The Evolution and Development of the Main Battle Tank

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THE EVOLUTION AND DEVELOPMENT OF THE MAIN BATTLE TANK

A thesis submitted to the National College of Art and Design by

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EVOLUTION

Initially, the First World War was a fast moving and very mobile set of operations. These were to be the last days of horsed cavalry and horse artillery. The pattern of the war changed in September, 1914, with the halt of the German advance and the beginning of trench warfare. In these conditions, cavalry operations were impossible and infantry actions were only possible under heavy artillery support. Even with this, losses were high, with only limited success. To compound this situation, the constant heavy shelling coupled with bad weather conditions led to open terrain turning to seas of mud. This restricted, and often made impossible, the movement of equipment. The High Command had to accept these conditions and their solution was committing larger and larger forces with more and more guns.

However, there were one or two people who were considering the problem more deeply and were obviously influenced by the ideas of 'landships' popularised in early science fiction novels. Lieut-Colonel E.D. Swinton was sent to France as an official war correspondent in September 1914, and concluded that the machine gun would be the defensive weapon of the war. The Royal Artillery had ordered American Holt agricultural crawler tractors to tow guns and Swinton had the idea that such a vehicle fitted with an armoured body would make an excellent means of storming enemy trenches by carrying infantry or guns across 'no mans land' safe from enemy rifle and machine gun fire. On his return, he submitted his report to his priors. The official view was, however, that such vehicles would be vulnerable to shell fire. They were eventually persuaded to examine Swinton's ideas and, on 17th Feb., 1915, they witnessed cross-country trials of a Holt tractor towing a trailer to simulate the weight of troops, armour and armament, but due to severe weather conditions, the vehicle performed badly. It should be said that Swinton's original idea did not envisage the use of a trailer. The committee were unimpressed with the tests and once more gave a negative response.

At the start of the war, the Royal Naval Air Service began to modify ordinary touring cars and fit them with armour plate and machine guns to protect their landing strips and seaplane bases in Calais and$\frac{7}{8}$ Dunkirk. The offensive capabilities of such vehicles were very limited but they proved to the R.N.A.S. the importance of armoured vehicles. Captain Sueter (Commander of the R.N.A.S.) put the suggestion of using a tracked armoured device for land warfare to Winston Churchill (Political Head of R.N.A.S.). He was inspired by the use of a tracked vehicle by Captain Scotts pre-war Polar expeditions, for which tracked trailers were considered. Meanwhile, Flight Commander T.G. Hetherington, the R.N.A.S. armoured car transport officer, had proposed to Seuter the use of a giant 'landship' with three 40ft. diameter wheels arranged tricycle fashion round a platform which mounted three turrets, each with twin 4 in. naval guns, the whole vehicle being driven by an 800 hp. submarine diesel engine. The wheel size was considered necessary to enable the vehicle to cross the widest German trench (9 ft.).

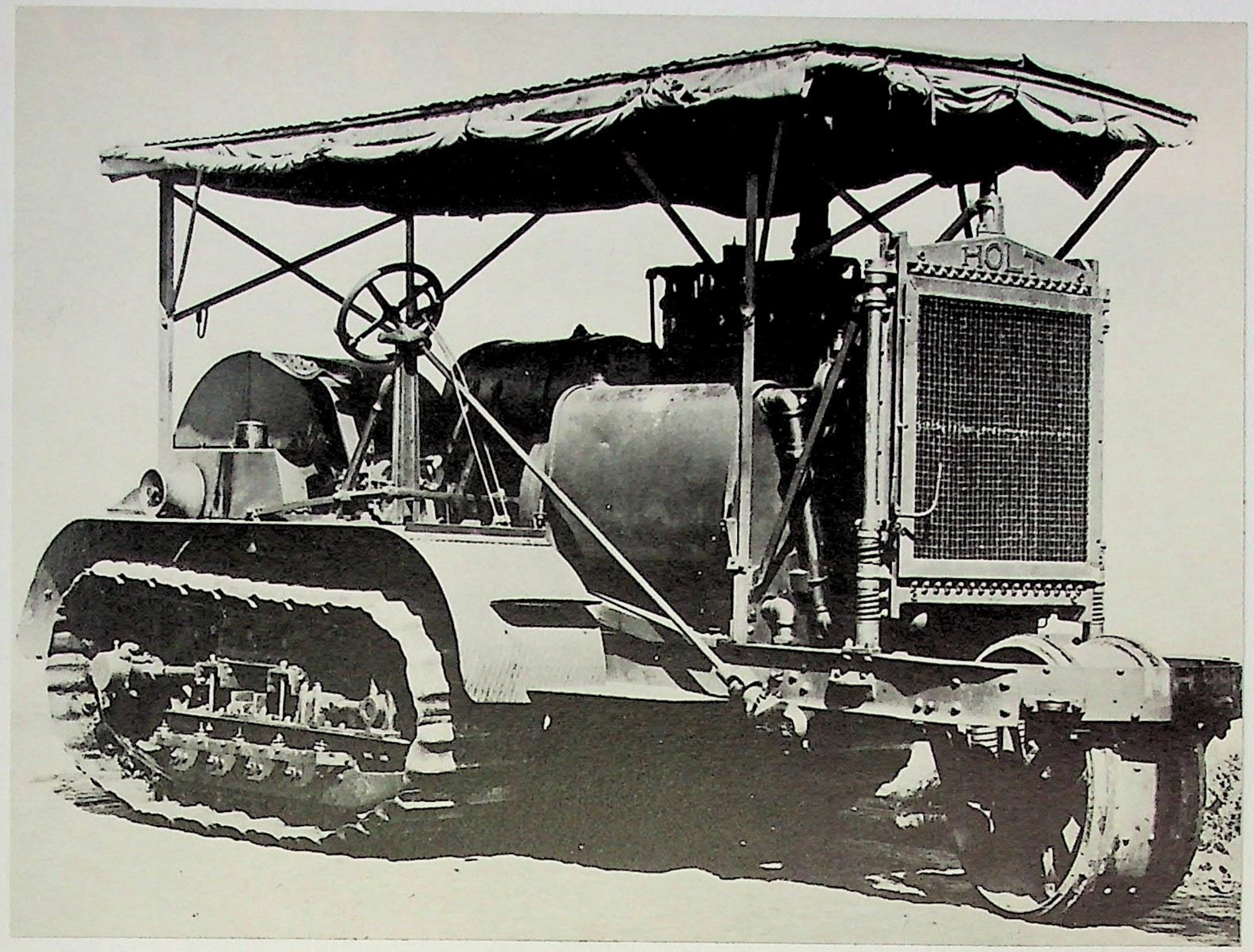
Churchill was very impressed with both ideas and promptly set up a Landship Committee to investigate them. By March 26th, Churchill authorized the construction of twelve tracked and six big wheel landships. The big wheel design had been scaled down by the Committee in the intervening months to more practical 15ft. diameter wheels.

The tracked vehicle was shown to be impractical due to its size, over 40 ft long, which was too big to negotiate lanes in France. The drive system was also over-complicated and the whole machine underpowered. The prototype was handed over to the army for use as a flamethrower but never saw service. An articulated chassis was now deemed necessary and a R.N.A.S. officer was sent to the U.S.A. to purchase two Bullock Creeping Grip Caterpillar tractors which would serve as a basis for the design. An order was also made for lengthened Bullock tracks as the standard ones were a little short for crossing 5 ft. trenches and surmounting a $2\frac{1}{2}$ ft. parapet - the minimum performance characteristics set by the committee. The Bullock tractor had been chosen as a suitable machine following demonstrations of its capabilities in test on Greenhithe Marshes.

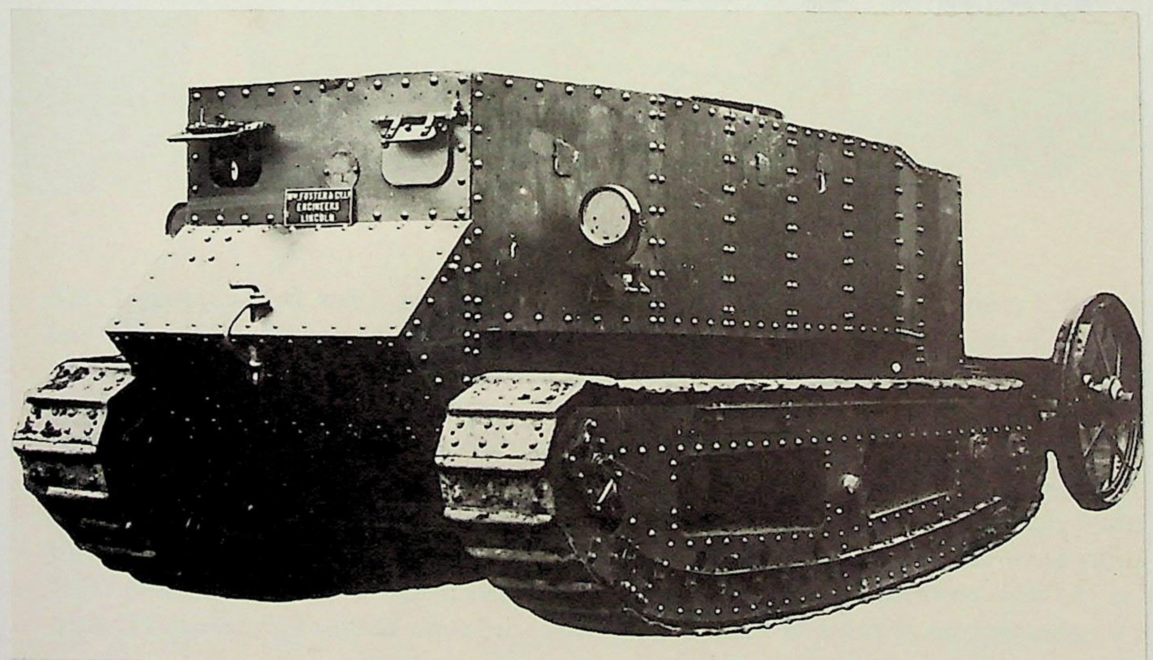
Meanwhile, the 'big wheel' landship project was abondoned after construction of a full size mock-up. It was found to be too big to be practical. It was finally cancelled in May, 1915. The articulated vehicle was also doomed. Testing showed that the stresses caused on the joining coupling were too great when the vehicle was crossing trenches and it was still too unwieldly. It was decided to develop a landship which would be equivalent to one half of the articulated vehicle. Work started on 22nd July, 1915.

By 11th August, construction had started on the 'No. 1 Lincoln Machine'. (See illustration). It consisted of a box-like body of boiler plate, a dummy turret simulating a revolving turret with a 2 pdr. gun. A 105 h.p. engine was used, with the extended Bullock tracks and suspension units. The overall height was 10 ft. 2 ins. with a weight of 14 tons. A Steering tail consisting of two $4\frac{1}{2}$ ft. diameter wheels was fitted to add stability and aid steering. The first trials were on 10th September, 1915 and it was immediately obvious that the tracks were inadequate for such a large vehicle. The track centres were narrow, the grip was poor and the tracks tended to shed. Tritton and Wilson (designers) noted the faults and set about designing an improved track/suspension system. The result was a much simplified form of track which became standard for all British tanks of the war. The new vehicle 'Little Willie' was completed on 15th December but, by that time, had been outmoded due to the new flood of ideas.

As far back as September, when the original 'No. 1 Lincoln' was running trials, Wilson had perfected the idea which eventually



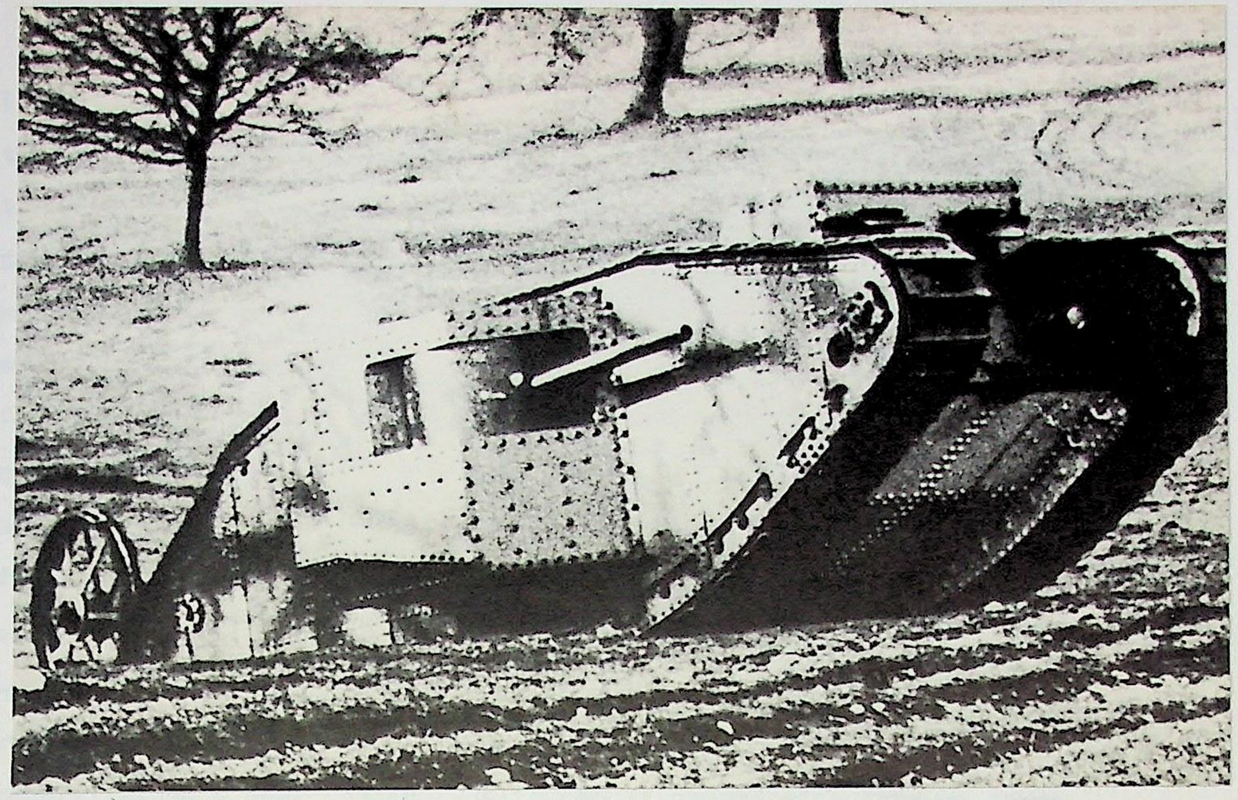
A IO ton American Holt tractor, inspiration for first tanks.



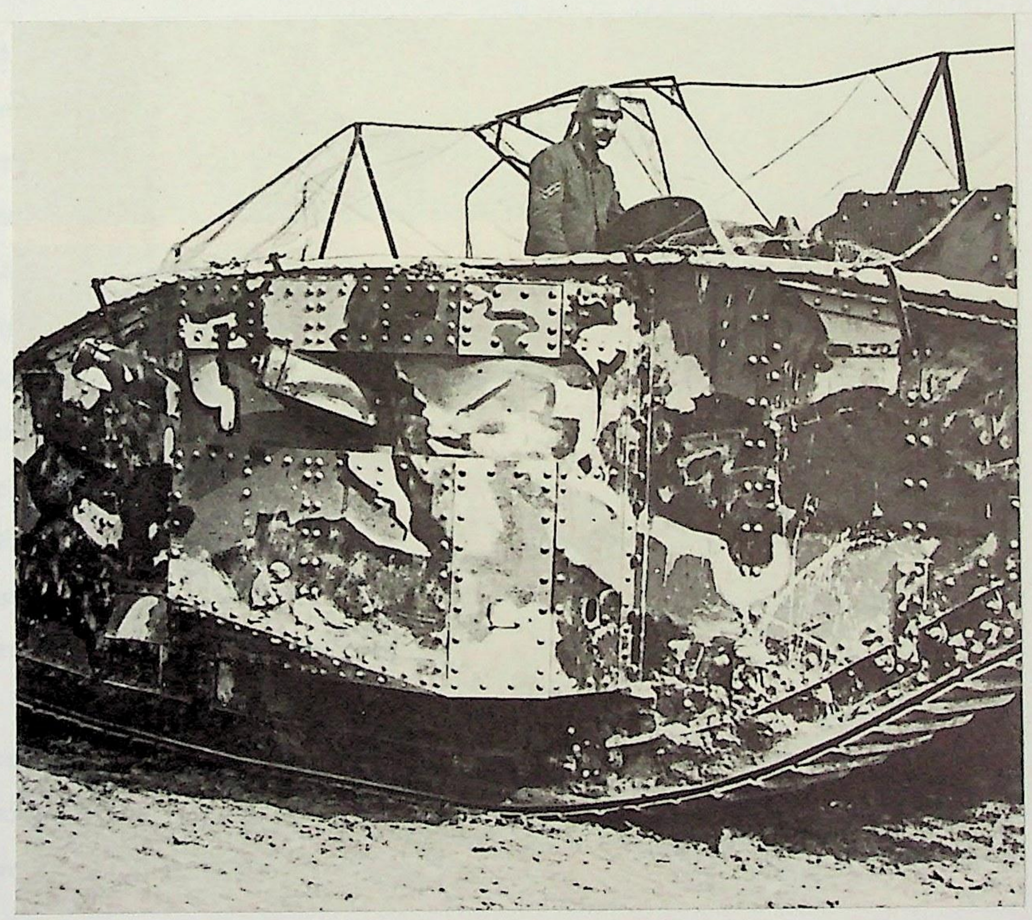
'Little Willie' - the first British tank - outmoded by the time it was completed.

evolved into the production tanks. One of the major drawbacks with the 'Lincoln machine' was its instability. It was at risk of over-turning when tackling a $2\frac{1}{2}$ ft. parapet and the standard German parapet was 4 ft. high. The 'Big Wheel machine' had been designed to cope with this height. Wilson drew up plans for a vehicle which retained the body of the 'No. 1 Lincoln Machine' but carried the track around the full height of the hull in such a way that the lower half was shaped approximately like the arc of a 60 ft. diameter wheel. This integrated the advantages of the 'Big Wheel' idea with the compactness of the tracked vehicle. The armaments were placed in sponsons, one each side, to keep down the height and reduce the centre of gravity. The final result was 'Big Willie' or 'Mother' which was first run on 3rd December, 1915. It was the familiar lozenge shaped vehicle with two 6 pdr. guns and 10-12 m.m. armament. It was about this time that the word tank was adopted, for security reasons. To answer the workers who could not avoid seeing the new vehicle, it was described as a 'water carrier' tank, which was shortened to 'water tank', then to 'tank'. By 12th February a production order for one hundred tanks based on the 'Mother' design was made. In April, this order was modified with the result being that half were to have all machine gun armament, to provide protection for the 6 pdr. vehicles against attack from infantry and also for chasing retreating enemy infantry. The 6 pdr. vehicles would then concentrate on enemy big guns, fortifications and defences. These vehicles (Mother) were known as 'males' and the machine gun versions as 'females'.

