

Richard Ogorkiewicz

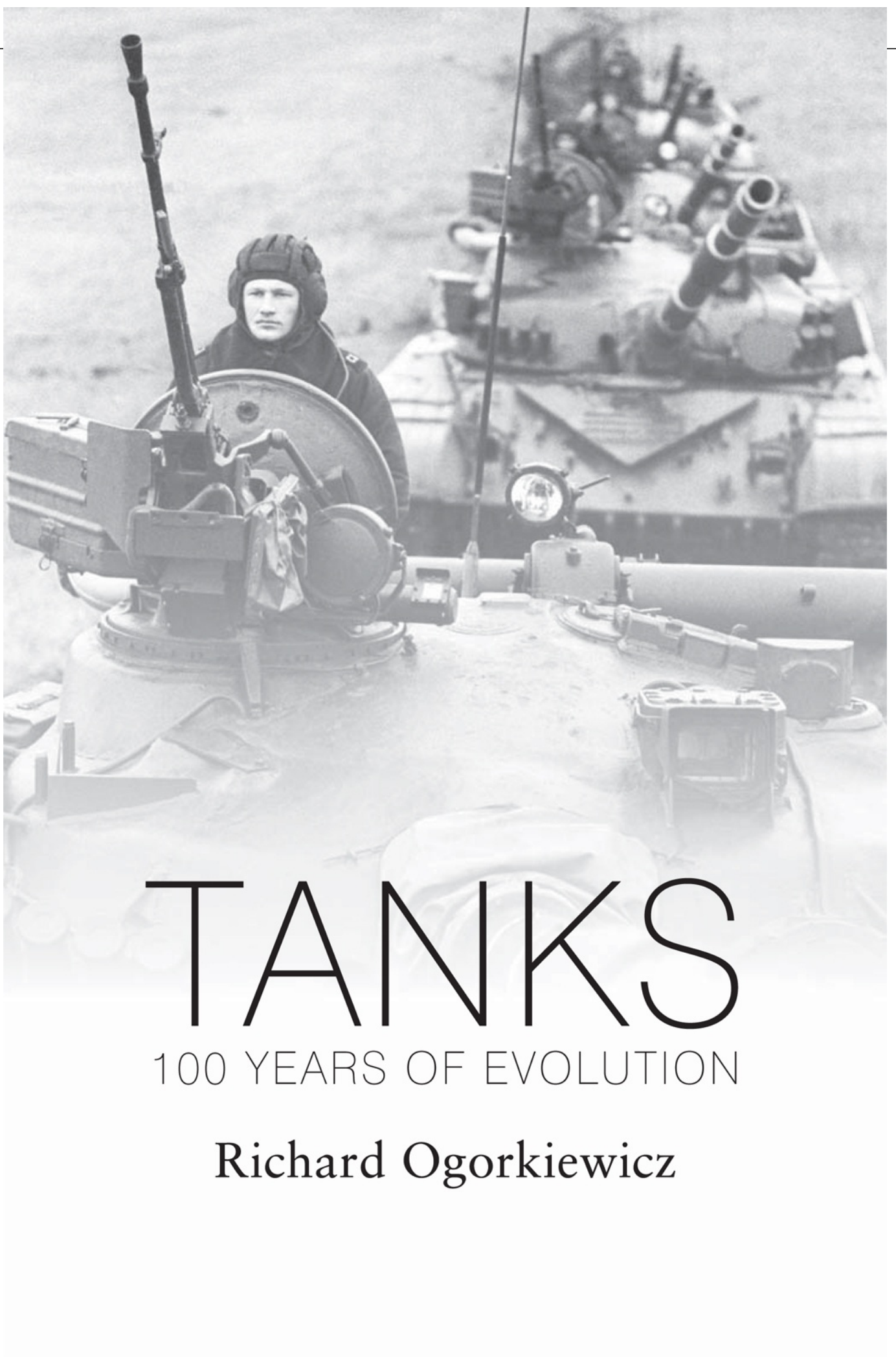
TANKS

100 YEARS OF EVOLUTION

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Introduction

The aim of this book is to present a comprehensive account of the worldwide evolution and employment of tanks from their inception a century ago to this day.

Because of their military importance and general interest much has been written already about tanks, including three books of which I have been the author.^{1, 2, 3} However, there is much more to be said about them, not only because of the more recent developments or because of tanks' worldwide proliferation but also because of the misconceptions about their origins and other developments.

In consequence, the present account starts with a reappraisal of what led to the development of tanks and how they came into being during the First World War. By the end of that conflict tanks had gained considerable importance but this was not sustained in its immediate aftermath, and a revival only began when the British Army started in the 1920s to experiment with a more mobile use of tanks. The subsequent rise in the importance of tanks was accompanied by and was partly due to technical advances in their design and performance that were achieved in Europe and America before the Second World War. The enhanced capabilities that tanks consequently acquired enabled them to become the core of combined arms, mechanized formations and these provided the most effective ways of employing them, which was demonstrated by the German panzer divisions at the outset of the Second World War.

The successes of the panzer divisions were followed by a widespread expansion of the armoured forces, which came to dominate ground warfare and resulted in the large scale production and employment of tanks during the Second World War by the Soviet Union, the United States and Britain as well as Germany.

The present account goes on to describe the development of tanks during the years of Cold War confrontation between the Western countries and the Soviet Union that followed the Second World War, when large numbers of tanks were deployed in Central Europe by the opposing armies and when

further intensive development of them took place in what were at the time the five leading tank producing countries, namely the Soviet Union, the United States, Britain, France and Germany. Significant developments also took place in a number of other countries, in particular in Switzerland, Sweden and Israel, while others acquired tanks produced elsewhere. Important progress has also been made in the Far East, where Japan, South Korea and China have developed in recent years tanks that in some respects have overtaken those built in the United States and Europe, while India and Pakistan have embarked on the production, respectively, of the latest Russian and Chinese designs.

Tanks produced in the various countries may appear to differ, but much of the technology on which they are based is common to them and the principal aspects of it are summarized in three Appendices. The first deals with the general growth in the gun power of tanks and the attempts to improve on it by resorting to guided missiles, liquid propellants and electromagnetic launchers. The second Appendix describes the universal quest for greater protection, which involves not only the use of different armour materials but also explosive reactive armour and computerized active protection systems. The last Appendix concerns the mobility of tanks and includes, among others, the development of various types of engines as well as the interaction of tanks with the terrain on which they operate.

Although the book covers a wide field it does not claim to be exhaustive. It does not, therefore, attempt to deal with more than the most important or the most interesting of the many tanks that have been built. Similarly, it does not attempt to do more than indicate the principal operations in which tanks have taken part, a detailed description of the operations being beyond the scope of one volume.

