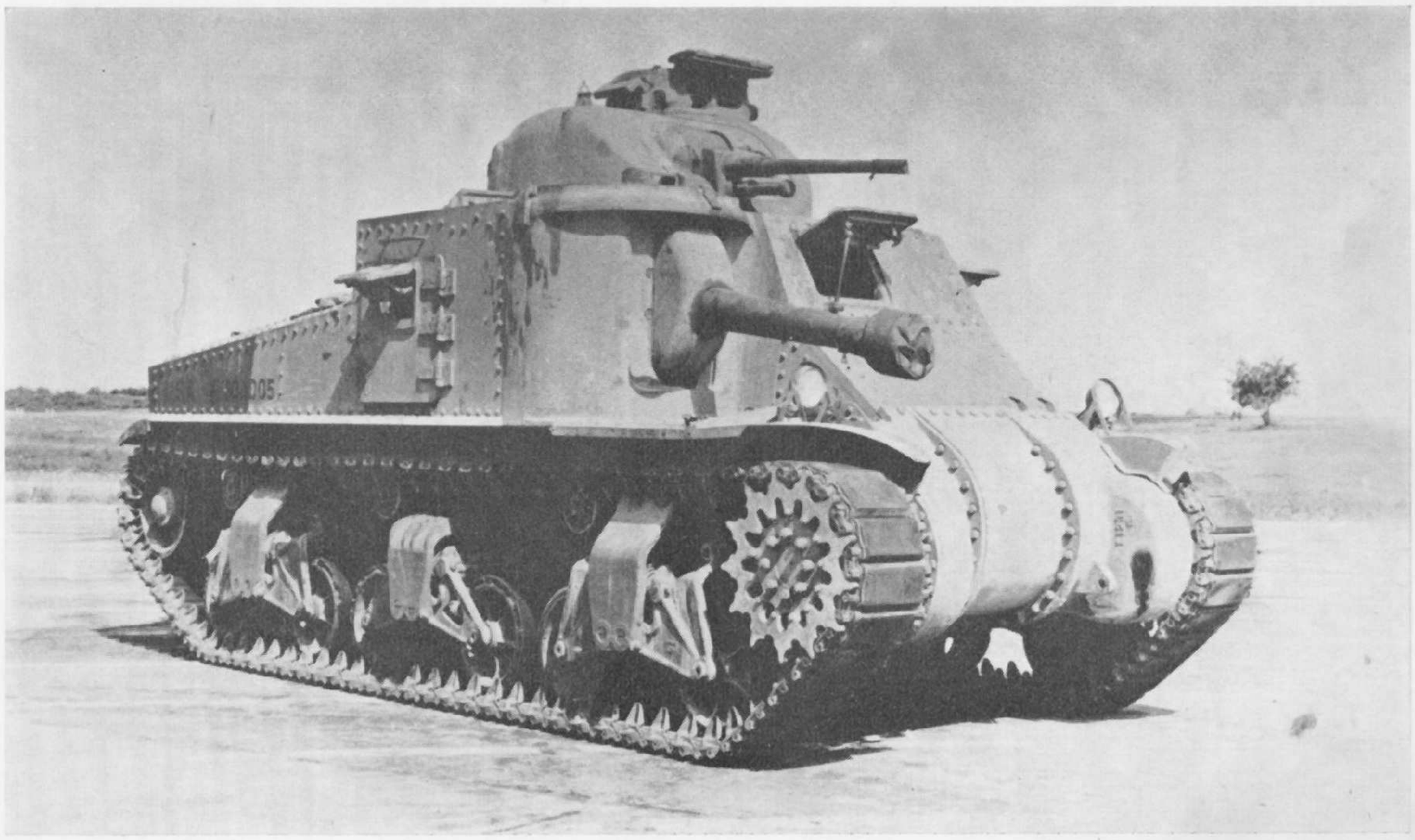
Yet another test vehicle was used with experimental trailing rear idlers. This is the Wright-engined M3. (Chamberlain Collection)

were in any case required for other military production like trucks and engines.

The Ordnance Department agreed that such a scheme would be worth investigating, if only because the need for additional tank production facilities was most urgent. Knudsen contacted the President of Chrysler Corporation, K. T. Keller, and asked if he would be prepared to undertake the task of setting up a new tank arsenal on behalf of the government, using Chrysler personnel and resources. Keller moved fast and sent a team of engineers to Rock Island Arsenal to look at the M2A1 prototype and bring a set of drawings—total weight 186 lbs.—back to the Chrysler plant in Detroit. By June 17 the engineers and production planners started to work on estimating the work force, the size of the plant, the size of the building, costing, and the thousands of other problems involved in turning out tanks from scratch from a building not yet erected. One of the most complex industrial schemes of all time, the planning and building of what became known as the Detroit Tank Arsenal, would have been a major undertaking even in the leisurely days of peace. The Chrysler engineers, however, were asked to have the plant fully operational within a year and turning out 100 tanks a month.

Planning and costing for the entire project took exactly a month during which time Chrysler engineers built a complete full-size wooden pattern model of a M2A1 using the Rock Island plans; this was to assist in the design of production plant. On July 17, 1940, Chrysler presented the full scheme to the Ordnance Department for approval. Cost of the complete arsenal was estimated at $21 million with a proposed output of ten tanks per day at $30,000 each less armament. The formal contract was signed on August 15 and covered building of the arsenal and production

A trials model of the M3A4 used for experiments with horizontal volute spring suspension, April 1942. Shown here in its early form, HVSS was later fitted on the Sherman tank. (U.S. Official)

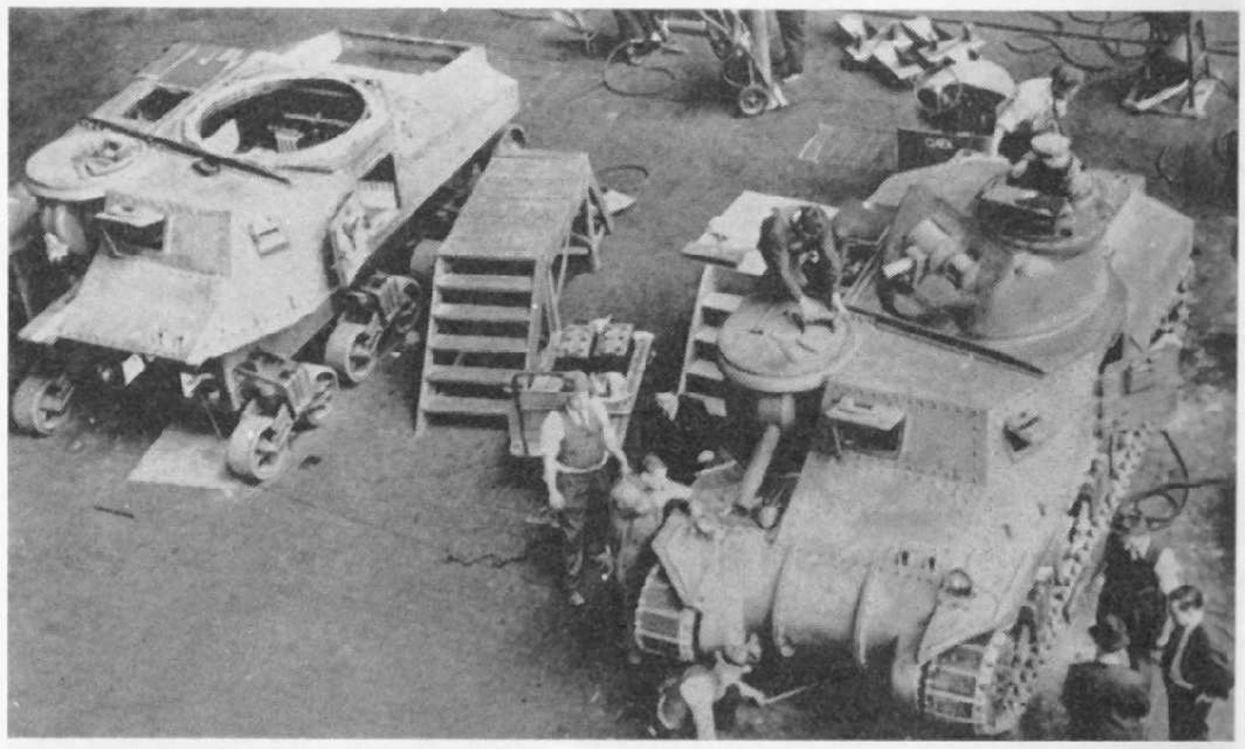


December 1942 "somewhere in England," a U.S. tank battalion in training with an impressive line-up of M3s. Nearest vehicles have M3 75 mm. guns, but those in the distance have M2 guns with counterweights. (U.S. Official)

of 1,000 M2A1 Medium tanks. These immediate plans were soon to change, however.

THE 75 mm. GUN

On June 5, 1940, just as Knudsen was pushing his ideas for a special tank arsenal, the Chief of Infantry—then still responsible for tank forces—forwarded a report on future requirements to the Ordnance Department.

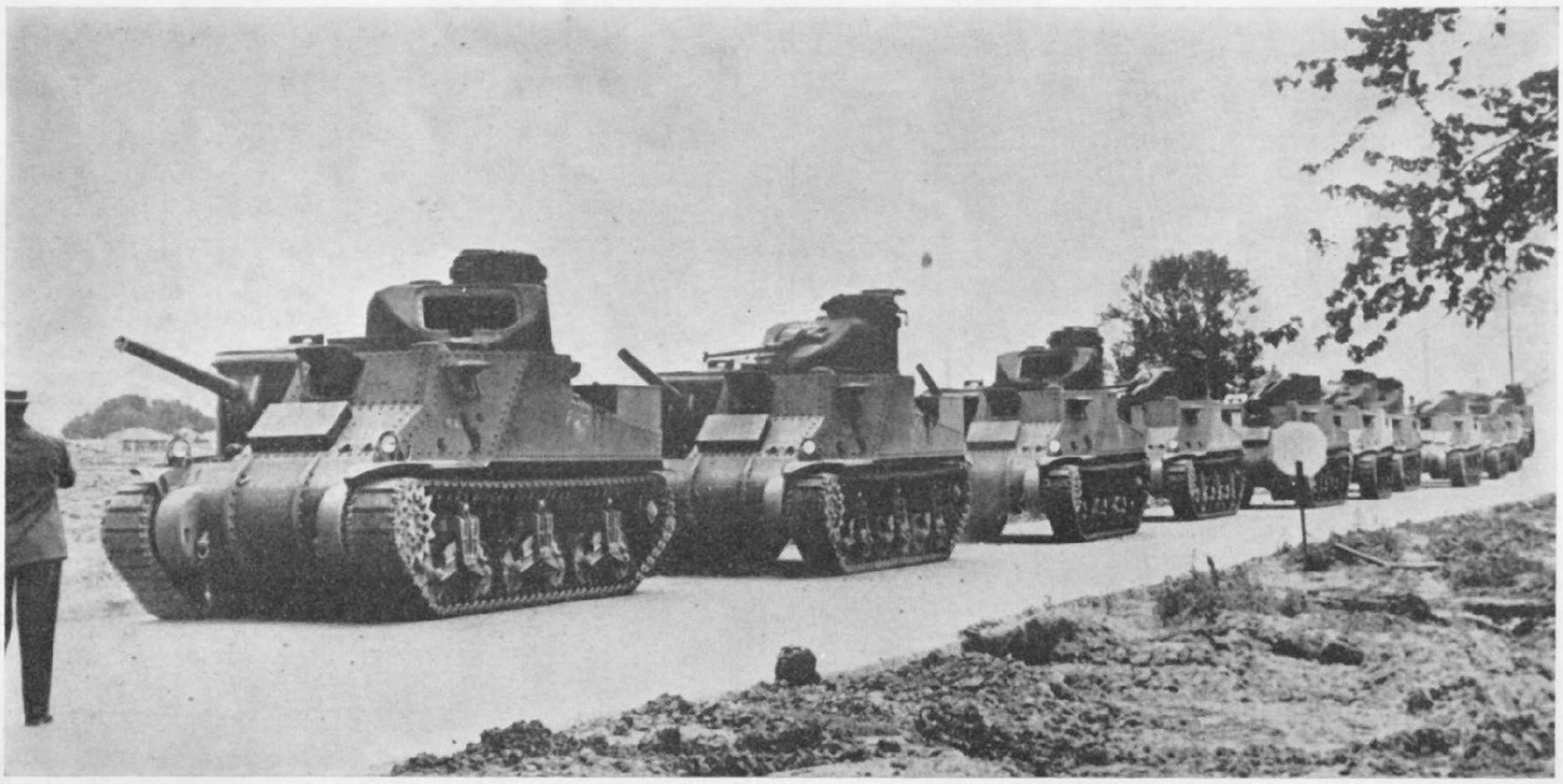


Building M3s at Detroit Arsenal in April 1942. (U.S. Official)

Based on staff studies of the tank fighting in the French campaign just ending, it had been noted that the Germans had been using tanks with 75 mm. guns (on some models of the PzKw IV). The Chief of Infantry urged that any future medium tanks produced should be armed with guns of at least this calibre. In short, tanks like the M2 and M2A1 with their 37 mm. guns had been tactically out-moded almost overnight.

