



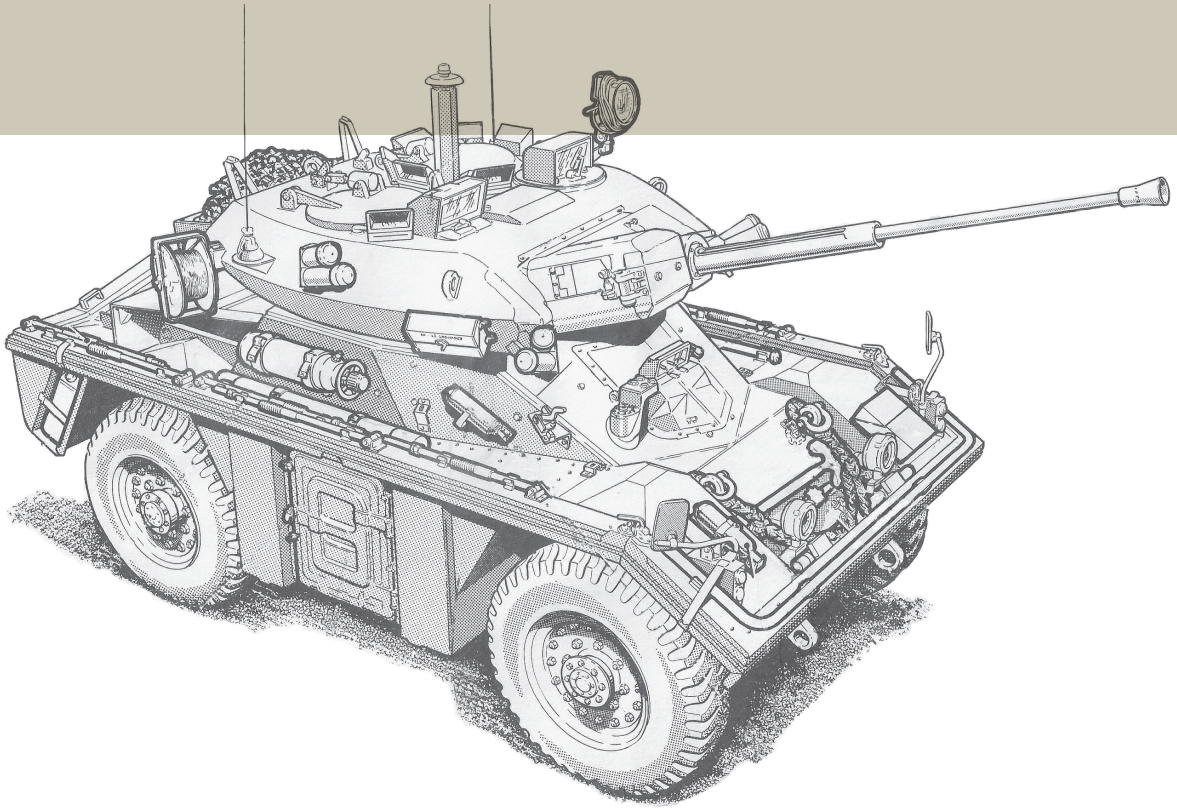
COLD WAR BRITISH ARMoured
VEHICLE DEVELOPMENT

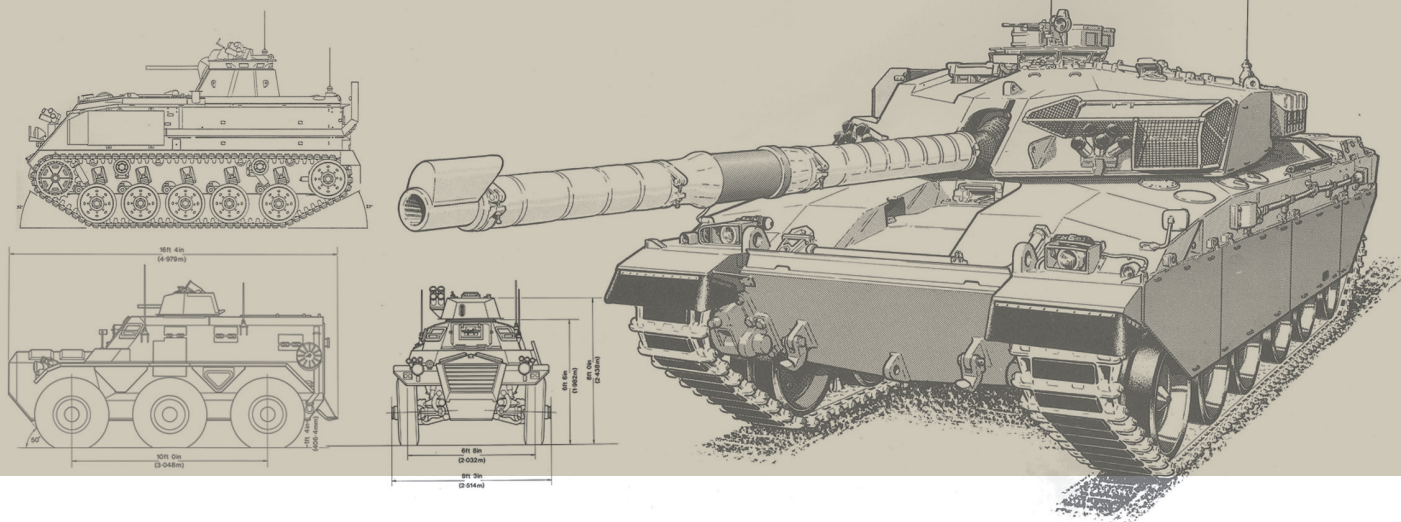
CHOBHAM ARMOUR

WILLIAM SUTTIE



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Cold War British Armoured
Vehicle Development

William Suttie

OSPREY PUBLISHING

Bloomsbury Publishing Plc

Kemp House, Chawley Park, Cumnor Hill, Oxford, OX2 9PH, UK

29 Earlsfort Terrace, Dublin 2, Ireland

1385 Broadway, 5th Floor, New York, NY 10018, USA

E-mail: info@ospreypublishing.com

www.ospreypublishing.com

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First published in Great Britain in 2022

This electronic edition published in 2022 by Bloomsbury Publishing Plc

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A catalogue record for this book is available from the British Library.

ISBN: HB 9781472855268;

eBook 9781472855275;

ePDF 9781472855282;

XML 9781472855251

Index by Zoe Ross

Cover Design and Layout by Stewart Larking

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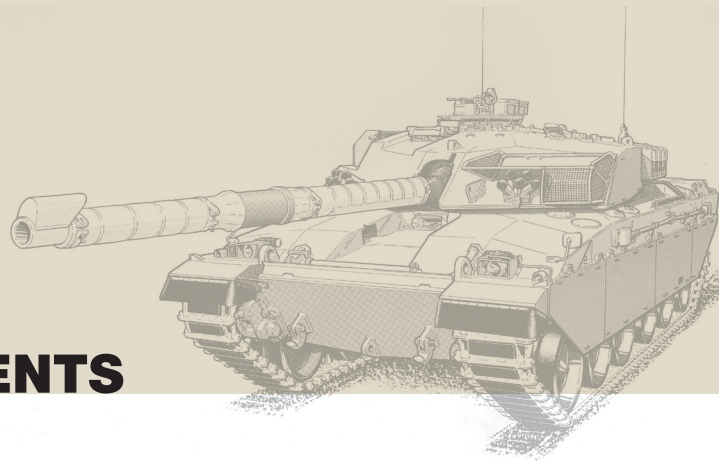
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ACKNOWLEDGEMENTS

I had the privilege of working at the Armoured Vehicle Research and Development Establishment on Chobham Common for over 20 years, up until most vehicle-related activities there stopped in 2003. The significance of the establishment encouraged me to write a history of the site, which I called *The Tank Factory* – the name used by locals when referring to it. When carrying out research into the history of the site I came across many reports, photographs and information about the concepts and vehicles developed there. Therefore, as someone with a lifelong interest in armoured fighting vehicles, I decided to write a detailed book focused on the design and development of vehicles at Chertsey through the period that was mainly characterized by the Cold War. I have endeavoured to cover both the resulting battle-winning vehicles developed there and also the wide range of interesting proposals and concepts that never made it as far as prototypes, let alone production.