Richard Ogorkiewic



Acknowledgements

This book is the outcome of several years of study of the evolution of tanks during which I received much help and encouragement from many individuals that I would like to acknowledge with gratitude.

My early studies benefited from the help given to me by my father, Colonel M. A. Ogorkiewicz, and by Colonel R. J. Icks, in his day the leading American historian of tanks, with whom I corresponded regularly over a period of more than 20 years. I also benefited from discussions with Sir Basil Liddell Hart, whom I had the privilege of assisting when he was writing his history of the Royal Tank Regiment and who encouraged me to write my first book on armoured forces.

During the course of my studies I had the good fortune to meet and subsequently be able to correspond with some of the pioneers of tank development, including Lieutenant Colonel Philip Johnson, whose Medium D tank led the way in the development of more mobile tanks after the First World War, and Leslie F. Little, who, as chief engineer of Vickers Armstrongs, was responsible for the design of the Valentine, the most numerous British tank of the Second World War. I also met and corresponded for several years with Lieutenant General Tomio Hara, who as a young engineer officer designed the first Japanese tank.

I also met some of the leaders of the more recent development of tanks and was able not only to discuss with them tank design but also to examine and to operate the tanks for which they were responsible. In particular they included Sven Berge, who was responsible for the design of the high speed original Swedish S-tank, and Major General Israel Tal, who led the development of Israel's Merkava tanks. They also included Dr Philip W. Lett, who as vice president of Chrysler Defense directed the development of the US Army's M1 tank. All three became close friends and I had the pleasure of serving with them for several years on the Technical Advisory Group of General Dynamics Land Systems.

Others who also became close friends included Dr M. G. Bekker, who introduced me in the early 1960s to his pioneer work in the United States on soil-vehicle mechanics, and Iwao Hayashi, who led the Mitsubishi Heavy Industries' team that developed Japan's Type 74 tank.

More recently I was able to share ideas and information with Professor Manfred Held, the inventor of explosive reactive armour, and Dr Vernon Joynt, the South African mine expert, while lecturing with them on armoured vehicle technology at the Royal Military College of Science over a period of more than ten years.

I have also benefited from sharing information with Rolf Hilmes, who directed studies at the German Defence Academy in Mannheim, with Christopher F. Foss, the editor of *Jane's Armour and Artillery*, with Rickard O. Lindstrom, of the Swedish Defence Materiel Administration, and with David Fletcher, the historian at the Tank Museum in Bovington, who helped to unravel several historical questions.

Richard Ogorkiewicz, London



CHAPTER 1

The Origin of the Species

For centuries wars were fought almost entirely with individual weapons wielded by hand. But when gunpowder came into use, the relative importance of hand-carried weapons gradually diminished while that of the heavier weapons increased until they became dominant during the 19th century. Not only Napoleon acknowledged this, reflecting on St Helena that ‘artillery decides to-day the destiny of armies and peoples’.

However, siege warfare apart, the effectiveness of guns was constrained by their limited battlefield mobility, which, at best, amounted to being hauled by horses from one firing position to another.

Machine guns became an exception to this when they were developed during the latter part of the 19th century because, unlike other non-portable weapons, they were light enough to be mounted on and fired from horse-drawn carriages. This offered a way of making them more mobile, which was actually adopted during the civil war that followed the Russian Revolution of 1917. Horse-drawn carriages mounting machine guns, or *tachankas*, were then used during the Polish-Russian War of 1920–21 by the Red Cavalry Army of Budyenny, and they were retained as standard equipment by the Polish cavalry until 1939 and by the Soviet cavalry well into the Second World War.

But, whatever mobility they provided, horse-drawn machine gun carriages were very vulnerable to enemy fire and their utility was to a very large extent confined to engagements between formations of cavalry. Moreover, by the time they came into use, far better means of making machine guns, as well as other guns, more mobile already existed in the form of self-propelled vehicles. Guns mounted on them could not only be moved more rapidly and fired more readily, but they could also be fitted with armour protection, which allowed the guns to be deployed more freely under enemy fire.

The first step in the development of self-propelled vehicles was taken by N. J. Cugnot, a French military engineer who in 1769 built a three-wheeled, steam-powered vehicle that can still be seen at the Musée des Arts et Métiers in Paris. Cugnot’s venture was supported by General J. B. de Gribeauval, the inspector general of French artillery, who laid the foundations of that arm of the Napoleonic army that Napoleon later used so effectively. A second vehicle was built for further trials but no progress was made beyond this.¹

The prospect of developing self-propelled vehicles for military purposes revived in the second half of the 19th century with the construction of steam-powered traction engines. It has been widely but wrongly believed that a traction engine fitted with Boydell footed wheels was already used by the British Army for towing guns during the Crimean War of 1854–56, the erroneous belief arising out of the confusion between Boydell’s traction engine and some horse-drawn carts with Boydell’s footed wheels that were used in the Crimea. In fact, the first steam-powered engine with Boydell’s wheels was only demonstrated at an agricultural show in England in 1855 and it was a Garrett-Boydell engine which appeared a year later, which was first tried for pulling a siege gun at the Woolwich Arsenal. The Burrell-Boydell engine, which is generally believed to have been used in the Crimea, was not completed until 1857 when two were ordered for gun-towing trials, again at the Woolwich Arsenal.²

Steam traction engines were also used to tow guns on other occasions during the second half of the 19th century. In the meantime, prompted probably by the Crimean War, J. Cowan proposed another use of steam traction for military purposes in 1855 in Britain by taking out patent No.747 for ‘Locomotive Battery for Field of Battle with a Steam Engine’ – a wheeled vehicle with a turtle-like iron carapace out of which protruded several guns and at the side of which were scythes for mowing

down any troops that might attack it.

~~Cowan's vehicle was never built, but during the South African War of 1899–1902 the British Army used about 50 traction engines for towing supply trucks and guns. In 1900 two of the engines were built for use in South Africa by John Fowler and Co. of Leeds were armoured, as were the trucks they were towed, to protect them against Boer attacks when they were used for carrying supplies. Eventually the number of the armoured Fowler engines sent to South Africa rose to four.³ The armour of the Fowler engines and of the trucks was provided with loopholes through which rifles could be fired, and a field gun could be hauled onto a truck instead of being towed. In principle, there was only a small step from this to a steam-powered, gun-armed armoured fighting vehicle. Such a vehicle had in fact already been envisaged by Cowan and was depicted in 1883 by A. Robida in a French journal *La Caricature*.⁴~~

The ideas of Robida, like those of Cowan, were never implemented, but 20 years later steam-powered armoured vehicles were the subject of a story by H. G. Wells, the science fiction writer, which was published in the *Strand Magazine* in December 1903 under the title 'The Land Ironclads'. This story is often presented as a prophetic vision of future armoured vehicles and as having influenced, albeit indirectly, the development of the first British tanks several years later.⁵ In fact Wells' 'ironclads' did not represent an advance on Fowler's armoured steam engines built three years earlier so far as their means of propulsion were concerned, and this was equally true of the armament, which still consisted of rifles. Nor did they foreshadow future armoured fighting vehicles in other respects, except for being envisaged to operate off the roads over broken ground. However, what was to make this possible was not very practicable, as it was based on the use by the 'ironclads' of Pedrails – another type of footed wheel devised around 1899 by B. J. Diplock. This wheel has been confused with the Pedrail track, which was not brought out by Diplock until 1910, and has led to the erroneous belief that Wells foresaw tracked armoured vehicles.