The MK1 was the next improved version and this type was used in the first ever tank attack at Flers-Courcelette on the Somme in September, 1916. It differed from 'Mother' in that the boiler plate was replaced with armor (all riveted construction). There was a raised cupola at the hull front for the driver and commander, who also acted as brakesman. A sponson on each side carried the armaments in



Male 'Big Willie' with 6 pdr. gun; note the body of 'Little Willie' between the tracks.



Female MK I with machine gun; note wire bomb roof.

limited traverse mounts. The sponsons could be unbolted for transportation to reduce weight and the tank width. They were often towed behind the tank in a trailer on confined routes, such as country lanes for the same width reason. The removal and replacing of the sponsons was a difficult task, each weighing 1 ton 15 cwt., as they had to be manhandled. There was a round manhole in the roof which was used for observation. Doors in the rear of the sponsons were used for getting in or out. A 'bomb roof' and 'steering tail' were other features peculiar to the MK1. The former consisted of chicken wire on a wood frame and was intended to prevent grenades from lodging and exploding on the roof. It was found in practice to be hardly necessary, and was soon discarded. The 'steering tail' was intended to aid steering and add stability. It enabled the vehicle to be turned without necessitating a gear change. Although it proved effective on roads, it was a hinderance cross-country, often getting stuck in mud or craters; for this reason, it was discarded on later models.

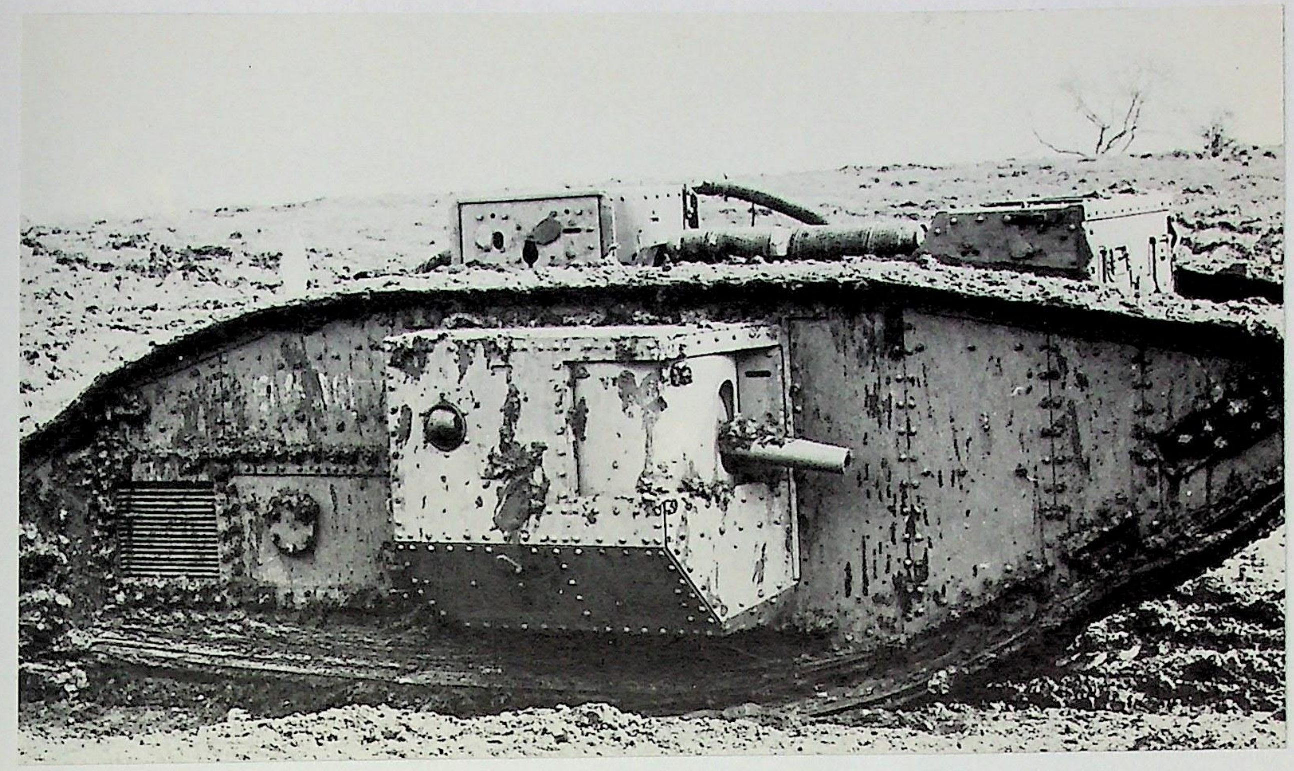
The 105 h.p. Daimler engine was centrally mounted and had a two speed differential drive. The drive sprockets were situated at the rear of the tank. The fuel was supplied by a gravity feed system and this often led to starvation when the tank was reared at angles. The vehicle could be steered using two methods, the first was by applying the brake on one side, but this was very tiring and bad for the brake. The other method was to change gear to neutral on one side and to engage first or second on the other. Then the clutch would be let in and the vehicle would lurch forward. Four men were needed for this operation, two gearsmen obeying hand signals from the driver and the brakesman/commander. When the turn had been achieved, the gears had to be changed again for straight running.

The MK1 was a roomy but extremely uncomfortable vehicle. The only vision devices were slits or flaps, ventilation was poor and the tracks were unsprung, giving a bumpy ride. Communication was crude.

Each tank in action had two carrier pigeons, other than that, flags or voice were used. There were no exhaust pipes fitted, the exhaust being directed straight out through the hull roof. The MK1 was followed by interim MK II's and III's; these were basically the same as the MKI, the only differences being thicker armour and widened track shoes. By the end of 1917, MK I - III had been replaced and were converted into supply tanks, the guns being removed to increase storage space. Others were converted into field offices, one sponson holding the wireless equipment, the other acting as office space. The MK IV moved in to replace all earlier MK's.

The MK IV retained the engine and transmission of the earlier MK's, but incorporated many other refinements in the light of battle experience. The most important of these was the externally mounted fuel tank with pump which was fitted between the rear horns. This improvement reduced the fire risk, the fuel tanks were previously within the hull, and guaranteed fuel supply to the engine, no matter what position the vehicle was in. There were smaller sponsons which could be swung inboard rather than removed. An exhaust pipe and silencer were fitted to the engine, this hugely increased comfort within the vehicle by reducing the fume and noise level. The calibre of the 6 pdr. was reduced, thus increasing its manoeuvarability. The armour thickness was increased to 12 m.m. since the Germans had developed an anti-tank rifle which could penetrate the thinner sides of the MK I.

The MK IV was numerically the most important tank of W.W.I but, by the fortunes of war, it also became the most important German tank. Captured MK IV's were refitted and used to equip four new tank companies in December, 1917. These supplemented the existing three designs with the German's own hastily contrived A V. The problem throughout all the MK's had been the transmission system and, with the MK V, this was largely overcome.



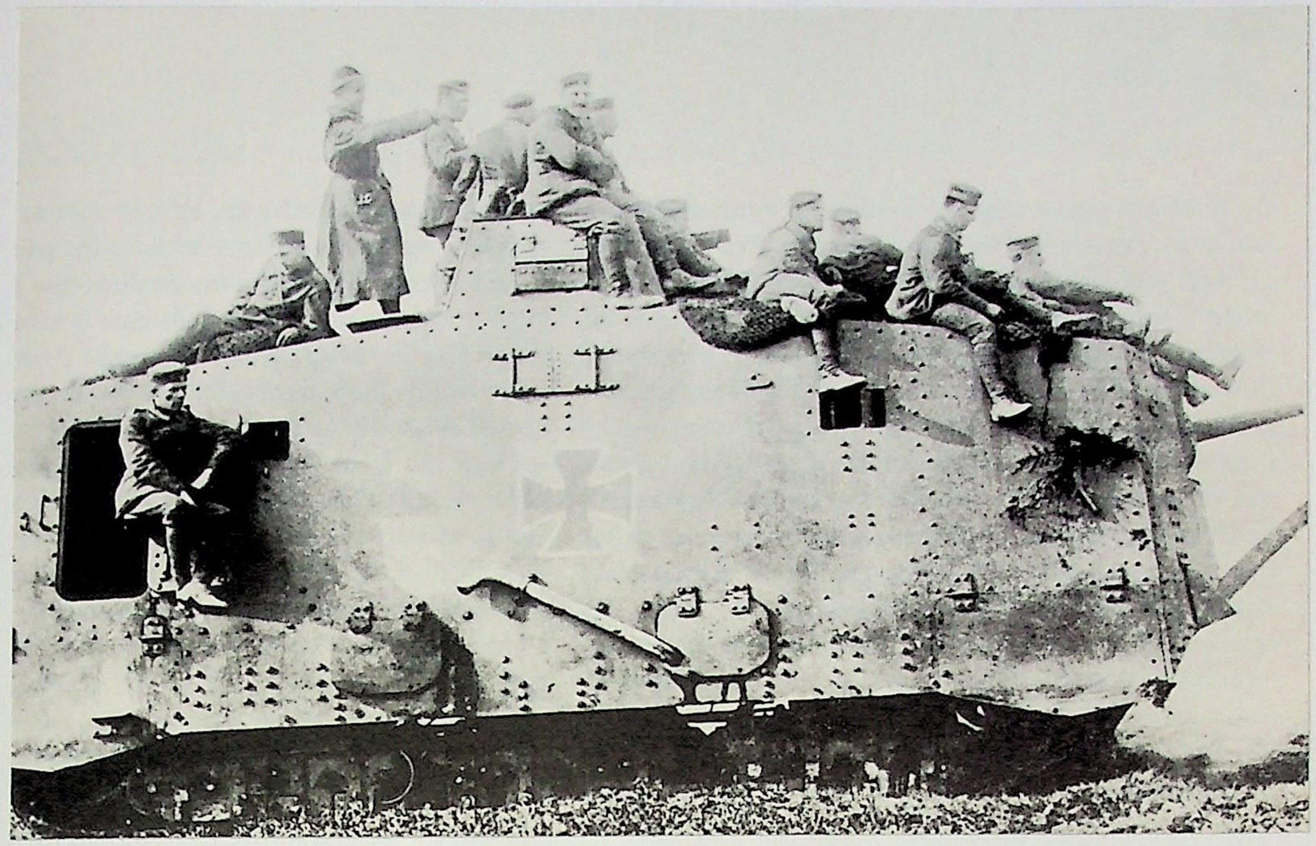
A British MK V - all gear-changing done by one man.

A knocked-out MK IV, doubling as an observation post.

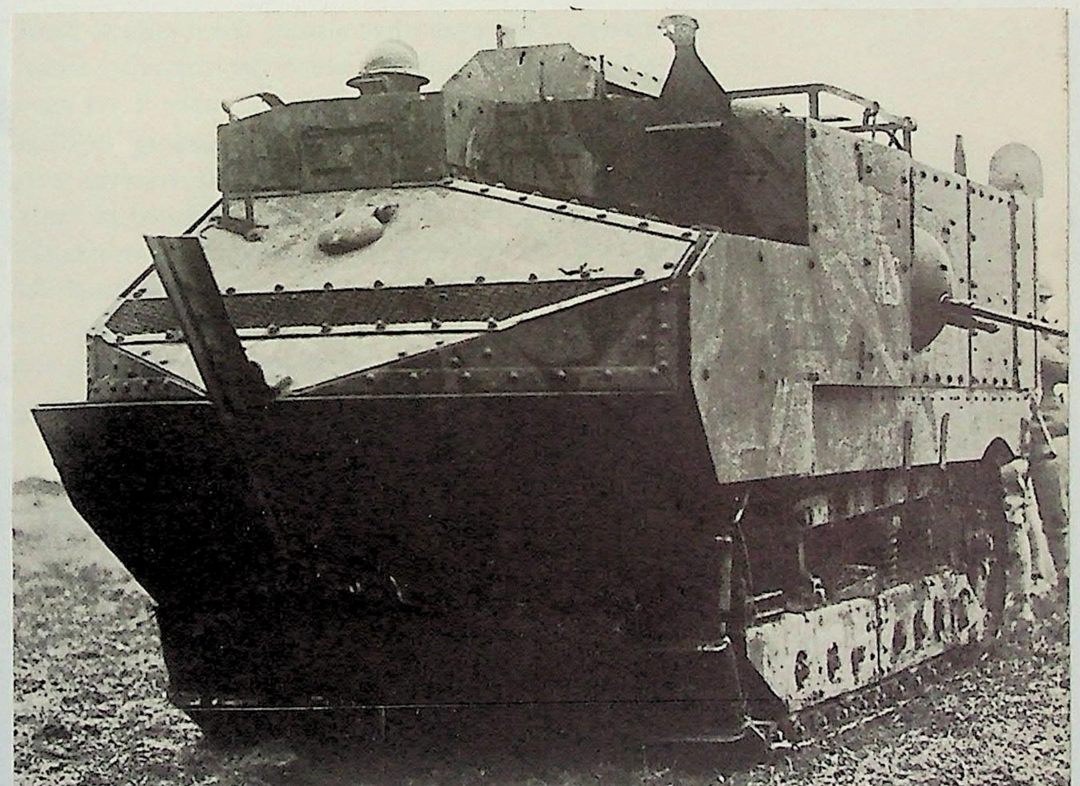
The mark V used an epicyclic gearbox with four speeds. This meant that the gear changing could be done by one man - the driver - with consequent improvement in vehicle control and handling. It also had a raised cupola at the rear which gave infinitely better vision from the interior. This also had flaps which gave access to the unditching beam chained at the extreme rear of the hull. A semiphore arm was fitted aft of the cupola and an additional machine gun in the flat plate at the rear.

By late 1917, there was a demand for increasing the 8 - 10 ft. trench crossing ability of the lozenge shaped tanks. The initial solution offered was the 'Tadpole Tail', longer rear horns to replace those existing. These would be made in kit form and fitted to the existing tank hulls. The tail increased the vehicle length by 9 ft. but lacked rigidity and was never adopted for service. The other, and adopted solution, was cutting the existing tanks in two and slotting in 6 ft. sections of plate. This gave the desired increase in ground contact as well as increasing the internal capacity. Up to twenty five infantry men could be carried and this troop carrying tactic was tried at the Battle of Amiens in 1918. Due to poor ventilation, however, the troops were in no condition to fight when they disembarked. After modifications, it became known as the MK V and was used for troop and storage carrying in the war's closing months.

It is significant that neither the French or Germans procuced successful heavy tanks in W.W.I. The German A V tank and the French St. Chamond and Schneider types simply followed up the first idea of putting armour over the chassis of a Holt tractor. This led to cumbersone top heavy vehicles which lacked traction and grip, were unstable and vulnerable. They would 'belly' and be stranded across a trench.



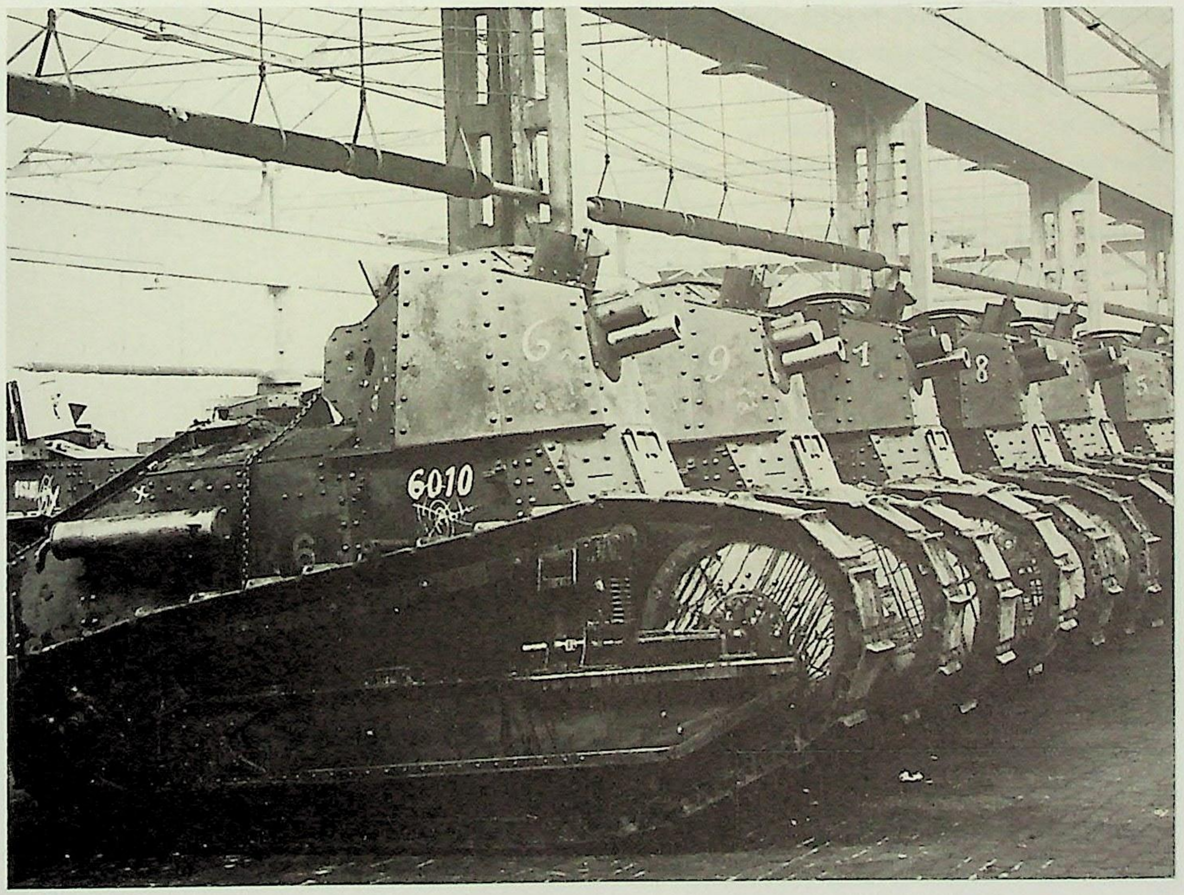
German World War I tank - Production consisted of 20 of these cumbersome A & V 'land fortresses'.