Recognizing that there are many excellent books available on the military vehicles used by the British Army, I have tried to avoid just repeating information that is already published, but instead I focus on using unpublished information, especially that from official sources in order to ensure that the information presented is as accurate as possible. I have also tried to use pictures which have not been published before.

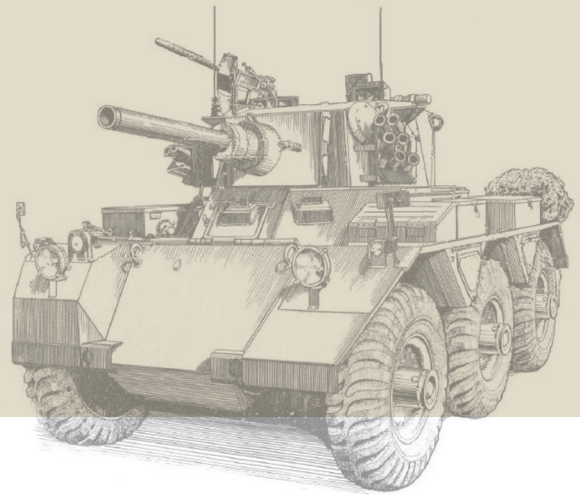
I would like to thank the UK Ministry of Defence and the Defence Science and Technology Laboratory (Dstl) for giving approval for this book, the staff at the Bovington Tank Museum for their support, and ex-Chertsey staff for their help and encouragement. Special thanks go to Steve Smith at Dstl for his review of the book and also to Angela, Gemma and Karina for their encouragement.

Finally, I would like to acknowledge all the men and woman of the British Army who fought in these vehicles as a ‘force for good’ throughout the world.

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INTRODUCTION

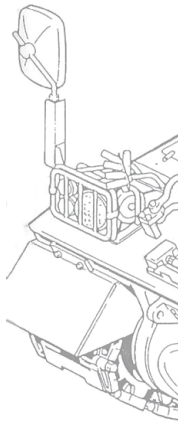


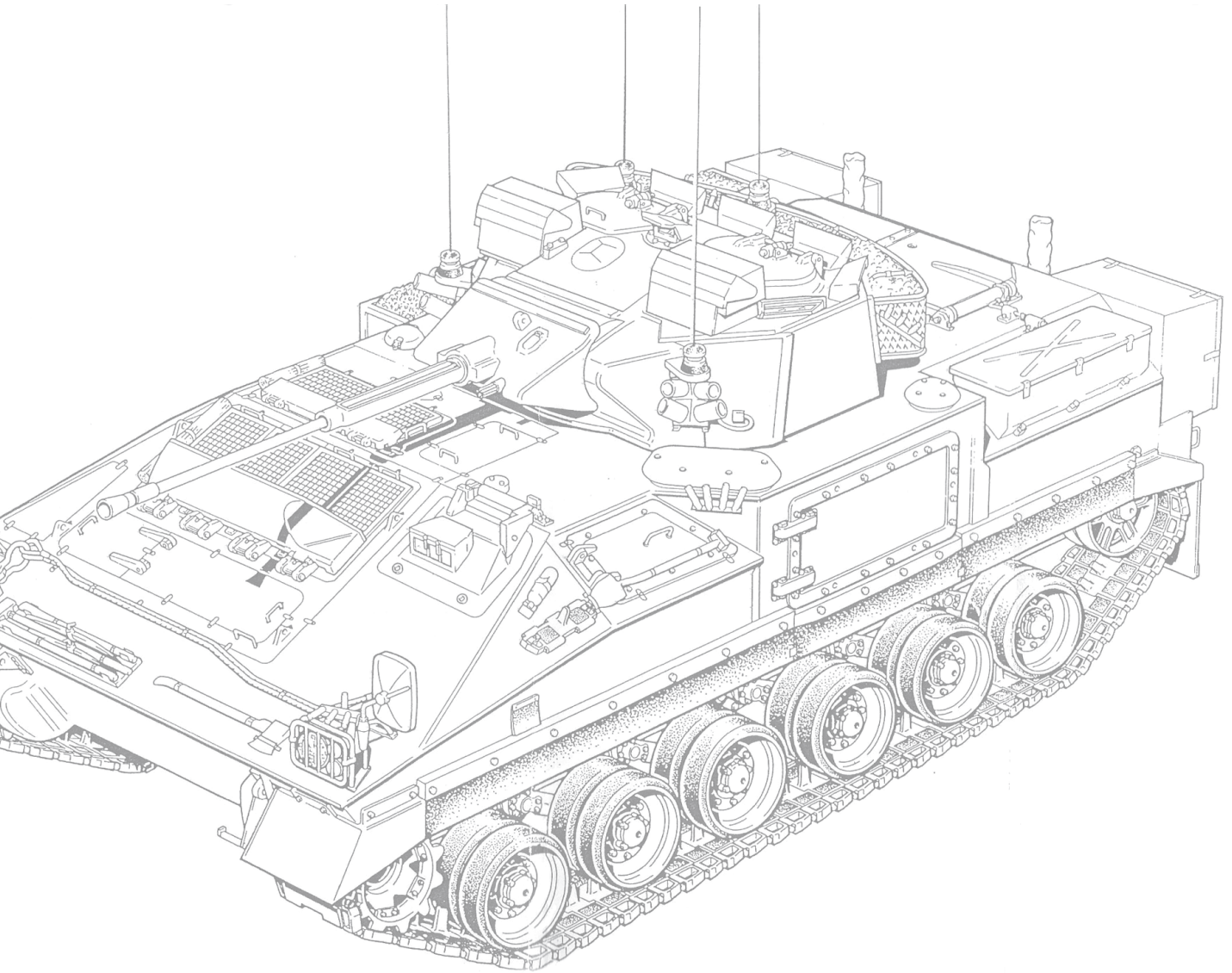
Chobham armour is the common name often applied to a ground-breaking armour technology which was developed at a Ministry of Defence site on Chobham Common. That armour transformed the design of NATO tanks from the mid-1970s onwards. The term Chobham armour could also be applied to the British Army armoured vehicle fleet through the Cold War era, as it was at the same Chobham site that these vehicles, and key technologies, were developed. A centre for military vehicle design, development and testing was established on Chobham Common in 1942. It became the design authority for British military vehicles, a responsibility it held until 1982 when this was transferred to industry. In practice this meant it was responsible for the design and development of most British military vehicles, principally armoured vehicles. It also generated technical specifications for design, test and acceptance of other military vehicles and related equipment, supported suppliers in industry with platforms development and undertook rigorous testing as part of vehicle development, assessment and user acceptance. It went through various name changes from its roots as the Department of Tank Design (DTD), through the Fighting Vehicles Design Department (FVDD), the Fighting Vehicles Research and Development Establishment (FVRDE) and the Military Vehicles and Engineering Establishment (MVEE). From 1984 until it closed in 2002 it was amalgamated with other Ministry of Defence establishments to become part of a larger organization initially coming under the Royal Armaments Research and Development Establishment (RARDE), the Defence Research Agency (DRA) and the Defence Evaluation and Research Agency (DERA) before finally being split to form constituent parts of the government Defence Science and Technology Laboratory (Dstl) and the privatized QinetiQ. Soon after this final reorganization it was closed as a military vehicle research establishment. Throughout its