By the time Wells' story was published a far more effective alternative to steam engines had already emerged in the form of the internal combustion engine, and the motor cars that they powered became a more practical basis of making guns more mobile. The first to recognize this appears to have been E. J. Pennington, a fraudulent American vehicle designer who came to England in 1895. Within a year of his arrival Pennington produced pictures of four-wheeled motor cars with low, boat-like armoured hulls above which protruded two Maxim machine guns with shields. What is more, he let it be known that such vehicles were being built in Coventry, which was becoming the birthplace of the British motor industry. There is no evidence of what inspired Pennington but, as one of his pictures showed armoured vehicles on a beach attacking a naval landing party, it could well have been the threat of cross-Channel invasion, which was seriously considered in Britain in the 1890s.

Pennington's activities led the *Naval and Military Record* to declare in 1896 that 'there is a great future for the military motor car' and news of them was published in Austrian and French as well as British journals.⁶ However, in 1897 a French journal, *La France Automobile*, expressed regret that Pennington's inventions only existed in the form of watercolours.⁷ In fact, Pennington never built an armoured vehicle, but the belief he created persisted and more than 60 years later he was still being credited with building one.⁸

While Pennington never put his armoured vehicle ideas into practice, a vehicle very similar externally at least, to those he depicted was built by F. R. Simms, a German-born British engineer and entrepreneur who was involved with the same motor syndicate as Pennington. After producing the design of a 'motor war car' Simms persuaded the armament firm of Vickers, Sons & Maxim to put up the money for its construction, which they did, and paid him £750 for it, according to the copy of an order dated 20th July 1898 in the writer's possession. A year later Simms exhibited detailed drawings of the vehicle he was building at a motor show in Richmond, Surrey. On the same occasion Simms also demonstrated a steam-powered quadricycle fitted with a Maxim machine gun, which became one of the

first self-propelled vehicles ever to be armed.⁹

Simms' 'motor war car' was completed in 1902, when it was exhibited at the Crystal Palace in London. It weighed about 5.5 tonnes with an open-top hull of 6mm Vickers steel and was armed with two Maxim machine guns and a 'pom-pom' automatic cannon. Powered by a 16 horsepower Daimler engine, it was reported to be capable of moving at up to 9 miles per hour, but its steel-tired wooden wheels restricted it to operating on paved roads. This was accepted as part of its proposed use for coastal defence, which formed another link between Simms' vehicle and Pennington's ideas.¹⁰

The mobility of Simms' vehicle was obviously limited, but it was the first self-propelled vehicle that was both armed and armoured, and even if it was not very practical the potential of vehicles of this kind was recognized by the technical press that reported on it. On the other hand no military officials came to see it, which provoked some very sarcastic comments on the attitude of the War Office in one of the motoring journals reporting on it.¹¹

The evident lack of official interest in Simms' 'war car' led to it being abandoned, and further efforts to make heavy weapons more mobile followed the more gradual process of mounting machine guns on motor cars and armouring the latter. The consequences of this process were foreseen by some when only one or two motor cars had been actually fitted with machine guns. One of them was A. C. Hales, a correspondent of *The Times*, who from the basis of his observations of the South African War wrote in May 1901 that armoured motor cars 'were going to revolutionise affairs both in peace and war'. A similar if more measured opinion was expressed by Brigadier J. H. A. Macdonald who wrote in 1902 that 'high speed motor vehicles, with bullet proof sides, would be of great value'.¹²

It was envisaged in both cases that the motor vehicles would be armed with machine guns, and an unarmoured motor car had already been fitted with one in the United States in 1898, a few months ahead of the appearance of Simms' quadricycle. The vehicle was a Duryea three-wheeled passenger car on which Major R. P. Davidson of the Illinois National Guard mounted a Colt machine gun with a small shield.¹³ This vehicle was followed by a four-wheeled version, and according to a contemporary report it was being built 'for city use against mobs', which suggests that it may have been inspired by the disorders which afflicted US cities in the 1890s.¹⁴

A further step forward took place in 1902 when the Charron, Girardot et Voigt company exhibited at the Salon de l'Automobile in Paris a car with a circular shield of armour plate instead of the rear seats and within it a pedestal mounting for a Hotchkiss machine gun. A French Army commission carried out firing trials with it in 1903 but saw no need for such a vehicle.¹⁵

Nevertheless, Charron, Girardot et Voigt continued to work on the development of an armoured car in collaboration with the Hotchkiss company and Major Guye of the French Artillery, whose patent turret it incorporated. The resulting vehicle was still based on a passenger car chassis but it had a fully armoured body surmounted by a turret with a Hotchkiss machine gun. It came to weigh about 3 tonnes and was capable of a road speed of 45km per hour.

The new vehicle was ready by the beginning of 1906 when it was inspected by the French minister of war. This was followed by tests during the autumn manoeuvres of the French Army, but a commission that reviewed reports on the vehicle as well as other new developments concluded in March 1909 that armoured cars should not be considered further because they could not move over all types of terrain and because of their high production cost. Moreover, the French cavalry preferred unarmoured machine gun cars.¹⁶

In the meantime the activities of Charron, Girardot et Voigt attracted the attention of the Russian authorities, who are claimed to have considered ordering 36 vehicles but ultimately settled for one which was delivered in 1906. Subsequently they ordered a series of ten, the last of which was still in France when the First World War broke out in 1914. It was immediately requisitioned by the French authorities and sent into battle but only to be quickly lost.¹⁷

While Charron, Giradot et Voigt were developing their armoured car in France, another armoured car was built in Austria by the ~~Österreichischen Daimler Motoren~~ company. It was designed by its technical director, P. Daimler, the son of Gottlieb Daimler the motor car pioneer, who started working on it in 1903, and it was completed in 1905. In the following year it took part in the manoeuvres of the Austro-Hungarian Army but the latter showed little further interest in it.¹⁸ By the end of the same year its constructors obtained permission to sell it to France, and at the beginning of 1907 it was tested at the Mont Valerien fort outside Paris. Its performance was described as 'spectacular' but this did not alter the negative opinion of armoured cars formed by the 1909 French Army commission.¹⁹

Like the Charron armoured car, the Austro-Daimler had a fully armoured body that was surmounted by a hemispherical turret with one or two Maxim machine guns. It was somewhat lighter, weighing less than 3 tonnes, and had a lower maximum speed of 24km per hour. But, unlike the other it had four-wheel drive, which only a few armoured cars were to have until the 1930s. Although they differed in detail, the Charron and the Austro-Daimler cars had a similar general configuration, which foreshadowed the design of most armoured cars built during the next three decades. However, this example was not followed until 1912. The intervening years did not provide any incentives for the further development of armoured cars and armies did not foresee their future potential.