The unwieldly 23 ton French St. Chamond.

Although the French were not as successful in evolving heavy tanks, they did make a major contribution to development of the tank by way of their light tanks, the Renault. The design was revolutionary in many ways, and it adopted the now normally accepted tank lay-out right from the start - that is a traversing turret on the hull top and the hull itself divided into three sections, from front to rear, driving compartment, fighting compartment and engine room. The majority of tank designs produced since then have featured such a layout.

The Americans played no part in the initial evolution of the tank concept. After and during W.W.I., they stocked their armoured divisions with British designs, often making them under licence. J. Walter Christie was the first great American tank innovator and his fast tank concept and suspension system had a great influence on late '30's design, especially the excellant Russian T-34.



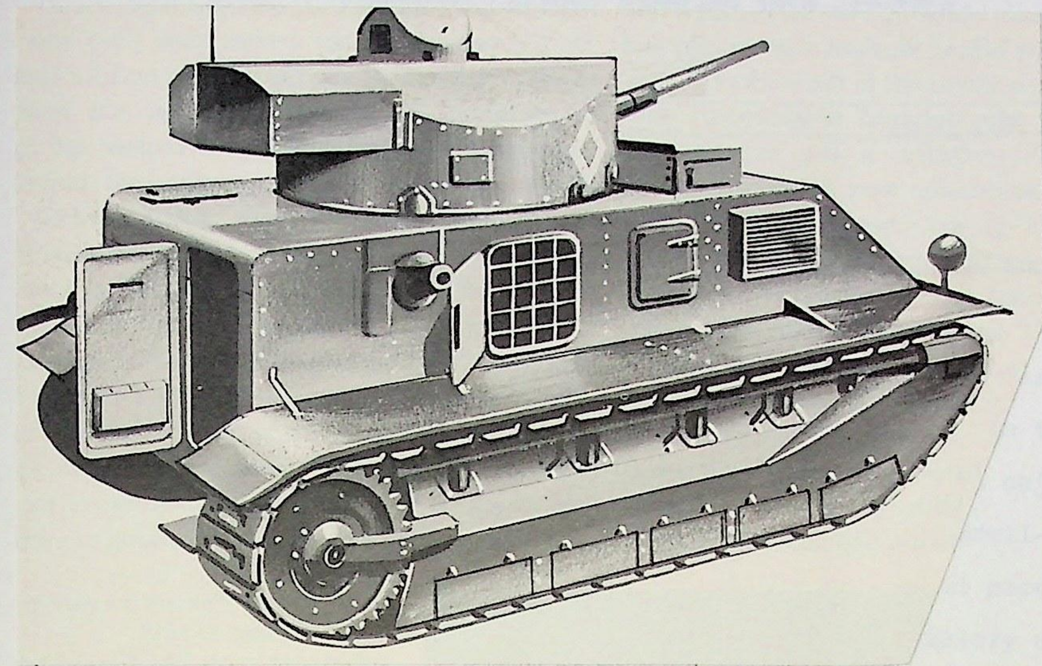
The revolutionary French Renault FT light tank.

THE INTER-WAR YEARS

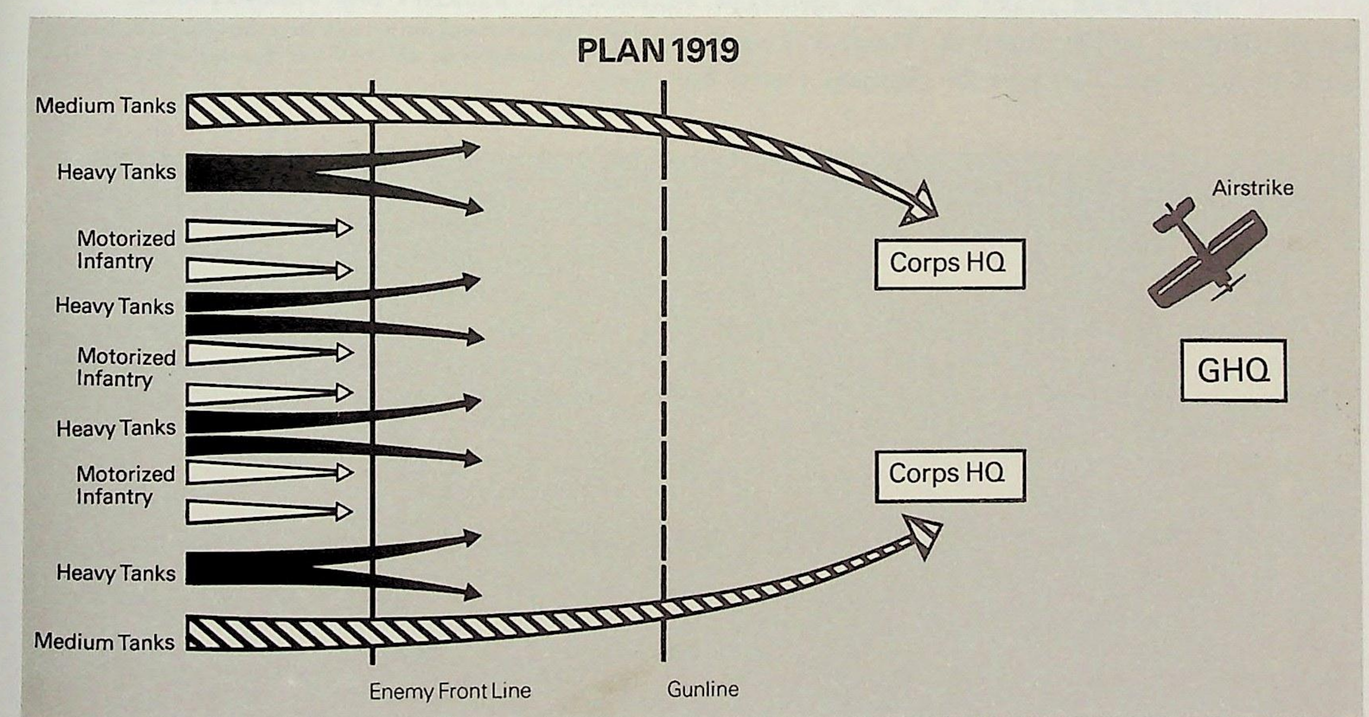
The development of tanks and tank warfare would have been much more rapid had the First World War gone on and allowed Major General Fuller's 1919 plan to be implemented (diagram). Tank and aircraft deployment would have been seen on an unprecedented scale. The plan envisaged the use of fast medium tanks, which would, with the aid of air support, advance far ahead of the main body and head for the enemy's headquarters behind the lines. Slower heavy tanks and motorized infantry would then fight their way through, again with air support. The fact that the plan was never needed meant that all the questions related to the strategic potential of these new weapons were left unanswered and, consequently, they provided a forum of debate for many years, thus retarding Britain's actual progress in the field of armour.

France had ended the war with the biggest stockpile of tanks and, at this time, led the field in tank tactics and deployment. However, the bulk of France's 3,000 tanks consisted of the Renault FT which was suited only in an infantry support role. This fact, coupled with the severe economic climate, meant that French progress in this field was retarded for more than a decade. It is ironic that the Renault FT, although an effective tank in itself, became a millstone round the neck of the French.

In Britain, the Royal Tank Corp, made a permanent body in 1923, received the Vickers I, its first post war tank, in 1924. In shape, it stands between the lozenge shape of the World War I and the low profile of the modern battle tank. It was the first tank in the British Army to have all-round traverse and geared elevation of the gun. The gun was a 3 pdr. but was unable to fire a high explosive shell. Fire power was, in part, sacrificed for speed (15 m.p.h. with a radius of 150 miles) and, as such, it was the first tank which would



Vickers I - First Post war British tank.



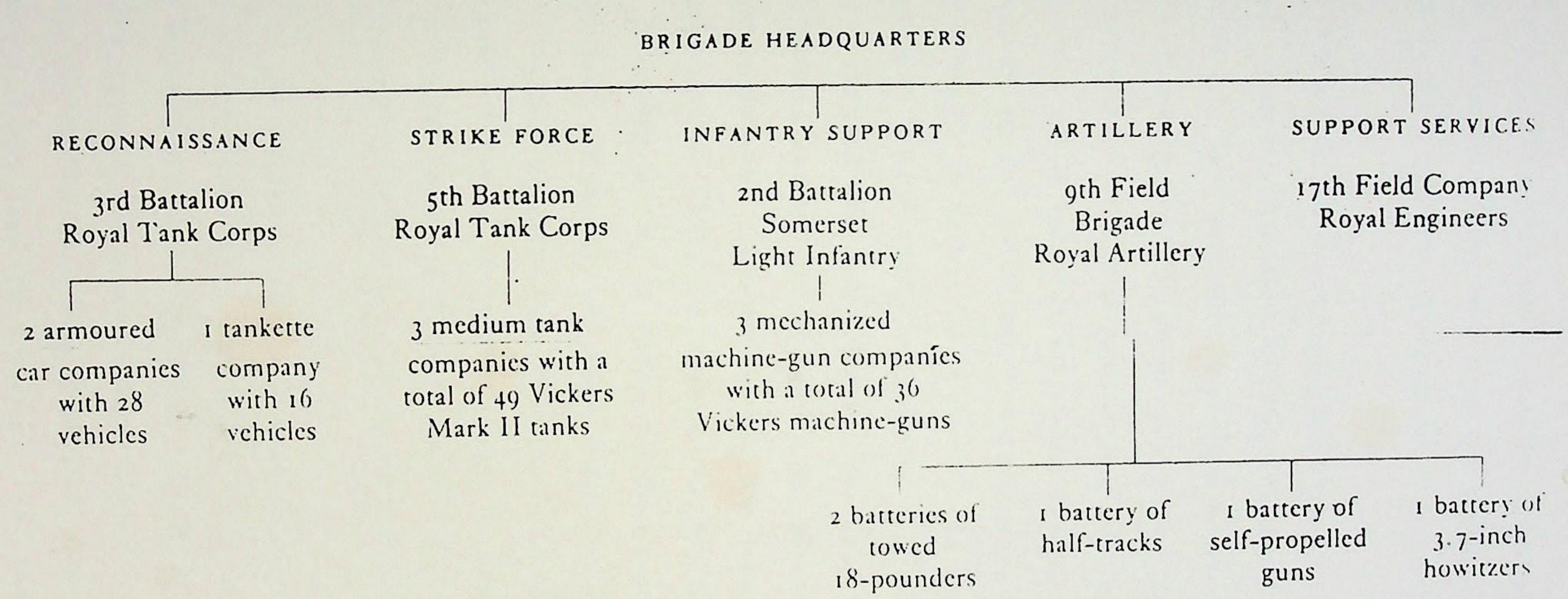
Fuller's 1919 Plan - the cause of much debate.

have been able to translate Fullers theories into practice.

Another major figure in tank tactics was Basil Liddell-Hart, Military Correspondent for the London Daily Telegraph. He was responsible for the concept of 'Indirect Approach' in which he evolved a method of attack which was designed to turn 'opportunism into a system'. Liddell-Hart saw a moving 'torrent' of tanks which would attack a fortified front along the line of least expectation, sapping, crumbling and overwhelming strongpoints before pouring through to achieve strategic exploitation behind the enemy's lines, the object being to paralyse the 'brain' of the opposing forces. Liddell-Hart believed that this would be achieved through the persistant pace and momentum of the advance. He envisaged infantry and artillery as providing support to the armour, the former being motorised to keep up with the advance. Additional support would be provided from tactical air forces.

The conservative military hierarchy finally gave way to Liddell-Hart and Fullers' persuasive writings and, in 1927, sanctioned the creation of an 'experimental brigade' to test the new theories (diagram). Demonstrations took place on Salisbury Plain with observers from U.S.A. and Europe in attendance. The trials were an obvious success and the observers returned home satisfied. The force incorporated all the units of the different arms that had been mechanised by that date. It contained every important element of armoured formations of the future - with the exception of specialised vehicles i.e. bridge layers, mine clearers etc. Although the force was at little more than brigade strength, it was entirely self-sufficient, even having its own R.A.F. air support squadron. Despite the success of this force, the much needed reform in doctrine was not undertaken due to the disastrous worldwide economic conditions. The official report on British tank experiments was completed in 1929 and entitled

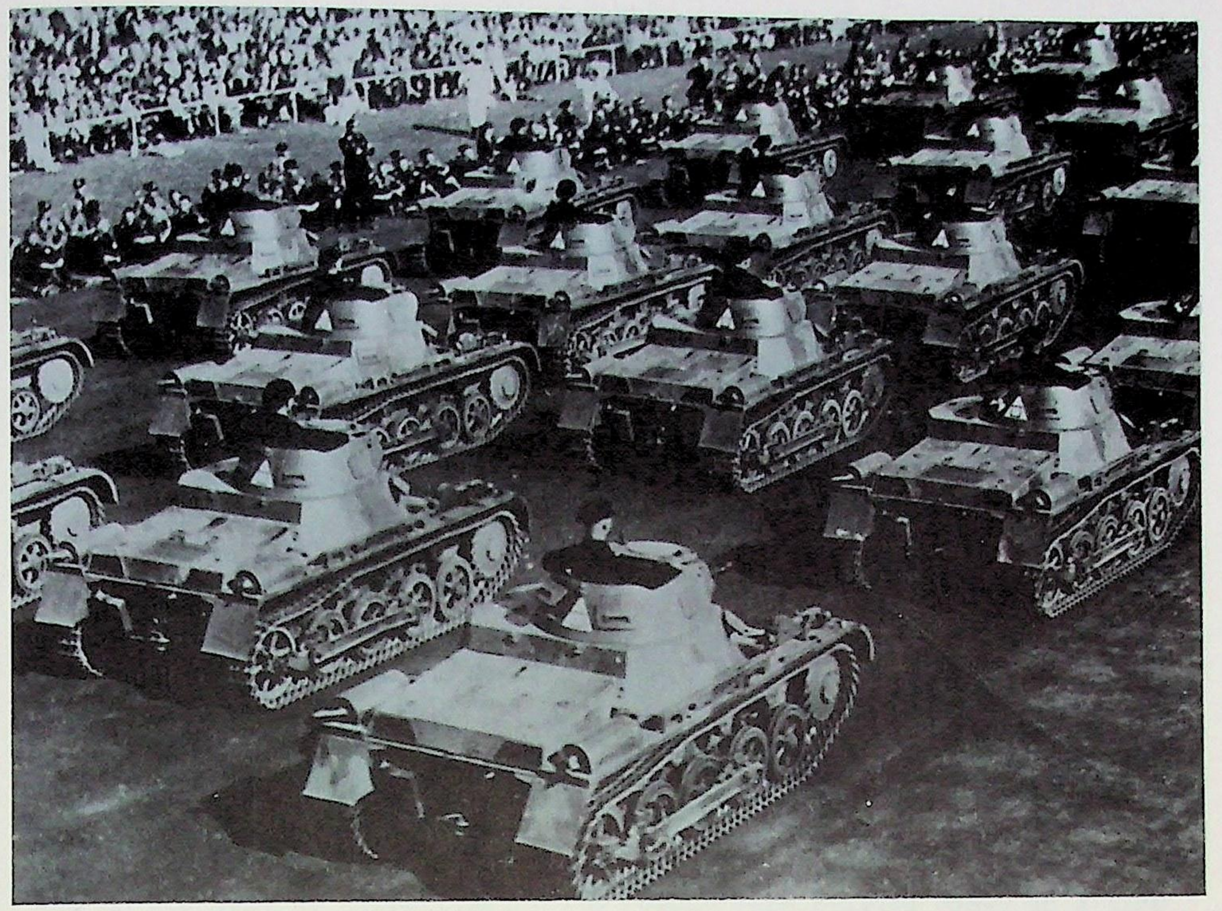
Mechanised Force



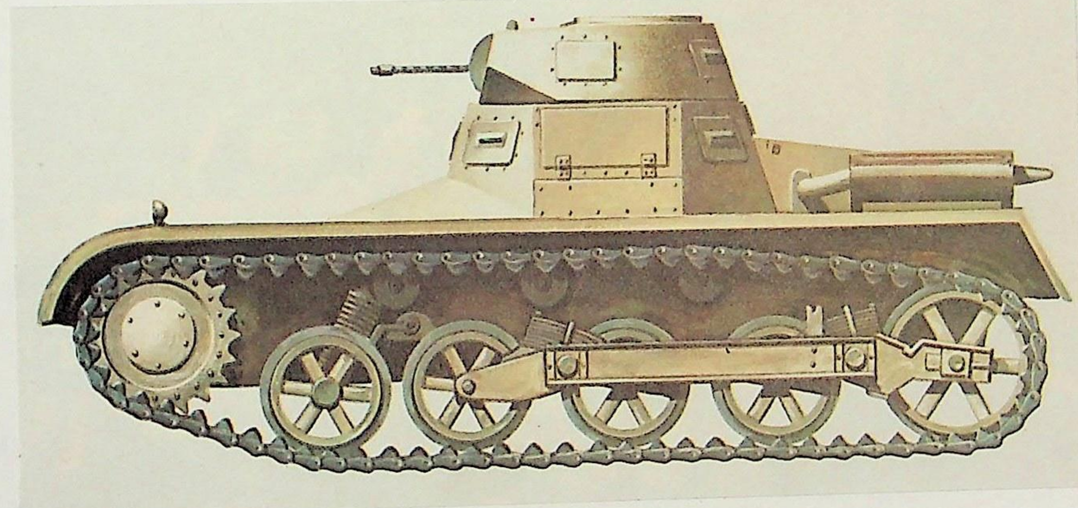
Mechanized and Armoured Formations. It was given a restricted circulation but its contents were leaked to the press and more importantly, they were reproduced in their entirety in Germany. It was there that they came into the hands of Germany's leading figure in tank warfare, Colonel Heinz Guderian.