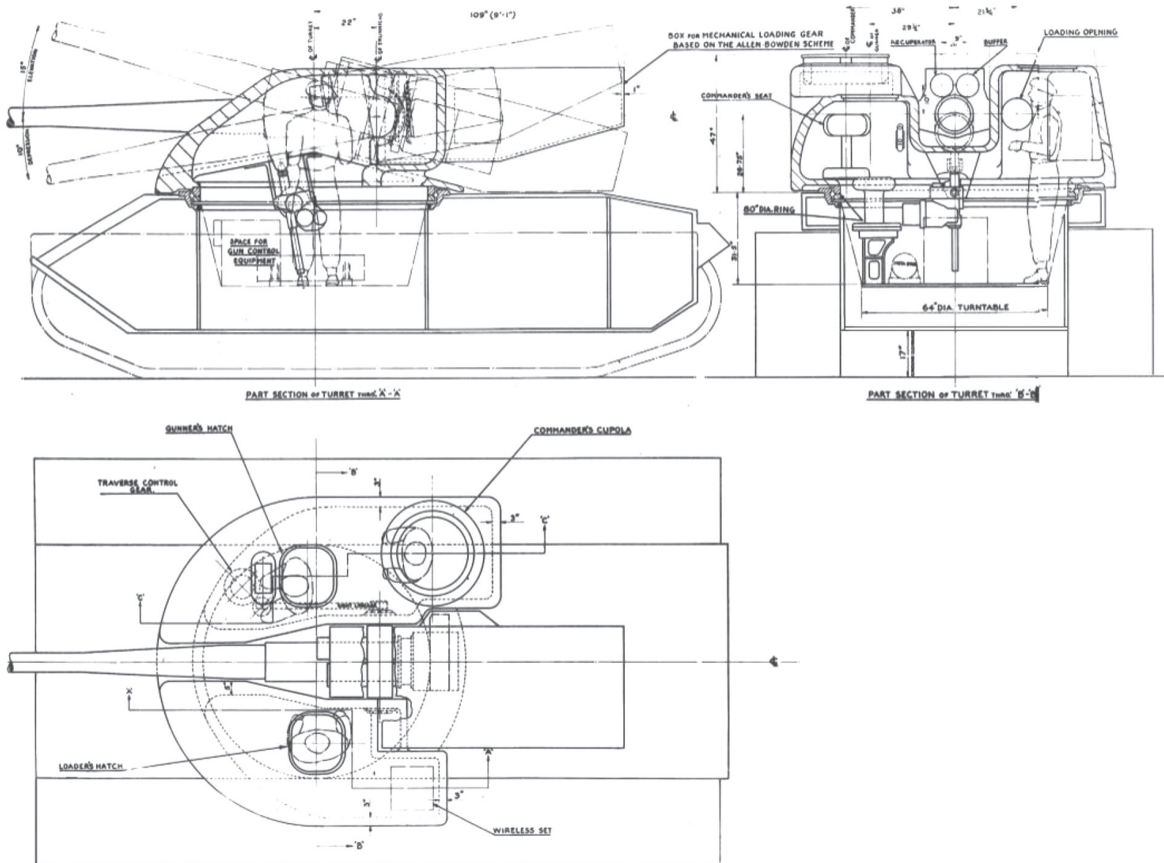
life the staff who worked there and the other government and industrial organizations that worked with the establishment referred to it by its postal address, 'Chertsey', and this is the name that is used throughout the book to refer to specific activities undertaken at the site.

As well as concept and design work to meet specific army requirements, Chertsey undertook more speculative concept development and the building of test rigs and demonstrators in order to explore the 'art of the possible'. Not all proposed equipment went into production or even passed the initial concept phase before being cancelled; some reached scale or full-size model status or even prototype phase, but due to changing requirements or budgetary constraints did not progress further. Since the end of World War II all proposed new vehicles and related equipment have been allocated an 'FV' number. The full range of the activities at the Chertsey establishment is reflected in the 'FV' number list given in Appendix A.

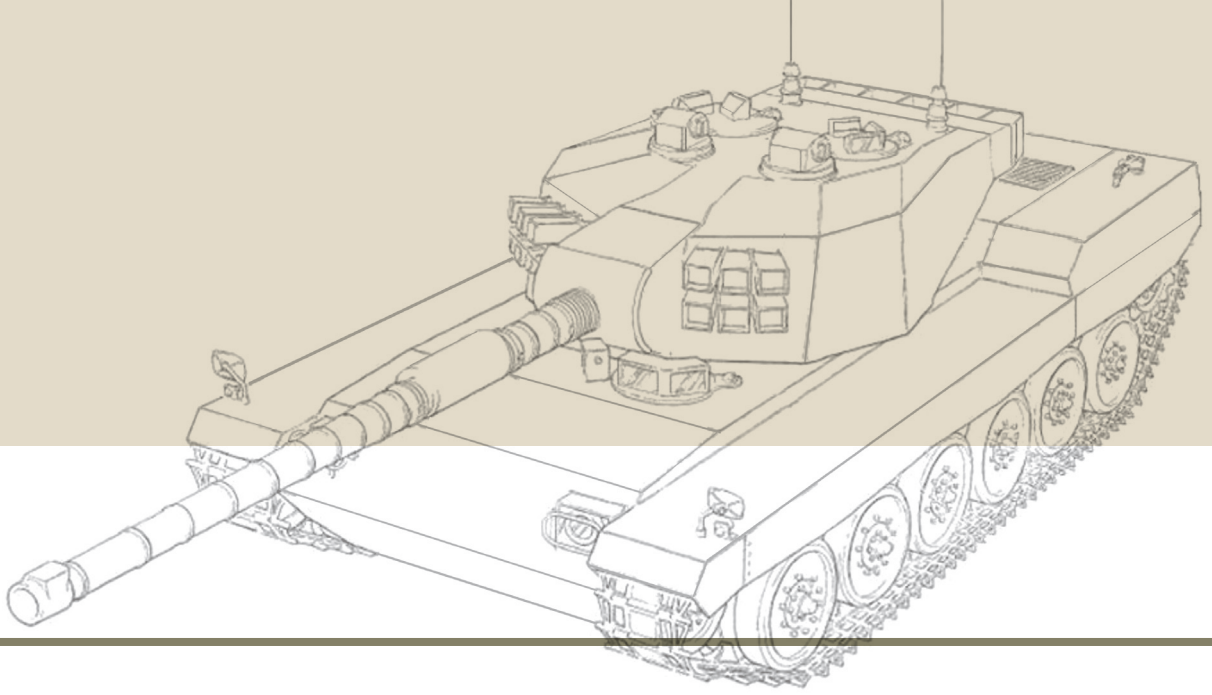
This book focuses on British Cold War Armoured Fighting Vehicle (AFV) design studies and development projects through the work at Chertsey. Arguably these vehicles achieved their intended purpose, which was to help deter a Soviet invasion of western Europe, and so were never required to fight the war they were designed for. However, they have been extensively and successfully used by the British Army in many campaigns including Korea, the Falklands, the Balkans, Kuwait, Iraq and Afghanistan and by other users around the world, proving their battle-winning capabilities.