It took the Italo-Turkish War of 1911–12 to prompt the building of two more armoured cars. Both were built at the Arsenal in Turin and were presented to the Italian Army for use in Libya by the Automobile Club of Milan.²⁰ One of them was based on a Fiat motor car fitted with an armoured body surmounted by a small cylindrical turret with a machine gun. The other, which was generally similar, was based on a Bianchi or Isotta-Fraschini car chassis. The two armoured cars were shipped to Libya in the autumn of 1912, but by then fighting had almost ceased and their use was limited mainly to escorting columns of other motor vehicles.²¹ Nevertheless, they became the first armoured cars to be used in military operations.

Two more armoured cars are reputed to have been built in Italy in 1913 and they, together with the two earlier Italian armoured cars and the ten produced in France for Russia, were the only additions to the number of armoured cars constructed before the outbreak of the First World War.

Yet motor cars were already being used in large numbers. In Britain, for instance, their annual production rose from 10,500 in 1908 to 34,000 in 1913 and in the United States the number of cars built in 1914 was no fewer than 573,000. Nevertheless, armies continued to rely on horses. The approach to motor vehicles was cautious, to say the least, and it was only under the pressure of events that they took up motor vehicles in earnest. For example, before the outbreak of the war in August 1914 the French Army possessed only 220 motor vehicles. The British Army had even fewer of them, its total of mechanical transport vehicles amounting to 100. But by the end of 1914 the French Army had acquired 13,000, mainly by requisitioning civilian vehicles, and by the end of the war in 1918 had 95,000 motor vehicles.

Similarly, it was only after the outbreak of the war that armoured cars came into use. This happened almost spontaneously as a result of the use of motor cars for reconnoitring and for harassing enemy forces in the opening stages of the war.

One of the countries in which this happened was Belgium, where within the first month of the outbreak of the war armoured cars began to be improvised on Minerva car chassis and used to harass the invading German forces. Almost simultaneously improvised armoured cars also began to be used in France. Recognizing their potential, the French minister of war ordered 136 armoured cars in August 1914, and a month later the first unit of them was attached to a cavalry corps to provide mobile fire support. The original French armoured cars were based on a variety of motor cars, but their construction was followed by another order to the Renault company for 100, this time all built on the same standard 18 horsepower car chassis, and they became operational before the end of 1914.²²

At the time Russia had virtually no motor industry but its one car company, the Russo-Balt located in Riga, Latvia, built an armoured car soon after the war started, and subsequently produced a few more so that a unit could be formed that was sent into action in October 1914.²³ More armoured cars were ordered by the Russian authorities from abroad and especially from Britain. The most numerous of the British cars were produced by the Austin company to a Russian design, which incorporated a very peculiar arrangement of two side-by-side machine gun turrets. Their total number, including armoured cars built in Russia on Austin chassis, rose eventually to more than 200. More armoured cars were procured from other companies and some were also built in Russia using imported chassis, bringing the total acquired by the Russian Army to more than 600 in 1917.²⁴

Improvised armoured cars also began to be used after the outbreak of the war by the British forces. However, in a bizarre twist of events, their use was taken up not by the Army but by the Royal Naval Air Service (RNAS). It arose out of the forward deployment in France of an air squadron of the RNAS charged with the defence of south-east England against attacks by Zeppelins. As a result of this armoured cars were improvised to support flying operations by ground reconnaissance and to provide protection. At first there were only two of them, but in September 1914 the First Lord of the Admiralty, Winston Churchill, authorized the procurement of 60 more. These were still of a fairly primitive type, with open-top hulls and based on three different motor cars. But the RNAS formed with them four armoured car squadrons and proceeded to develop better vehicles. The outcome of this was an armoured car of about 4 tonnes based on the Rolls-Royce 'Silver Ghost' car chassis, which was armed with a machine gun in a revolving turret and which was normally operated by three men. This design proved to be the most successful of those devised during the First World War and became a model for other armoured cars built during the following two decades, while some of the vehicles originally based on it were still being used, albeit with modifications, by the Royal Air Force in Iraq in 1941.

The first three of the turreted Rolls-Royce armoured cars were delivered in December 1914 and soon afterwards RNAS formed a new squadron with 12 of them. The formation of five more such squadrons followed, as did that of others equipped with different types of armoured cars, the total number of which came to about 140, including 78 Rolls-Royce cars.²⁵

Italy bypassed the use of improvised armoured cars as a result of not entering the war until March 1915. By then the use of the Belgian armoured cars had attracted the attention of the Italian minister of war, who ordered the armament firm Ansaldo to develop an armoured car for the Italian Army. The outcome of this was a turreted armoured car based on the Lancia I.Z. car chassis. Deliveries of these began in June 1915, when the first Italian armoured car unit was formed.²⁶ Eventually about 120 Lancia I.Z. armoured cars were deployed by the Italian Army, which used them for the rest of the war. They proved as durable as the Rolls-Royce, as some were still in use in Africa in 1941.

In 1915 the use of armoured cars spread outside Europe and in particular to India, where about 60 armoured cars were improvised to bolster the internal security forces depleted by the departure of British and Indian troops for service on the different war fronts. In 1915 the first armoured car was also built in the United States. Interestingly, it was designed by R. P. Davidson, the pioneer of the installation of machine guns on motor cars, and was based on a Cadillac car chassis. A year later the US Army deployed its first two armoured cars during the operations along the Mexican border against Pancho Villa.²⁷

Thus armoured cars had come to be used in a number of countries. Most were armed with one or two machine guns, but a proportion of the French cars were armed with 37mm cannon, while some British as well as French vehicles carried 47mm cannon, and a few Russian armoured cars, based on American Garford truck chassis, even mounted short-barrelled 76mm guns.

Armed with these guns, armoured cars were what would later be described as mobile weapons.

platforms. As such they constituted a revolutionary advance in the employment of some of the heavy weapons by increasing their mobility well above that provided earlier by animal traction. They also provided a degree of protection for their crews, although this was an adjunct to their mobility: enabled them to operate more freely under fire but was subservient to their basic function of being a mobile source of fire power.