The German Army was restricted to 100,000 men and was denied the use of tanks, aircraft and heavy artillery under the Treaty of Versailles. This was more advantagous than at first might be thought because it meant that the Germans were not left with or held back by large amounts of obsolete equipment. In the early 1920's, the Germans set about secretly acquiring tanks. This was initially done with the co-operation of the Bofors Company in Sweden who built small quantities of the German LK II tank. At about the same time, the Germans made a pact with the Soviets, the intention of which was to mutually benefit the countries in the field of armour development. A tank school was set up in Kazan, far beyond the scrutiny of the Western overseers. At the outset, the Swedish built tank was assembled at Kazan but, in 1930, the Russians purchased a British Carden Lloyd light tank from which the PzKWI was developed (Panzer MKI). This was a light tank whose only armaments were two 7.92 m.m. machine guns. It was lightly armoured but capable of speeds of up to 22 m.p.h. and had a crew of two. When Hitler came to power in 1933, he was greatly impressed with Guderian's theories on mechanised warfare and, by 1935, three Panzer divisions were in existence with more planned.

In the United States, the National Defence Act of 1920 merged tanks with the infantry; the budget for tank development for that year being 500 dollars. It was under such a climate that American tank doctrine sank to its lowest ebb. Little interest was shown in the work of Walter Christie, the design of a revolutionary suspension system for tanks (see under T-34). The Americans did construct a few



Panzer II



Panzer I

experimental vehicles on his suspension principle but it was the Russians who took advantage of the advanced system and purchased two of these vehicles, the M-1931, and eventually developed through the BT series, the T-34.

By the early 1930's the Russians had developed a powerful mechanised army and were constantly developing new tanks. By 1935, the Soviet Union possessed the largest mechanised force the world had ever seen, but the Stalin purges which followed, decimated the ranks of 'progressive' officers and, with them, went progressive thinking. Their place was taken by the old conservative cavalry officers with the result that the mechanised corps were disbanded and the tank was relegated to supporting the rifle divisions.

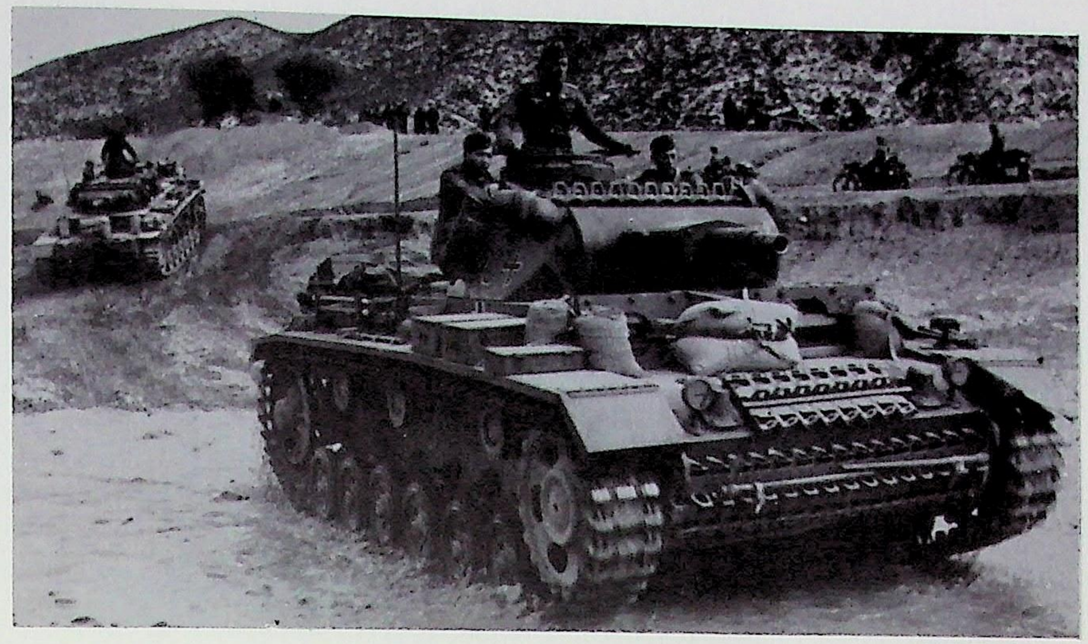
Meanwhile, in both Britain and France the tank still remained low on the list of priorities. The French were relying heavy on a line of fortresses known as the Maginot Line and the British had acquired a seemingly unending faith in the bomber. They did, however possess four main types of armoured vehicle:-

1. The tankette - a sort of armoured tricycle used for machine-gun and mortor transport and firing.
2. The light tank - used for reconnaissance, a small fast tank which would be lightly armoured and armed e.g. Vickers light MK IV, comparable to Panzer I.
3. The cruiser tank - these vehicles would be quite large but still lightly armoured and armed but capable of good speed, and used for exploitation of weaknesses in enemy lines.
4. Infartry tank - slow, heavily armoured and lightly gunned vehicles designed to give close support to infantry.

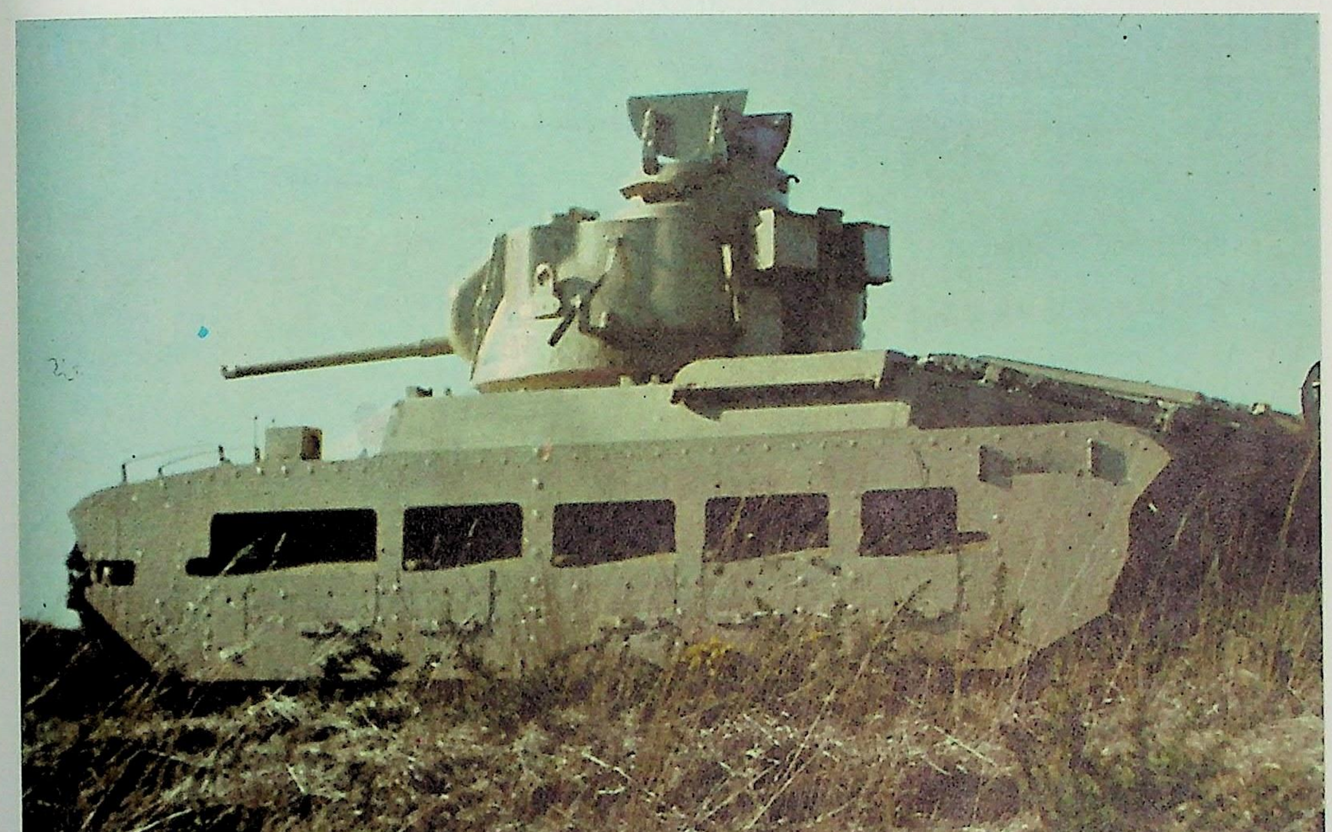
All these machines reflected the current thinking, that the anti-tank gun was superior to the tank and so, there was no development of heavier armour along the lines the Germans had taken. Generally the British tanks relied on mobility rather than protection. By 1930, this attitude had waned slightly and an order was put in for a new heavy infantry tank (Infantry Tank MK I) but this, although it had heavy armour protection, had a machine gun for its main armament and was quite inadequate for a combat situation and, although used in France in 1939, it was rapidly followed by the M.K. II (Matilda). This was merely an upgunned version, whose main armament was the excellent 2 pdr. gun, good for its time, but not capable of firing high explosive shells). To sum up, at the time of entry into World War II, the British tanks were totally unsuitable for any battle situation, which was clearly shown by the Panzers.

Although the German's main tank was the MK I, which was more suited to training than fighting, they had more tanks planned, and had a distinct advantage over the British and French in that they had armoured divisions which contained infantry and support formations capable of operating at the speed of the tanks. As early as 1935, the Germans saw a need for a medium tank with a 75 m.m. gun; the Panzer MK IV was the result, the tank that was supreme in Europe until the invasion of Russia where it was made obsolete overnight by the T-34. By 1935, the Panzer II (20m.m. gun) and III (50 m.m. gun) began to appear in numbers in the armoured divisions.

Between 1935 and 1937, there was bitter controversy within the German high command. General Beck, the Chief of Staff, wanted to follow the French idea of deploying tanks in close support of infantry; a tactic which proved fatal for the French in 1940. Guderian (Commander armoured divisions) successfully combated Beck and went on to form the Panzer Corps, each composed of a Panzer division and a motorised infantry division. The Germans learned much about tactical air support during the Spanish Civil War and with this was experience, with superior equipment and tactics, the Germans entered the war.

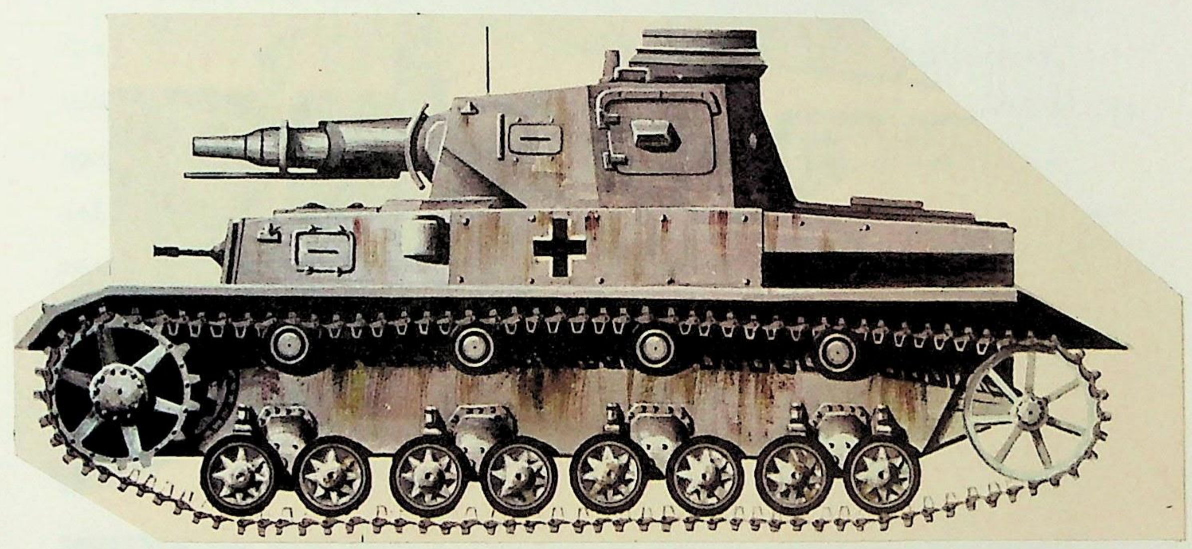


Panzer III



British Matilda

The invasion of Poland on 1st September, 1939 was the first glimpse the world had of the mighty Blitzkrieg.



PANZER MK IV - 1939

BLITZKRIEG

Diagram (A) Phase I - Advance to Contact.

In the opening stage, motor cycles and armoured cars use a smoke screen and close support from their dive bombers to surge towards enemy positions, seek out weaknesses and infiltrate the opposing lines. They are immediately followed by the Mark II Panzers which, in turn, were followed by the more powerful tanks (Marks III and IV) and the motorised infantry carried in armoured half-tanks.

Diagram (B) Phase II - Contact.

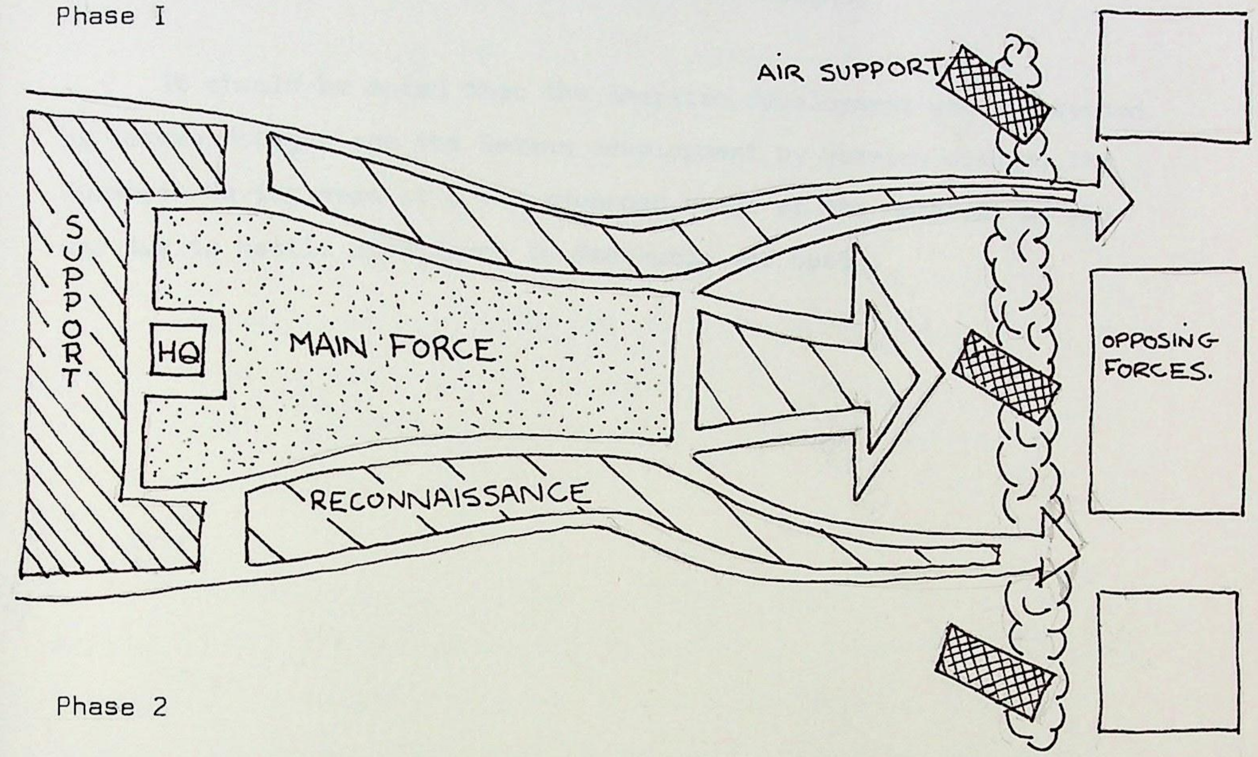
While the outlying enemy units are being engaged by the main force, the armoured cars and motorcycles (recce units) speed on towards the enemy's industrial and administrative centres, which they again seek to bypass, isolating them for the main assault, to be delivered by the infantry and artillery. At the same time, Stukas carry out lightning bombardments, destroying enemy aircraft on the ground, setting fire to factories and disrupting communications.

