A-SERIES ENGINE REDO

How to Take a BMC Race Engine From Average to A+

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BMC's A-series engine has powered many favorites, including icons like the Mini, Sprite and Midget. It can be built into a fine race engine, too; turn the page to learn how.

Without a doubt one of the most popular powerplants in the history of sports car racing is the venerable A-series engine. Throughout its nearly 50-year lifespan it appeared in such vintage racing icons as the Austin-Healey Sprite, Mini Cooper and MG Midget–plus limited-production cars like the Turner 950 Sports.

Despite those racing chops, the A-series has more humble origins. It made its debut in 1952-'56 Austin A30 and Morris Minor sedans, basic workhorses designed to transport postwar British families. The engine's 803cc displacement churned out 30 horsepower.

The A-series soon got sportier, though, as the factory upped displacement to 948cc when placing it in the 1958 Austin-Healey Sprite. Mini and high-performance Mini Cooper variants soon joined the A-series ranks, and displacement eventually maxed out with the 1275cc version found in the 1966-'71 Austin-Healey Sprite, 1966-'74 MG Midget and 1969-'80 Mini. A revised engine, known as the A-Plus, would remain in production through 2000.

Various racing associations have allowed earlier Sprites and Midgets to run the 1275cc engine, making them a ubiquitous combination–except, of course, in more stringent programs and classes that require the original-sized engines.

Racing Means Breaking

One of the realities of vintage racing is that the engines require periodic rebuilding. The more aggressive the setup, the more frequently that rebuilding will take place. We've all heard tales of A-series engines producing 150-plus horsepower–but barely making it through the weekend.

Getting 100-plus horsepower per liter is certainly an admirable goal for an engine with restricted port configurations, but service life must also be part of the equation, especially if you're racing on a budget. And while there are certainly many highly qualified engine shops that have extensive experience with the BMC A-series engine, there are also those enthusiasts who seek the challenge of going through the engine themselves. That's our aim with this particular project.

Our A-series engine was professionally built in 2010 and enjoyed limited success, albeit more through consistency than the ability to outpower the field. But a couple of DNFs due to a blown head gasket and some internal carnage dictated a rebuild. So here we are.

Aiming for a 150-horsepower grenade was not part of the equation. We wanted to improve power through some basic changes in the intake system and camshaft. An updated valvetrain should expand the engine's power curve. Our realistic goal: 10 to 12 percent more power.

Lighter Is Faster

In recent years there has been a trend of aggressively lightening the valvetrain. This allows the engine to spin up quicker and sustain a higher powerband while placing less stress on the components.

The original A-series valves feature 7mm stems, but some of the more prolific competitors are using valves with 5.5mm stems. A bit of research shows that certain Honda valves are ideally sized, requiring only modifications to the length and keeper groove.

Mark De Groff made special guides to accommodate our new valves before cutting fresh valve seats on his Serdi machine.

Our A-series race engine rebuild included upgraded valves. The new ones, on the right, feature thinner, lighter stems. We matched those valves with titanium retainers and lightweight dual valve springs.

Manley Performance, a major supplier of motorsports valvetrain components, has a solution with their custom Gen II stainless-steel valves. They keep valve blanks on hand that they can quickly finish to the customer's specifications. In most cases, they say, the job takes 10 working days.

Manley also offers valve stems that narrow near the valve head itself, thus offering less restriction into the combustion chamber. Many of their Gen II custom valves offer this Pro Flo technology, and it's said to significantly improve flow, especially at lower valve lifts. So, in short, Manley simply modified a set of Honda valves for our BMC engine.

Manley also manufactures valve springs, retainers and locks, facilitating a matched assembly. Their NexTek springs for our Honda valves, along with svelte titanium retainers and machined steel keepers, dropped mass by about 20 percent. The original configuration weighed 120.4 grams per cylinder, while the new ones check in at 99.9 grams.

Our engine came with one of Richard Longman's highly regarded cast-iron heads. They're known for their excellent flow characteristics. The task of adapting the Honda-based valvetrain components to the Longman head was handled by Mark De Groff, a longtime secret weapon for many successful vintage racers. De Groff made special guides to accommodate the 5.5mm valves and topped them with Viton seals. He also set the springs to the proper installed height, providing the required tension per the camshaft manufacturer's specs.