A few days after the thousand M2A1 tanks had been ordered, the new Chief of the Armored Force, Chaffee, met senior Ordnance Department officers at Aberdeen Proving Ground for a conference on future tank requirements. It was agreed here that the provision of a tank with a 75 mm. gun was now of paramount importance. However, studies by the Ordnance Department showed conclusively that a weapon of this large calibre could not be mounted in the turret of the existing M2A1. An entirely new larger turret would be needed which would impose delays since no turret of the size required had ever previously been built in America and much work would be needed on such a

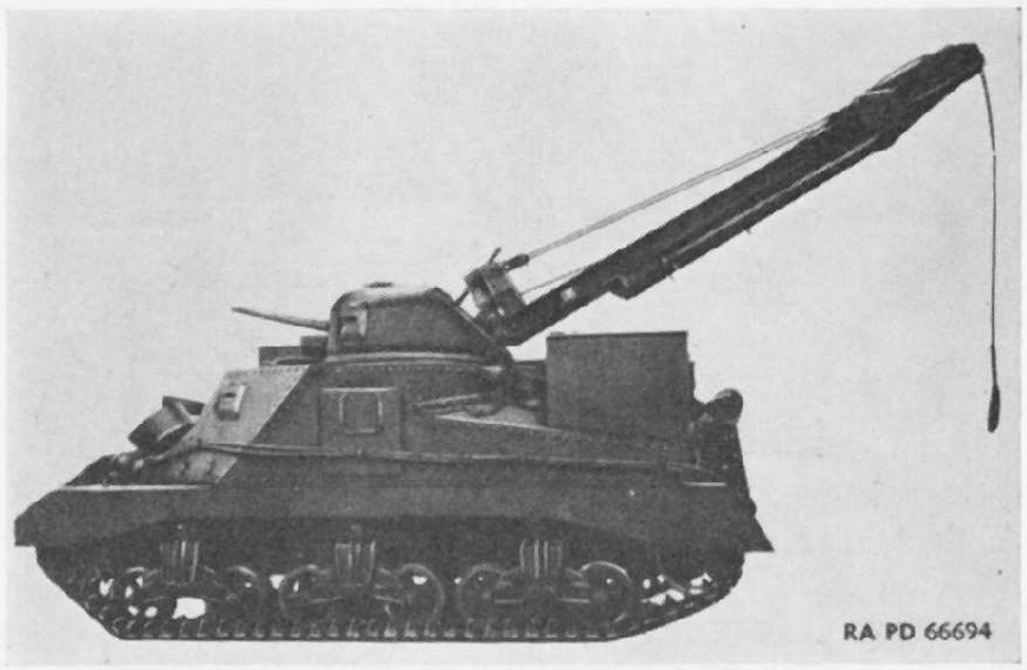
Late production M3A4s on the test track at Detroit Arsenal in the fall of 1942. All have the M3 75 mm. gun, but on most the turret guns are yet to be fitted. (U.S. Official)



project to overcome the necessary design and casting problems.

It was decided that while such work should be put in hand at once, the need for a tank with a 75 mm. gun could be met by mounting the weapon in the hull as had been tried successfully in the experimental T5E2 the previous year. This would enable most of the basic features of the M2A1 to be utilized including the complete chassis virtually unaltered and the same engine and mechanical parts. Only the hull and superstructure would need revision and this was to be based exactly on that of the T5E2 as far as possible. The turret with 37 mm. gun was to be retained, however, and would be offset to the left on the hull top in place of the rangefinder turret in the T5E2. Thus was born the M3 Medium tank, recognized from the start as an interim design while work continued on a medium tank with 75 mm. gun in a fully traversing turret—the design which was later to become the M4 Medium tank, better known as the Sherman.

On August 28, shortly after the Aberdeen decision, the contract for the thousand M2A1s was cancelled in favour of an identical contract for 1,000 M3s. At this time the M3 had still not been designed, but the Ordnance Department gave themselves 60 days to achieve this, during which time it was estimated that 10,000 working drawings would be necessary. Meanwhile, construction of the arsenal was to proceed even though the changed plans meant that some of the plant would have to be further altered or even replaced for the new design.



A M31B2 TRV (tank recovery vehicle) seen with its boom topped up on the winch and the telescopic support legs folded. These were usually rigged on the engine decking. Note the dummy guns and the welded-up side door. This is based on the M3A5 with GM diesel motors. (U.S. Official)

Building of Detroit Arsenal started early in September 1940 on a 100-acre site just outside Detroit. The skeleton of the building, 1,380 ft. long and 500 ft. wide, was completed by January 1941 and most of the construction work had been finished by March. Meanwhile Chrysler engineers were designing plant piece-

Early M3s in U.S. Army service take part in exercises in October 1941. Note that they lack the 75 mm. gun, still in short supply at this period. Troops are still wearing 1918 type steel helmets. (U.S. Official)

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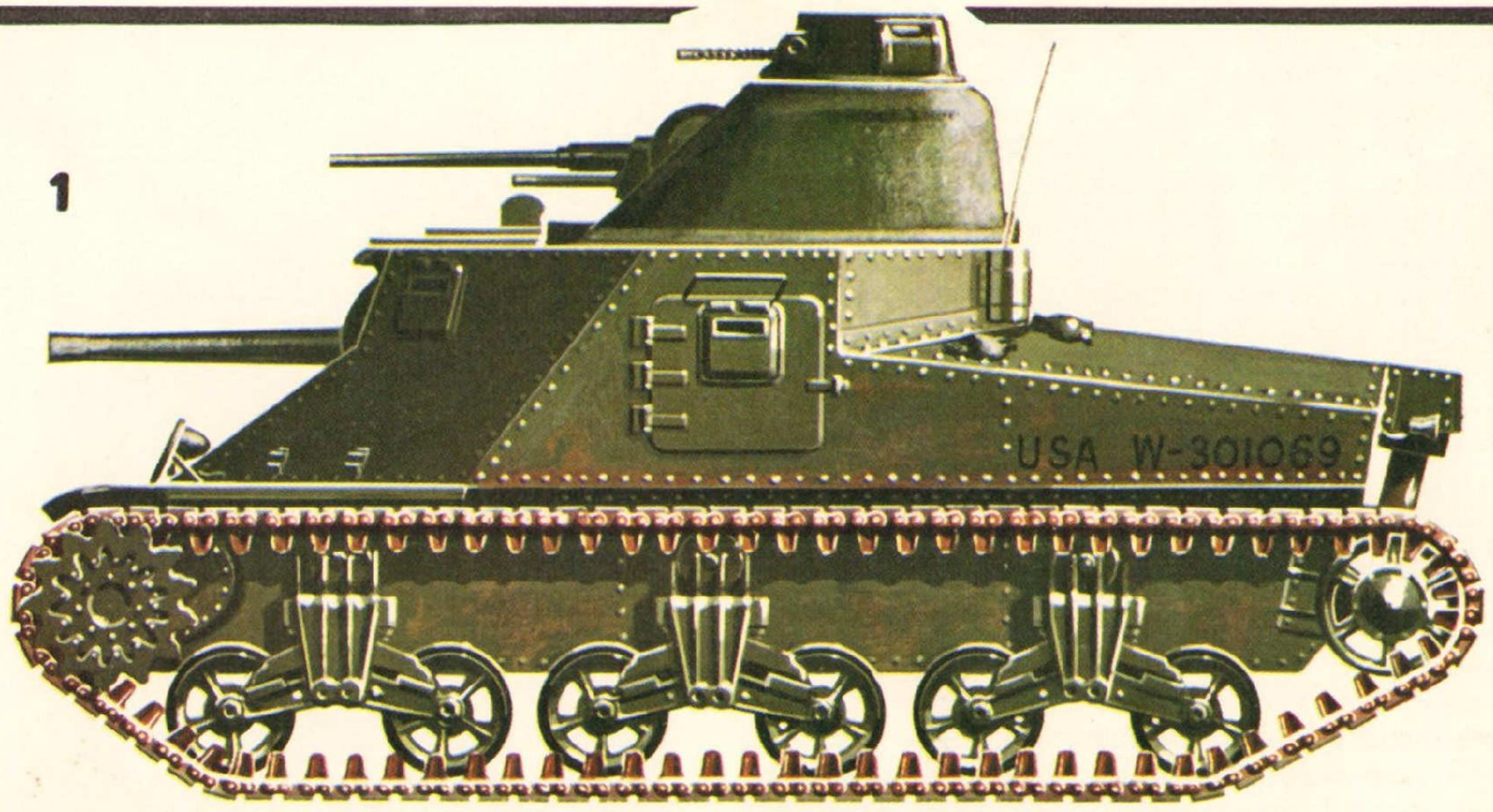

