words and pictures **Craig Moore / Armoured Engineering**

Firing on all *Cylinders*

Craig Moore chats to Gavin Barlow of Armoured Engineering to find out more about the Sherman V and a recent rebuild

Based in the south-east of England at Old Romney, Kent, Armoured Engineering specialises in the repair, restoration and maintenance of World War Two tracked armour. Many readers will have seen the company's work without realising.

In 2017, the team overhauled the Tank Museum's Vickers Mk IV light tank and won the Milweb Award for Most Outstanding Military Vehicle at The War and Peace Revival 2017.

Company director and mechanic Gavin Barlow and mechanic Paul Lovell are both serving REME reservists. They are currently assisted by mechanic Dave Voice who previously worked at the Tank Museum.

In 2018 they were asked by William Bannister to rebuild his 1943 Sherman V tank and make it ready to take part in the XXX Corps Operation Market Garden rally in September 2019.

This they successfully managed to do. William is a trustee of The Tank Museum and the Sherman will be on long term loan to the facility. William bought the tank and covered the cost of the rebuild to stop this rare and most representative Sherman used by the British Army in World War Two being sold to the US. He also owns the recently restored M3A1 British Army Stuart on display at the Tank Museum.

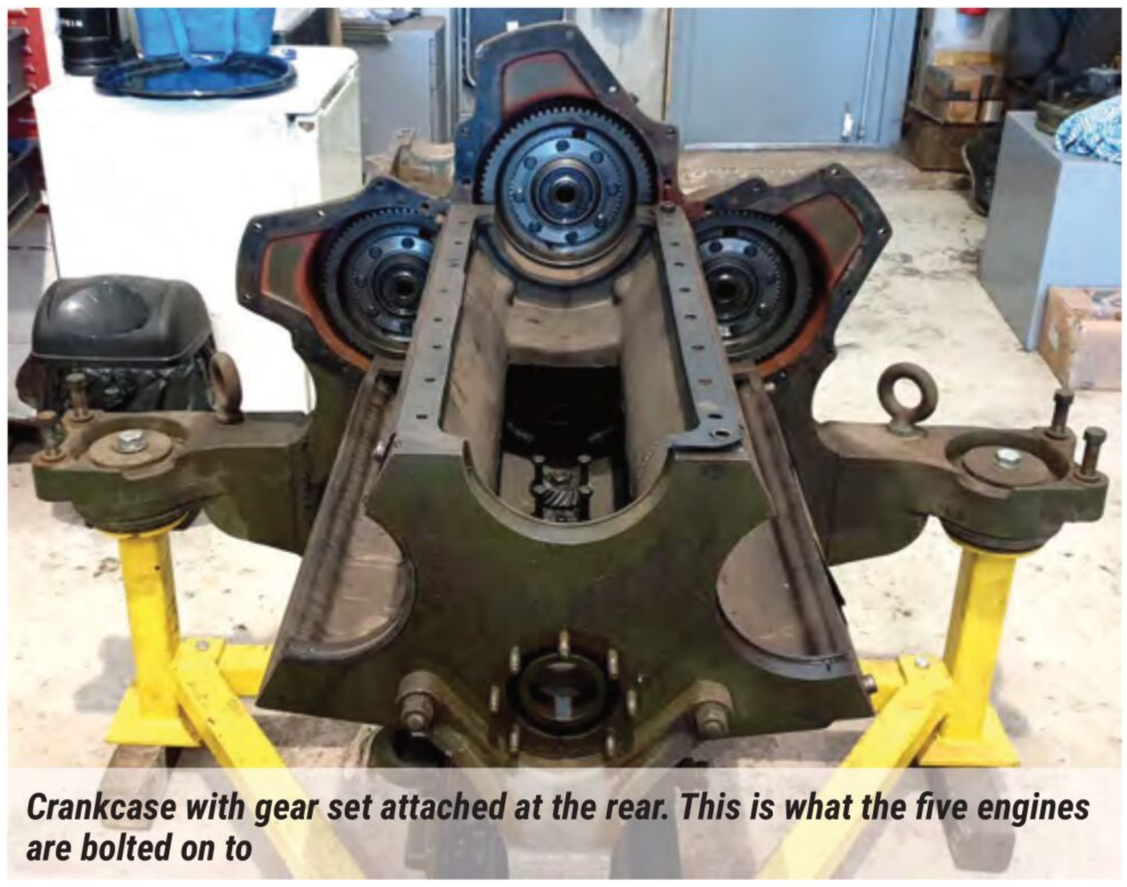
The Sherman V (M4A4)