It should be noted that the initial point of contact with the enemy is at the point they least expect. For example, the French expected the main blow of the German attack north of Namur; the Germans struck south of Namur and through the Ardennes Forest, which the French thought impenetrable by armour. This left the Germans with a fifty mile front to concentrate on, which was manned by reservists and over 40's who had little motor transport and no defence against air or tank assault. The result of hitting this least expecting part was that the Germans were almost immediately in the heart of France and behind the line of French defensive fortresses (Maginot Line). It took the Germans from the 10th May to 22nd June to over-run France using the Blitzkrieg tactics.

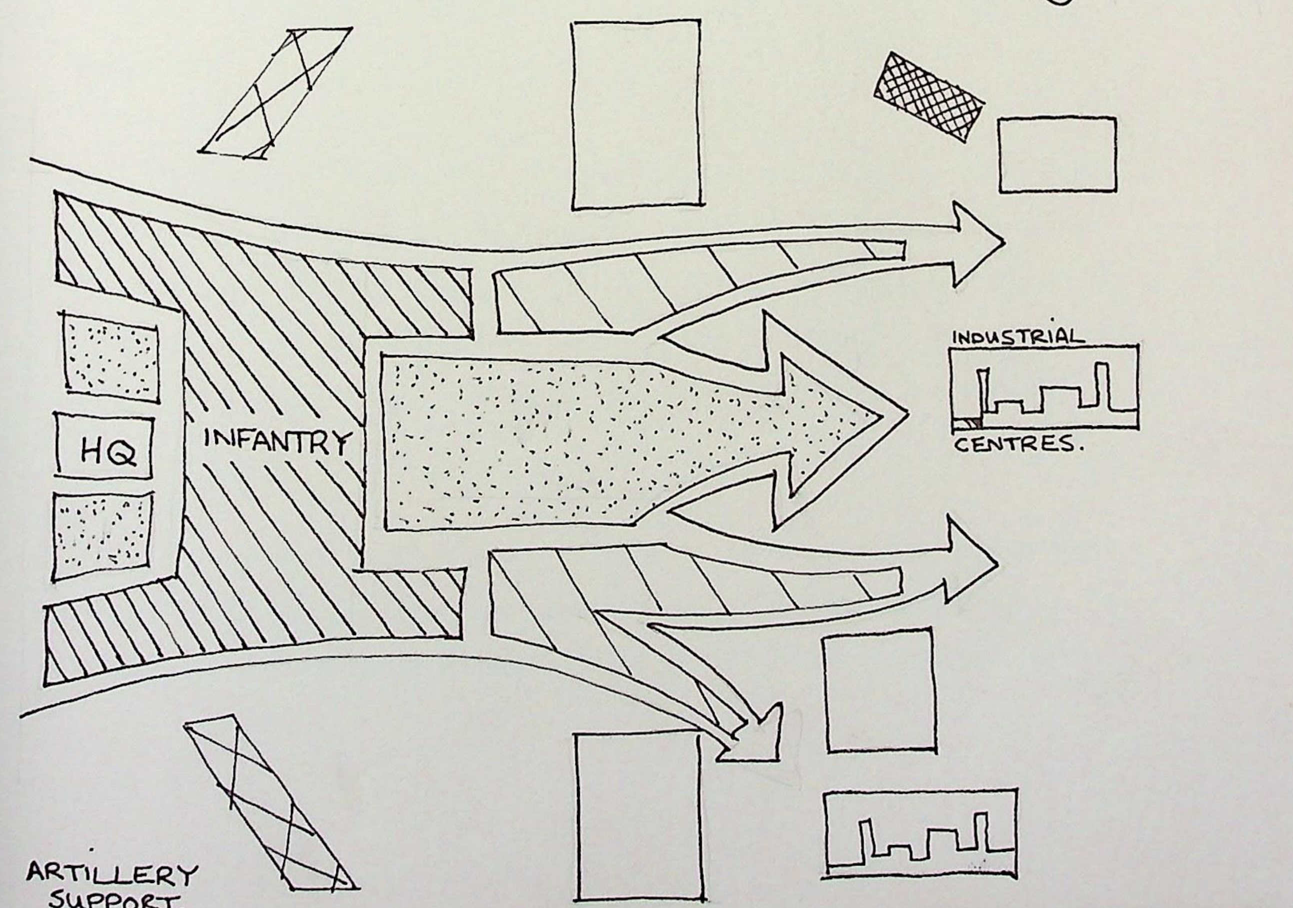
Although the Allies had numerical advantage in the field of armour, they deployed their forces equally over what they considered likely attack points. This meant that the Germans, using the Blitzkrieg tactic, had localised mumerical supremacy no matter where they struck, this being further compounded when they attacked at the least expected points.

Blitzkerg

Phase I



Phase 2



The following three chapters concentrate on the development of tanks in the U.S.A., Russia and Germany during the Second World War, each of which is dealt with separately. The result of the rapid development in these countries during the War Years were tanks (M IV, t)34, Panther) which have heavily influenced tank development since and, in the case of the U.S.A. and Russia, their modern M.B.T.'s are direct descendents of the World War II designs.

It should be noted that the American development was influenced by German designs and the German development by Russian design, the Russians having been at a far advanced stage at the outbreak of the war due to battle experience in Manchuria and Spain.

AMERICAN DEVELOPMENT - THE M-4

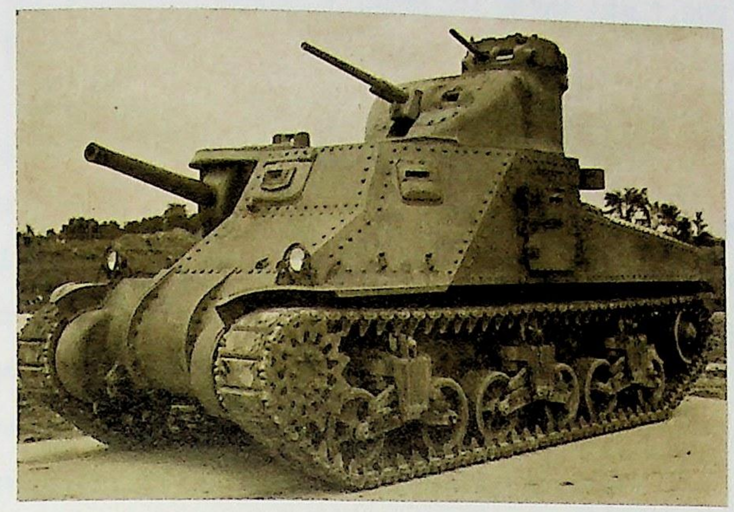
Between the two World Wars no major nation made as little progress in tank development as the United States. Germany, Russia and France built up considerable forces in the 1930's, Britain were advanced in tank warfare ideas if not in the tanks themselves. America had entered the First World War late and the Armistice put an end to her expanding Tank Corps. In 1920 the National Defence Act made tanks an Infantry responsibility, this meant relegation to the lowest defence budget for tank development. In April, 1922, the General Staff finalised the decision with a statement which started:-

> "The primary mission of the tank is to facilitate the uninterrupted advance of the rifleman in the attack. Its size, armament, speed, and all accessories ..... must be approached with the above mission as the final objective...."

This decisively established a definite policy based on the earliest ideas for the employment of tanks, the entire idea being to save money. Between 1920 and 1935, only 35 tanks were built in America, and American tank forces were far smaller than any other nation's.

It was not until the German invasion of France in 1940 that impetus was given to the production of big tanks on a large scale and the result was the M3 Medium Tank (known as the Grant and Lee), which went from drawing board to battlefield in under two years and played a major part in restoring Allied fortunes in the Western Desert.

The M3 was developed from the M2A1 (illustration) which was the product of American tank development up to the late 30's. It reflected the infantry support ideas of the First World War with



The intermediate M3 design.

The M4 Sherman.

machine guns sticking out at all angles, the main armament being a 37 m.m. gun. In August, 1940, an order for 1,000 M2A1 was placed but this was quickly to be revised. Based on staff studies of tank fighting in France, it was noted that the Germans had been using a 75 m.m. gun. This meant that the M2A1 was outmoded overnight, therefore, a recommendation was made that any future medium tanks should be armed with a gun of at least this calibre. It was quickly discovered that the bigger 75 m.m. could not be accommodated in the existing M2A1 turret. An entirely new larger turret would be needed which would impose delays since no turret of the size required had previously been built in America and much work would be needed to overcome design and costing problems.

It was decided that while this work should commence at once, the need for a tank armed with a 75 m.m. gun could be met by mounting the weapon in the hull. This would enable most of the basic features of the M2A1 to be utilised, including the complete unaltered chassis with the same engine and mechinical parts, the hull and superstructure only requiring revision. The turret and 37 m.m. gun was to be retained and offset to the left on the hull top. Thus the M3 was born, always looked upon as an interim design while work continued on the 75 m.m. gun with fully traversing turret - the design later to become the M4 Medium tank or Sherman.

The M3 Medium was fitted with a revolutionary gyrostabiliser. The idea was to maintain the gun at any given elevation irrespective of the pitching of the vehicle as it moved across country. Previously, a tank could only fire with accuracy when stationary. With the gyrostabiliser, a tank could fire while on the move, giving a definite tactical advantage.

M3 - Anatomy

The chassis of the M3 Medium tank was the same as its predecessors, the suspension consisting of three vertical volute bogies, with a rear idler and sprocket in the front. The Wright Continental R 925 nine cylinder air-cooled engine was at the rear with access doors in the hull back-plate. Fuel tanks flanked each side of the engine compartment. The drive shaft went forward under the floor to the gear box situated beside the driver, who sat on the left of the hull front, the driver also operated twin machine guns in the nose. Most of the hull consisted of face-hardened plates of riveted construction. The maximum armour was 50 m.m. on the hull front and turret, the sides and lower hull front being 37 m.m. The turret mounted the 37 m.m. gun with a co-axial .30 calibre machine gun. The turret ring was 5 ft. in diameter and could be traversed by hand or hydrualically. The commanders cupola was normally rotated with the turret but could be rotated independently by hand, if desired.

The roomy fighting compartment was dominated by the 75 m.m. gun in a barbette which had a limited traverse of 15 degrees each side and had elevation limits (-9^{o} to -20^{o}). This gun was both the M3's strength and weakness. While it provided a bigger punch than any previous Allied tank, to bring the gun into action meant exposing the vehicle's high silhouette which, in desert fighting, could have severe or often decisive consequences. With the lack of all-round traverse, the vehicle suffered from the same problems as a self propelled gun; the only way to counter an outflanking enemy was to turn the whole vehicle. Mainly for these reasons there was no time lost in replacing the M3 with the M4 but, for all its defects of design, it was an important addition to British armoury, which had no match for the German Panzers.

The Sherman (M4)

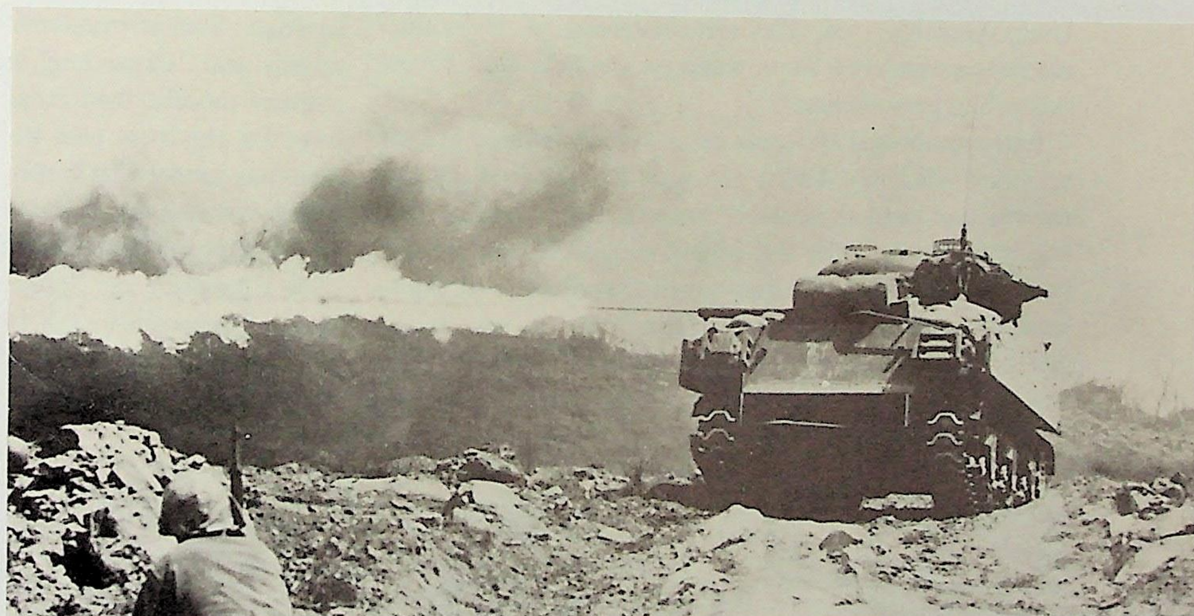
Once the design of the M3 had been completed the M4 design began. The M4 was to have the same engine and chassis as its predecessors, but due to the massive U.S. rearmement of 1940-42, it became apparent that the source of these engines would be insufficient to meet demand, for this reason other types of engines were used and these gave rise to the different production models in the M4 series.

All the M4 series medium tanks (M4, M4A1, M4A2, M4A3, M4A4, M4A6) were of the same general design and size, and carried initially a 75 m.m. gun (as in the M3). This was later increased to 76 m.m. in the quest for more powerful armament, with a number being fitted with a 105 m.m. howitzer to provide a close support tank. About 600 British Shermans were fitted with the powerful 17 pdr. gun to combat the German Tiger and Panther in Normandy, these became known as Sherman Fireflys.

All had identical transmissions, volute spring suspensions and shoe tracks. Other identical units were the turret and turret platforms, gyrostabiliser, combination turret gun mount and .30 calibre bow gun mount. The tank crew consisted of five men. The driver sat at the left bow of the tank, to the left of the transmission. The assistant driver's position was in the right bow, to the right of the transmission and directly behind the bow machine gun. The tank commander was stationed at the rear of the turret, just to the right of the main gun guard. The gunner's station was almost directly in front of the commander. The loader's station was to the left of the main gun.

For each of the five crew stations there was a periscope, all except the gunner's were rotatable for observation in any direction

Sherman's line up at a river crossing.



A Sherman converted to a flame thrower.

and could be tilted to raise or lower the line of vision. The gunner's periscope was connected to the gun mount by linkage that kept the line of vision in constant alignment with the gun as it was elevated or depressed. This periscope was fitted with a telescopic sight so mounted that it could be moved independently of the periscope.

For the driver and assistant driver, direct vision was provided by horizontal slots in the hull front plate which were fitted with heavy protective covers, these slots were deleted in later models. A periscope in a revolving mount in the turret hatch was provided for the use of the tank commander when the hatch was closed. All late production vehicles of the 1944-45 period, however, had a new vision cupola with six episcopes; offering a great improvement over the original arrangement.

Access to the tank was provided by two hatches in the bow and a revolving hatch in the turret. For use in an emergency, a quick opening escape hatch was provided in the tank floor behind the assistant driver. All models had a radio and an interphone system for crew communication. The radio and interphone were shock mounted on a common base located on a shelf in the turret bulge.

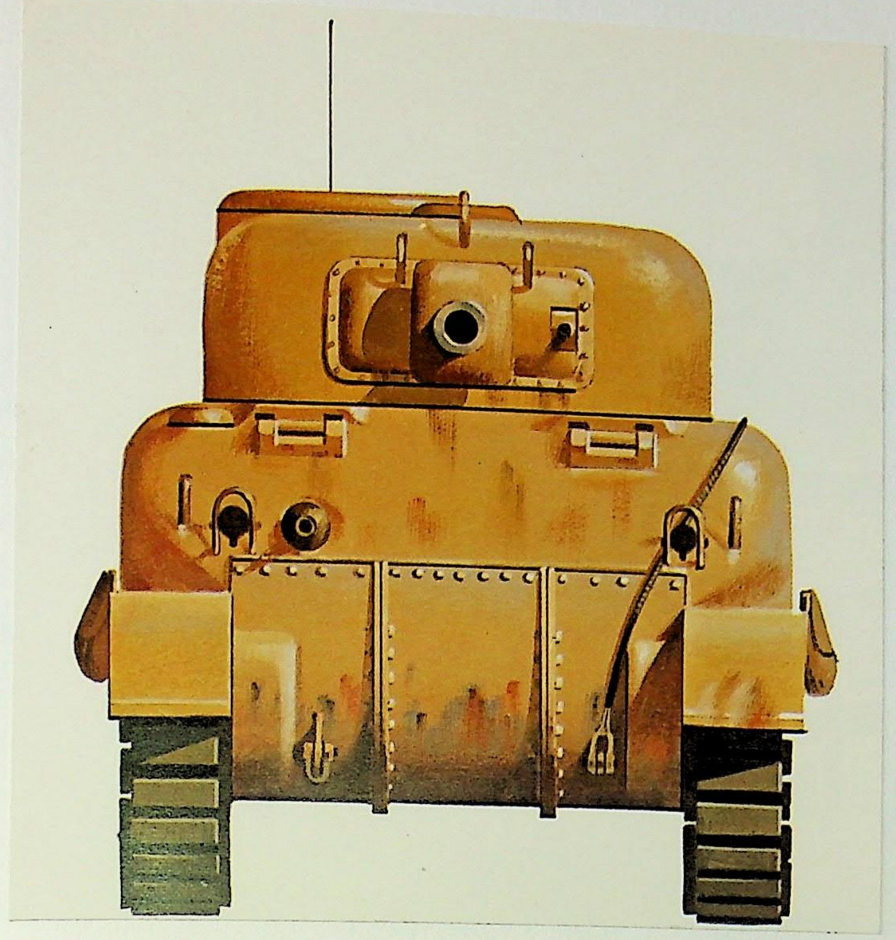
The turret platform, or basket, rotated with the turret, which could be traversed through 360°, either by hand cranks or by electric hydraulic motor. The gun mount allowed the gun to be elevated 25 degrees or depressed by 10 degrees.