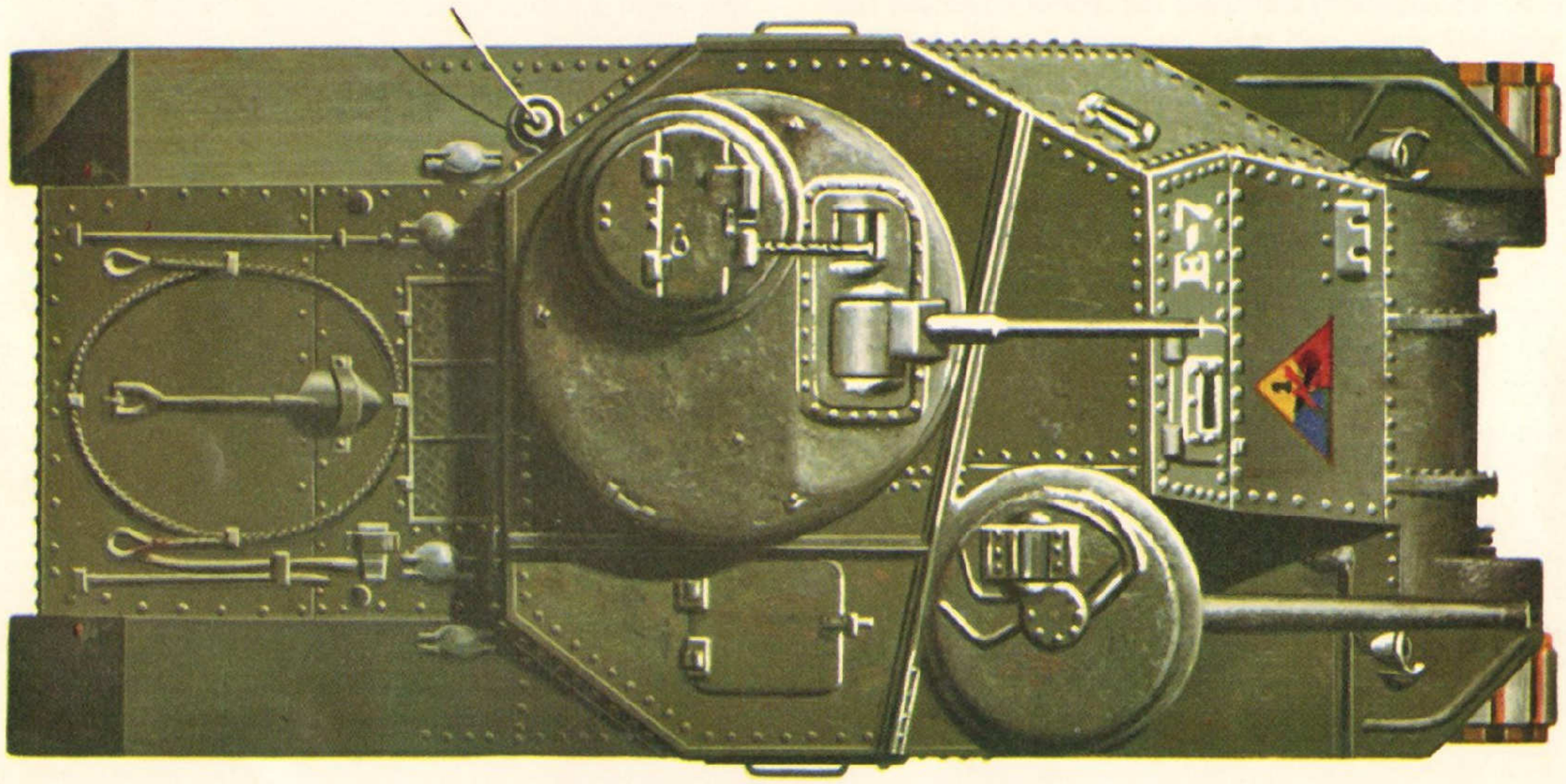

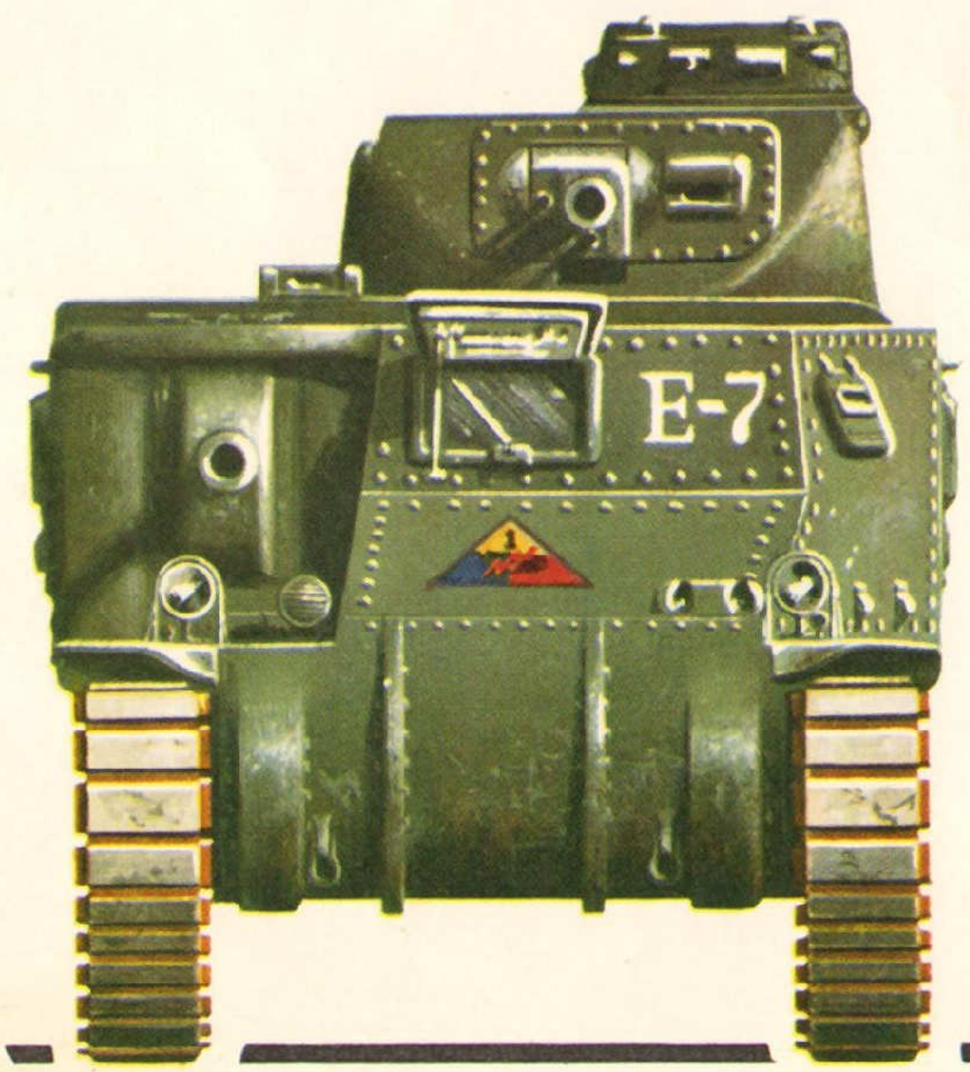

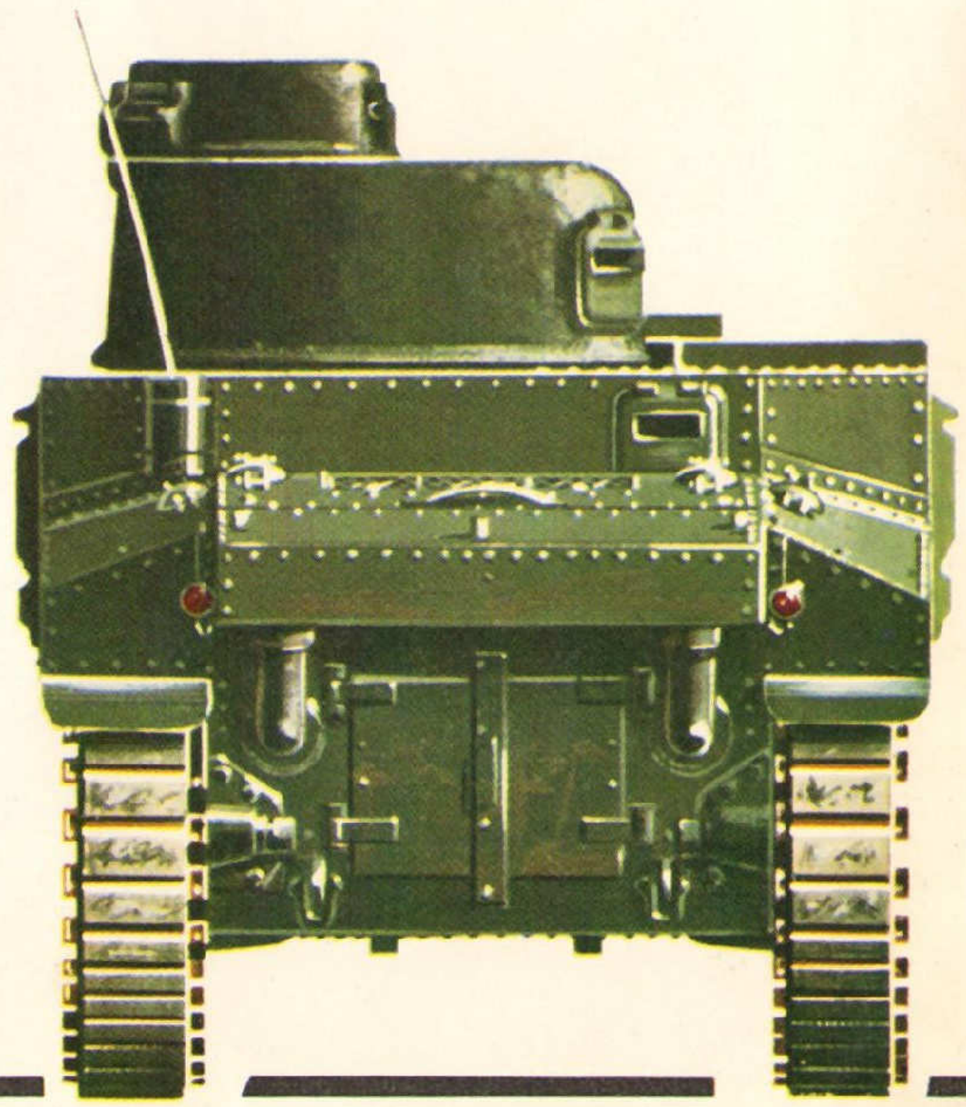

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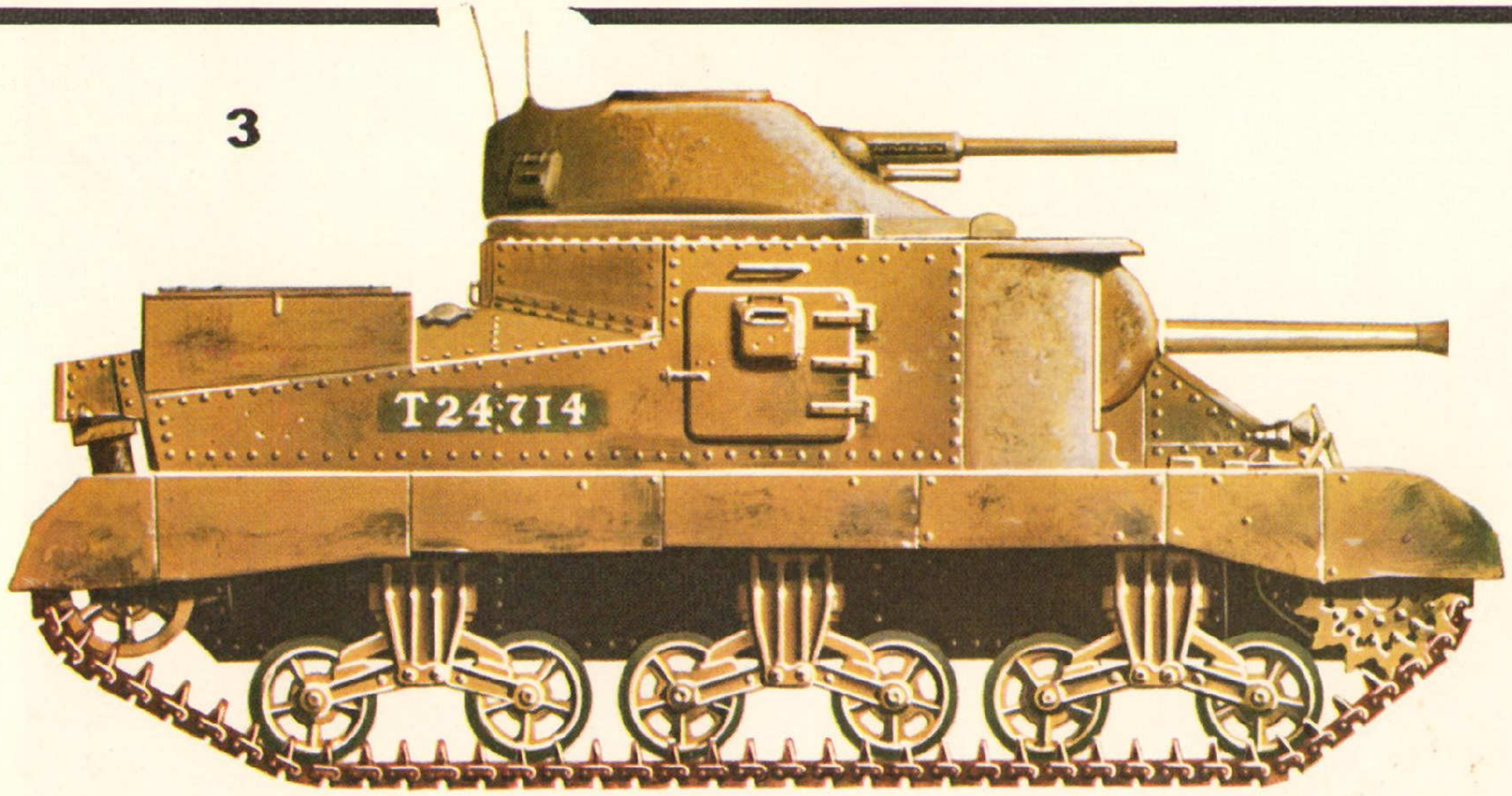