The British Army gave the US-built lend-lease M4A4 Shermans the designation Sherman V. Only the standard 75mm M3 L/40 gun version was manufactured in the US, but the M4A4 was also widely used as a basis for the British Army modified M4A417-pdr Firefly tank.

Chrysler built 7,499 M4A4 Shermans. They had a lengthened welded rear hull with more widely spaced bogies to enable the Chrysler A57 multibank to fit in the engine compartment. There is a bulge in the engine deck immediately behind the turret to accommodate the large radiator. These are the main recognition features on the M4A4 tank.

The Sherman was built this way due to several factors. The first was transportation. US-built tanks had to be shipped to battlefields across the Pacific and Atlantic oceans. If the tank was too heavy, dockside cranes would not be able

Arrived at 'Klein Amerika' Camp, Groesbeek after fixing the governor fault during the XXX Corps Operation Market Garden rally in September 2019



Crankcase with gear set attached at the rear. This is what the five engines are bolted on to

Engine parts after an initial strip down

to load and unload them.

The army wanted as many tanks at its disposal as possible. The proposed US M6 60-ton heavy tank, armed with a 75mm gun and coaxial 37mm gun was rejected. Instead, the army preferred the option to ship two 30-ton M4 medium tanks rather than one 60-ton tank.

Unlike the Germans, who could transport damaged tanks by railroad back to the factory that built them to be overhauled, US tanks needed to be relatively reliable.

All tanks breakdown but US-built tanks need to be fixed in the field. This is why many parts used in the construction of the Sherman tank were not new. The engineers just improved the design of parts they knew already worked on earlier vehicles. The Sherman VVSS (Vertical Volute Spring Suspension) and the main gun was known to work on the M3 Lee/ Grant Medium Tank.

The Sherman was designed to be easy to maintain. The final drives and transmission at the front of the tank could be accessed by unbolting the front lower hull curved armour plate and a

‘The British Army gave the US-built lend-lease M4A4 Shermans the designation Sherman V’

new one fitted. If the road wheels or suspension system were damaged by an anti-tank mine, the crew just unscrewed 16 securing bolts and swapped out the bogie. This was a lot easier than doing the same repairs on a T-34, Tiger or Panther tank. Archive tank comparison trial reports show that over 1,700kms, the Sherman needed 420 specialist maintenance and repair staff-hours. In contrast, a Cromwell tank needed nearly double that at 814 hours.The Sherman M4A4 was 6.05m long, 2.61m wide and 2.74m tall. It had a ground clearance of 40cm and had 13.2psi ground pressure.

The combat fully loaded weight was 31.11 tons. It was the longest and heaviest of all the Sherman tanks armed with the standard 75mm gun. The driver and hull machine gunner had small armoured hatches and protective protruding hoods. The ammunition stowage bins were of the dry type. The vertical volute spring suspension) comprised of 12 rubber rimmed road wheels on six bogies – three bogies per side. The track drive sprocket wheel was at the front of the tank and the idler wheel at the rear. Four different 42cm wide double pin tracks could be fitted: T48 chevron rubber; T49 parallel bar steel, T51 smooth rubber and T54E1 chevron steel. Because the tank length was extended to accommodate the A57 engine it required longer tracks than other Sherman versions.