The turret guns could be manually elevated or depressed by operating a handwheel. When the gyrostabiliser was in operation, the gun was elevated by hydraulic power which was controlled by the handwheel, and the stabiliser automatically held the gun stable at any quadrant angle of elevation at which it had been laid. The two turret guns were fired electrically by means of firing buttons (foot operated switches) to the left of the gunner. The vehicle was steered by means of levers which operated steering brakes in the differential housing. Braking was effected by pulling back both steering brakes at once. Its armour was similar to that of the M3.

By 1944 the Sherman had reached the peak of its development and it proved more than adequate for the blitzkrieg role for which it was mainly used. The German Army had very suitable defensive weaponry - such as the Tigers and Panthers and, on paper, no Sherman could stand up to either of these, but the U.S. armies had the advantage of supporting air power, adequate reserves and overwhelming superiority of numbers. In these conditions, the tank became a component of a co-ordinated attack scheme. The main requirements were for mobility, reliability and adequate armament and the Sherman had all these. In vast outflanking exercises which avoided the heaviest enemy armour - leaving it for aircraft or tank destroyers - the Sherman was used in an advance on exploitation role.

The Sherman, best known and most widely produced tank in the history of armoured warfare, earns its place in posterity by its success against the fearful German Panzers. From 1942 to 1944, the Crysler Corporation alone built over 18,000 32 ton M4 Shermans. At the height of production, the full tank could be assembled in thirty minutes.

The M4 has been used by the armies of over a dozen nations and could still figure predominently in the Israeli-Egyptian wars of 1967-73.



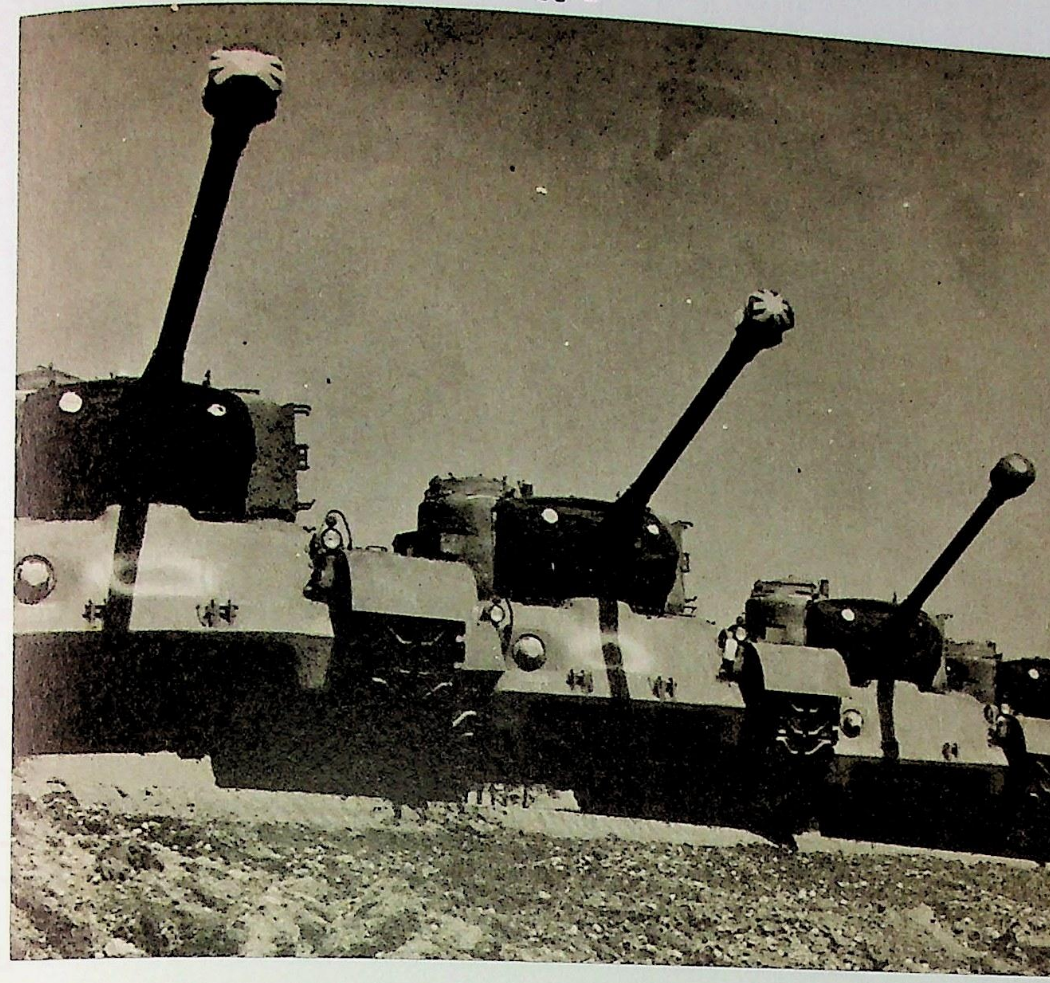
The Sherman

Length	19 ft. 10½ in.
Width	8 ft. 7 in.
Height	9 ft.
Weight	32 tons.
Crew	5
Max. Speed	26 m.p.h.
Range	100 miles.
Armament	75 m.m. M3 (97 rounds) 2 / .30 in. Browning MG's
Armour	25 - 76 m.m.

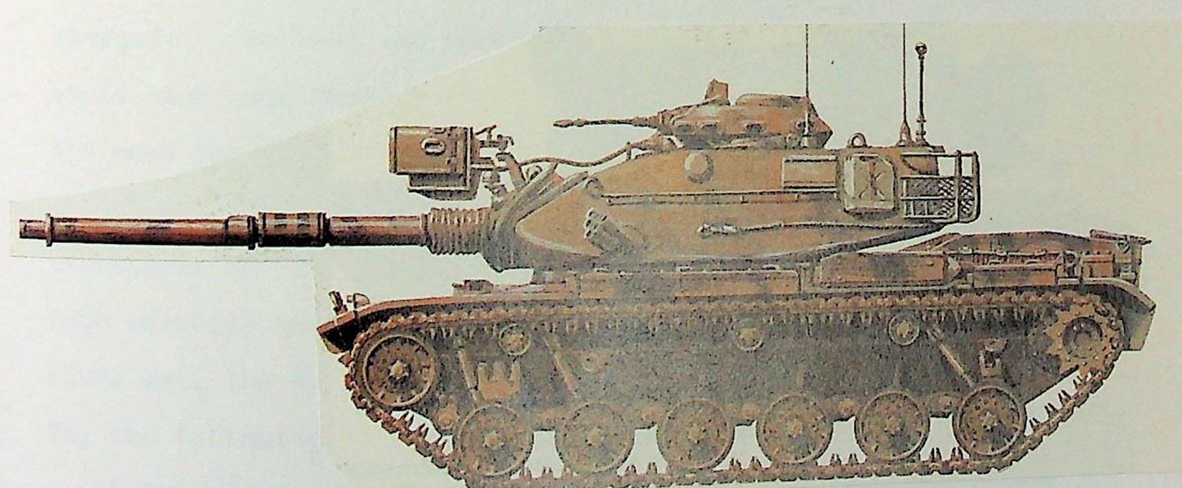
U.S.A. DEVELOPMENT TO HEAVY TANKS

Once the M4 series had reached production, consideration was given to a successor. The Americans appreciated that the Sherman was unlikely to maintain its superiority in 1943. The T20 was the first step on the road to a successor. It was to be more thickly armoured, have a more powerfully sprung suspension, a lower silhouette and a 90 m.m. gun. The General Staff argued that the Sherman could be up-armoured, up-gunned and fitted with improved suspension, so illuminating the need for the T20 and, at the same time, this would cause far less disturbance in the production lines. Numbers were preferable to individual improvement. For these reasons, the T20 project was dropped and the Sherman improved - the Panzers in the Ardennes Offensive of 1944 proved the General Staff wrong by outclassing the opponents.

Although American tank production was colossal (57,027 medium tanks), the technically out-classed crews suffered serious morale problems as well as heavy loss of life. Even the up-armoured Shermans with 100m.m. frontal plate and 76 m.m. gun were inadequate, and the need for a 90 m.m. gun was imperative. A successor to the T20 was, therefore, revived in a great hurry - the result was the 38 ton 'M26 Pershing' which saw service in Europe towards the end of the war. The M26 was designated as a heavy tank (illustration). It was a dimensional bigger tank due to its larger turret, needed to facilitate the 90 m.m. guns, the hull front was simplified, more angular (47^{o}), taking away the Sherman rounded look and was more heavily protected with 50 - 100 m.m. armour. It was this period that changed the shape of the American tank from the simple boxy appearance of the Sherman to the lower, sleeker vehicles of today. There is a direct line of decendency from the M26 to the M60A1 which forms the backbone of U.S. armoured forces today.



The M 26 Pershing.



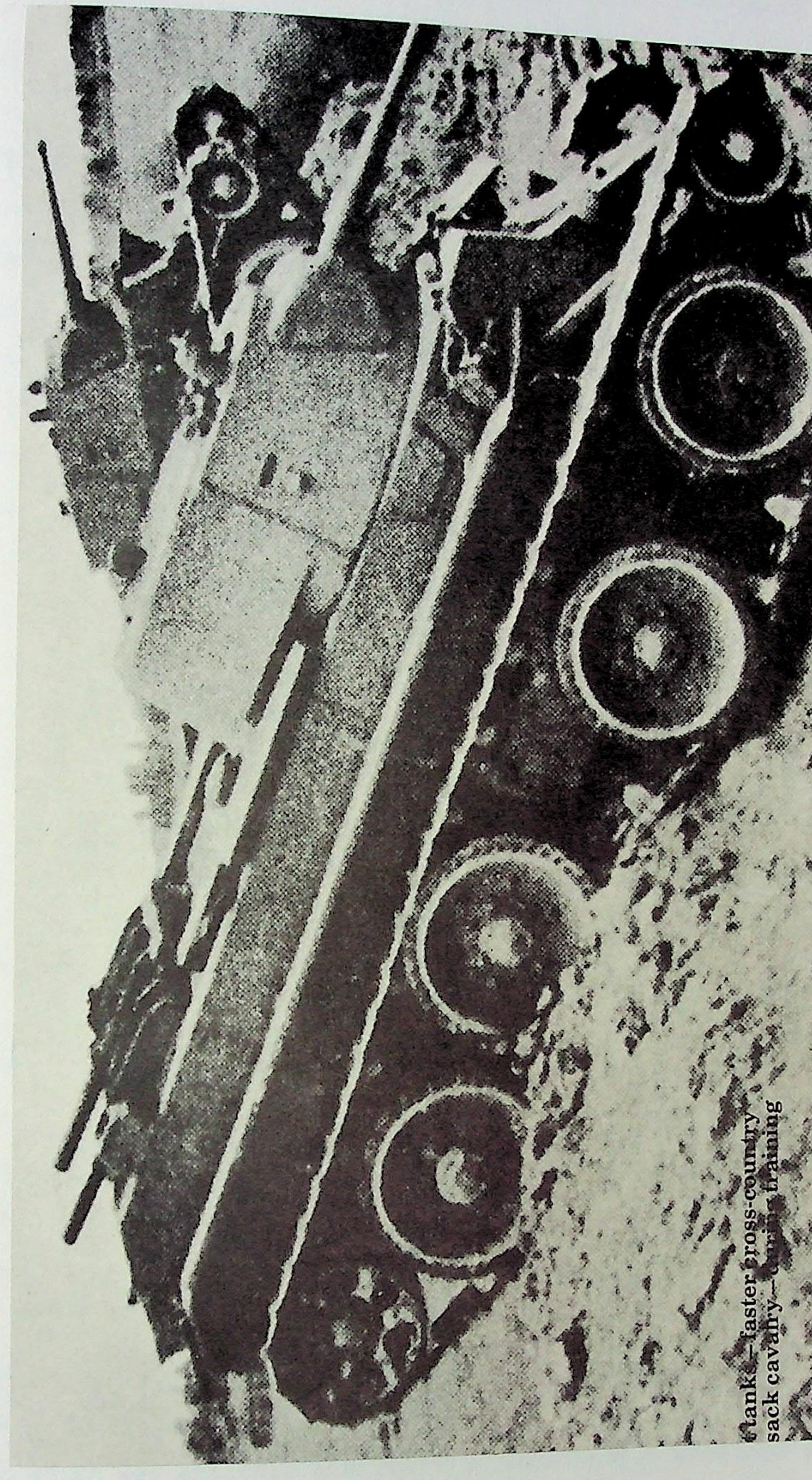
M60A1 - backbone of the American armed forces today.

RUSSIAN DEVELOPMENT - THE T-34

It is widely held that the T-34 was the greatest tank design in history. It balanced the qualities of fire power, armour protection and mobility as near to perfection as has yet been achieved. It was also incredibly reliable and simple to build and maintain. Its degree of advancement is proven by the fact it was still a viable fighting vehicle well into the 60's and, indeed, was still in service with Soviet influenced nations right into the seventies.

The T-34 was conceived as a replacement for the Russian T-28 medium tank in 1934. The T-28 was a typical '30's design, a slow boxy, multi-turreted vehicle (of which all the major powers had examples). It was originally based on the American Christie fast tank concept (suspension system - illustration). The first stage was to match the Christie suspension to the T-28 classis, which resulted in a faster version of existing bad design. It was decided to produce a heavier version of the BT series (a light tank developed by the Russians in the Christie principles). Eventually, through a series of marks which developed sloping armour, greater fire power and, finally, dispensing with Christie's wheel or track options, the T-32 emerged. The T-32 was successful on trials and a production order would have gone through but for the Spanish Civil War which suggested the need for thicker armour. Two revised marks were made and tested, T-33, T-34, the latter of which won through. From further was experience in Finland and Manchuria, other changes were made such as high velocity guns and all welded construction. During the Spanish Civil War, The Russian tanks showed up badly to anti-tank gun fire and, so, the following recommendations were made for future designs.

1. New models should have a sloping armoured hull projecting over the tracks replacing the mudguards used hitherto, thus affording protection to this vulnerable spot from cannon fire.

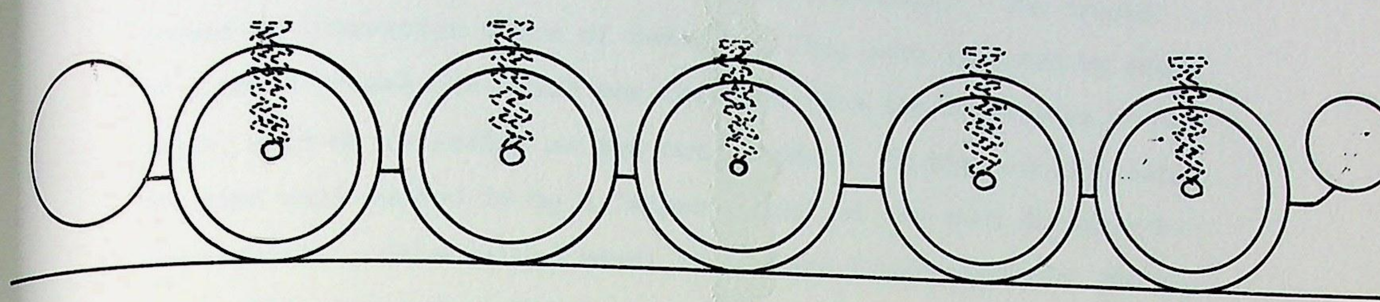


The BT-7 Fast Tank

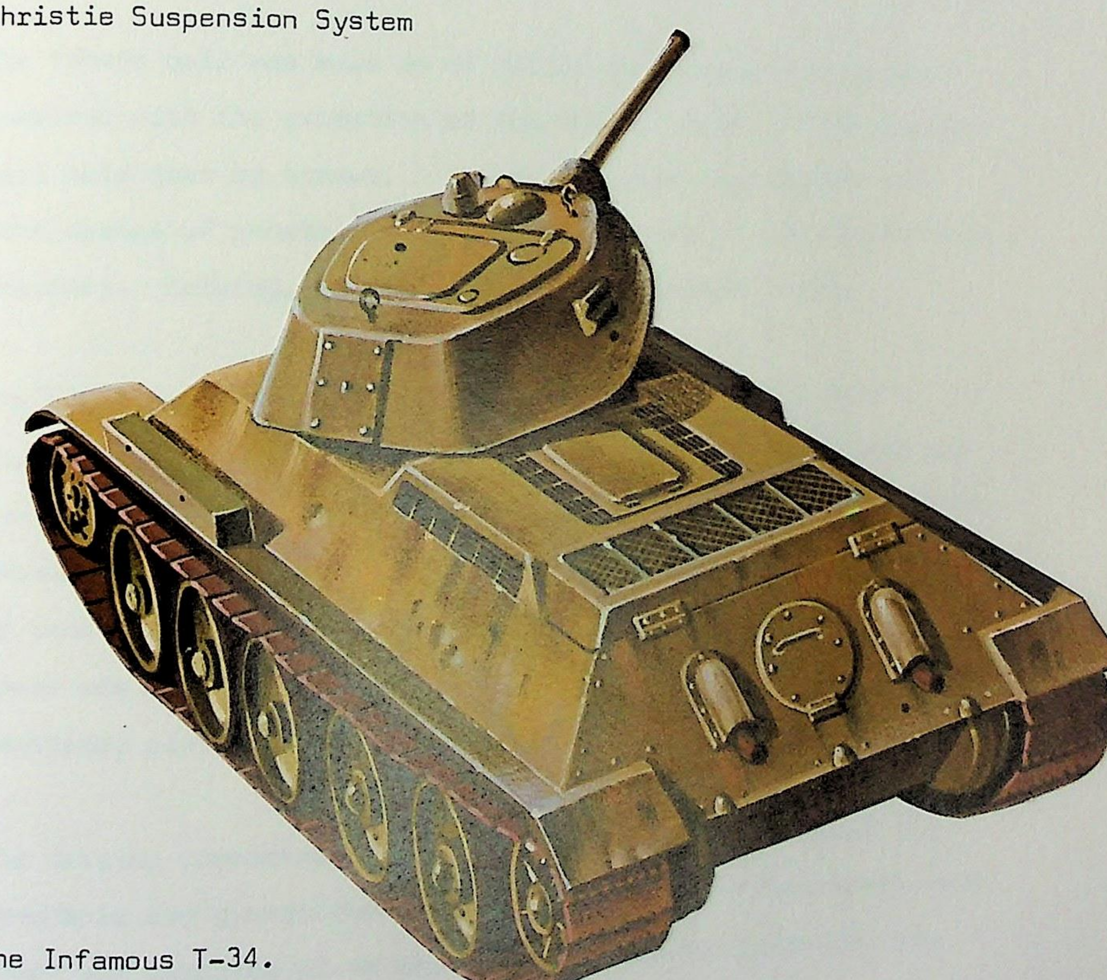
2. All components must be of unit construction to facilitate repair by replacement of complete components.
3. All equipment in tank construction must be standardised and simplified.
4. Medium and heavy tanks must be fitted with wide tracks with small-pitched links and fully floating pins.
5. New models should have high top speed and good slope climbing ability.
6. Hulls and turrets must be streamlined to prevent the lodgment of anti-tank projectiles.
7. The light and medium tanks must employ Christie type suspension, with single suspended bogie wheels.
8. Future models are to utilise the newly developed high-powered diesel engine and simple clutch and brake steering. This will increase the range of operations, reduce fire hazard and, at the same time, greatly simplify maintenance problems.