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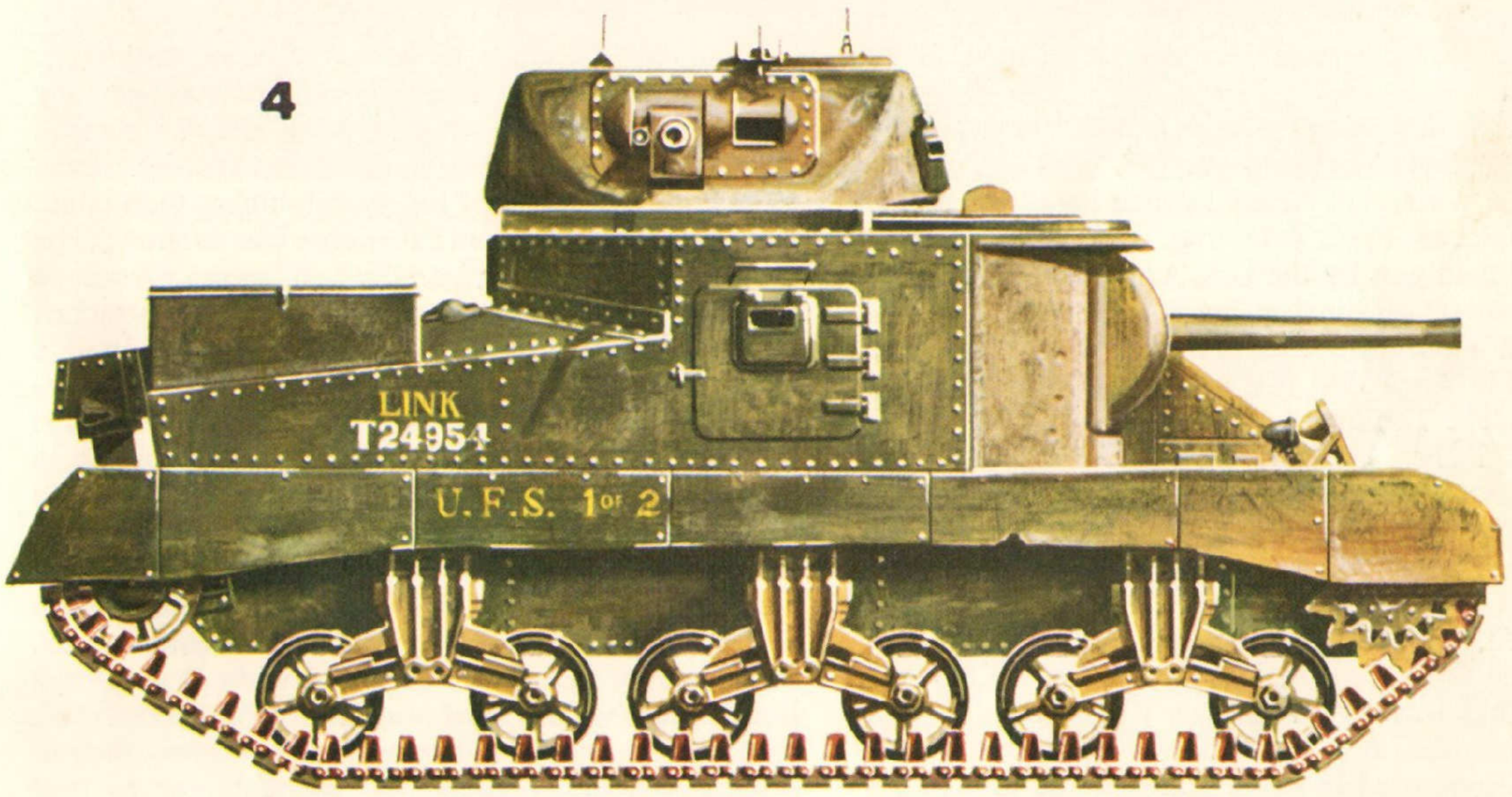

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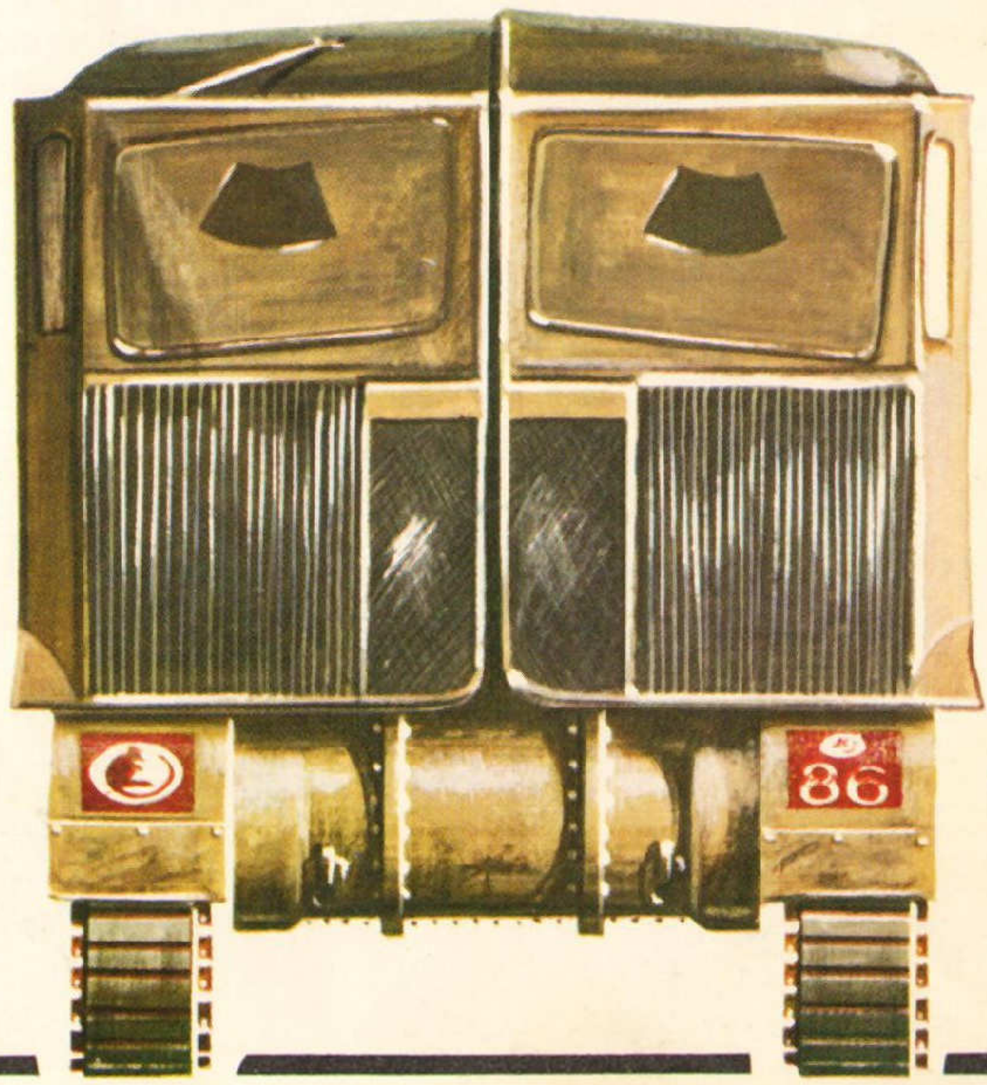


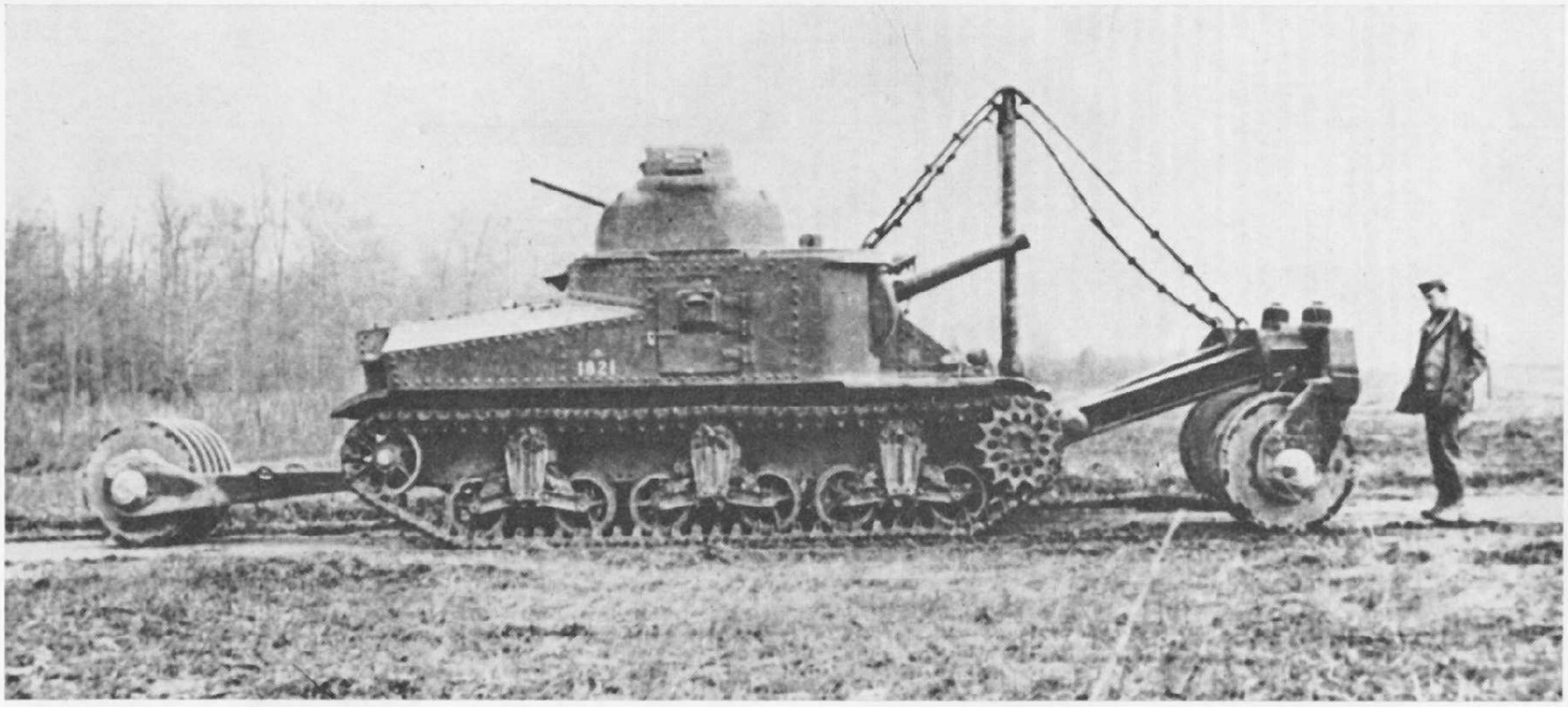
1 Medium Tank M.3
'E' Company tank of a battalion of 1st Armored Division, November, 1941

2 1st Armored Division emblem

3 Grant Mk. 1. (M.3. Medium) of 22nd Armored Brigade, 7th Armored Division, June, 1942

4 Grant Mk. 1. Command tank of 2nd Armored Brigade, 1st Armored Division, at Battle of Alamein, October, 1942

5 Grant, showing front view of sunshield, made to resemble a lorry to confuse enemy observers



M3 Medium tank seen with T1 Mine Exploder equipment, designed for but rarely used with this vehicle. (U.S. Official)

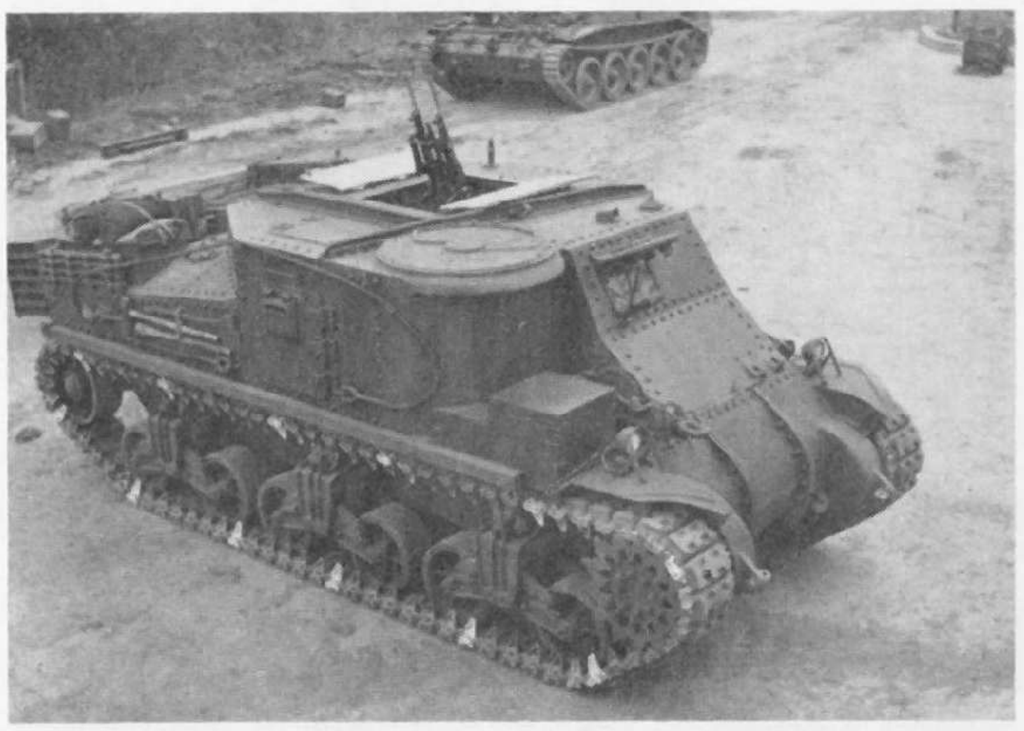
meal as the M3 drawings were completed in stages at Aberdeen.