Armour

The M4A4 Sherman had rolled homogenous steel sloped armour front glacis plate that was 50.8mm thick which was angled at 56° from the vertical. If you consider the thickness of the armour

The M4A4 Sherman V had a cast turret and welded extended hull

Hull with transmission unit removed. (gearbox, steering unit, differential and final drives)

The Sherman V rebuild project

Within the constraints of the Covid-19 restrictions, I asked Gavin a few questions about the rebuild.

Leaving Dommelen camp on day one of the XXX Corps Operation Market Garden rally in September 2019. Gavin Barlow is driving the Sherman V

Q. Gavin, why did Chrysler use five car engines bolted together to power the M4A4 tank?

A. *After the USA entered the war, availability of the aircraft radial engines became a supply issue as these were demanded for aircraft use. This forced Chrysler to develop a new power unit for the M4A4.*

Q. How is the power from five separate engines connected to drive the tank's tracks?

A. *The five engines are meshed together using a large gearset at what should be the flywheel end of the crankshaft. These gears then drive one output shaft located in the centre of the gears which has a conventional flywheel/clutch assemble bolted to it, much the same as the radial engine. The power is then transmitted to the five-speed gearbox at the front of the vehicle using a long prop shaft. The drive is then turned through 90° using crown wheel pinion gears before utilising a differential, steering unit, and finally transmitting drive to the tracks via final drive units.*

Q. Was it important to keep the parts for each engine separate or were they interchangeable?

A. *In theory, all the parts can be interchanged between engines. But, it is good practice to label every part in relation to its engine. This allows you to understand the condition of the engine before commencing any rebuilding work.*

Q. Four of the engines are fixed into position at an angle. Does that cause problems with oil and fuel circulation? Does gravity play havoc with the functioning of the engine?

A. *There are no real issues relating to gravity and the supply of oil and fuel to the power unit. Both the oil and fuel pumps are located at the lowest point to allow the fluids to naturally congregate in the pump. With the engine running, the pumps simply pressurise the fluids sending them up pipes and oil galleries to either the carburettors or the crankshaft and camshaft bearings. In the case of the oil feed, it runs up a central tube to the rear of the water pump, where it enters a circular gallery.*

From here the oil is forced out through five smaller channels to feed each engine at equal pressure. The overall oil pressure is regulated in the pump itself, and there is also a bypass regulator located at the top which prevents any over pressurising of the system. This bypassed oil is then used to lubricate the gearset directly.

Q. What is the firing sequence? Is there a dominant engine that the others take the lead from?

A. *The firing sequence is extremely complicated being 30 cylinders. It is easier to understand that each six-cylinder engine has a firing order of 1-4-2-6-3-5. The engines are then equally phased apart from each other, starting with the top engine set at TDC, and the other four engines either being advanced or retarded in the four-stroke cycle by 72/144° respectively. With the engines set in this position, they will be synchronised to fire 24° between power impulse, giving you 30 small explosions in 720° of the four-stroke cycle.*

Q. Is it easy to tell if there is a mechanical issue with one of the engines and which one?

A. *There are a series of warning lights and dials on the dash which can give you some early warning signs of an engine issue. Temperature switches are located on each exhaust manifold which let you know if an engine is not running at all. After all, how can you tell if it is only running on 24 cylinders instead of 30?*

Q. Has it been a problem getting spare parts?

A. *It has been a challenge, but we found an extremely helpful engine specialist in the US who identified the engines using casting numbers and managed to source suitable replacement parts such as pistons, rings, bearings, gaskets, etc.*

Q. Is the Sherman's repair and maintenance design as good as the books say?

A. *After working on this vehicle extensively, both in the workshop and in the field, my personal view is that the Sherman was indeed designed to be easy to fix. Especially the larger items such as transmission, final drives, and the power units. The multibank power unit in particular shows all of the early features you expect to find on a modern tank pack design as the radiator is integral with the engine and could be removed with the water still in. This would allow a well-drilled crew to remove an engine in a matter of hours.*

