Tuning The 1800cc MGB

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There are few mysteries about the engine employed in the MGB.

During the era in which the B Series engine was designed, hydraulic lifters for automotive applications were still in their technological infancy, therefore the engine was designed to use solid lifters. This offered the designers the opportunity to wisely leave the camshaft exposed to the crankcase so that its lobes could be lubricated by a spray of oil emitting from the lower ends of the connecting rods. This desire to lubricate the lobes of the camshaft and the lower sections of the tappets dictated the thickness of the connecting rod big end. Adequate bearing support was achieved by using a large diameter big end design.

Its Heron-type head used Weslake-patented combustion chambers which were a marked advance beyond previous technology, allowing for superior flow characteristics while permitting excellent flame propagation. The incoming fuel/air charge was directed toward the spark plug and away from the hot exhaust valve, minimizing preignition and allowing less ignition advance to be used. The siamesed intake ports, like some other features of the engine, were largely the result of production economics. By using siamesed intake ports the intake manifold could be of simple design and thus be inexpensive to produce. The tappets and pushrods could also be neatly situated between the ports, thus keeping the head as narrow and light as possible. The placement of the intake and exhaust manifolds on the same side of the head meant that only one mating surface need be machined, and fewer manifold mounting studs and their attendant threaded bores were required. It also allowed the distributor and generator to be placed on the opposite side of the engine, thus greatly simplifying maintenance.

There are also some distinct engineering advantages to this approach. By placing the intake ports with their cool fuel/air charge next to the hotter exhaust ports, this area of the head is better cooled than it would be in a crossflow design, precluding warpage and possibly extending the life of the exhaust valves, although this configuration allows more heat to accumulate in the walls of the intake ports and thus is detrimental to intake charge density and hence lowers power output potential. The small-bore long-stroke configuration gives better thermal efficiency and thus better fuel economy. The bore centers are the same as those on the earlier, smaller displacement versions of the engine, so the new engine could be produced on much the same tooling, thus keeping costs within reason.

Although the B Series engine design is truly a compromise, it's a brilliant one that modern mechanics recognize as one that was far ahead of its time when introduced. It was further improved with the introduction of its 5 main bearing version. A higher capacity Holbourne-Eaton oil pump was provided to supply the bearings which were 1 1/8" wide for the front, center, and rear bearings, and 7/8" wide for the intermediate bearings. They all had diameters of 2.125", a full 1/8" greater than that of the previous 1622cc three main bearing version. This produced an almost unbreakable crankshaft with lots of overlap between its journals and counterweights. Certainly there were other new engine designs that were even more advanced in the mid-to-late 1940s, but this one was intended to be available in cars that ordinary people could afford to own and operate. In those days, that made it special, and its designers had every reason to be proud. During an era when full race engines struggled to reliably produce 1HP per cubic inch, when the 18G Series arrived in 1962 it boasted 95HP from a mere 110 cu. in., giving it a specific output of .864hp per cu. in., and this was an engine that could reliably be used as a daily driver! In its heyday, it was impressive indeed. Pretty fantastic for a relic whose design is well over a half century old! A true classic engine for a true classic car!

Everybody who is about to rebuild their tired engine entertains the thought of improving upon the power output of this classic engine design. However, nobody wants to end up with a temperamental beast. Since you're rebuilding the engine, this is a good opportunity to do it the Peter Burgess way. As a former professional mechanic who has built custom engines, I can assure you that I have thoroughly read both of Mr. Burgess' books "How to Power Tune MGB 4-Cylinder Engines" and "How To Build, Modify, And Power Tune Cylinder Heads," and that his theories are both sound and logical. His reputation as the MGB engine tuner is well deserved. His books should be in every MGB owner's library. His website can be found at http://www.mgcars.org.uk/peterburgess/ . If you have not studied his books, they are available from Veloce Publishing at http://www.veloce.co.uk/newtitle.htm . I wholeheartedly agree with his statement "The entire engine system needs to be considered as a whole, otherwise the gains from component changes may not be fully realized."

Before you begin, you will need to have a proper Service Manual. I would recommend that you purchase a reprint of the original factory service manual that the MG dealers had for their mechanics to consult. To my knowledge there is nothing that can compare with it for completeness. Its actual title is "The Complete Official MGB," although it is often called "The Bentley Manual" as it is printed by Bentley Publishers. They have a website at http://www.bentleypublisher.com/ where you can order it direct.