All this meant that armoured cars had the characteristics that have come to be associated with armoured fighting vehicles. But they could only act as such in a very restricted sense because they were generally confined to operating along roads. In fact, for much of the time they were tied to roads almost as much as armoured trains were restricted to operating along railway tracks.

This did not handicap the armoured cars greatly on the Western Front at the beginning of the First World War, when there was no shortage of roads along which they could operate. There was therefore no lack of opportunities for the original Belgian, French and British armoured cars to skirmish along them. But when the opening, mobile phase of the war was followed by trench warfare, roads were cut or blocked and the conditions that allowed armoured cars to operate vanished. It was only three years later, in the final stages of the war when the fronts began to break, that they were used effectively again on the Western Front.

This happened in March 1918 during the final German offensive, when a total of about 13 armoured cars attached in small units to French cavalry divisions fought a series of delaying actions. Another opportunity occurred in August 1918, during the Battle of Amiens, when armoured cars of a British battalion equipped with 16 twin-turret Austins left over from the Russian orders drove through a breach in the enemy lines and wrought havoc behind them.²⁹

In the meantime, when the opportunities for their use in France disappeared in 1915, squadrons what had by then become the Royal Naval Armoured Car Division were sent to other theatres of operations where it was thought there would be greater scope for their employment. This included German South West Africa (present Namibia), German East Africa (now Tanzania) and Gallipoli, but in the event they provided few if any opportunities. There appeared to be greater scope for the employment of armoured cars on the Eastern Front, where there was more room for manoeuvre. In consequence a relatively large Royal Navy unit equipped with 20 or more Lanchester armoured cars which were similar to the Rolls-Royce, was sent to Russia. It became best known after its commanding officer, Commander Locker-Lampson, and operated in 1916 in the Caucasus and then on the Romanian and Ukrainian fronts. In the course of its far-flung operations the unit overcame some very difficult terrain conditions, which spoke well for the armoured cars at this early stage of their evolution, but the military impact of its small scale actions was very limited. The same applied to the Russian armoured cars, which, although more numerous in total than all the others, were used in small units and could only claim some local successes.³⁰

In fact, armoured cars could not have achieved greater results even if they had been concentrated in larger units because they could not spread out on the roads and could, therefore, only fight along them in ones or twos. In consequence, it was only in exceptionally favourable circumstances that they could move off the roads and act more decisively.

A rare example of this was provided by the British armoured cars sent to Egypt in 1915. In March 1916 a unit of nine of the Rolls-Royce armoured cars commanded by the duke of Westminster took advantage of the relatively hard, flat ground to dash at up to 40 miles per hour to surprise a large Arab-Turkish force at Bir Aziz south of Sollum in Cyrenaica, which the armoured cars charged, in line abreast, routing it completely.^{31, 32, 33}

To act equally effectively under conditions less favourable than those of the Cyrenaican desert armoured cars would have required the ability to operate over other, more difficult types of terrain. The need to provide them with this capability was in fact perceived in more than one country by 191

The consequent pursuit of it led to the use of tracks instead of wheels and hence to the next stage the evolution of armoured fighting vehicles, which was the development of tanks.



CHAPTER 2

The 'Invention' of the Tank

The coming into being of tanks, the first and the most important of the tracked armoured vehicles, commonly described as a unique event inspired by the ideas of one man, who is usually identified as Lieutenant Colonel E. D. Swinton, an engineer officer of the British Army. Such accounts bear little relation to what actually happened, although Swinton himself professed that it was true. He made this very clear in his memoirs, written several years after the first British tank was built, in which he described himself as its 'originator' and included a chart showing how the ideas leading to it, 'seeds' as he called them, sprang from him.¹

In fact, tanks were the outcome of the ideas and activities of several men, and any contribution that Swinton might have made to their evolution was small and indirect. Moreover, the construction of the first tanks was preceded and based on developments that took place during the previous half-century.

The most important of these developments was that of the tracked running gear. Its use in steam traction engines was proposed as early as 1858 or 1859 in patents taken out in the United States. By 1867 at least one steam-powered tractor was actually built there with its two rear wheels as well as the front steering wheel replaced by short tracks.² However, the development of tracked tractors did not begin in earnest until 1904, when B. Holt replaced the rear wheels of one of the steam traction engines produced in California by his company by tracks. Because it retained its front steering wheels, Holt's original tracked tractor was what would later be called a 'half-track', as were other tractors produced by him until 1912.

In the meantime, in 1905, a further advance took place when Richard Hornsby built the first fully tracked tractor in Britain. It was shown in 1905 and 1906 to the Mechanical Transport Committee of the War Office, which was sufficiently impressed to conduct official trials in 1907. A year later the Hornsby tractor even took part in a revue at Aldershot before King Edward VII, and in 1909 the War Office ordered a somewhat smaller tractor designed by Hornsby to military requirements, which has been preserved to this day at the Tank Museum at Bovington in Dorset.³ This tractor was tested at Aldershot, but after about 1911 the British Army lost further interest in tracked tractors, although the tractor built to its requirements was exhibited in London at the beginning of 1914.

Seeing no opportunities for further business in Britain, Hornsby sold his tractor patents to the Holt Manufacturing Company in California, which started to produce tracked tractors on a regular basis in 1908 and subsequently exported a few of them to Europe in addition to those sold to American farmers.

While it lasted, the interest of the War Office in the Hornsby tractors was prompted by the possible use for hauling guns. But in 1908 a member of the Mechanical Transport Committee, Major W. E. Donohue, suggested that instead of being towed a gun be mounted on a tractor and provided with some form of protection. This amounted to a proposal for a tracked self-propelled gun, but Donohue's suggestion was not pursued.⁴

Remarkable as it was, Donohue's proposal was not the first of its kind. Five years earlier a French artillery officer, Captain Levavasseur, put forward a scheme for a self-propelled 75mm gun on an armoured tracked chassis. The scheme was considered by the French Artillery Technical Committee but the latter came to the conclusion that animal traction was preferable for guns and finally rejected the scheme in 1908.⁵

Other proposals made before the outbreak of the First World War in 1914 did not fare any better. The most interesting of them was made by Captain G. Burstyn, an Austrian officer who apparently saw a Holt tractor in 1911 and this inspired him to design a '*motorgeschutz*', a tracked armoured vehicle with a turret mounting a cannon and with rollers on extended arms to assist the crossing of trenches. Burstyn offered his design to the Austro-Hungarian War Ministry but the latter rejected it.⁶

In Russia, V. Mendeleev, the son of the famous scientist, is reputed to have started working in 1911 on the design of a tracked armoured vehicle armed with a 120mm naval gun, but his work did not advance beyond drawings.⁷ Another design originated in Australia, where L. E. de Mole, a civil engineer, produced drawings of a tracked armoured vehicle. He submitted his design to the British War Office in 1912 but the latter showed no interest in it.⁸

The idea of a tracked armoured vehicle had clearly emerged in more than one country before the outbreak of the First World War in 1914, but failed to arouse the interest of the military authorities in any of them. To be fair, few tracked tractors from which tracked armoured vehicles were to be derived had been built and their characteristics or even existence were not widely known. What is more, armies did not fully appreciate the growing importance of heavy weapons and the extent to which their effectiveness was constrained by their limited mobility, based as it generally was on horse traction. In consequence they were less receptive than they might have been to the idea of tracked armoured vehicles, which offered to make heavy weapons more mobile and to a far greater extent than armoured cars had done already.