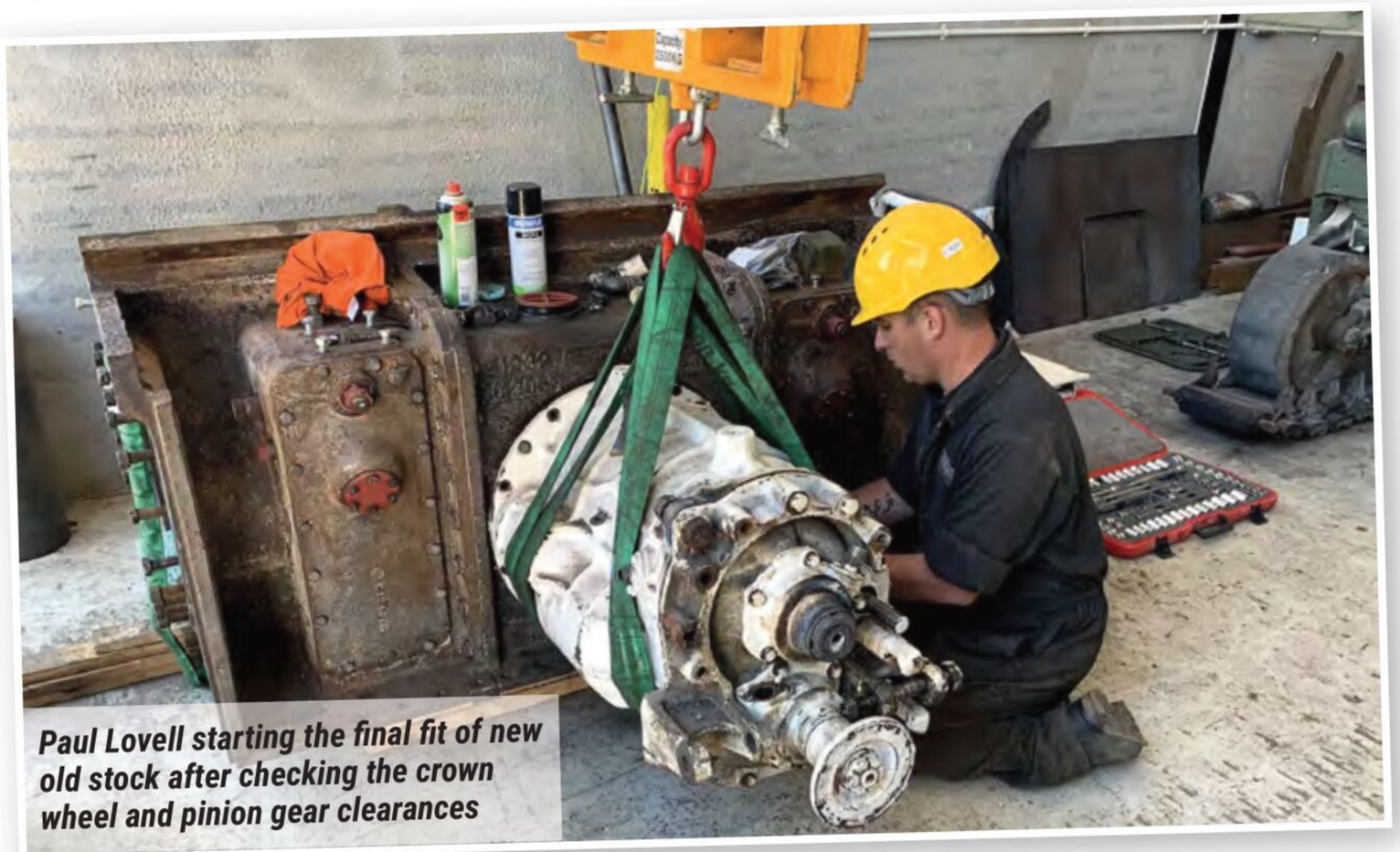
Q. What unexpected problems did you find?