As well as designing the vehicle itself the necessary 75 mm. gun had to be designed. This work was carried out by the Watervliet Arsenal which based the design on the famous French 75 mm. gun, adopted as a standard field gun by the U.S. Army in 1918. In mid-July an initial "off the drawing board" order for 1,308 guns and mountings was placed and the first were delivered in April 1941 just in time to go into the M3 pilot models. The first version, designated M2 had a barrel 84 inches long and had a muzzle velocity of 1,860 f.p.s. A later improved model, the M3, had a longer 110-inch barrel and increased muzzle velocity of 2,300 f.p.s. Most M3 Mediums were fitted with the shorter M2 gun, but the M3 gun was being produced in time for fitting in later production vehicles.

Planned for fitting in the M3 Medium (and M3 Light) tanks was a gyrostabilizer which was a revolutionary innovation as far as tanks went. Based on a principal long used in naval gunnery, the idea of the gyrostabilizer was to maintain the gun at any given elevation irrespective of the pitching of the vehicle as it moved across country. Previously a tank could only fire with any certainty of accuracy when stationary. With a gyrostabilizer a tank could fire with accuracy while on the move, which gave a definite tactical advantage to the possessor of such a facility. (Even so less use was made of the gyrostabilizer than could have been, as subsequent experience was to show.) The gyrostabilizer was based on the well-known gyroscope principle and in essence it consisted of a gyro attached to the gun cradle on the same axis and set spinning. Any subsequent displacement due to vertical movement of the vehicle caused the gyro, and hence the gun barrel, to return to its original axis. For use in tanks the gyrostabilizer system had to be reduced in size to fit a confined space and be tough enough to survive the severe conditions in which tanks operated. From July 1941 the gyrostabilizer was fitted to both the 75 mm. and 37 mm. guns of the M3 Medium tanks. Some early vehicles were produced without stabilizers but in many cases they were retrospectively fitted. When the longer M3 gun appeared, it was necessary to provide different settings for the stabilizer to take account of the longer, heavier barrel. Subsequently most vehicles with the earlier M2 guns were fitted with counterweights on the muzzles so that they simulated

M31 TRV (based on M3 tank) seen in British service as a Grant ARV II carrying a scout car slung from its boom. M31B1 was similar vehicle based on the welded M3A3. (Imperial War Museum)

Grant ARV I was a British conversion for the recovery rôle with turret removed, fitted winch, and demountable A-frame jib, seen stowed on lower hull side. (Imperial War Museum)



A brand new M3 test fires its guns on the testing-ground which was built adjacent to Detroit Arsenal. (U.S. Official)

the weight of the M3 barrel and could be used with identical stabilizer settings, thus simplifying maintenance.

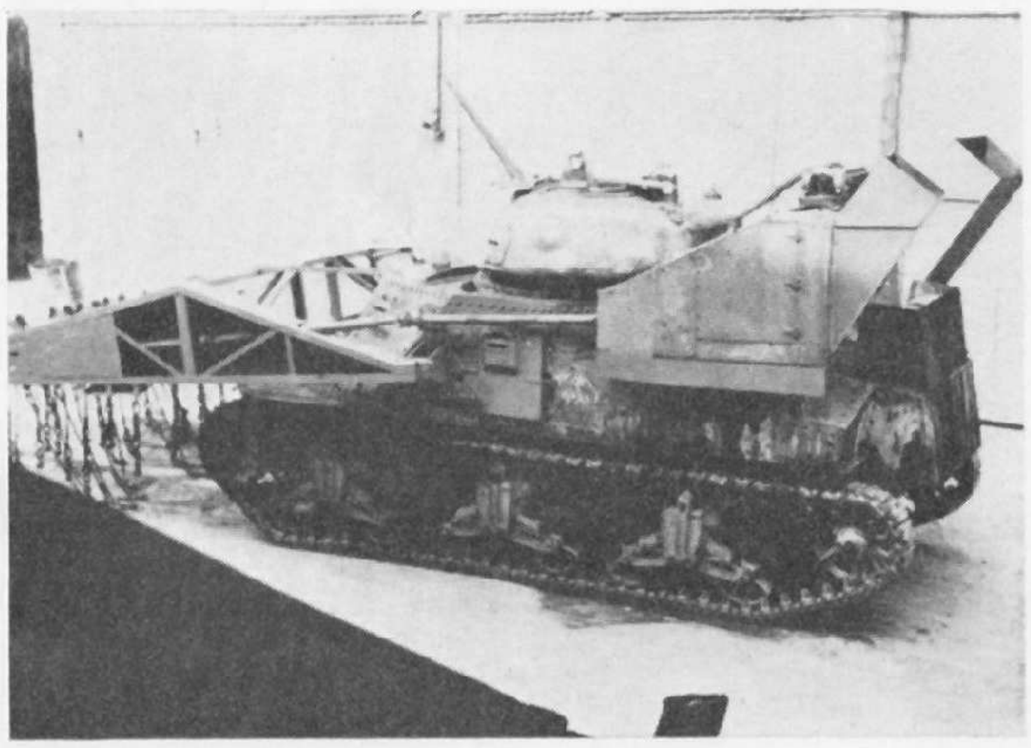
INTO PRODUCTION

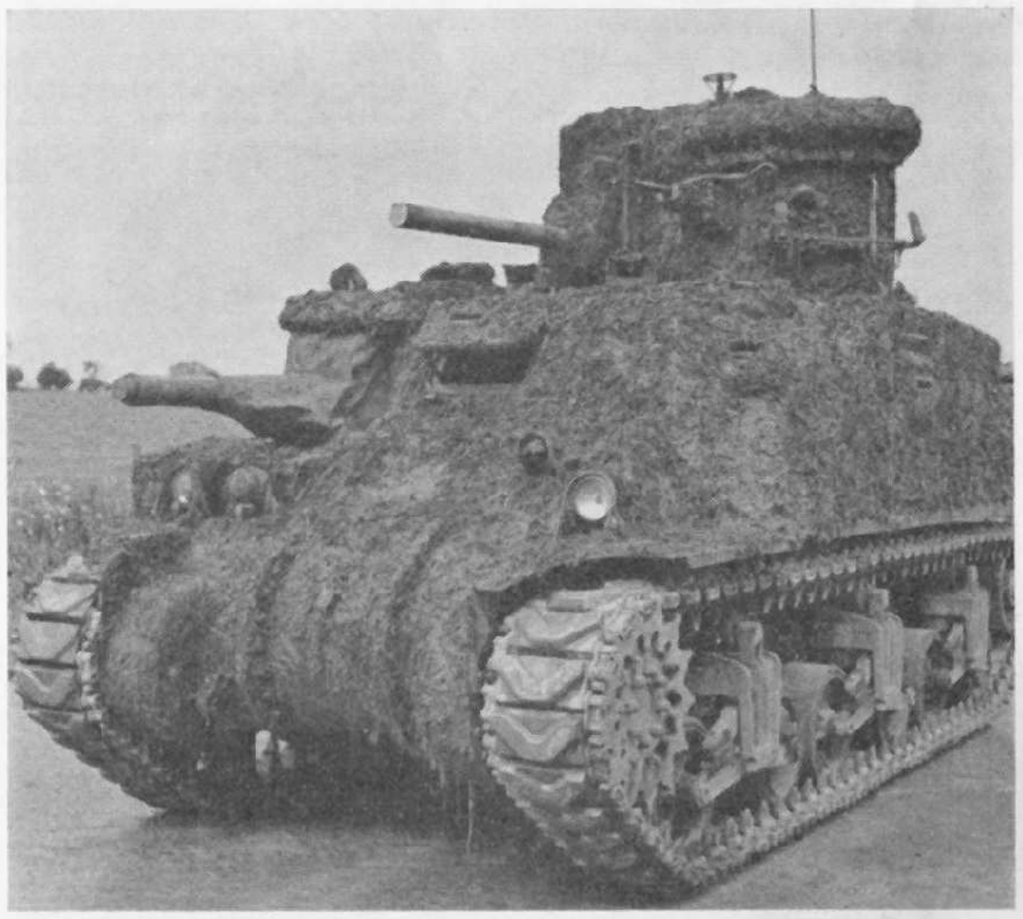
The speed at which the M3 was designed produced immense problems. Difficulties multiplied when plant delivery fell behind or outside contractors for small components could not keep up with the development timetable. For the first couple of months of production most of the M3s turned out from Detroit were almost literally hand-made in part since essential machinery did not arrive, or when it did had to go back for modification. The earliest M3s delivered sometimes lacked either the 75 mm. or the 37 mm. gun, and sometimes both, but they were better than nothing at all for crew training. More literally than most, the M3 Medium was built straight "off the drawing board". Final design work was not completed until March 1941 and the pilot models were produced less than three weeks later in early April 1941.

In addition to production at Detroit Arsenal it was decided in October 1940 to order M3s from two of the big engineering firms as originally planned. Accordingly American Locomotive Co. (685 vehicles) and Baldwin Locomotive Works (534 vehicles) were brought in and sent their engineers to work with the

A well-camouflaged Grant CDL in 1944 during exercises in Britain prior to D-Day. Note the dummy gun on the searchlight turret and the later type of rubber chevron-pattern tracks. (Imperial War Museum)

The Grant Scorpion IV was an improved model with a second Bedford engine at the left rear to assist in driving the flail rotor. The Scorpion III had only one drive engine, on the right-hand side. (Imperial War Museum)





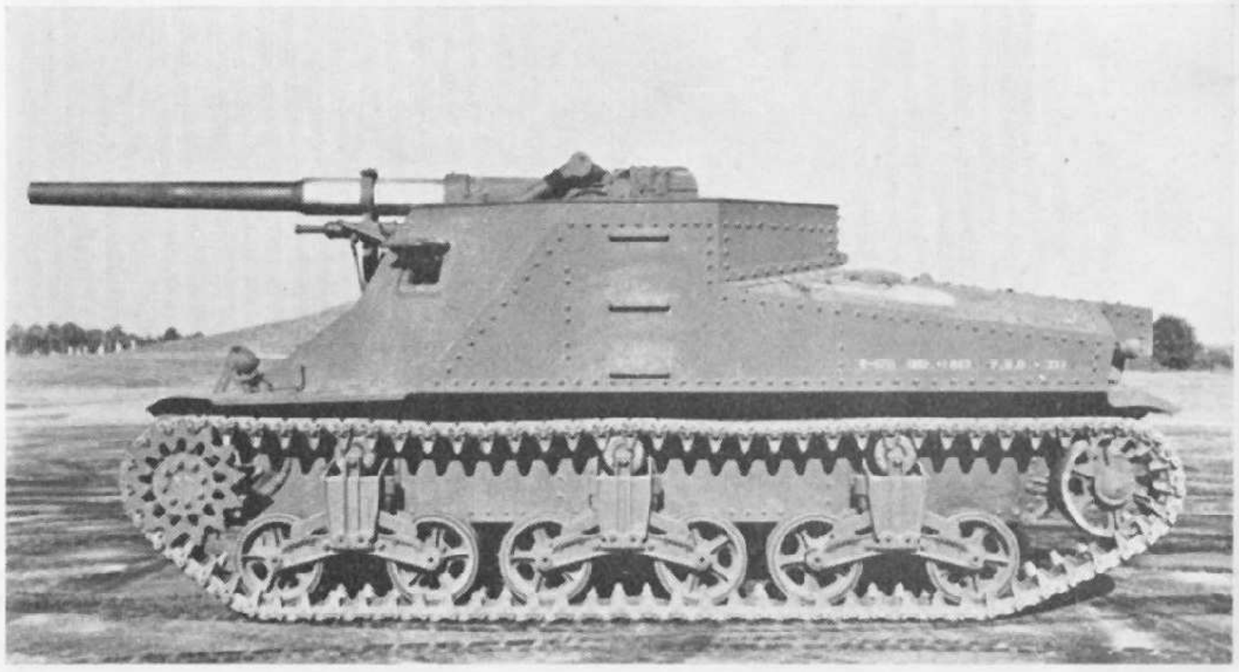
M3 in Canadian service had local modifications including jettisonable fuel tanks and mud chutes beneath the top run of the track.
(Canadian Official)

Chrysler engineers on production planning. In the event American Loco. and Baldwin completed their pilot models a little ahead of Detroit Arsenal—mainly because they were not involved in building a factory at the same time. The severe shortage of components in these early days is reflected in the fact that when American Loco. completed their M3 pilot model in the first week of April 1941 there existed only one complete set of transmissions and final drive, freshly turned out by the contractors for this vital part of the vehicle. This was installed in American Locomotive's pilot model so that it could make a ceremonial drive past at the factory for the Secretary of War and the General Staff. Immediately after this the same transmission was unshipped from the vehicle and rushed to the Baldwin plant so that it could be fitted in their pilot model for a similar ceremony a few days later. Last pilot model completed was Detroit's on April 11, 1941 and this vehicle was ceremonially presented to the Chief of Ordnance on April 24 together with the first actual production vehicle which had been paid for by subscription from Chrysler dealers throughout America.