ABOVE
 Split turret concept, one of many schemes considered for the Medium Gun Tank No.2. (Crown Copyright MOD)



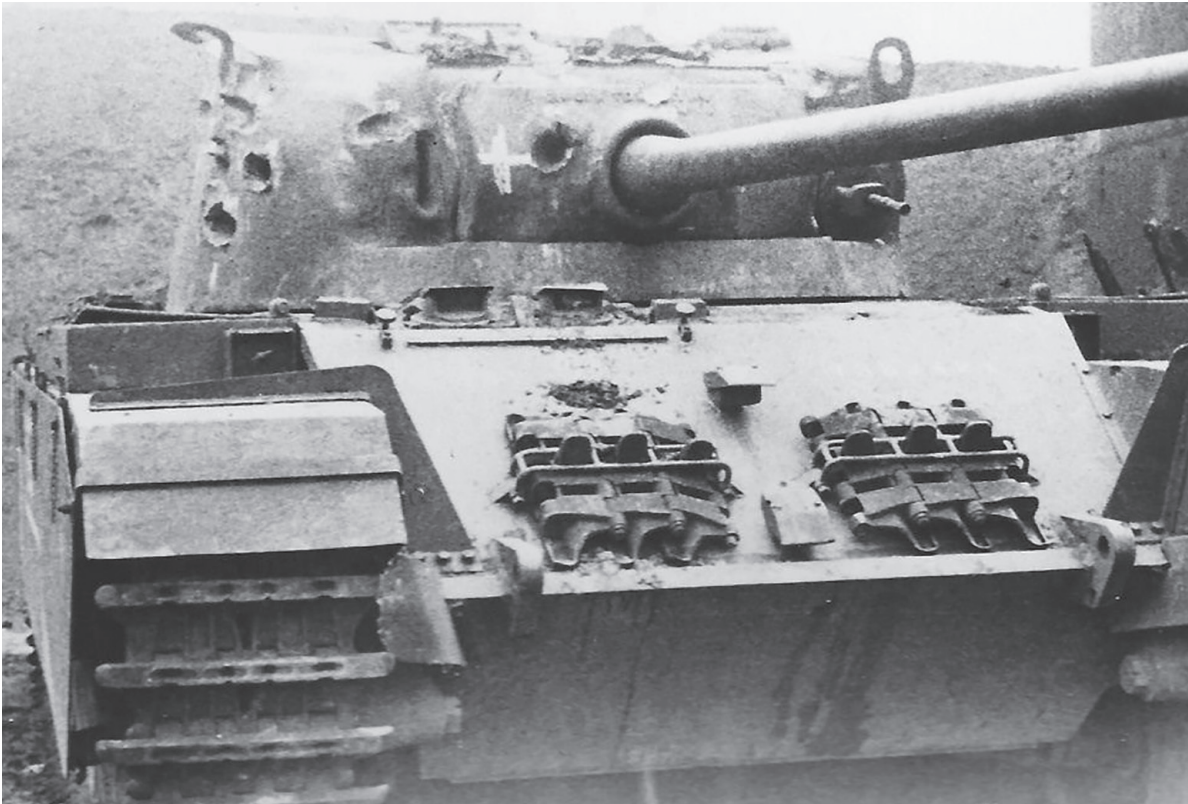
PART 1

MAIN BATTLE TANK DEVELOPMENT

ABOVE

Future Tank Concept A, small turreted tank.
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CENTURION



Centurion Mark 1
undertaking armour
protection trials.
(Crown Copyright MOD)

The first significant post-war armoured vehicle associated with Chertsey was the A41 Centurion tank. Development of this vehicle had actually started at what was then called the Department of Tank Design (DTD) in August 1943 but the first prototypes were delivered too late to see action in World War II. The design and development work was under the direction of Sir Claude Gibb, who had been appointed Director-General of Tank Production that year. It was originally designated as a 'heavy cruiser tank' and the key driver for the tank was the need to overcome the mismatch between the firepower and protection of contemporary German and British tanks. The vehicle requirements were developed by the Army Council Secretariat and were heavily influenced by experience in the Western Desert. The final specification was agreed in November 1943 with the key high-level requirements defined as:

- An armament capable of defeating the German Tiger tank, which was just coming into service, and also able to fire high-explosive (HE) rounds;
- Armour proof against the German 88mm gun;
- Attention to be given to improved mine protection compared with existing vehicles;
- High-agility cross country, but not a high top speed;
- A high-speed reverse gear.

Initially a weight of less than 40 tons was specified in order to conform with existing tank transporter trailers, but this was soon relaxed in order not to compromise the protection levels. Width was to be limited to 126 inches for transport by rail within the United Kingdom and to cross the Bailey bridge. The turret ring was to be as large as possible to support future up-gunning and it was suggested that in the future the 94mm 32-pdr gun could be fitted.

A mock-up of the vehicle was completed in December 1943 and the final specification accepted at the 38th Meeting of the Tank Board on 23 February 1944. The Department of Tank Design worked on the design and development with AEC Ltd who were appointed as Design Parents. The Chief Engineer at AEC was G. J. Rackham who had served as a Tank Corps officer and AEC already had some experience of developing military equipment having been involved in the development of military lorries, armoured cars and flamethrowers. The first mild steel prototype hull was available in May 1944 and was inspected by the Director Royal Armoured Corps on 24 May at AEC's plant at Southall. The Tank Board recommended that 20 prototypes be produced, but the build of these did not start until January 1945. The first full prototype was delivered to Chobham in April 1945, and by May 1945 six prototypes had been made, three at Woolwich and three at the Royal Ordnance Factory (ROF) at Nottingham. On 14 May these were sent to Southampton to be rushed to Germany, but arrived just too late to see action. They had been shipped across to Antwerp and had successfully covered the 400 miles to Schleswig-Holstein on arrival. They remained in Germany until July for field testing, under what was called Operation *Sentry*, before returning to the UK via Calais.

The 20 prototypes that were built had a number of different weapon fits:

- Prototypes 1–5 mounted a 17-pdr main gun and 20mm Oerlikon cannon, plus a machine gun mounted in the rear of the turret;

- Prototypes 6–10 were similar to 1–5, but had no turret rear machine gun;
- Prototypes 11–15 mounted a 7.62mm Coaxial machine gun in place of the 20mm cannon;
- Prototypes 16–20 mounted the 77mm gun as used on the Comet tank.

The 20mm cannon had been proposed as a weapon for defeating towed anti-tank guns, however, it was operated by the loader – distracting him from the main tasks of loading the main weapon and operating the radios. In addition, there was a call from the army for a forward-firing machine gun, since there was no hull-mounted machine gun, which meant the 20mm gun was soon replaced. The initial concepts had Christie-type suspension based on that used on the Comet but with a longer hull and an additional wheel station on each side; however, it was considered inadequate for the heavier vehicle and was soon replaced by Horstmann double bogie wheel assemblies; these were easier to maintain than Christie suspension and simpler to repair following mine damage. The ride was not as good as that provided by Christie suspension but was still assessed to be adequate. One innovation on Centurion was the installation of an 8hp Morris car engine to drive an auxiliary generator; this allowed batteries to be charged and electrical equipment operated without running the main engine.

On its return from Operation *Sentry* in Germany, one of the prototype vehicles was fitted with a ‘Canal Defence Light’ (CDL) system by the Special Armour Establishment. The CDL was a very bright light source that had been developed during World War II to support night operations when, as well as providing illumination, it was intended to dazzle enemy gunners. The Centurion system was fitted to the left side of the turret so that full weapon functionality was retained; however, it was never fielded.

The layout of the Centurion reflected what became the standard for post-war British Main Battle Tanks (MBTs). Most previous tanks developed during World War II had a five-man crew, with a driver and co-driver or hull machine-gun operator in the hull and commander, gunner and loader in the turret; however, the Centurion had a four-man crew with just a driver in the hull. The driver was located at the front right-hand side of the hull and, unlike previous Cruiser British tanks, was protected by sloped armour. The centrally located turret had a crew

of three; the commander and gunner seated in tandem to the right of the gun and the loader to the left. The rear of the hull housed the engine and gearbox which drove the tracks through rear-mounted sprockets. Throughout its service life in the British Army, the Centurion was continuously improved with the Mark 13 being the final version. Full technical data for the main variants of the Centurion gun tank are given in Appendix B.