A. *When we received the vehicle from the Tank Museum the symptoms were a head gasket failure and a blown core plug. We opted to strip the engine fully, and luckily we did.*

We found swarf laying under each crankshaft which points to an oil pressure failure and damaged crankshaft bearings. The actual cause was a ¼ inch unf bolt that had jammed the oil pump, which in turn snapped the drive shaft leading to complete failure of the crankshaft and camshaft bearings.

After further inspection, the crankshaft journals were damaged and had to be reground. During the XXX Corps rally, we encountered several issues. The first was a fuel leak from around the sender units. We only discovered the fault after filling the tanks, which made fixing the fault very tricky. The second fault was the main ignition cable detaching from the power unit causing it to cut out. This was repaired and running again in minutes. This was shortly followed by a governor linkage snapping which jammed open the throttle. We had to be recovered to the nearest staging post where we carried out an expedient repair enabling us to drive into camp at sunset under our own power.

The final, and terminal issue was a head gasket failure on a lower engine. This could not be repaired easily in the field due to access issues so we opted to recover the vehicle back to the UK, where it could be repaired in a workshop. - Gavin and his team can be contacted via their website:www.armoured-engineering.co.uk



Paul Lovell starting the final fit of new old stock after checking the crown wheel and pinion gear clearances

Dave Voice and Gavin Barlow fitting the Multibank engine after the rebuild

‘The M4A4 Shermans were powered by a Chrysler A57 multibank 30-cylinder 4 cycle ‘cloverleaf’ water-cooled petrol engine’

Discussing the vehicle performance and driving technique during the morning tea break. Gavin Barlow is in the driver's position

and the slope, the frontal armour is nearly as thick as a Tiger tank’s 100mm vertical front armour. An enemy shell being fired head on to the M4A4 Sherman’s 50mm thick glacis plate would have to penetrate around 91mm of armour due to the slope. Not many people realise that.

The side and rear hull armour were 38mm thick; the hull deck was 19mm; the side and rear turret armour were 50.8mm; the front turret armour and gun mantlet 76.2mm; and the turret roof 25.4mm. The rear hull upper armoured plate was sloped, and it covered the two rear engine compartment access doors.

Armament

The M4A4 Sherman’s main gun was a 75mm M3 L/40 gun fixed into an M34 gun mount in the turret (This was later changed to the M34A1 gun mount in later production tanks). It was a 40-calibre gun that could penetrate 88mm of vertical rolled homogeneous armour at 100m and 73mm at 1km firing an armour piercing M61 round. The gun had a manual elevation of +25° to –12°. With a good crew, it had a firing rate of 20 rounds per minute. The turret had a hydraulic and manual 360° traverse at a maximum traverse rate of 15 seconds.It was also armed with had two .30 calibre Browning M1919A4 machine guns, one in the hull and another in the turret-mounted next to the main gun. A .50 calibre Browning H2HB machine gun could be fixed to a flexible anti-aircraft mount on the turret. The gunner used an M4 periscope with an M38 telescope and an M70 telescope. The driver, hull machine gunner, loader and commander used M6 periscopes.

Engine

The M4A4 Shermans were powered by a Chrysler A57 multibank 30-cylinder four-cycle ‘cloverleaf’ water-cooled petrol engine. It was constructed using five car engines bolted together on a large metal frame. Its maximum net horsepower at 2,400rpm was 370hp, and it had a maximum gross horsepower rating at 2,850rpm of 425hp. It used 80 octane petrol and had a fuel capacity of 605.6 ltr. It had a maximum level road speed of 32km/h and for short bursts could reach up to 40km/h.

Modifications

The Sherman was continually improved during the 1942 to 1945 production run with the addition of things like more crew hatches, larger hatches, additional armour, wet ammunition stowage bins, better suspension system, wider tracks and a more powerful gun.