The T-34 reflected all of these recommendations. It was noted for its well-shaped hull and turret which were made up of flat plates inclined at steep angles. The tank's gun was also radical in that it was the first long barrelled high velocity gun to be used in the medium class tank. The independent suspension allowed high speed over rough terrain, while the wide tracks reduced ground pressure and increased travel capability over mud and snow. The design also meant that repairs could be carried out in the field by the crew or, at most, one repair team.

When Russia was invaded, T-34 production was not in full swing and a certain panic resulted. One effect of this was the crew training which was entirely inadequate - drivers and mechanics received 1½-2 hours experience of tank driving before being assigned to operational units.



Christie Suspension System



The Infamous T-34.

The T-34 was conventional in design - hull, turret, engine, transmission, steering unit, chassis and suspension, stowage and equipment being its basic components. The suspension, Christie type, was made of five large double wheels on each side, each wheel independently suspended on a vertical coil spring which was on the inner side of the hull. The drive sprocket was at the rear to reduce vulnerability (opposite to German thinking). The tracks showed an innovative piece of design. They were retained by means of a round headed pin which was inserted from the inner side of the track, with no retention on the outer side. As the tracks rotated, the pins were pushed in by a 'wiper plate' at the rear (diagram to illustrate). This method meant that track blocks could be quickly and easily replaced. For further protection, the suspension system was covered by track guards extending 10 in. to the rear and 4 in. to the front.

The tank's hull was made up of rolled armour plate which was electro-welded with the exception of the access plates to the engine which were held down by screws. All plates were well sloped to reduce the chance of penetration. The hull interior was divided into four sections:- driving, fighting, engine and transmission.

The fighting and engine compartments were separated by a bulkhead. The outer deck behind the turret was slightly raised and had a row of engine grills, the engine access plate flanked each side by an exhaust pipe. Hand rails were supplied on both sides of the hull for tank borne infantry - 'tank riders'. The death rate among tank riders was extremely high as they fought with little cover from a very unsteady platform.

The driving compartment, at the extreme front, contained the driver/mechanic and gunner/radio operators' seats. These seats were well padded and inclined at an angle. However, the area was very cramped due to its extremely forward position in the tank. This area also contained the controls (main clutch pedal, foot brake, fuel-injection pedal, two steering levers, brakes and gear changes), instrument panels, a lever for opening/closing the engine compartment cover as well as compressed air bottles. Ammunition was also often stored here and, depending upon the tank, radio equipment. The driver/mechanic gained access to his seat through a hatch in the left armoured hull top. Three periscopes were mounted on this hatch and were his only means of observation. On the driver's right hand side, the forward firing DTM machine gun was mounted, in the glacis plate, the mounting being protected by armoured plates. A foot pedal on the full bottom could enable the driver to render the tank immobile at any time. As no bulkheads separated the driving and fighting compartments it meant that movement was possible between the two, no matter what the turret position.

The fighting compartment was in the middle of the hull. The floor and walls were lined with ammunition bins, some in special containers, others in boxes. The hull side also held the fuel tanks. The turret enclosed the fighting compartment. The turret was very low, to reduce the silhouette and the chances of sustaining a hit. This feature, however, restricted the depression of the main gun. The turret rested on a bed and contained no basket - integral floor. It contained the main gun (76.2 m.m.) which was co-axially mounted with a DTM machine gun, sighting and observation devices and some ammunition. The turret held two crew members - the commander who doubled as a gun layer and a loader. The turret was traversed with the aid of an electric motor, there was also a lock which prevented unnecessary free movement. The elevation of the gun was done manually using a handwheel.

The transmission compartment held the main clutch, ventilators, gearbox, final drives, brakes, electric starter and two main fuel tanks.

This area proved to be the most troublesome in the T-34 design.

The T-34 (1940 model) had a turret with distinctive overhang. The commander's patch had occupied about half of the top area of the turret; it also opened vertically thus impairing the commander's vision. (In World War Two, it was common for the commander to have his hatch open, to attain better vision, even in a battle situation.)

The 76.2 m.m. gun could be fired by either of two methods - by hand or foot pedal. The co-axial machine gun fired at a rate of 600 r.p.m.,each magazine holding 60-63 rounds. With the innovation of the German Tiger and Panther, the T-34 needed a more powerful gun. This came in the form of a 85 m.m. gun which was claimed to penetrate the 100 m.m. frontal armour of the German Tiger, and therefore, the Panther, at a range of 1,000 m.

In 1947 the T-34/85 was introduced. This was a design which, with redesigned turret, eliminated the shell trap caused by the original models turret overhang. It also had an advanced transmission with better vision and fire controls. This model was used extensively in the Korean War. Production of the T-34 ceased in 1964. The production of this tank proves its worthiness:-

1939-40	-	115
1941	-	2,810
1942	-	5,015
1943	-	10,000
1944	-	11,758
1947-64	-	12,000

While the T-34 survived through the 1970's, the Russians continued in a logical progression from this design. In fact, there is a direct line of progression from the T-34 to the present Russian MBT, the T-72. It was finally in 1947 with the T-54 that the Russians admitted that the Christie type suspension was not workable for the heavier tanks. The German torsion b r system, first seen on the Panther, was used. Infra-red night fighting sights were also fitted, making the T-54 the first MBT to have this facility as standard.

The T-54 also had the, now conventional, ballistically superb 'inverted frying pan' turret which originated with a former Russian heavy tank design, the Josef Stalin 3. This type of turret is very simple with the main difference being the removal of the mantlet in favour of an internal splash plate. The next stage of development was the T-62 which was a slightly lengthened version of the T-54, however, with a 115 m.m. gun. This has since been replaced by the T-72 and T-80, of which little is known as they have not been seen yet in combat.

The T-62, with the inverted frying pan turret, during training exercises.

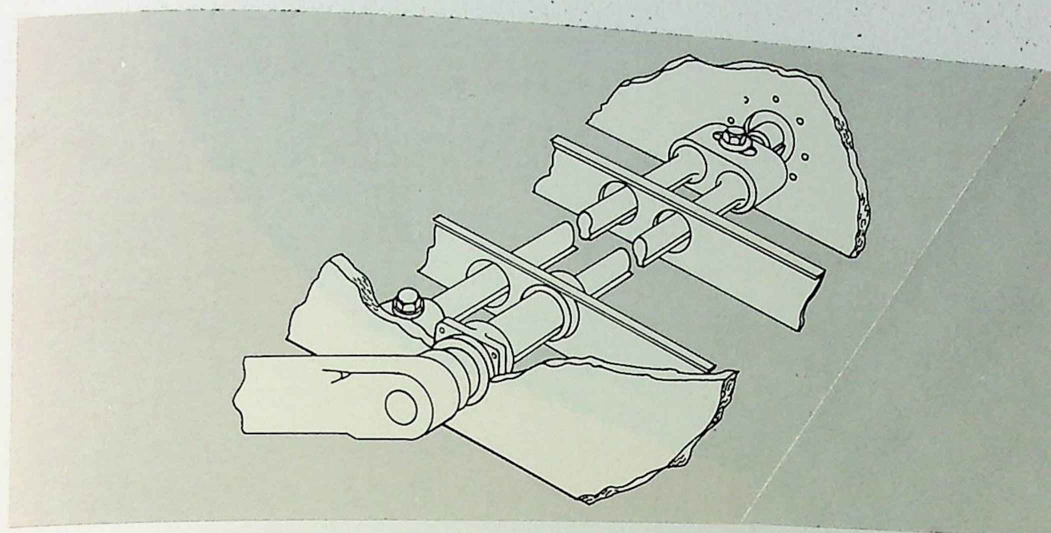
GERMAN DEVELOPMENT - THE PANTHER

Until the invasion of Russia in 1941, the Germans had experienced total supremacy in the area of tank design. However, all their armour became obsolete overnight, when they encountered the T-34. The German Panzer III and IV tanks had to move into a range of 500 m. before penetrating the thinner parts of the T-34 and were, obviously, easy meat for the superior Russian vehicles.

This situation prompted panic in the German High Command and led to the rapid development of an anti-tank gun with a penetration of 140 m.m. at 1000 m. range. This was eventually to be the Panther's gun. Subsequently, a team of enquiry was sent to the Russian front to examine the T-34. From this visit came a Development Order for a tank with frontal armour of 60 m.m. and a weight of 34.4 tons, as the ultimate answer to the T-34. The project developed into the Panther or Panzer V.

Designs were submitted by Daimler-Benz and MAN, the MAN design being accepted. In ten months, tests were being carried out on the first prototype. At this stage, frontal armour thickness was increased to 80m.m. which, in turn, increased the weight to 44 tons. This led to a mechanical unreliability because the components had been designed for the original weight. There was no time to make component changes.

The shape of the Panther's hull resembles that of the T-34 and was obviously influenced by it. The springs of the Panther were torsion bars mounted inside the tank (as is conventional now - illustration). This left them clear of mud. Torsion bars can also be one-third the weight of coil springs and one-fifth the weight and volume of leaf springs. In order for the crew to get a reasonably



Torsion Bar System.

Panther, Driver's vision port was omitted on this version.

smooth ride, the spring lengths had to be twice the width of the tank, therefore, they were run across the floor and back in a hair-pin shape. This is still the suspension method used in modern M.B.T.'s, the only difference being the doubling back is now done by running a torsion tube over a torsion bar.

The Panther conformed to the usual layout of German tanks. The driving and transmission compartment was placed forward, so the tracks get rid of dirt before it reaches the sprocket, the fighting compartment and turret in the centre and the engine at the rear.

The driver sat on the left side forward with a vision port in front of him in the glacis plate. This was fitted with a laminated glass screen and had an armoured hinged flap on the outside which was closed in combat. Forward vision was then attained to two episcopes in the compartment roof, one of which faced directly forward, the other, left at 10.30 position. This system led to extremely restricted vision and was replaced by a rotating periscope.

The wireless operator and hull gunner sat to the right of the driver. Initially, he fired a standard MG 34 machine gun through a letter box type flap in the glacis plate. This was later replaced by a ball mount. His radio equipment was situated at his right in the sponson which overhung the tracks. Vision was possible by the use of episcopes - duplicating the driver's side.

In the turret, the gunners position was on the left hand side of the gun. On earlier M K's, he had a binocular sight which was later changed to monocular. The gun was fired electrically by a trigger fitted on the elevating handwheel. The co-axial machine gun, fitted in the mantlet, was also fired by the gunner by means of a foot switch. The turret was traversed either by hydraulic power or, in the event of a breakdown, by hand.

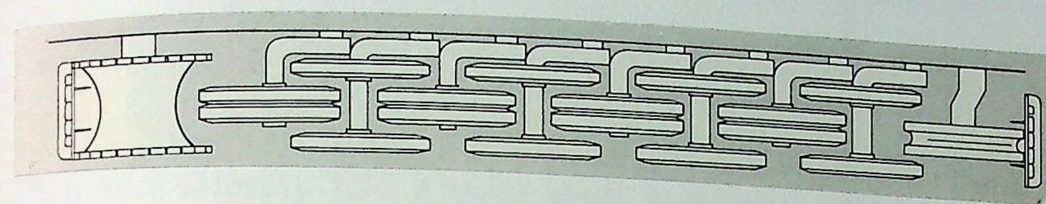
The Gun's breech was extremely long, practically dividing the turret in two. This meant the commander's position was offset to the left. He had a prominent cupola in which six vision slits were provided, this was later changed to seven periscopes. The cupola had a hatch that lifted and opened horizontally, so as to allow all-round vision. A MG34 was fitted above the cupola for air defence. The final crew member was a loader who was situated on the right of the turret.

The turret itself had sloped walls and rounded front which was protected by a curved cast mantlet. The cage had a full floor which rotated with the turret. There was a minimum amount of turret holes. They included a large circular hatch at the rere which acted as an access/escape hatch for the loader as well as being a port for ammunitioning. On the left side, beneath the cupola, was a hatch for ejecting spent brass cartridge cases, this hatch was removed in later models. Similarly, pistol ports, one in each wall of the turret, were done away with.

The Panther engine was a 23 litre unit producing 700 h.p. This gave the tank a top speed of 34 m.p.h., which was slightly faster than its main rival - the T-34. Access to the engine for maintenance was via a large inspection hatch on the rear decking. The rest of this area was taken up with cooling grills and fans. The exhaust was taken off through manifolds on the squared-off hull.

The hull itself was built up of armour plate, all of which was welded. All sheets were mortised to give added strength to the joint. The glacis plate was made up of 80 m.m. plate and shaped at 33^{0}. This angle meant that a striking shell would be deflected upwards missing the mantlet on its upward path.

The suspension was made up of eight sets of double bogie wheels



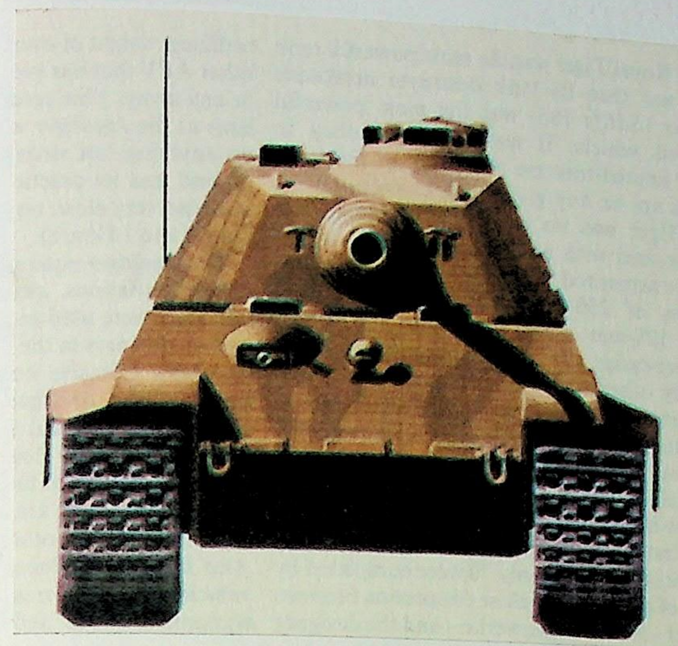
Panther Suspension System.

Panther Commander on the alert for enemy aircraft.

on either side. The first, third, fifth and seventh were double wheels, the rest carrying spaced wheels overlapping the others inside and out. (See diagram). The wheels were connected by a radius arm to the torsion bars described earlier. This system gave the tank superb flotation. It caused maintenance problems, however, due to the inaccessability of the inner wheels coupled with the trouble involved with changing a wheel. Generally, the Panther was a good tank for the crews except for its mechanical unreliability (due to the increased weight). The gun had very high muzzle velocity which more than compensated for its smaller shell (penetrative power = mass of shot X velocity^2). A small shell need only drill a small hole in enemy armour to penetrate and would be sufficiently lethal once inside. As a result, the crews placed great faith in the gun which was only bettered in 1944 by that of the enormous Tiger 11 and the British 17 pounder.

The modern tank owes much to the Panther, indeed it did much to influence Britain into the Main Battle tank concept. The Germans considered the Panther as their best tank and, undoubtedly, it was. It was a balanced design blending firepower, mobility and protection. The Tiger II Panzer, designed to keep Germany ahead of any future Russian armour development, which did not see service until 1944, was heavily influenced by the Panther, indeed, it was designed to share many of the same components. It was merely a more heavily armed, harder hitting and dimensionally bigger tank. Its effectiveness could be summed up in one sentence. The King Tiger (Tiger II) went into action in Normandy in June 1944 and the first tank was not knocked out until August of that year.