The main engine fitted to the Centurion was the Rolls-Royce Meteor. This was based on the Merlin Aero-engine modified for vehicle use and was first used operationally on the Cromwell Tank. In December 1942 Rolls-Royce came to an arrangement for Rover Ltd to take over the production of the Meteor whilst Rolls-Royce took over the development of jet engines; at the time Rover was leading the work on jet engines with Rolls-Royce in support. Rover took over full responsibility for the production of the Meteor, and its derivatives, in January 1944, and continued to manufacture the engines until 1964. The engine fitted to the A41 prototypes was the Meteor Mark 4 which generated 570bhp. This had been increased to 600bhp for the Mark 1. The Mark 2 saw the introduction of the Mark 4A which generated 650hp and the Mark 3 had an improved Mark 4B giving the same power output. The gearbox was the Merritt Brown Z51, a development of that fitted to the Comet tank, giving five forward and two reverse gears. An alternative gearbox, the Sinclair-Meadows Powerflow automatic gearbox, was fitted to Prototype No.5 which was designated the A41S. This gearbox had eight forward and two reverse gears but was not adopted.

Although not fitted to the prototypes, consideration continued to be given to the provision of a hull-mounted machine gun with a report proposing solutions issued in 1945; however, none of the proposals was taken forward.

As a result of user testing of the prototypes a number of changes were requested and incorporated into the Mark 1. This had the same armament as prototypes 11–15 and went into limited production for troop trials and training. By August 1947, 100 Mark 1 vehicles had been manufactured of which 70 were delivered to the Field Army; by that time it was agreed that the remaining Mark 1s would be converted to the Mark 4 build standard. The conversions did not go ahead but these Mark 1s were used for other variants. The Mark 1 was soon followed by the Mark 2 which had thicker armour, increased from 127mm to 152mm,

and a new design cast turret which incorporated a cupola with all-round vision for the commander. It also had the improved version of the Meteor engine. The Centurion Mark 2 was the first version to go into full production and entered service with the 5th Royal Tank Regiment in December 1946. By July 1948 244 Mark 2s had been delivered.

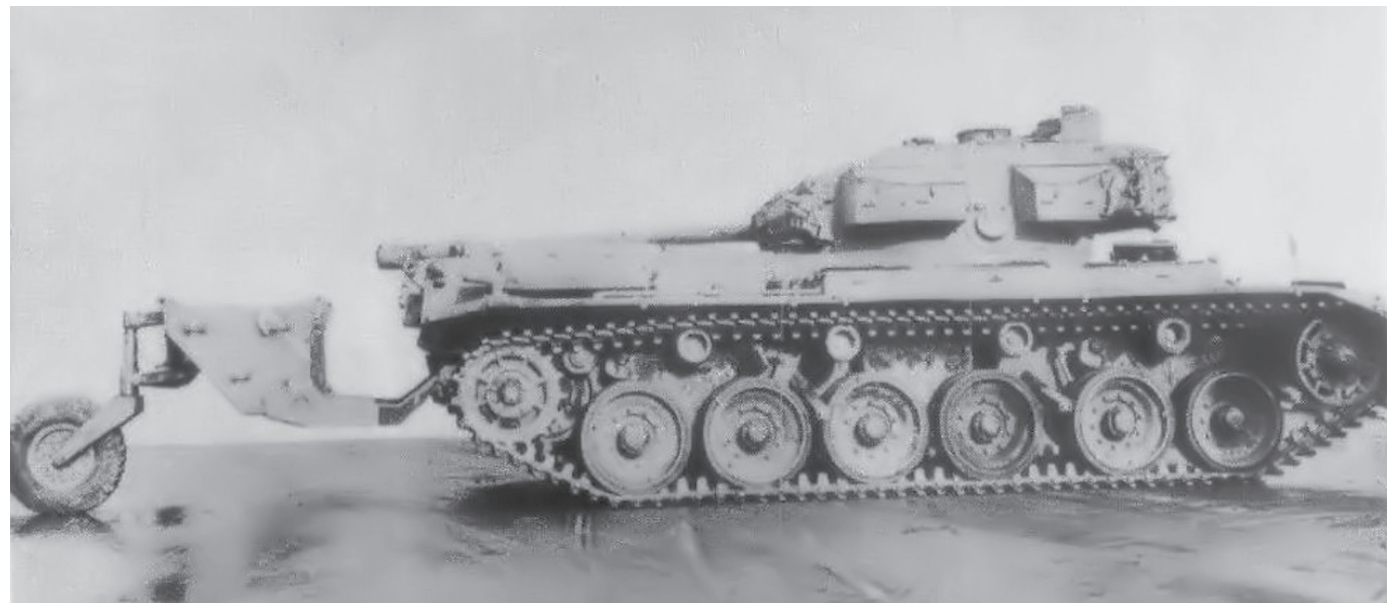
A key innovation introduced early to the Centurion was the use of electrical stabilization of the main weapon in both elevation and azimuth and this was first fielded on the Mark 3. The Department of Tank Design had first looked at gun stabilization systems in 1941 when a hydraulic elevation stabilization system of the type fitted to US Lee/Grant tanks was tested on a cruiser tank at Lulworth. This approach was not taken forward but in 1943 work started on an electromechanical system developed in cooperation with Metropolitan Vickers and first tested on a Centaur. That exercise gave confidence in the approach and led to the development of a system for Centurion. The equipment was installed in a development turret mounted on the prototype hull P2 and used in trials at Kirkcudbright in 1946. By October 1947 six modified Centurion Mark 2s were at Lulworth for user trials following which, in early 1948, the system was accepted for use on production vehicles. The Centurion was thus the first operational tank to have electromechanical stabilization for the main weapon in both azimuth and elevation, a system which provided a significant improvement in the probability of hitting a target when moving. The use of electrical weapon stabilization contributed to Centurion being a more survivable vehicle than contemporary NATO vehicles which had hydraulic stabilization systems.

As well as stabilization the Mark 3 also saw the introduction of the 20-pdr gun. Originally designated the QF3.3-Inch, it was 83.8mm in diameter and had a barrel length of 66.7 calibres. The 20-pdr design was based on that of the 17-pdr but exploited lessons from analysis of the German 88mm KwK43 weapon fitted to the King Tiger, and even though it was of slightly smaller calibre than the German 88mm it could penetrate armour nearly twice as thick. Key to the performance of the weapon was a new Armour Piercing Discarding Sabot (APDS) round. APDS rounds had been under development in the UK since 1941 and replaced the Armour Piercing Capped Ballistic Cap (APCBC) ammunition previously used. The APDS ammunition had a full-bore sabot around the armour piercing core which fell away once the round left the barrel. The overall round was lighter than a conventional round

and so had a higher muzzle velocity. In flight, being of smaller diameter, there was less drag and therefore a lower velocity drop, resulting in better performance at longer ranges. The muzzle velocity was 1465m/s, the highest of any in-service tank gun at the time and, as well as good armour-piercing capability, the high velocity gave it a flatter trajectory which increased accuracy. This high accuracy was used to great effect in the Korean War. The ammunition was 618mm long and of larger diameter than the 17-pdr requiring the ammunition stowage to be revised with 65 rather than the original 74 rounds being carried. The Mark 3 was also fitted with a coaxial Browning machine gun in place of the original Besa. Work had started on the Mark 3 even before the Mark 2 had entered service, with a mock-up at Chertsey being completed for examination by the Army on 3 October 1946. By July 1948 29 Mark 3s had been delivered and in November 1948 the Mark 3 with the 20-pdr gun was adopted as the Army standard operational version to equip all tank regiments; apart from the 7th Royal Tank Regiment in Hong Kong which was to retain the Comet.