Meanwhile the M2A1, displaced from the Detroit Arsenal scheme, was nonetheless built in small numbers. Rock Island Arsenal undertook production and turned out 94 (of 106 ordered) between November 1940 and August 1941. The decision was taken to build these as an interim type to have available while the

General Montgomery, 8th Army Commander, observing battle operations from his temporary command tank, a Grant of the Staffordshire Yeomanry, in the late autumn of 1942.
(Imperial War Museum)

The T24 3-inch Gun Motor Carriage was an early attempt to produce a SP version of the M3. It was a prototype only.
(U.S. Official)



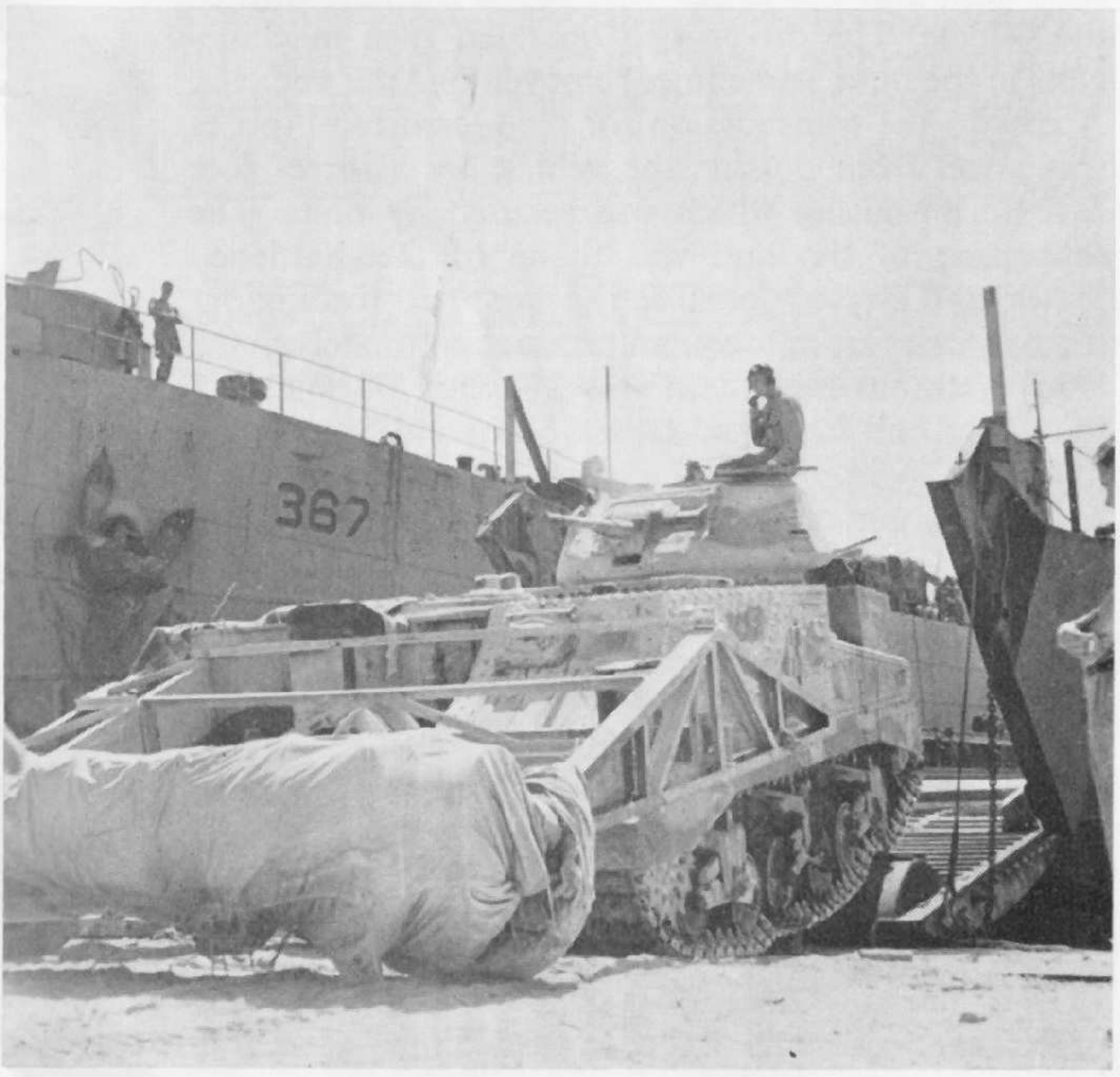
A M31 TRV comes ashore over the Normandy beaches during the follow-up to the D-Day landings. This vehicle belongs to the French 2nd Armoured Division. (Imperial War Museum)

M3 reached production status. These vehicles were used only for training and experimental work in the United States, however, and saw no combat service.

THE BRITISH MISSION

The withdrawal through Dunkirk in May 1940 left the British Army with only about 150 tanks, mostly obsolete, for home defence against an invasion which could be expected hourly. The need for tanks was desperate and a British Tank Mission was sent to America in June 1940 with the specific task of arranging contracts with American firms to build tanks for Britain. With considerable optimism the British Mission's original idea was to have tanks built in America to existing British designs. However, Knudsen of the National Defense Advisory Commission pointed out to the U.S. Government that to allow this dispersion of effort at a time when America was also desperately short of tanks would be a waste of existing resources. The British Mission was told that it had to accept American designs or nothing. At this time there were, of course, only two available designs in the pipeline, the M3 Medium and M3 Light. Britain took both types on a "cash and carry" basis (this was before the days of Lend-Lease). In October 1940 Britain placed contracts with Baldwin, Lima Locomotive Works, and Pullman-Standard Car Co. for M3s modified slightly to suit them for British requirements. The main change requested was a new, lower turret which accommodated British radio equipment in the turret rather than in the hull which was American practice at that time. The prominent machine-gun cupola of the original M3 was eliminated since by British standards the vehicle was considered too high. Design of the turret for British requirements was completed by Ordnance in November 1940 and a test installation was made in one of the M2 tanks. The British version of the M3 was later called the Grant (after General Grant) and deliveries of these vehicles were rushed to North Africa early in 1942 where they were first in action at the big Gazala battle in May 1942. The Grant's appearance at this time had a profound effect on Britain's fortunes in the desert fighting. For the first time the British tank forces

Grant Scorpion III leaves a LCT during training for the Anzio landings. (Imperial War Museum)



The T40 was an improvement over the T24 with a lower mount for the 3-inch gun. It became standardized as the M9 but never saw service. (U.S. Official)

had an accurate high velocity gun of a calibre powerful enough to match the best German guns and at the same time able to give indirect support fire with HE, a facility lacking in all previous tanks in British service.

The Lend-Lease Act was passed in March 1941 and this made further vehicles available to Britain which did not have to be paid for in cash. Accordingly the British also received the standard version of the M3 Medium, which they called the Lee. By October 1942, at the time of the Second Battle of Alamein, there were nearly 600 M3s of both types in British service—though not all of them were in Egypt. With the M4 Shermans which were just arriving, Grants and Lees formed the backbone of the British tank forces for the Alamein battle. Earlier in 1942 a depot had been set up in the desert near Cairo where American personnel trained British crews on their new vehicles. Further M3s were sent to Britain for training purposes.

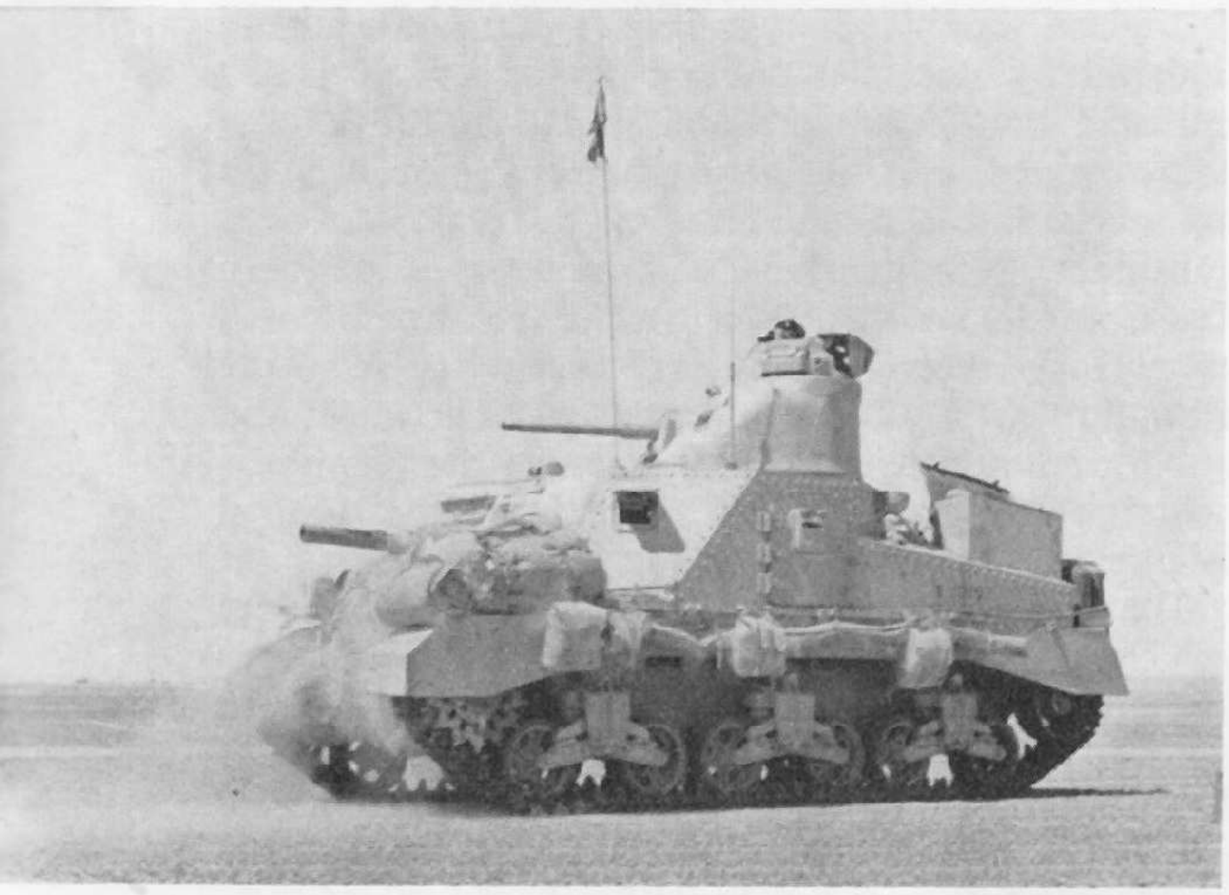
Later when the M4 replaced the M3 in British service in the Western Desert the redundant Grants and Lees were shipped to Australia for use in the campaigns against the Japanese. With a less critical need for up-to-date equipment in the Far East, the M3s were used by the British and Australian regiments fighting in Burma and the S.W. Pacific right until the end of the war, though long replaced elsewhere by Sherman tanks. The Canadian Army was another big user of the M3, both Grants and Lees.