Containing the Combustion

Sealing the combustion chamber is, of course, critical for any high-performance engine. The A-series is notorious for blowing head gaskets, so we needed to optimally distribute the clamping load. We'd make arrangements while the head was off.

The 1275cc block originally came with nine head studs, but later versions had 11. Since the head was designed to accommodate those 11 studs, it's a fairly easy task to machine the block to accept the additional two studs. ARP sells a head stud kit for this application.

ARP's head studs are made of a heat-treated chrome moly–200,000 psi tensile strength–and have a significantly higher safety margin than the original hardware. Even so, cranking up the preload too much can be detrimental to the gasket.

While the cylinder head was off, we didn't machine its face any further. Upping an engine's compression by shaving down the cylinder head's mounting surface is certainly a path to increased power, but it comes with added cylinder pressure and potential head gasket issues. Our engine already had a 12.22:1 compression ratio, so we decided to keep things status quo.

After we honed the cylinder walls and finished the block with POR-15 MG Maroon paint, we installed a set of ARP head studs. ARP Ultra-Torque Fastener Assembly Lubricant was used to provide anti-seize protection.

LOOKING GOOD UNDER THE HOOD

We wanted to improve more than just our engine's performance with our rebuild. We wanted it to look better, too. First we repainted the block and head, trading the original Austin-Healey dark green for POR-15 Engine Enamel in MG Maroon. The dark red is a better match for our engine's host vehicle. Next we plated the oil pan, mounts and pulleys in gold iridite. And for a finishing touch, we used ARP polished stainless-steel fasteners wherever possible.

Procuring New Pistons

The engine carnage that put us out of the race resulted in two damaged pistons, so we decided to replace them with exactly what we already had: JE forged-aluminum flat-top pistons. Ours have a 1mm top ring, 1.22mm second ring and 2.82mm oil ring.

Fortunately, some more very good parts were employed during the previous build, including Carrillo connecting rods fitted with ARP Custom Age 625 bolts and a Moldex billet crankshaft. To ensure a bulletproof bottom end, we fitted the block with ARP main studs to accommodate special main cap supports made of billet steel.

Front and Rear of the Crank

Like so many other British engines, the A-series rear main seal features a scroll on the crankshaft. The idea is that stray oil will be pulled into a drain cavity in the bearing cap. Alas, it doesn't always work so well, giving A-series engines a reputation for seepage.

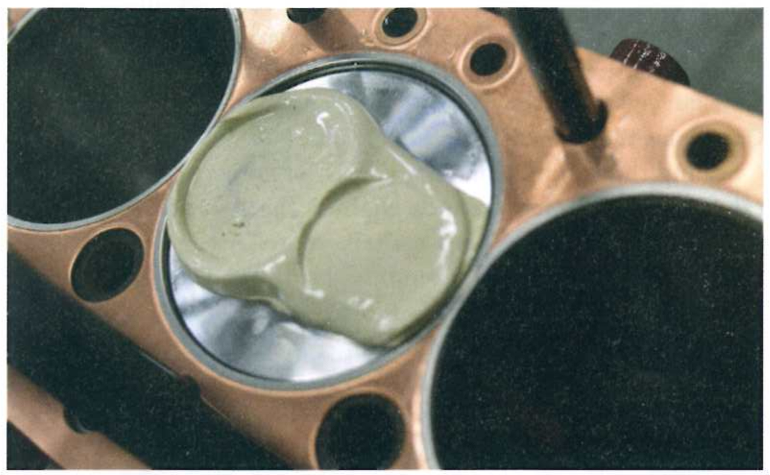
The folks at Moss Motors have developed a kit that adds a conventional rubber seal to the equation. A seal housing simply bolts to the block, and it can be retrofitted to an assembled engine to provide extra protection from oil leaks.

An oft-overlooked but important component is the harmonic balancer. Our OEM-type damper had a decaying elastomer, so for the sake of safety we replaced it with a BHJ billet-steel unit. The new damper–the one shown in front of the old piece–is fully SFI 18.1 certified, meaning it won't come apart during competition use. The BHJ piece is also machined with degree marks, which helps in tuning.