The Mark 3 first saw action in Korea where it was found to be much superior to the Soviet-built T34/85 tanks it came up against. Based on user feedback numerous minor changes were made to improve the -Mark 3 with 250 being recorded by 1950, including changes to the loader's hatch and the deletion of the rear escape hatch.

Centurion Mark 3 with mono-trailer. (Crown Copyright MOD)

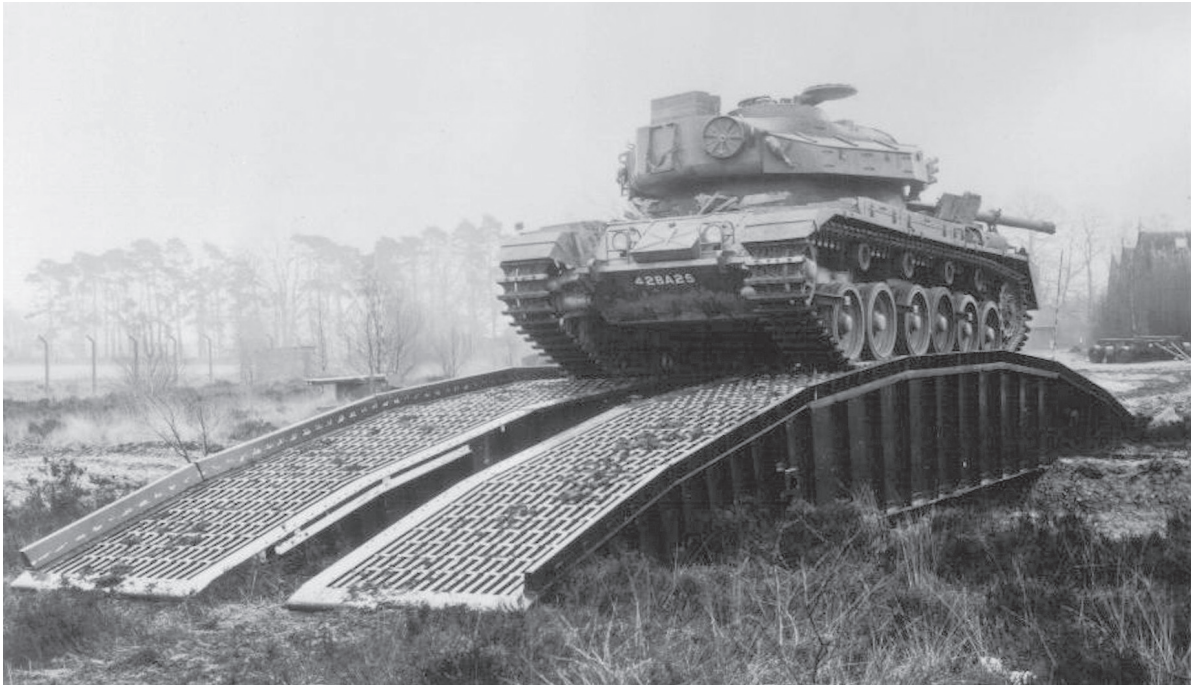


A limitation of the Mark 3 was its short range of only 62 miles. To address this issue an armoured trailer was developed to carry additional fuel. Designated FV3751 it had a single wheel at the rear, hence the designation 'Mono-Trailer'. It weighed 2 tons when full and was fitted with an under-armour jettison system. Trials were completed in 1952 and it was built by Joseph Sankey Ltd. It was also supplied to Sweden and Holland. In 1953 the design was modified to have provision for a support arm to be used when crossing combat bridges without a central running track. Despite the range benefits it was not liked by the user. The use of external fuel barrels mounted at the rear of the hull was also considered and in 1951 a range of trials were undertaken using prototype P10. These involved firing 20mm Hispano cannon and 0.50 Browning machine gun rounds, including tracer rounds into barrels filled with petrol. Although the barrels ignited, they usually fell off and, even when they remained in place, damage was generally limited to the road wheel rubber.

The Mark 4 was intended to be a close support tank with a 95mm Howitzer. A Mark 1 was modified to this configuration in 1947 but it did not enter production.

Development of the Mark 5 started in 1952 with Vickers-Armstrong working under the direction of the Fighting Vehicles Research and Development Establishment (FVRDE). It was of the same overall configuration as the Mark 3 but had a range of improvements including a 0.30in. Browning coaxial machine gun, revised loader's periscope and an upgraded gun and fire control system.¹ Later Mark 3 production vehicles saw the introduction of a fume extractor fitted to the 20-pdr gun. There had been a noticeable increase in fumes collecting in the turret with the introduction of the larger gun, and research into fume extractors had been under way since 1950. A fume extractor is a short cylinder around the barrel typically around halfway along its length. Holes in the barrel allow high-pressure gases to enter the fume extractor when the gun is fired; once the round exits the barrel, the high-pressure gas exits the fume extractor through holes that are angled towards the muzzle creating a forward flow of air that clears the barrel as the breach is opened. Following trials of a gun fitted with a fume extractor at Lulworth a report was issued in January 1957 recommending that it be fitted to all vehicles. As further improvements were developed for the

1 The 'gun and fire control system' is the name given to the complete gun stabilization and aiming system on British tanks.



Centurion, they were retrofitted to the Mark 5 with the updated version, which included the additional armour and 105mm gun, being referred to as the Mark 6.

Around 2,500 Mark 5s sold to overseas customers and most of these were manufactured on a production line set up at the Ministry of Supply factory at Farringdon near Preston. Sometimes called the 'Tank Arsenal', it was run by Leyland Motors.

The Mark 7 involved some significant design changes including the provision of a full turret turntable floor and increased ammunition stowage. It also had increased fuel capacity, up from 123 gallons to 228. A Centurion Mark 7 undertook hot weather trials in Libya in 1956. Moreover, desert trials were started on 'hardened' tracks that year which gave a longer track life.

Thicker armour was also subsequently introduced to the Mark 7 (designated the Mark 7/1) and this was likewise retrofitted to earlier Marks. The retrofit scheme involved an additional 51mm appliqué plate being welded to the upper hull glacis. This modification also required changes to the front track guard supports and the headlight harness. The main driver for this change was the fielding of the T54 tank by the Soviet Union which posed a more significant threat than the T34/85s that it replaced.

Centurion Mark 7
crossing a No.6 bridge.
(Crown Copyright MOD)

One of the most significant upgrades to the Centurion was the fitting of the 105mm L7 gun. Development of this gun began using a 20-pdr barrel bored out from 83.8mm to 105mm thus providing a gun that was of a larger calibre and with a greater expansion ratio of the propellant gases. The increase in calibre was matched by improvements to the APDS round it fired with the move from tungsten carbide rounds to new improved tungsten alloys. Work on the 105mm was undertaken in 1954 leading to successful firings of a re-bored barrel. However, initially development was not taken any further. Then in October 1956, during the Hungarian Revolution, a captured Russian T54A was driven through the gates of the British Embassy and the opportunity taken to examine the vehicle. It was assessed that the performance of the 20-pdr against the thick-sloped frontal armour of the T54 would be marginal and so work on the 105mm was restarted. Re-arming of Centurions with the new gun began in 1959. Trials in Germany indicated an armour defeat performance improvement of 25 per cent over the 20-pdr. A later development of its armour-piercing round, the L52 APDS, could penetrate 120mm of armour steel at 60 degrees at ranges up to 1,830m. As well as the Centurion the L7 was adopted by other nations for their Main Battle Tanks, including the US (M60), Germany (Leopard 1), Sweden (S-Tank) and Japan (Type 74) with around 35,000 different tanks of different designs mounting the weapon. On the Centurion the effectiveness of the gun was supported by the use of a Ranging Machine Gun (RMG). Research and development of a ranging machine-gun solution, as an alternative to bulky and expensive optical rangefinders, had been ongoing at Chertsey since the early 1950s and trials demonstrated that its use significantly improved the first-round probability of hit, especially when firing High Explosive Squash Head (HESH) rounds. To enhance the effectiveness of the RMG a new gunner's sight was developed, the AFV Periscope No.27 Mark 1.