Once the war began, heavy weapons and in particular machine guns and field guns, until then regarded as only an adjunct to the rifle armed infantry that constituted the bulk of the armies, proved dominant. At the same time horse traction failed to provide them with the mobility necessary for offensive action. All this favoured static defence in which heavy weapons needed little, if any, mobility and in which they could be used to full effect. The effectiveness of static defence was further increased by the use of entrenchments and barbed wire.

The outcome was deadlock, particularly on the Western Front in France, with neither side being able to break through the other's defences by the traditional massed infantry attacks. The immediate problem became that of finding a way that would enable the infantry to continue to attack in the face of machine guns and barbed wire. In response to this came proposals for armoured assault vehicles that would pave the way for the infantry by attacking enemy machine guns and by crushing the barbed wire.

The first in Britain to think of using tracked vehicles to solve the problems created by the onset of trench warfare appears to have been Swinton, and to this extent he deserves credit for originality. But what his thoughts were is not very clear and, whatever they were, any influence they might have had on the development of the first British tanks was indirect and limited.

According to his own account written several years after the event, the idea of a tracked armoured vehicle came to Swinton suddenly in October 1914 when he recalled the description of a Holt tractor sent to him four months earlier. This occurred while he was travelling to England from France where he was acting as the sole official correspondent with the British Expeditionary Force (BEF). On arrival in London he discussed his views with Lieutenant Colonel M. Hankey, the secretary of the influential Committee of Imperial Defence.⁹ There is no record of what was actually discussed but it seems likely to have included the possibility of converting tracked tractors into some kind of assault vehicle, and such a vehicle is alluded to in a letter written a month later by Swinton to Hankey.¹⁰

A clearer outcome of the contacts is a device described in a memorandum written by Hankey in December 1914 and this, according to Swinton, embodied what he had put to Hankey.¹¹ But what Hankey proposed was only a large heavy roller pushed by a single, engine-driven track and provided with an armoured cab for a driver and a machine gun. As Hankey explained, the object of this device

would be 'to roll down the barbed wire by sheer weight'.¹² What he was proposing was therefore specialized wire crusher and not an armoured fighting vehicle.

A copy of Hankey's memorandum was sent, among others, to the First Lord of the Admiralty, Winston Churchill, who after receiving it wrote to the Prime Minister, H. H. Asquith, saying that he agreed with Hankey about the use of 'special mechanical devices for taking trenches'. However, he saw them in a different form from that envisaged by Hankey, namely that of steam tractors that were armoured and fitted with machine guns as well as tracks. The prime minister then took the matter up with the Secretary of State for War, Lord Kitchener, and this led to the formation of a War Office committee that was to consider the possible adaptation of tracked tractors to the role of assault vehicles. As part of its activities the Committee arranged tests of a Holt tractor over an obstacle course made up of trenches and barbed wire entanglements in February 1915. The tractor, handicapped by being made to pull a heavy trailer, failed to cross some of the trenches, which led the Committee to conclude that what was proposed was impracticable and to abandon further consideration of it.

Prior to the test the Committee received a memorandum written by Captain T. G. Tulloch, an artillery officer recommended by Swinton, which more clearly than hitherto envisaged armoured vehicles armed with machine guns that could move across country and over barbed wire to attack enemy trenches. The vehicles were to be based on Holt tractors but coupled in pairs to form articulated vehicles – which Tulloch appears to have been the first to propose in 1911 in sketches of a large articulated armoured vehicle.¹³ However, the ideas contained in Tulloch's memorandum were not taken up. But its title, which was 'Land Ship', became the designation of the first British tracked armoured vehicles and also reflected the influence of naval ideas on contemporary thinking.

In the meantime Churchill had Hankey's idea of using large rollers to crush barbed wire put to test by the Royal Naval Air Service, which he controlled. The test was carried out using steam rollers which proved incapable of climbing the slightest slope, and the whole idea was abandoned. As a result Churchill turned his attention to other ideas. These were put to him by officers of the RNAS who were seeking vehicles more capable than their armoured cars, which were becoming ineffective with the onset of trench warfare.

The earliest of these ideas came from Flight Lieutenant T. G. Hetherington, who in November 1914 proposed to Commodore M. Sueter, the director of the Admiralty Air Department who was in charge of the RNAS, the construction of a giant three-wheel armoured vehicle armed with 12in (309.8mm) naval guns. Sueter realized that this was not a practical proposition but was prepared to pursue the idea of a scaled down version, which he submitted to Churchill in January 1915.

The vehicle that was now being proposed was still very large, the front two of its three wheels having a diameter of 40 feet (12m). Moreover, it was to have three turrets, each with two 4in. guns while its weight was estimated to be 300 tonnes. In its proposal it was described as 'a cross-country armoured car of high offensive power', which showed that the aspirations of the RNAS officers were sound. But their judgement of what was practicable was not. It is not surprising therefore that when Churchill referred the proposal to the Admiralty it was turned down by one of its experts, Admiral Sir Percy Scott.¹⁴

However, Hetherington's idea of a large three-wheeled vehicle was not entirely irrational. Such a vehicle with two driving wheels with a diameter of 10m, or almost as large as those of Hetherington's proposed vehicle, was actually being built in Russia in 1915. Its construction was promoted by M. Lebedenko, the head of the experimental laboratory of the Russian War Ministry, and was allegedly supported by the tsar. But it was abandoned as impracticable without being completed.¹⁵

Although it was not practicable and in spite of its rejection by Admiral Scott, Hetherington did not abandon his idea of a large-wheeled vehicle and got a chance to put it directly to Churchill at a dinner on 14 February 1915. This time Churchill showed greater interest in it and referred it to the Director

of Naval Construction, E. H. T. d'Eyncourt. The latter concluded that the proposed vehicle would weigh 1,000 tonnes and was not therefore practicable. But he did not reject the concept of a large wheeled armoured vehicle, and suggested that Hetherington's vehicle be replaced by a smaller one. Churchill agreed and ordered the formation of a committee chaired by d'Eyncourt to pursue the idea put to him. This came into being on 20 February 1915 under the title of 'Landships Committee'.¹⁷