<u>The Tiger II</u>



PANTHER (1942)

Length	29 ft. 6 in.
Width	11 ft. 6 in.
Height	9 ft. 10 ins.
Weight	43 tons.
Crew	5
Max. Speed	28 m.p.h.
Range	105 miles.
Armament	1 X 75 m.m. gun with 70 rounds. 1 X 7.92 m.m. machine gun with 4,200 rounds
Armour	80 m.m. (max.) 3 miles per gal.

BRITISH DEVELOPMENT TO THE CHIEFTAIN

This chapter deals with British Tank development, particularly with the progression from the 1945 Centurion to the formidable Chieftain. It is significant that the British, after being the major instigators of the tank concept, had no immortal WWII design. It was not until the Centurion that they came to terms with the concept of a balanced mixture of firepower, protection and mobility.

The chapter lays out in detail the abilities of the Chieftain, highlighting its differences from late 40's designs. The Chieftain is, in fact, a rather conventional tank in layout, comparable with the T-34, Panther and Sherman.

When reading the chapter, the Chieftain should be looked upon as an example of the modern main battle tank. All the features described, with the exception of the auxillary engine, can be seen in some form on the Russian, American, French and Israeli tanks of today.

Before World War II, British tanks were either very slow, well protected and lightly gunned for infantry support or fast, lightly armoured and gunned for exploited weaknesses in enemy lines. The fault of this design thinking was clearly shown by the German tanks. The speed of the British could not out run the accurate and powerful German guns, whereas the British ammunition often bounced off the German tanks.

The British General staff were thus forced into rethinging, this led to the Concept of the "main battle tank", (MBT) which was to replace the (Infantry' and 'Cruiser' tanks described briefly above. The first MBT to see service was the Centurion in 1945. Its 17 pounder gun intending to match the heavy German AFV's (armoured fighting vehicle). The Centurion was developed through a dozen marks, the best of which had such features as infra-red fighting and driving equipment, 105 m.m. gun. It served between 1956 and 1973 with Israel and came out on top over the Russian T-34, T-54, T-55 and T-62. It was noted for its superior firepower, ranging, mechanical reliability, crew space and adaptability to the desert war situation.

The British, however, wished to keep this superiority and so, even in 1951, there were plans to design a successor to the Centurion. It must be kept in mind that it takes 15 years, in peacetime, to take a tank from the concept phase through to full production. By 1963, the new design had been tested and approved by the army, and although it did not meet specifications with regard to mobility and automotive aspects, it was decided to bring it into service and then carry out the improvements. It was named the Chieftain.

The Chieftain, mark 5, is powered by a 720 b.h.p. engine, originally this was 585 b.h.p. This gives the tank a top speed of 27 m.p.h. and a radius of operation of 300 miles on roads or 175 miles cross-country. Although the top speed may seem slow, it must be

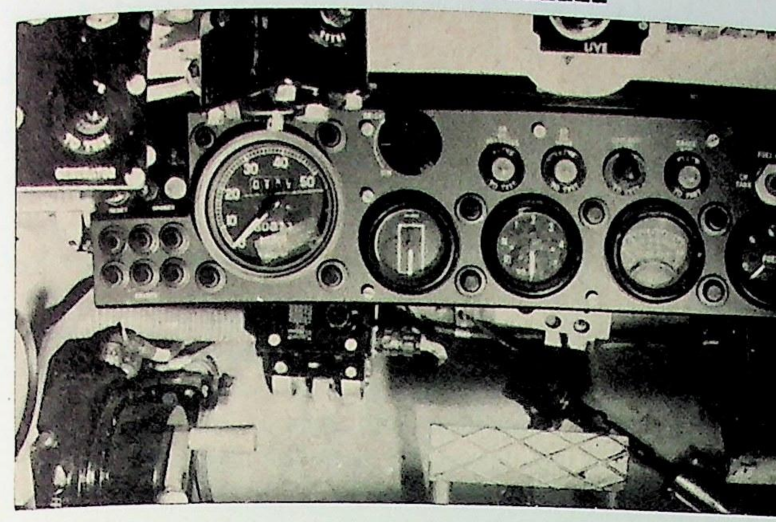
The Chieftain showing the 120 m.m. gun.

remembered that tanks are designed to fight away from roads and, therefore, it is the maximum speed cross-country and agility due to acceleration that ultimately counts. The top speed for any tank traveling cross-country is not so much limited by the engine, but more by the amount of discomfort the crew can withstand, this reduces all tanks to a common speed of 25 m.p.h. The Chieftain is adequate cross-country for this reason and because of its excellant six forward and two reverse gearbox, it gives the driver good control and provides the necessary agility.

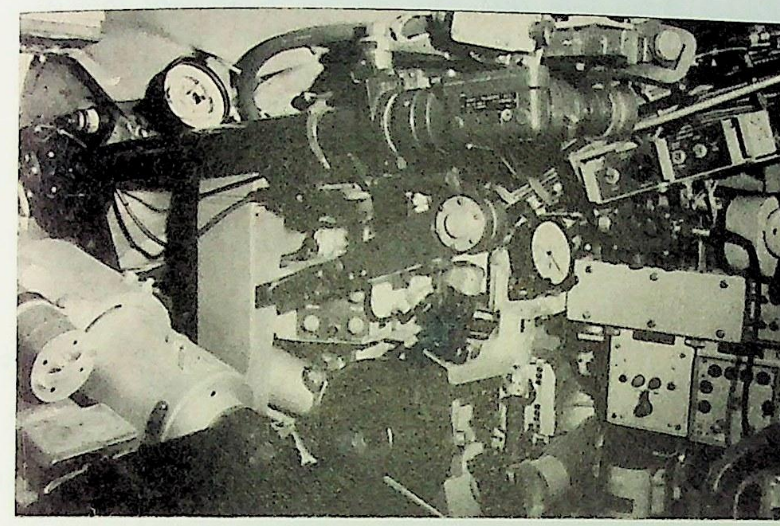
A feature peculiar to British tanks is the fact that they use an auxillary engine to power a generator which, in turn, powers the vehicles lights, radio and gun control equipment (gun elevation, turret traverse and gun stabilization are all achieved by electric motors). This means the tank can operate all its equipment without starting the main engine. In a stationary defence situation, this saves fuel and reduces the noise and, therefore, the chance of detection.

A tank's heart it its gun and there is none to better that of the Chieftain. The 120 m.m. UI A3 tank gun is the most powerful and most accurate in the world today. Advanced design and manufacturing techniques have meant that very high muzzle velocity and internal pressures can be achieved within a relatively light and extremely long barrel. This achieves very hard and lethal hitting at long range and this is, perhaps, the greatest asset of the Chieftain. A gun, however, is only as good as its control equipment and, again, the Chieftain with precise sighting and stabilization comes up trumps. At a range of 3,000 m., the gunner can achieve a very high percentage of hits with Armour Piercing Discarding Sabot ammunition. What this means is that the Chieftain can outshoot and outrange all other MBT's in service today.

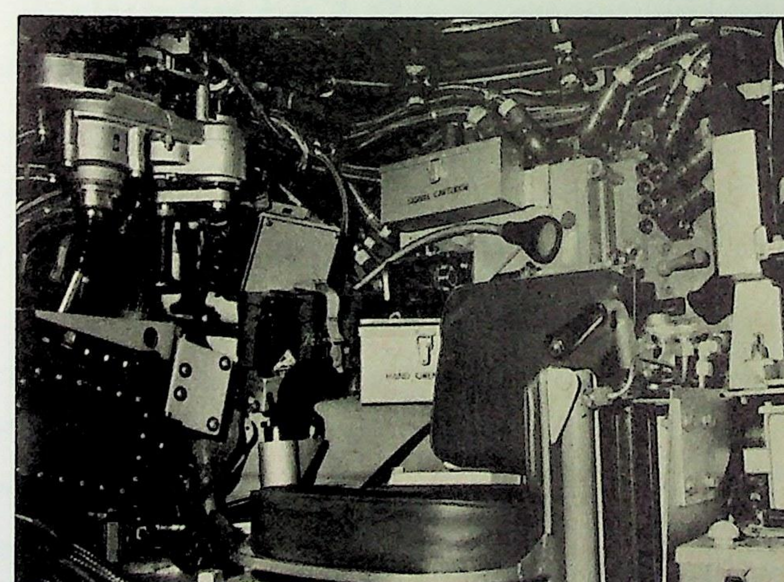
Chieftain's Interior



Driver's Instruments.



Gun Breech as seen from gunner's seat.



The Commander's seat.

Before a target can be fired on, it must first be located, identified and the range established. Again, the commander and gunner have the best available optical equipment. In addition to a ring of 9 X I magnification periscopes, which allow all-round vision, the commander has a powerful X 12 magnification sight mounted in his cupola (note diagram showing cupola). The cupola itself can be rotated independently of the main turret so that the commander can observe a second target while the gunner lays the main gun on an earlier target. From this position, the commander can operate a contra-rotation mechanism which will automatically traverse the turret until the gunner's sight and the gun line up with the new target.

The gunner has a combined X 10 magnification sight and laser range finder. This tank laser sight projects a narrow beam of high intensity light. This beam is reflected off the target and back to a receiver on the tank. This system gives the gunner an accuracy of 10 m. over 3,000 m. In the event of this system failing a X 7 magnification telescope is fitted for the gunner, alternatively the commander can operate and fire the gun using his X 12 sight.

The Chieftain has two 7.62 m.m. general purpose machine guns to complement the 120 m.m. main armament. One is fitted co-axially with the 120 m.m. gun while the other is mounted on the cupola for operation by the commander as an anti-aircraft gun. A .5 in. Browning is also fitted to help in range finding, should the laser system fail.

Recent developments in computer technology have added to the Chieftain's fire control system which now uses information supplied by the tank laser system and five other sensors which monitor barrel wear, wind velocity and direction, air density, trunnion tilt and angle of sight, and target crossing speed. All this information is fed to the computer which automatically corrects the aiming mark to achieve a direct hit. In trials, one tank crew registered nine direct hits out of nine round at a range of two miles in 53 seconds.

The Chieftain's main gun uses two types of ammunition. APDS (Armour Piercing Discarding Sabot) and HESH (High Explosive Squash Head). All the ammunition is of the 'seperated type', this means that the actual fired projectile is separate from the firing charge. The charge and its container is totally burned up in creating the necessary pressure to fire the projectile. The advantages of the separated ammunition are that each piece can be easily handled and loaded and there is nothing to be ejected after the round is fired. In comparison with a normal shot, a hot brass case would be ejected, full of acrid cordite fumes which would build up in the turret as more rounds are fired, causing extreme discomfort to the crew.

The acrid cordite is removed by means of an extractor which is situated half-way down the barrel. The initial crash as the round is fired is followed by a 'shush' and a jet of white smoke from the muzzle as the extractor does its work.

The MK 5 Chieftain undoubtedly provides the best protection available today. The frontal armour is extremely thick and very well sloped. It must be remembered that protection is not just a matter of sticking a crew in an armoured box. All the Chieftains fuel is carried in self-sealing rubber bags which are, in turn, kept within the hull armour. All ammunition is kept in water-filled containers which saturate the charge, thus making it safe, if the containers are penetrated by red-hot metal. Most of the ammunition is stored low down in the hull where the likely-hood of a direct hit is reduced. The engine compartment is protected by an automatic fire alarm and an in-built fire extinguishing system which can be operated from inside or outside the tank. All the crew hatches have fire proof seals.

Chobham Armour.

The MK 5 Chieftain provides protection against the modern was 'nasties' i.e. chemical, biological or radio-active nuclear particles. This is achieved by using an air-filtration unit which supplies clean air at 7.5 millibars to the crew compartment. The crew can close down for three days at a time inside their tank using an electric cooker, food and water. Waste material is ejected through a trap door without reducing the internal pressure. All the sights and periscopes have washers and wipers permanently fitted which enables the crew to see and fight under all weather conditions. The final protection available is a detector which will operate when an infra-red beam is on the tank. When the tank needs to take rapid cover, a bank of six smoke dischargers can lay a smoke screen in a few seconds.

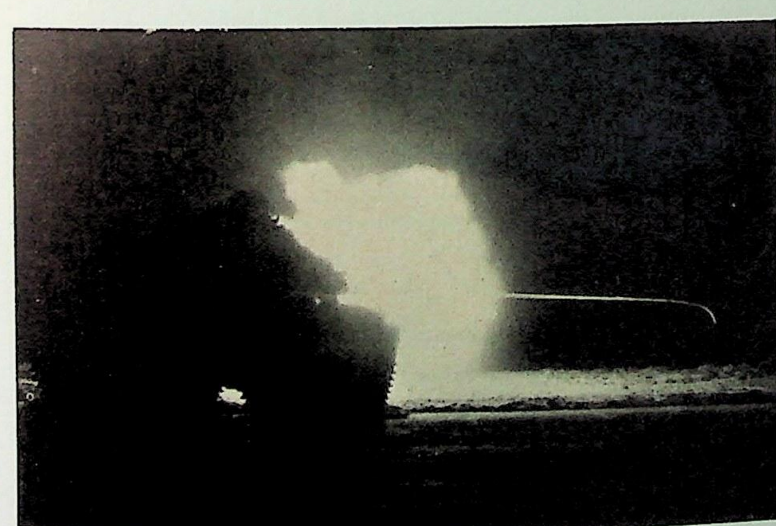
The Chieftain can operate as efficiently in darkness as in daylight. The driver has an image intensifier periscope to replace the daylight equipment and both the gunner and commander can replace daylight equipment with IR sights. The driver can choose between either white of IR driving lights. The commander has his own spot-lights that follow the path of his 7.62 m.m.machine gun.

There is room for criticism, however, with the Chieftain's design. A power to weight ratio of 20 to 1 is generally excepted as the minimum for a modern MBT. The Chieftain's ratio is 14 to 1, which leaves it at the bottom of the mobility league. However, few tank men would trade its positive aspects for an extra few miles an hour.

Only the Chieftains supplied to Iran have been fitted with a revolutionary armour, known as Chobham Armour. This armour can be applied to the existing hulls. It is described as 'the most significant achievement since World War II'.

So what is the Chieftain like in action? Outside the turret, there is considerable blast and flash from the 120 m.m. gun. Without ear-protectors, the noise would be unbearable to anyone close to the tank. Inside the turret, however, the noise is quite bearable, even without protectors with the recoil only causing slight jarring.

The Chieftain represents the best that N.A.T.O. has to counter the Warsaw Pacts T-62 and T-72's, and has no superior in today's armoured forces. With its ultra sophisticated technology, it is the equal of any armoured fighting vehicle East or West.



Chieftain demonstrating flash from its 120 m.m. gun.

CHIEFTAIN (1965)

Length	35 ft. 2 in.
Width	11 ft. 6 in.
Height	9 ft. 3 in.
Weight	51 tons.
Crew	4
Max. Speed	25 m.p.h.
Range	250 miles
Armament	1 X 120 m.m. gun - 53 rounds
	1 X 12.7 m.m. michine gun - 600 rounds
	2 X 7.62 m.m. machine guns - 6,000 rounds
Armour	

THE FUTURE OF THE MAIN BATTLE TANK

Many experts predict the demise of MBT.because of its vulnerability to the helicopter. The modern helicopter can carry a lethal missile which is capable of a kill at a range of 4 km. (well beyond the range of a tank's fire). The speed and manoeuvarability of the helicopter means that it is also able to bring reinforcements to a crisis situation on the battlefield.

Although there is no doubt that the helicopter is a weapon system with great potential, it is very doubtful that it can replace the battle tank. The essential quality which the tank has displayed in the past and which is needed to the same extent today, is its high degree of tactical mobility in terms of cross-country performance and armour protection from a large number of hostile weapon systems. There is no helicopter in service which can carry a high-velocity, large calibre cannon - the most effective anti-tank weapon at present available. It should be said at this point that homing missiles are being developed to be fired from a ground support aircraft, but their effectiveness has yet to be proven. The helicopter's effectiveness is also impaired by bad weather and darkness.

I feel the battle tank is still, and will remain, the dominant element in the land battle situation. It possesses the armour protection, mobility/agility and firepower which is essential to its survival on today's battlefield and of all army weapons, it is the only one capable of effective offensive and defensive operations. These feelings are backed up by Romistrov, the Russian Chief Marshal of tanks, who wrote:

"Under conditions of a missile and nuclear war, the armour of a modern tank protects the crew from the light radiation of the nuclear blast and significantly weakens the penetrating radiation. Because of its weight, it easily withstands the impact of the shock wave which arises at the moment of blast and also serves as a protection against shell and bullet fragments. In essence the tank is not only a powerful offensive/defensive weapon, it is also a mobile shelter, protecting against the harmful elements of the nuclear blast and standard weapons fire."

BIBLIOGRAPHY

Books

1. Illustrated Encyclopaedia of Military Vehicles.
   Ian Hogg and John Weeks. Published Hamlyn.

2. U.S. War Machine Encyclopaedia.
   Dr. James E. Dornan, Jnr. Salamander.

3. Guinness History of Land Warfare.
   Kenneth Macksey. Guinness Superlatives Ltd.

4. Waeffan S.S. in Russia.
   Bruce Quarrie. Published P.S.L.

5. Panzers in Russia 1941-1943.
   Bruce Quarrie. Published P.S.L.

6. Weapons and Warfare of the 20th Century.
   Eric Morris, Curt Johnson, Christopher Chant, H.P. Willmott.
   Octupus.

Journals and Papers

7. Tank Design and Ergonomics.
   D.J. Hawkins.

8. War monthly - Issue 22- 40.

9. World War II Tanks.
   Eric Grove.

10. German Tanks 1939-45
    Chris Ellis, Peter Chamberlin, John Batchelor.

11. Soviet Ground and Rocket Forces
Christopher Donnelly, Bill Gunston, Dr. James E. Dornan.

12. Tanks at War.
Andrew Kershaw.

13. War Machine I. A Guide to the World's Main Battle Tanks.