In late 1940 the Canadian Government ordered 1,157 M3s which were to be built by Montreal Locomotive Works, a subsidiary of American Locomotive Co. These Canadian vehicles had small detail changes, the main one being the provision of mud chutes between the bogies primarily to clear snow and slush in the winter training conditions experienced in Canada. Other local Canadian changes included the provision of jettisonable fuel tanks.

THE M3 DESCRIBED

Chassis of the M3 Medium tank was essentially similar to that of the M2 and M2A1 which preceded it. Suspension consisted of three vertical volute bogies of the standard design each side, with a rear idler and sprockets at the front. The Wright Continental R975 9-cylinder air-cooled radial engine was at the rear with access doors for maintenance in the hull backplate. Fuel tanks flanked each side of the engine compartment. The drive shaft led forward under the floor of the fighting compartment to the gearbox which was sited alongside the driver who sat at the left front of the vehicle. The driver also operated twin machine-guns in the nose, sometimes removed on later vehicles. Access to the transmission for maintenance purposes was given from outside the vehicle by a three-piece cast nose housing which was secured by bolts. The remainder of the hull was made of face-hardened plates, and riveted construction was used throughout (except for some subsequent production models noted later). Armour maximum was 2 inches (50 mm.) on the upper hull front and turret. Sides and front lower hull were 1½ in. thick. The turret mounted a 37 mm. M5 or M6 gun with a co-axial ·30 cal. machine-gun. Turret ring was 60 inches in diameter and could be traversed by hand or hydraulically. In the American M3 (i.e. the Lee) the cupola normally rotated with the turret, but it could also be rotated independently by hand if desired. There was a further ·30 cal. machine-gun which could be mounted in the cupola, but this was frequently removed. The British M3 (the Grant) lacked a cupola but had an extended rear bustle which housed the radio equipment.

The roomy fighting compartment housed the 75 mm. gun in a barbette which had a limited traverse of 15° each side and had elevation limits of –9° to



Lee Mk. I in British service in the Western Desert, 1942. (Imperial War Museum)

+20°. This gun was both the M3's strength and also its weakness in tactical terms. While it provided a bigger punch than any previous Allied tank design, to bring the gun into action meant exposing the vehicle's high silhouette which in the Western Desert fighting could have severe, and even decisive, consequences. With lack of all-round traverse the vehicle suffered from the same limitations as a self-propelled gun so that outflanking by the enemy could only be countered by moving the complete vehicle, which was not always desirable or possible. Thus no time was lost in replacing the M3 once its successor the M4 was available, but in the existing conditions of 1942 the M3 Medium, for all its defects of design, was a most important addition to the British armoury.

PRODUCTION MODELS

Several changes were made in the design of the M3 series during its production life. Some resulted from combat or user experience while others were production expedients. A particular problem with all American tank production in the 1939-45 period was the constant shortage of suitable engines. In the earlier part of the war the policy of using adapted aero engines in tanks presented as many problems as it solved. The fact that suitable engines were available saved production time and cost, but the National Munitions Program of 1940 also called for a vast increase in aircraft production which drastically reduced aero-type engines available for fitting in tanks. The quest for suitable alternative power plants partly led to some of the model changes which followed. The production series for M3 Medium tanks is summarized in chronological order:

M3: Original production type as designed with Wright R975 (Whirlwind) engine and all-riveted construction. Built by American Loco (April 1941–August 1942, 385 vehicles), Baldwin (April 1941–March 1942, 295 vehicles), Detroit Tank Arsenal (April 1941–August 1942, 3,243 vehicles), Pressed Steel (July 1941–July 1942, 501 vehicles), Pullman (August 1941–July 1942, 500 vehicles).

M3 (Diesel): This was a variation on the standard M3 but with a Guiberson diesel motor replacing the Wright gasoline unit to overcome engine shortages.
British designation for the M3 was Lee Mk. I.

M3A1: Identical mechanically to the M3, this version differed in having a cast hull. Built by American Loco (February–August 1942, 300 vehicles), this firm having casting facilities for this type of hull.

M3A1 (Diesel): As for M3A1 but with Guiberson diesel motor. British designation for the M3A1 was Lee Mk. II.

M3A2: This was similar to the M3 but had a welded instead of a riveted hull. Built by Baldwin (January–February 1942). Only 12 of these were built because the adoption of a new engine led to a designation change.

M3A3: This was simply the all-welded M3A2 fitted with twin General Motors 6–71 diesel motors. Built by Baldwin (March–December 1942, 322 vehicles).
British designation for the M3A2 was Lee Mk. III and for the M3A3 was Lee Mk. IV. Lee Mk. V was the designation given to a M3A3 re-engined with the Wright R975 unit.

M3A4: This was similar to the original M3 but had the Chrysler A-57 Multibank engine replacing the Wright engine. The Chrysler A-57 was a makeshift power unit made up of five automobile engines on a common crankshaft, specially developed for tanks at Detroit Arsenal. The M3A4 was built at Detroit only (June–August 1942, 109 vehicles). The chassis on this model was lengthened slightly to take the bulkier engine.
British designation for M3A4 was Lee Mk. VI.

M3A5: This was the same as the *M3A3* but had a riveted instead of welded hull. It was built by Baldwin (January–November 1942, 591 vehicles).
British designation for this model was Grant Mk. II. The original Grant—the basic M3 with the British type turret—then took the designation Grant Mk. I.

Grants and a Crusader in the desert at the time of the Battle of Alamein. Note the sandshields which were fitted to the Grants supplied to the British in North Africa. This view shows the AA machine-gun fitted, not commonly used. (Imperial War Museum)

PRODUCTION CHANGES

An early addition to production vehicles was a stowage box on each side of the rear decking. When later gyrostabilizers were fitted (as previously mentioned) counterweights were fitted to the muzzles of the earlier M2 guns. Later vehicles, however, were

When replaced in the Western Desert by the Sherman, most Grants were sent to Australia where this vehicle is seen on exercises in late 1943. (Imperial War Museum)

A Grant in the desert at the time of Alamein, while engaging distant targets. Note the upended fabricated funnel on the rear decking used for re-fuelling. (Imperial War Museum)

built with M3 guns. The sponson side doors weakened the hull sides and it became common practice to weld up these openings in overhauled, or even new, vehicles. In very late production models the doors were eliminated completely. The very last M3 series production vehicles turned out (November–December 1942) had the later pattern volute bogies, as used on the M4 Sherman, which had trailing return rollers. Sometimes vehicles were repaired with the later bogies also.

SPECIAL PURPOSE TYPES

Like all obsolescent vehicles, the M3 Medium chassis was pressed into service for several important auxiliary rôles. Old vehicles with the guns and turret removed were re-designated as M33 Prime Movers for artillery use pending the development of high-speed tractors. M33s were widely used in the N.W. Europe campaign towing 155 mm. and 240 mm. guns. A couple of flame-throwing devices were developed for the M3 and there were also numerous experimental conversions, the most important of which are illustrated.

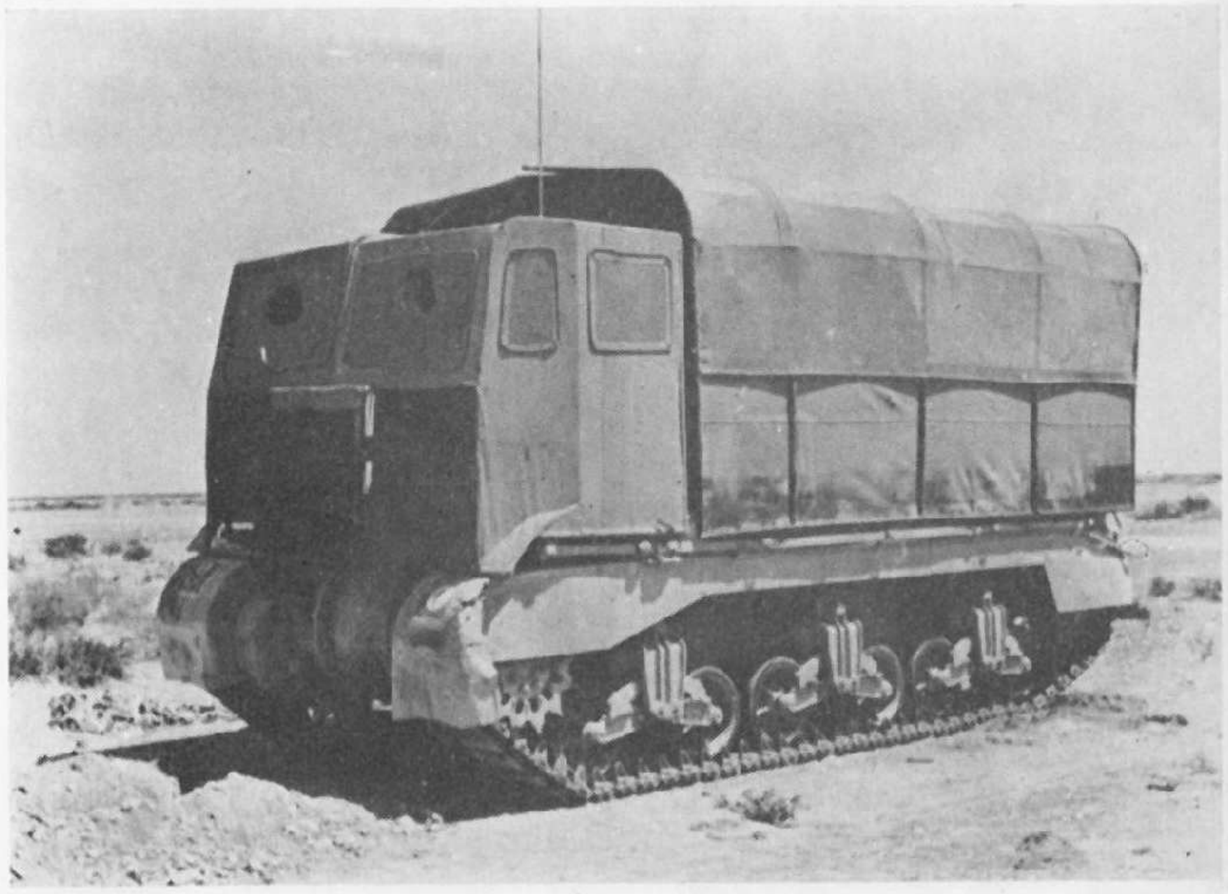
Of major service importance were the tank recovery vehicles (TRV). The U.S. Army developed the T2 TRV (later standardized as the M31) which appeared in several forms depending on the basic chassis. This handy and widely used type had its guns removed and replaced by dummies. A boom was attached and operated by a 60,000 lb. winch housed in the fighting compartment. The turret basket was removed and a big access door took the place of the original 75 mm. gun mantlet (though it was disguised as a mantlet). Telescopic legs were attached to the boom and could either support it from the rear decking or from the ground for lifting and winching work. The turret and boom were normally traversed aft and the boom was held by a special plate which replaced the original 37 mm. gun mantlet.

The British produced an ARV (armoured recovery vehicle) of their own, by removing the turret and guns and fitting a winch internally. This vehicle, the Grant ARV I, was equipped to the same standards as other British Mk. I ARVs complete with demountable A-frame jib. In 1944 the Australians produced their own version of an ARV by converting some of their Lees with added earth spades, gantry, and internal winch operating through the turret flap.

An important British conversion was the Grant CDL in which an armoured searchlight turret replaced the original turret. This vehicle, replacing the Matilda CDL, equipped a whole brigade. But Grant CDLs were never used, except in small numbers for the Rhine and Elbe crossings in 1945. The U.S. Army was impressed by the CDL and built more than 300 of these themselves by converting redundant vehicles to equip six battalions. Known under the "camouflage" designation of T10 Shop Tractors, they were never used.

The British converted Grants as Scorpions for mine clearing with flail rotors. These saw limited use in Tunisia and the invasion of Sicily and Italy but they mainly played an important part in the development of the more famous Sherman Crab which was widely used in the D-Day landings in 1944. One of the first American mine-clearing devices was developed for the M3. This was the T1 Mine Exploder, a system of trailed and pushed heavy rollers. However, the idea was transferred to the M4 Medium when this vehicle was standardized.