When available, the 105mm gun was retrofitted to existing vehicles as well as new-build vehicles. It was introduced during the production of the Mark 7 and around 200 conversion kits were manufactured for converting the early Mark 7s, the converted version being designated the Mark 9. Other earlier Marks were also up-gunned. As well as replacing the barrel, the conversion to the 105mm gun required new buffer lugs, ammunition racks and clips, gun depression rail, cartridge case deflector, sight scales and barrel cleaning equipment. In addition, modifications to the gun crutch were required.

Later Marks of Centurion had a white light/Near Infrared (NIR) Search Light and NIR headlights, which were introduced from 1962 onwards. Another innovation introduced on the Mark 8 was a contra-rotating cupola which automatically maintained the commander's line of sight regardless of the gunner traversing the turret. The Mark 8 also had a new resilient mantlet, which was better for mounting the larger 105mm gun, and a new rack and pinion elevating gear. Design work on the new mantlet had been going on for several years with full ballistic trials of the proposed design being undertaken in 1957.

Further minor improvements were developed and assessed even when the Chieftain tank was starting to enter service, for example in March 1966 a report was issued on a system trialled on Centurion and Saladin for providing pressurized air to crew when wearing respirators in order to reduce their breathing load. In November 1965 a report on installing Swingfire missiles on Centurions was issued. The British Aircraft Corporation (BAC) undertook a trial installation as a private venture activity and a vehicle was displayed at the 1971 British Military Vehicles exhibition. This had two ready-to-fire missiles mounted either side of the turret and additional missiles stored at the rear of the turret. The periscopes for target acquisition and missile guidance were linked to the stabilization system to enable firing on the move.

The designation of the different versions of Centurion is somewhat complex, due to the range of different build standards applied to new and updated vehicles, the main versions being:

Mark 1 (A41*): Initial production model

Mark 2 (A41A): Modified turret design, increased armour and an improved engine

Mark 3: Initial standardized version with stabilized 20-pdr gun; most later upgraded to Mark 5 standard

Mark 4 (A41T): 95mm howitzer close support tank – not put into production

Mark 5: Upgraded gun and fire control system, fitting a .30in. Browning machine gun in place of the 7.62 Besa and other minor changes

Mark 5/1: Mark 5 with the additional armour welded to glacis

Mark 5/2: Mark 5 up-gunned with the L7 105mm gun

NEXT PAGES

Mark 13 Centurion, a preserved vehicle from the Norfolk Tank Museum. (Author's Collection)





Mark 6: Mark 5 with both the additional armour and 105mm gun

Mark 6/1: Mark 6 with infrared (IR) searchlight and turret stowage bins

Mark 6/2: Mark 6 with ranging machine gun

Mark 7 (FV4007): Improved design with turret turntable and increased fuel capacity

Mark 7/1 (FV4012): Mark 7 with additional armour

Mark 7/2: Mark 7 with 105mm gun

Mark 8: New turret mantlet which improved the gun mounting, new elevation gear mechanism and a contra-rotating cupola

Mark 8/1: Mark 8 with additional armour

Mark 8/2: Mark 8 retrofitted with 105mm gun

Mark 9 (FV4015): Mark 7 with 105mm gun and additional armour

Mark 9/1: Mark 9 with night-fighting equipment

Mark 9/2: Mark 9 with ranging machine gun

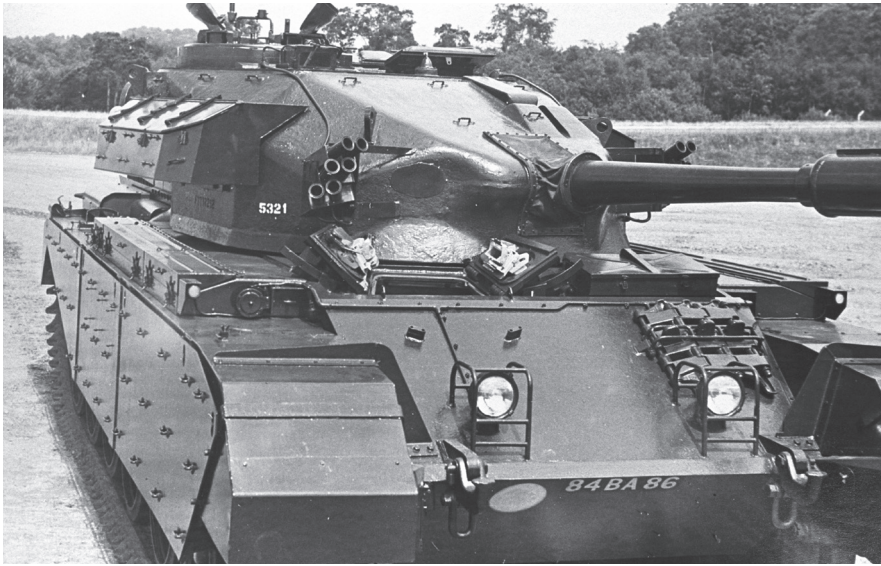
Mark 10 (FV4017): The final new-build version which was in production between 1959 and 1960. It was a Mark 8 fitted with the 105mm gun, stowage for 70 rounds, improved gun stabilization system and improved armour

Mark 10/1: Mark 10 with night-fighting equipment

Mark 10/2: Mark 10 with ranging machine gun

Centurion tanks at the Long Valley test site. (Crown Copyright MOD)





Centurion Mark X with a prototype cleft turret. (The Tank Museum, Bovington)

Mark 11: Mark 6 with night-fighting equipment, ranging machine gun and stowage basket on the turret rear

Mark 12: Mark 9 with ranging machine gun and turret basket

Mark 13: Mark 10 with ranging machine gun, night-fighting equipment and the L7A2 105mm gun

The production of new-build vehicles was undertaken as follows:

Mark 1: Woolwich, ROF Leeds and ROF Nottingham

Mark 2, 3 and 5: ROF Leeds, ROF Dalmeir, Vickers-Armstrong, and the Farringdon 'Tank Arsenal' near Preston

Mark 7 and 8: ROF Leeds and the Farringdon

Mark 10: ROF Leeds

At least one standard Centurion hull was fitted with a cleft turret of the type fitted to FV4202. The turret equipment was to Mark 9/2 standard with a contra-rotating cupola and ranging machine gun. It is sometimes referred to as the Mark X.

In 1967 a study was undertaken into installing the L60 engine, as used in Chieftain, in Centurion. This would have given commonality of spares and fuel type between the Chieftain and Centurion vehicles and variants still in service but, with ongoing reliability issues with the L60, the idea was not pursued.

CENTURION IN SERVICE USE

The Centurion was recognized as one of the world's best tanks of its time and has been in service in Australia, Canada, Denmark, Egypt, India, Iraq, Israel, Jordan, Kuwait, Lebanon, the Netherlands, New Zealand, South Africa, Sweden and Switzerland.