While these events were taking place, Sueter was pursuing his interest in the use of tracks originally for mobile armoured shields to be pushed by infantrymen in front of them like wheelbarrows. Then, having apparently turned against big wheel vehicles, he began in February 1915 to consider the design of a tracked 25-tonne armoured vehicle armed with a turret-mounted 12-pounder gun. The design was produced in collaboration with B. J. Diplock and incorporated the latter's Pedrails, which were the only tracks made at the time in Britain.¹⁸

By the time the Sueter-Diplock design was drawn, the Landships Committee had come into existence and shortly afterwards was informed about it. In consequence, the committee had two different designs to consider, one being that of a wheeled vehicle derived from Hetherington's proposals but with wheels having a diameter of 16 feet (4.9m) instead of 40 feet, and the other being a tracked vehicle with Pedrails. The committee reported on them to Churchill, who, relying on the advice of d'Eyncourt that the two proposed designs were viable, took it upon himself to authorize on 26 March 1915 the construction of six-wheeled and 12-tracked vehicles.¹⁹

The order for the wheeled vehicles went to the William Foster Company in Lincoln. Their work suffered a series of false starts and the order issued to them was cancelled in June 1915 without a vehicle being built.²⁰ Work on the tracked vehicles produced more tangible results. It was directed initially by Colonel R. E. Crompton, an experienced engineer who pioneered the use of steam traction engines in India in the 1870s and was then involved with their use in the South African War, who was appointed a consultant to the Landships Committee.

Working with another engineer, L. A. Legros, Crompton produced a design similar to that conceived by Sueter and Diplock. But, instead of having a turret with a 12-pounder gun, Crompton's vehicle was to be an armoured carrier capable of carrying as many as 50 or even 70 men, which cannot be considered at that stage the tactical purpose of what were beginning to be called 'landships'. Otherwise it was to have the same peculiar configuration as that adopted by Sueter and Diplock, which consisted of a long rigid chassis resting on two wide Pedrail tracks arranged in tandem, each driven by a separate engine. The vehicle was to be steered by turning the track assemblies in relation to the chassis, which meant that its turning circle was impractically large. Crompton realized this even before the vehicle was built, which it eventually was in a reduced form by the Stothert and Pitt company in Bath, and proved unsatisfactory.²¹

The failings of the original design became clear to Crompton after a visit to France on 21 April 1915 when he concluded that the vehicle he was designing would not be able to negotiate the bends of roads and village streets. In consequence, he decided to abandon the original design in favour of an articulated vehicle that would have a smaller turning circle and therefore be more manoeuvrable. The idea of an articulated tracked vehicle was not entirely new, as one had already been proposed by Tulloch, and it was actually implemented by Diplock who exhibited an articulated tracked truck in London in 1913.²² But no other articulated tracked vehicle had been built and it was going to take more than 40 years before one was successfully developed.²³

Each section of Crompton's second articulated vehicle was still to have only one Pedrail track. But by May 1915 he recognized the shortcomings of the complicated and heavy Pedrail tracks, which had not been used successfully in any vehicle, and recommended the purchase of American tractors with lighter and proven tracks. As all the available Holt tractors had been earmarked already for the British Army for gun towing, the Landships Committee ordered two similar 'Creeping Grip' tractors from the

Bullock Tractor Company of Chicago.²⁴ Following this Crompton started working on his third design which was similar to the second design but with each section of the articulated carrier having two Bullock tracks.

In addition to recommending the purchase of the two Bullock tractors, Crompton also arranged the purchase of a lighter American tractor produced by the Killen Strait company. This tractor was almost unique in having a short track instead of the steering wheel that almost all contemporary tractors still had. This was not of any mechanical merit, but the two main tracks of the Killen Strait tractor were very effective for their day. As a result the Killen Strait tractor was used very successfully in June 1915 to demonstrate for the first time the ability of tracked vehicles to negotiate barbed wire entanglements and other obstacles in front of the Minister of Munitions, Lloyd George, Churchill and others whose support was essential for the development of landships.²⁵ The Killen Strait tractor was subsequently fitted with the hull of an RNAS Delaunay-Belleville armoured car, and this combination became in July 1915 the first, albeit only experimental, tracked armoured vehicle.

When the two Bullock tractors arrived in England they were coupled to test Crompton's concept of an articulated vehicle. Tests of the coupled tractors were carried out in July 1915 and showed that an articulated vehicle would be difficult to develop.²⁶ In consequence, the Landships Committee decided to abandon further work on it and at the same time terminated the appointment of Crompton as its consulting engineer. Instead of the large articulated troop carrier that was aimed at until then, the Landships Committee decided to develop a smaller vehicle with a rigid, one-piece hull and a turret-mounted cannon. An order for such a vehicle was issued on 29 July to the William Foster Company, which had worked previously on the wheeled landships. It proceeded with remarkable speed and had the vehicle built and running by 6 September 1915.

The vehicle built by Fosters, which came to be known after its managing director W. A. Tritton corresponded to one half of Crompton's third design, that is the articulated carrier with lengthened Bullock tracks. In the interest of speed Tritton used the engine, gearbox and differential of a heavy wheeled artillery tractor that his company was producing. He also copied the method of steering used by the Bullock as well as other contemporary tractors, which involved a pair of steering wheels both mounted behind instead of in front of the vehicle. However, the vehicle could also be steered by braking one of the output shafts of the differential – a method first used by Hornsby 10 years earlier.

Tritton's vehicle was only an experimental machine with a box hull of boiler plate and a fixed dummy turret. But it provided, at last, a sound basis for the mechanical development of landships. When it began to be tested its Bullock tracks proved unsatisfactory and it was rebuilt with a longer and stronger type of track. The new type of track was designed by Tritton, whose prior experience of track development was confined to a single half-track tractor called 'Centipede' built by his company in 1913. Nevertheless, the track proved successful and its performance was crucial to the further development of landships.

When it was modified and fitted with the new type of track, Tritton's vehicle became known as 'Little Willie' and in that form has been preserved at the Tank Museum at Bovington. It was successfully demonstrated in December 1915, and because of its longer tracks could cross wider trenches than in its original version, whose 4ft trench crossing capabilities proved inadequate when it was first tested in September 1915.²⁷

In the meantime the Landships Committee had established contact with the War Office and on 2 August 1915 received from it a set of requirements to be met by landships. These requirements were derived from three memoranda submitted by Swinton to the General Headquarters of the British Forces in France between 1 and 15 June and sent on to the War Office on 22 June.²⁸ In the memoranda Swinton set out his ideas concerning 'machine gun destroyers built on the caterpillar principle that would lead infantry assaults on enemy trenches' and suggested, among others, that they should be able

to cross trenches 5ft wide. This was subsequently incorporated in the War Office requirements which the Landships Committee received on 26 August.²⁹

However, on 29 June Swinton wrote again to the General Headquarters tentatively suggesting that the trench crossing requirement be increased from 5 to 8ft.³⁰ This suggestion obviously arrived too late to be included in what was sent to the War Office seven days earlier and was not part of the requirements received by the Landships Committee.