A Grant in the typical desert "lorry" camouflage made of hessian stretched over a removable framework.
(Imperial War Museum)



Two major self-propelled guns (the M7 and M12) were developed on the M3 chassis but their story is more properly told separately since they had a history of their own and long outlived the original M3. Earlier attempts to make a self-propelled gun version of the M3, however, resulted in the T24 3-inch Gun Motor Carriage which utilized a redundant AA gun of 1918 vintage on what was virtually an open-topped M3. Developed in September 1941, tests found it to be far too high and clumsy and the project was dropped in favour of the T40, a modified design with the same 3-inch gun in a more compact mount set lower in the hull. Trials were promising and the vehicle was standardized as the M9 Gun Motor Carriage on the understanding that at least 50 old 3-inch guns were available for fitting. However, only 28 guns could subsequently be found and the M9 was never produced, an unusual example of standardization without production following.

M3 SERIES—COMMON CHARACTERISTICS

Armament

One 75 mm. gun M2 or M3	In Mount M1
One 37 mm. gun M5 or M6 and One Cal. ·30 Browning machine-gun M1919A4 (flexible)	In Combination Mount M24 in turret
One Cal. ·30 Browning machine-gun M1919A4 (flexible).	On cupola anti-aircraft
One or two Cal. ·30 Browning machine-gun M1919A4	In bow
Provision for: One Cal. ·45 sub-machine-gun.	Equipment of crew.

Ammunition, Stowage

75 mm.	46 rounds
37 mm.	178 rounds
Cal. ·45	1,200 rounds
Cal. ·30	9,200 rounds
Hand Grenades	12

Armour

	Actual	Basis
Hull, Front, Upper	2 in.	$4\frac{3}{8}$ in.
Lower	$1\frac{1}{2}$ in.	$2\frac{3}{4}$ in.
Sides	$1\frac{1}{2}$ in.	$1\frac{1}{2}$ in.
Rear	$1\frac{1}{2}$ in.	$1\frac{5}{8}$ in.
Top	$\frac{1}{2}$ in.	
Bottom	$\frac{1}{2}$ in.–1 in.	
Turret, Front	$2\frac{1}{4}$ in.	$6\frac{1}{2}$ in.
Sides and rear	$2\frac{1}{4}$ in.	2 in.
Top	$\frac{7}{8}$ in.	

Vision and Fire Control

Periscope M1	1
Periscope M3	1
Protectoscopes	7

Communications

Radio (with interphone)	SCR-508
Command tank	SCR-506

Battery, Voltage, total	24

Fire Protection

Fire Extinguisher, CO_2-10 lb. (fixed)	2
CO_2-4 lb. (hand)	2

Transmission, Type	Syncromesh
Gear ratios	
First speed	7·56:1
Second speed	3·11:1
Third speed	1·78:1
Fourth speed	1·11:1
Fifth speed	0·73:1
Reverse	5·65:1
Differential, Controlled, Gear ratio	3·53:1
Steering ratio	1·515:1
Final Drive, Type	Herringbone
Gear ratio	2·84:1
Sprocket, No. of teeth	13
Pitch diameter	25·038
Suspension, Type	Volute spring
Wheel or tyre size	20 ×9
Idler, Type	Adjustable eccentric
Wheel or tyre size	22 ×9
Track, Type	Rubber block
Width	$16\frac{9}{16}$ in.
Pitch	6 in.
No. of shoes per track	158 (166 on M3A4)

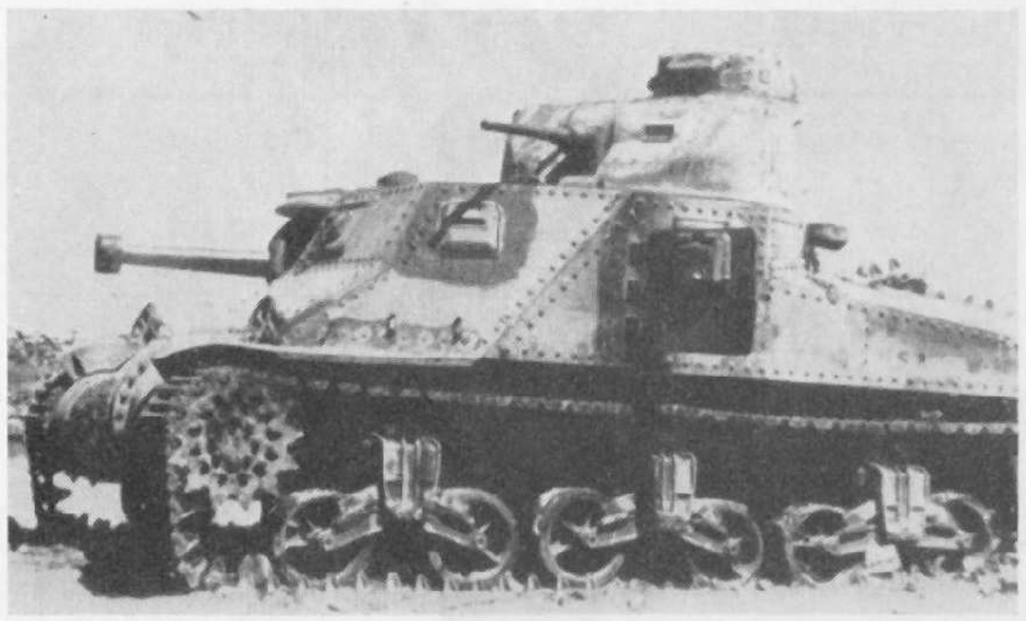
An attempt to produce an AA tank resulted in the T36 Gun Motor Carriage which had a single Bofors 40 mm. gun and its sight gear in a streamlined armoured turret set on an M3 with lowered and modified superstructure. Designed in October 1941 and tested soon after, it was a neat design but was considered too complicated for its relatively light fire-power. Hence the project was abandoned and only the prototype was built.

THE M3's SWANSONG

M4 Medium tank production started in July 1942 and by the end of that year was in full swing. As rapidly as possible the plants building M3s switched over to M4s and the last M3s left the production lines in December 1942. The eclipse of the M3 in U.S. service was rapid. M3s first entered U.S. Army service in late summer 1941. When the M4 was standardized in October 1941, the M3 was reclassified "substitute standard" and was further reclassified "limited standard" in April 1943. In April 1944 the M3 was declared obsolete by the U.S. Army and by this time was almost out of service, even for training. Special purpose variants, particularly the M31 TRV remained in use until after the end of the war. However, M3s saw little actual combat service with the U.S. Army though some were used in the Torch landings, November 1942, and they were widely used by U.S. armoured divisions in Britain though they had been replaced by Shermans for the Normandy landings.

Except for special purpose variants, most British Grant and Lee models were also swiftly withdrawn as soon as the Sherman was available in quantity from the end of 1942 onwards. M3s remained in use for training in Britain, however. Most of the 8th Army's Grants and Lees were sent east in early 1943, going to the Australian army for service in the S.W. Pacific area as a partial replacement for the Matilda. One British regiment, the 3rd Carabineers, was equipped with Grants and Lees (mostly the latter) in Burma 1944–45 where they spearheaded the advance south and were in service until the end of the war.

Under Lend-Lease some M3s were supplied to Russia where this vehicle is shown knocked out. (Imperial War Museum)



Lees and Shermans in British service in a desert leaguer at the time of the Second Battle of Alamein, October 1942.
(Imperial War Museum)

The Japanese gave very little armour opposition, however, and the M3 was more than adequate for the job it was asked to do, mainly to support the infantry. Ironically enough this was the very function for which the Americans had mainly developed medium tanks in the inter-war years. The jungle slogging match against the Japanese was the closest the M3 got to "facilitating the advance of the rifleman in the attack." But by 1945 such ideas, like the M3 tanks themselves, were absurdly out of date. Vindicating the generals' ideas of 1922, however, was a neat way for the M3 Medium tank to end its illustrious fighting career.

AFV Series Editor: DUNCAN CROW

SPECIFICATION—MEDIUM SERIES (LEE) PRODUCTION MODELS

	M3 (riveted)*	M3A1 (cast)	M3A2 (welded)	M3A3 (welded)	M3A4 (riveted)	M3A5 (riveted)
Crew	6	6	6	6	6	6
Physical Characteristics						
Weight (gross)	60,000 lb.	60,000 lb.	60,000 lb.	63,000 lb.	64,000 lb.	64,000 lb.
Length	18 ft. 6 in.	18 ft. 6 in.	18 ft. 6 in.	18 ft. 6 in.	19 ft. 8 in.	18 ft. 6 in.
Width	8 ft. 11 in.	8 ft. 11 in.	8 ft. 11 in.	8 ft. 11 in.	8 ft. 11 in.	8 ft. 11 in.
Height	10 ft. 3 in.	10 ft. 3 in.	10 ft. 3 in.	10 ft. 3 in.	10 ft. 3 in.	10 ft. 3 in.
Turret ring diameter (inside)	57 in.	57 in.	57 in.	57 in.	57 in.	57 in.
Ground clearance	17⅛ in.	17⅛ in	17⅛ in.	17⅛ in.	17⅛ in.	17⅛ in.
Tread (centre to centre of track)	83 in.	83 in.	83 in.	83 in.	83 in.	83 in.
Ground contact	147 in.	147 in.	147 in.	147 in.	160 in.	147 in.
Ground pressure per sq. in.	13·36 lb.	13·36 lb.	13·36 lb.	13·36 lb.	12·9 lb.	13·36 lb.
Performance						
Maximum speed	26 m.p.h.	26 m.p.h.	26 m.p.h.	29 m.p.h.	26 m.p.h.	29 m.p.h.
Maximum grade ability	60%	60%	60%	60%	60%	60%
Trench crossing ability	6·2 ft.	6·2 ft.	6·2 ft.	6·2 ft.	6·2 ft.	6·2 ft.
Vertical obstacle ability	24 in.	24 in.	24 in.	24 in.	24 in.	24 in.
Fording depth (slowest forward speed)	40 in.	40 in.	40 in.	36 in.	40 in.	40 in.
Fuel capacity	175 gal.	175 gal.	175 gal.	150 gal.	160 gal.	175 gal.
Cruising range	120 miles	120 miles	120 miles	160 miles	120 miles	160 miles
Turning radius	37 ft.	37 ft.	37 ft.	37 ft.	39 ft.	37 ft.
Engine, Make	Continental	Continental	Continental	G.M. 6-71	Chrysler	G.M. 6-71
Model	R-975-EC2 or C1	R-975-EC2 or C1	R-975-EC2 or C1	6046	A-57	6046
Type	Radial A.C.	Radial A.C.	Radial A.C.	Twin, In-Line, L.C.	Multibank, L.C.	Twin, In-Line, L.C.
No. of cylinders	9	9	9	12 (6 × 2)	30 (6 × 5)	12 (6 × 2)
Fuel, octane or cetane type	92 or 80 Gasoline	92 or 80 Gasoline	92 or 80 Gasoline	50 Diesel	80 Gasoline	50 Diesel
Max. governed speed	2,400 r.p.m.	2,400 r.p.m.	2,400 r.p.m.	2,100 r.p.m.	2,400 r.p.m.	2,100 r.p.m.
Net h.p. at r.p.m.	340 at 2,400	340 at 2,400	340 at 2,400	375 at 2,100	370 at 2,400	375 at 2,100
Max. torque, lb.-ft. at r.p.m.	800 at 1,800	800 at 1,800	800 at 1,800	1,000 at 1,400	1,020 at 1,200	1,000 at 1,400

* Grant I for British service was as for M3 but with different turret and British radio.

AFV

The new **Profile Publications** AFV Series of books on the Armoured Fighting Vehicles of the World, continues the pattern established by the twenty-four issues of Armour in Profile. But there is a big difference—in presentation, format and size.

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8	Crusader—Cruiser Tank Mark VI
9	Early British Armoured Cars
10	PanzerKampfwagen V Panther
11	M3 Grant
12	Mediums Marks I–III
13	Ram
14	Bren/Universal Carriers
15	PanzerKampfwagen I and II
16	Churchill and Sherman Specials
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18	PanzerKampfwagen 38(t)
19	Armoured Cars—Guy, Daimler, Humber
20	Sherman '75'
21	French Mediums
22	T–54/T–62
23	LVT I–IV
24	German 8-wheeled Armoured Cars
25	M48/M60
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