If your engine is a post-1967 North American Market model, then it is equipped with an antipollution system. To get better performance out of the engine, it will be necessary to remove some of the components of this system. Prior to doing this, check with your State Officials to find out if this is illegal. Be advised that in some states where it is illegal to tamper with a vehicle's antipollution system it is not required to be maintained once a car has reached a certain age, so specifically inquire about this issue as well. Be aware that it is desirable to retain certain items of this system, so don't start by simply stripping everything off. Instead, proceed with the same methodical approach that you would use toward any other part of the car.

If yours is a 1964 through 1969 GA through GF Series engine equipped with a PCV Valve, it should be retained to reduce atmospheric pressure inside the engine. However, if the compression rings start to fail, oil mist from the engine will saturate the

oil separator tube of the early version of the front tappet chest cover and be transferred into the combustion chambers through the induction system, the consequent carbon buildup eventually resulting in problems such as preignition, sometimes called "pinging." The front tappet chest cover from the later 18V engines (18V-797-AE, 18V-798-AE, 18V-801-AE, 18V-802-AE, 18V-883-AE-L, 18V-884-AE-L, 18V-890-AE-L, 18V-891-AE-L) is preferable due to its better breathing characteristics and for having incorporated into its cover design an oil reservoir/return chamber which minimizes the transfer of oil mist into the induction system. When replacing the gaskets on the tappet chest covers, use sealant to glue the gaskets to the covers and allow it to harden overnight so that the gasket will not move during installation.

If you choose to not remove the hose that leads from the Gulp Valve to the fitting on the center of the intake manifold, it can be simply blocked with a plug, or, after removing the intake manifold, threads can be tapped into the intake manifold with a 1/4" NPT tap and a nipple installed.

At this point you may remove both the hoses and the Check Valve that connect the Air Pump to the Air Injectors atop the head. Next, remove the Air Pump, its air cleaner, and the attendant mounting brackets. When the engine is equipped with the Air Pump, the Gulp Valve is necessary to prevent backfiring when closing the throttle at high engine speeds, so remove the Gulp Valve along with its hoses and its attendant hardware as well. At idle the intake manifold vacuum is in the order of 18 to 20 Hg, while on the overrun it rises to 23 to 25 in Hg without the Gulp Valve. This is not enough to make a significant difference in terms of the amount of fuel pulled out of the jet, thus the Gulp Valve is unnecessary once the Air Pump is removed. Next, remove the Air Injectors and replace them with 7/16"-20 fine threaded bolts 3/4" in length. Do not be tempted to use Allen head plugs because they will have to be bottomed out into the head, projecting into and thus creating an obstruction to air flow in the exhaust ports. Finally, if your engine is from a post-1974 model, remove the EGR Valve and its hose and control pipe, the fuel shutoff valve, and the vacuum advance valve.

You should retain the Anti-Run-On Valve fitted on the 1973 and later models as its purpose is to apply such a strong vacuum to the chamber above the fuel in the float bowls that the fuel cannot exit the fuel jets when the ignition is switched off, thus preventing the car from running on. When the ignition is turned off the ignition switch energizes this solenoid-actuated valve to close it, then the oil pressure switch releases it after the engine has stopped and oil pressure has fallen. When the engine is running the Anti-Run-On valve is open, allowing fresh air to be pulled through the adsorption canister, clearing it of the vapors that have expanded into it from the fuel tank and the carburetor float bowl chambers, then through the rocker arm cover and tappet chest into the induction system to be consumed in the combustion chambers. The rocker arm cover is equipped with a restrictor tube to prevent the fresh air being drawn in from overly diluting the fuel/air mixture and causing lean running. This Anti-Run-On system can be readily retrofitted onto 1970 through 1971 18GJ and 18GK engines as well as the 1972 18V-584-Z-L and 18V-585-Z-L engines, all of which have the necessarily modified fuel tank, adsorption canister, non-vented oil and fuel filler caps, and restrictor tube equipped rocker arm cover as standard equipment. Do not remove or disconnect the Vapor Separator that connects the fuel tank to the Adsorption Canister.