Whether Swinton's 8ft trench crossing requirement was ever made known to the designers of the landships is an open question. If it was it could only have been after they received the War Office requirement for a 5ft trench crossing capability on 26 August, by which time they were bound to have started thinking of improving on the design of the first landship since a full size wooden mock-up of the second landship was already built by 19 September, when Swinton first saw it.³¹

Nevertheless, after seeing the mock-up of the second landship Swinton declared that it was 'the actual embodiment of my ideas and the fulfilment of my specification'. In fact, the only feature of the second landship that might have provided some justification for such a claim was its ability to cross wide trenches. But, although this was similar to what Swinton had belatedly suggested to the General Headquarters, the second landship was designed without reference to him and the general ideas represented were already embodied in the first landship, which, as Swinton himself acknowledged, was not built to his specification.³²

As to Swinton's more general claim, quoted earlier, to have been the 'originator' of the tank, Churchill, who was closely connected with its development, rightly observed 'there was never a person about whom it could be said "this man invented the tank"' and added, with some justification, that the tank was a child of the RNAS.³³ But when Sueter quoted this in a book in which he tried to put on record the achievements of the RNAS, Swinton wrote on the margin of his copy of the book now in the possession of the present writer 'It was not. EDS', refusing to let go of the claim that he had assiduously fostered for many years.^{34, 35}

The second landship was actually designed by Tritton and Lieutenant W. G. Wilson, an engineer seconded from RNAS to Fosters who was to become well known for his designs of epicyclic transmissions. Its salient feature was the novel layout of the tracks, devised by Wilson.³⁶ This provided the tracks with a high, upturned nose and a high return run so that they went around the bottom of the vehicle instead of being below it. The upturned nose was inspired by the high parapets of enemy trenches, and together with the long length of the tracks provided the second landship an exceptional trench crossing capability that greatly exceeded the War Office requirements. It also gave the second landship its characteristic rhomboidal silhouette.

The configuration of the vehicle did not lend itself to the installation of a turret and the original idea of arming it with a turret-mounted gun was therefore discarded. Instead the vehicle was armed with two guns mounted in sponsons projecting out of its sides – a contemporary mode of mounting the secondary armament of the larger warships. As the Army was short of suitable guns, the vehicle was armed with 57mm 6-pounder naval guns that the Director of Naval Ordnance promised to supply in sufficient quantity. In addition to the two 57mm guns the vehicle was also armed with three machine guns.

In other respects the second landship followed Tritton's machine. In particular, it was powered by the same 105 horsepower Daimler engine and had the same Foster wheeled tractor transmission as well as a pair of steering wheels at the rear. It also ran on the same type of unsprung plate track as its forerunner. The thickness of its armour, which was simulated by soft steel plates, varied from 6 to 12mm and fully laden it weighed 28 tonnes.

Development of the vehicle proceeded with remarkable speed: a mock-up of it was built in September 1915, its design was completed in October and the vehicle itself was completed by 2

January 1916. It was at first referred to as the 'Wilson machine' but later as 'Big Willie' and 'His Majesty's Land Ship Centipede', and eventually as 'Mother' as it became the progenitor of the British heavy tanks of the First World War.

By February 1916 the Army finally decided that it wanted what by then had begun to be called tanks rather than landships for reasons of secrecy. However, its decision was only taken after trials of Mother at Hatfield in January and February 1916 during which it successfully negotiated all obstacles. This included trenches 9 feet wide, while the official requirement was still that it should cross trenches 5ft wide and not what Swinton ultimately suggested.³⁷ Its performance convinced most of the military and civilian officials who attended the trials of its potential value, although Lord Kitchener dubbed the tank 'a pretty mechanical toy'.

However, the decision to go ahead with the production of tanks similar to Mother was, curiously, left to the General Headquarters of the British Forces in France. Its representatives attended the trials at Hatfield and recommended the acquisition of tanks, although only 40 were subsequently asked for. On hearing of this ridiculously small number Swinton, who had returned to an influential government post in England in August, persuaded the War Office to raise the number of tanks to be produced to 100 and on 12 February 1916 the Ministry of Munitions authorized their production.

Thus the evolution of tanks in Britain reached the end of its experimental phase and entered that of production and use in the field.

Concurrent with the development of the tank in Britain and with no knowledge of it, the tank was also developed in France. That this should have happened is not entirely surprising since the two countries faced the same military problems and possessed or had access to similar technological resources. Nevertheless, it is remarkable that some of the steps in the development were taken in the two countries at almost the same time. This applied, among others, to the decisions to produce tanks which were taken in Britain and in France within days of each other.

The French decision was bolder as it called for the production of 400 tanks. However, no prototype of the French tank had yet been built and the French production order took several more months to implement than the British.

As in Britain, the development of the tank in France was preceded by proposals for the use of special devices to overcome the problems created in 1914 by the onset of trench warfare and in particular that of attacking trenches protected by barbed wire. The first of them appears to have been a proposal made in November 1914 to convert a road roller into an armoured vehicle that would crush barbed wire. The proposal was actually implemented and the resulting Flot-Laffly roller was tested but only to be rejected as being impractical, like the rollers considered in Britain by Hankey and later by Churchill. Another proposed barbed wire crusher consisted of the Boirault apparatus – a bizarre device consisting of six large, 4 metre by 3 metre linked skeleton panels engine-driven by chains to move forward as if it were a hexagonal wheel or six-link track. On the advice of the French commander-in-chief a ministerial commission rejected this device outright, but it took a demonstration carried out several months later to make another commission, representing the technical services of the Army, reach the inevitable negative conclusion.

A different method of breaching barbed wire entanglements, which amounted to the use of a large wire cutter mounted on a wheeled agricultural tractor, was proposed in November 1914 by J. Breton, an influential deputy to the National Assembly. This method was tested in July 1915 and, in spite of the inadequate performance of the tractor over broken ground, the Ministry of War ordered the construction of ten Breton-Prétot wire cutters.³⁸

Much more practical results followed the development of an armoured car on which the Schneider armament company of Le Creusot embarked towards the end of 1914. By mid-January 1915 its design had been drawn, and later that month a Schneider engineer involved with the project, E. Brillat,

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