Although too late to see action in World War II, Centurion was used to good effect in a number of conflicts. As discussed, it first saw action in Korea where, as well as the accurate weapon, the robustness of Centurion was a key factor in its success, especially in light of the widespread use of artillery by the opposing forces. The first vehicles to arrive were three squadrons of Mark 3s of the 8th Kings Royal Irish Hussars which landed at Pusan on 14 November 1950 and saw particularly fierce fighting at the battle of Imjin River in April 1951 and again in the same area taking part in Operation *Commando*. The Hussars were relieved by the 5th Royal Inniskilling Dragoon Guards in

Late Mark Centurion as used by the Dutch Army. (Author's Collection)



December 1951. By this time the warfare was largely static but the tanks continued to provide excellent service, often providing fire support once they had climbed seemingly impossible slopes to dominant fire positions. A number of vehicles were fitted with US searchlights to counter Chinese attacks and patrols at night, often with one vehicle illuminating the targets and another engaging them. The effectiveness of the Centurions meant they were often the target of Chinese artillery and mortar attacks. Rocket-propelled anti-tank weapons were another threat and one vehicle of the Royal Inniskilling Dragoons was repaired, following a hit to the hull glacis, by having a track pin welded in the hole. The 1st Royal Tank Regiment took over in December 1952. Both the Dragoons and 1st Royal Tank Regiment provided invaluable support in fighting around Hook Hill in November 1952 and May 1953. During the May 1953 battle supporting the defences against mass attacks by the Chinese, C Squadron of 1st Royal Tank Regiment fired 504 rounds of 20-pdr ammunition and 22,500 rounds of machine-gun ammunition. The tanks suffered an average of five direct hits from shells and mortars without loss. The excellent mobility was also of note in the steep rocky terrain of Korea, and when vehicles sustained damage to the turret it was common to remove the turret and use the vehicles as 'tugs' to transport stores to remote inaccessible locations. In addition to the challenges of terrain and enemy action, the vehicles also had to cope with the Korean winter with temperatures as low as -26°C recorded in the winter of 1950/51. At the Royal Armoured Corps conference held in November 1957, Major Nelson of the 8th Hussars reported on its performance,

We gave the tanks a thorough bashing and before I left the average mileage was 1,200. They have shown themselves to be extremely good cross-country vehicles. There are very few steep hills which they could not get up. They would cross paddy unless it was extremely soft and bottomless. Centurions would sink less deeply in paddy than Cromwells' or Carriers. The 20pr guns were so accurate that you can, what we call 'Post letters into pill boxes'.

His only regret was the fact that they had had little opportunity to take on enemy tanks. The success of the Centurion in Korea was one of the main factors that resulted in many overseas sales.

Centurion gun tanks also saw action with UK forces in Egypt during the Suez crisis where, with vehicles fitted with deep wading kit, they were used to support the Royal Marine Commandos during the initial landings on 6 November 1956.

Centurion was also used operationally by the Indian Army during the Indo-Pakistan war of 1965. One infamous engagement was the battle of Asal Uttar on 10 September 1965 where, in the face of the invading Pakistani forces, Maj. Gen. Gurbaksh Singh of the Indian Army ordered his division to fall back and assume a horseshoe-shaped defensive position with Asal Uttar as its focal point. The Indian armoured force consisting of 45 Centurion tanks and around 45 Sherman tanks and 45 AMX 13 faced a force of 176 US-built Patton tanks and 45 M24 Chaffee light tanks. In the night, the Indian troops flooded the sugar cane field which impeded the mobility of the attacking Pakistani tanks and it is reported that in the ensuing battle 99 Pakistani tanks were destroyed or captured for the loss of only ten Indian tanks. Meanwhile, in the Sialkot region, the Indian Army launched a counter-attack which resulted in the largest tank battle since World War II. The Indian troops were initially concerned about the potential superiority of the US-supplied M48 Pattons; however, the Indian crews employed the 'three round battle range technique' developed by Col. Eric Offord when he was the commandant of the Lulworth Gunnery School. This was used for target ranges below 1,000 yards (914m) and involved firing three rounds in quick succession with aim points at 800 yards, 1,000 yards and finally 600 yards; this usually resulted in two or three hits within 20 seconds – well before the gunner of the more complex Patton could fire his first round. As well as being able to rapidly destroy the enemy armour the Centurion proved once again to be robust against attack with one Mark 7 tank of the 3rd Cavalry Regiment continuing to be operational after 15 hits.

The Israelis also had much success using Centurions with various upgrades, and considered it far more survivable than the later US M60s in service at the same time. Of note were the actions involving Centurions in the Sinai Peninsula in the 1967 Six Day War and in the Golan Heights in 1973. One notable incident during the Six Day War was the battle of the Mitla Pass; after the war the brigade commander, Col. Iska Shadni addressed the question of how they were able to destroy 157 enemy tanks for almost no losses; he outlined training, support from the air force and the Centurion tank which he said proved to be far superior to the T54 and T55 tanks equipping the opposing Egyptians.

Centurion was the main Israeli tank used in the Golan Heights in 1973 because its running gear was much better suited to the terrain than the M48 and M60 tanks also in service. Initially around 177 Centurions faced an attacking Syrian division of 540 tanks with two further Syrian divisions in reserve. By this time the Centurion had been up-gunned to the 105mm weapon and this proved more than adequate for dealing with the Syrian T62s. Again the robustness of Centurion was demonstrated; analysis after the conflict concluded that on average each vehicle received three hits by various weapons but less than 10 per cent of the fleet was damaged beyond repair.

The South African Army updated its Mark 2 and 3 Centurion tanks with the 105mm L7 gun, a new engine, updated sights and enhanced protection, calling the resulting vehicle Olifant. This entered service in 1978 and was used with much success against T34 and T55 tanks in Angola, although it had less success against Cuban T62 tanks.

The Centurion was a key asset for the Australian units in action in Vietnam where 58 vehicles were fielded between February 1968 and August 1971. Its presence on the battlefield provided effective support to infantry in offensive and defensive actions; this was despite being operated in very different terrain and scenarios than those for which it was designed. The response of infantry to the presence of supporting Centurion tanks is given in the C Squadron 1 Armoured Regiment narrative in Commander's Diary describing the battle of Long Dien (22 August 1968) where Australian infantry drove threat forces out of the town supported by four Centurion tanks. 'The infantry moved astride the roads and indicated targets to the tanks which moved forward to engage them. The infantry were overjoyed.'

The After Action Report of Operation *Tong and Hammer* describes the battle of Binh Ba, 6–8 June 1969, stating 'Tank support was outstanding and there is no doubt their activities were a battle-winning factor. They moved with infantry, covered the movement close up to houses assisting infantry to get into the houses to deal with the enemy inside bunkers and tunnels.' An assessment of the Centurion when supporting operations in urban areas in Vietnam states:

The enemy's light anti-armour weapons – the RPG 2 and RPG 7 [rocket-propelled grenades] – were unable to inflict significant damage on the Centurion tank, particularly when it was given infantry protection.

Only at the battle of Binh Ba were tanks put out of action and then only under very heavy RPG fire leading to numerous hits and when the tanks were being 'misemployed' without the protection of dismounted infantry to suppress the fire of the enemy RPG gunners.

One Australian Army Centurion Mark 3 has a unique claim to fame, vehicle No.169041. Built in 1951 it was delivered to the Australian Commonwealth Government in 1952. On 15 October 1953 it was used in a nuclear weapon experiment at Emu Field when it was placed less than 500m from a 9.1kt weapon blast. The blast moved the vehicle nearly 2m, removed antennae, damaged sights and lights, incinerated the mantlet cover and blew off the skirt plates – which landed some 200m away. After the trial the vehicle was driven away and the damage repaired. Nicknamed 'The Atomic Tank' it later saw action in Vietnam where in May 1969 it was hit with an RPG. There were some injuries to members of the turret crew, but no fatalities, and the vehicle remained battle worthy with no critical components damaged. The tank remained operational until May 1992 and is now at the Robertson Barracks in Australia; the only vehicle to survive an attack by both nuclear and conventional weapons.

FV3802, prototype 25pdr self-propelled gun based on a shortened Centurion hull with five wheel stations. (The Tank Museum, Bovington)