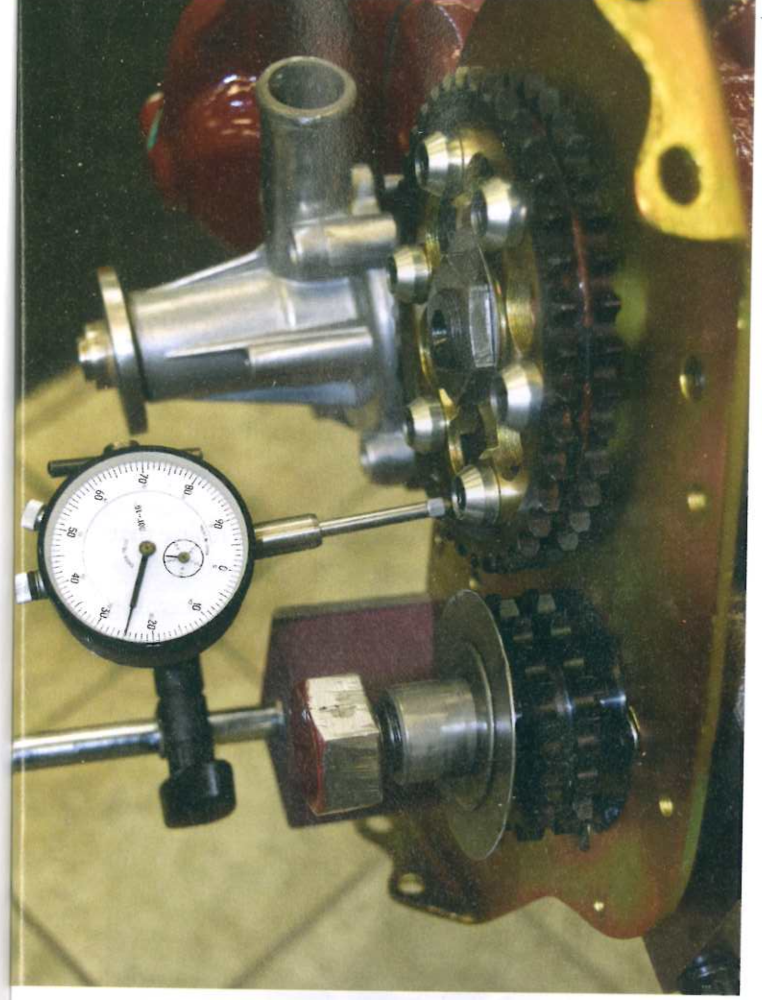
Coming on the Cam

We also wanted to replace the camshaft. David Vizard's 500-plus-page tome "Tuning the A-Series Engine" explains the scatter camshafts designed and developed by A-series guru David Anton of APT Performance.

The A-series engine features Siamese ports, meaning some of the cylinder ports are shared–specifically, this four-cylinder engine features three exhaust ports and just two intake ports. The theory behind Anton's scatter camshafts is that there are performance gains to be had



During assembly we used some clay to check the valve-to-piston gap: too tight will cause problems, while too loose allows blow-by. Our new APT camshaft drives the oil pump via a slot, so we needed to change pumps.



by varying valve lift, duration and lobe spacing from cylinder to cylinder. The big downside to such a complex camshaft? It's not a cheap, easy proposition.

Our camshaft was joined by a set of APT's precision chilled-iron lifters. A set of 1.5-ratio Harland Sharp aluminum roller rocker arms amplify that camshaft.

Cam timing is also of critical importance, so we employed an adjustable vernier-type double-roller cam gear. The previous timing set showed an uneven wear pattern, so we took extra care to perfectly align the cam and crank gears. To accomplish this, some material had to be machined off the back side of the gear. It's the little things that help eliminate problems before they crop up.

Oil's Well

Our race engine already had a well-designed pan and windage tray combination, but the unregulated oil system was producing unusually high pressures. Our solution: Integrate an adjustable oil pressure regulator into the system.

For an extra measure of insurance, we also installed a 1.5-quart Moroso accumulator. The pressurized canister ensures that the system is primed at startup; it also delivers an instant oil supply in an emergency.

In order to align our timing pulleys, some machining was necessary. Our new cam operates a set of low-friction aluminum roller rockers, while an oil accumulator helps maintain pressure. The stock oil pressure relief valve (on the left in the above photo) features a fixed value. The new one (on the right) is adjustable.

The reward for our hard work was more horsepower than before. Eventually, though, we'll have the engine back on the bench.

Good Carbs

One last big change: We replaced our familiar twin SU carburetors with a single Weber 45 DCOE carburetor and intake sourced from Pierce Manifolds–an allowable mod per many vintage racing associations. "When you look back at what the best works teams ran, the majority were using Webers," Mike Pierce explains. A K&N filter keeps out the bad stuff.

Dyno Time

Our new hardware was assembled. Yes, we realize that we made a lot of upgrades at once. Think of it this way: We basically turned a midpack engine into something that should run closer to the sharp end of the field. Now it was time to see if the parts bill was worth it.

A dyno sheet that came with our car indicated that the engine produced 120.3 horsepower at 6700 rpm, along with 98.1 ft.-lbs. of torque at 5800 rpm. Reality reared its ugly head regarding an ideal apples-to-apples comparison, though: The dyno figures for the original configuration were taken on an engine dyno, while we tested and set up the new one on a Dynojet chassis dyno, meaning that the new horsepower numbers include some driveline loss. How much loss? Most experts say 15 to 20 percent.

Our new engine's best run showed a max of 119.7 horsepower and 98.1 ft.-lbs. of torque. If we factor in a 15-percent driveline loss, that equates to about 137 horsepower at the flywheel. In other words, we more than achieved our goal of increasing output by 10 to 12 percent.

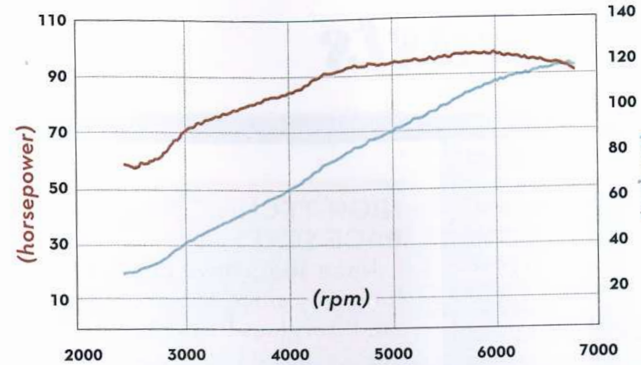
Then there was the real test: how the car performs on track. At a subsequent outing at VARA's Big Bore Bash at Willow Springs International Raceway, our Sprite passed cars it couldn't before. We're going to call this build a success.

HOW MUCH TO BUILD A RACE ENGINE?

The answer to that question is typically pretty nebulous. After all, when a project's completed, do you really want to tally receipts? But let's pick apart the cost of our Sprite's engine.

Fortunately, a previous owner had already installed some high-dollar parts under the Sprite's hood, including the forged Moldex crankshaft (about $3500) and Longman cylinder head (worth about $2500). The rods are supposedly Carrillo (about $1500).

For this latest rebuild, the big-ticket items included the JE pistons ($647), Manley valves and related hardware (about $625), APT camshaft and lifters ($538), BHJ damper ($390), Weber carburetor setup (about $600), Moroso accumulator ($195) and Moss crankshaft sealer kit ($208). Then we tied it all together with ARP hardware.



SOURCES

Advanced Performance Technology
(951) 686-0260
aptfast.com
Camshaft, lifters

Automotive Racing Products
(800) 826-3045
arp-bolts.com
Engine fasteners

BHJ Dynamics
(510) 797-6780
harmonicdampers.com
Harmonic damper

De Groff's Mark Cylinder Head Service
(818) 701-5274
Cylinder head work

JE Pistons
(714) 898-9764
jepistons.com
Pistons and rings

Manley Performance
(732) 905-3366
manleyperformance.com
Valves, springs, retainers

Moroso Performance Products
(203) 453-6571
moroso.com
Oil accumulator

Moss Motors
(800) 667-7872
mossmotors.com
Rear oil seal kit

Penta Motorsports
(747) 888-9800
pentamotorsports.com
Engine assembly, dyno test

Pierce Manifolds
(408) 842-6667
piercemanifolds.com
Weber carburator, intake

POR-15
(800) 726-0459
por15.com
Engine paint