It is important to retain the crankcase ventilation system. Properly maintained, crankcase gases are drawn into the combustion chambers of the engine by the vacuum created by the fuel induction system, either through the intake manifold as in the 18GB through 18GF engines, or through the carburetors as in the later engines. This permits the crankcase to function in a partial vacuum which causes oil mist inside the crankcase to be drawn upwards towards the camshaft and tappets. Without the partial vacuum provided by this system, the pressurized gases inside the crankcase of the B Series engine would cause oil to be blown past the pistons into the combustion chambers leading to carbon buildup and consequent preignition problems. In addition, an excess of these pressurized gases and oil mist would also be vented partially through its rocker arm cover, pressurizing the adsorption canister and interfering with its function, rather than traveling down through the pushrod passages as they should to aid in the lubrication of the lower ball ends of the pushrods and the upper sections of the tappets. For the excess pressurized gases in the crankcase to arrive at the rocker arm cover they would have to travel up the past the pushrods. This means that the gases would be forced upward around the tappets, depriving their upper sections of the additional lubrication supplied by the oil mist and the oil running down the pushrods from the rocker arm assembly. It thus must be understood that all of this is prevented by drawing all of the pressurized gases inside the engine out through the tappet chest cover and into the induction system under vacuum, and as such the system contributes to a prolonged engine lifespan. These procedures having been performed, you can now set out on a quest for more power.

You must accept the fact that more power will increase both wear and stress on your engine's components. Hence it is important that the basic components of the engine provide a sound foundation. Remember: if anything is worth doing, it's worth doing right. Have all of your components, including the crankshaft, block, heads, connecting rods, and rocker arms hot tanked to remove the years of accumulated crud that is to be found in all old engines. Prior to this being done insist that all of the gallery/core/frieze plugs be removed. Remove the aluminum Engine Number Tag from the block prior to hot tanking as the caustic chemicals will dissolve it. After hot tanking, all of the internal passages should be chased out thoroughly with brushes and flushed. Be sure to tell your machinist that the area inside of your block around the rear cylinder is commonly a trap for sediment and to be sure that all of it is removed. All threads in the block should be chased with a tap and all holes should be reamed. Also insist that new oversize bronze plugs be shrink-fitted slightly beneath the surface of the block so that they won't interfere with proper gasket sealing of the sump and end plates. Bronze has a higher coefficient of expansion and contraction than iron. To "shrink-fit" them into the block, put them into a ziplock bag, turn the thermostat all the way down on your deep freeze, and leave them in there overnight. That "shrinks" them to a smaller diameter. When you're ready to install them, take them out, spray them with WD-40 to displace any moisture on them, then seat them into the block with a flat-nosed punch. When they warm to room temperature, they'll be in there good and tight because they've expanded! The only way to get them out is to drill and tap threads into them and use a puller! Because bronze expands more than iron when it gets hot, there's no way that they'll ever come out while driving down the road. Stainless steel Frieze plugs should be used for the same reason. Their high chromium content also

means lots of expansion when hot, so they won't pop out, either. Make sure that they have a good concentric seating surface by specifying that an end mill bit be used to clean up their seating surfaces in the block. Not the cheap way to do it, but it always works.

Never reuse old gaskets, seals, oil gallery plugs, frieze plugs, core plugs, bushings, bearings, valve springs, shims, thrust washers, piston rings, circlips, wrist pins, rocker bracket studs, rocker shafts, head mounting studs, manifold studs, connecting rod bushings, connecting rod bolts, or the main bearing cap studs and/or nuts. None of these items are expensive, and recycling them into your engine is not only false economy, but an open invitation to future mechanical failure.

Be sure that all bearing support surfaces are line-reamed and their oiling holes carefully deburred. If possible, it would be wise to have the rocker arms, heads, block, crankshaft, and connecting rods magnafluxed or, better yet, x-rayed to be certain that there are no cracks. All of the rocker arm faces should be resurfaced on a contour grinder and rehardened if they are not to be replaced by new ones.

Warped mating surfaces are the major contributing factor in leakage and in the development of cracks in the head casting. While today's sealants are excellent and today's gaskets possess greater compressibility than those of the past, they can compensate for warped mating surfaces only to a very limited degree. Use a Payen or Fel-Pro head gasket or one that is marked FRONT/TOP as these should be quality gaskets. These gaskets are resin-impregnated, have copper sealing rings, and require no additional sealing coatings. The resin softens when it gets hot and makes a better seal. They are particularly appropriate for use on engines that have been converted to aluminum heads as they handle the differing coefficients of expansion between a cast iron block and an aluminum head quite well. Do not allow the gasket to overhang into the bore of the cylinder as this will lead to a blown gasket and/or internal damage to the engine. You will need to retorque the cylinder head immediately after the initial running of the engine.

During the course of an engine rebuild it's common to find that the block is warped along its longitudinal axis, so we're always prepared to line-bore the main bearing and camshaft journals. However, we rarely stop to consider that this warpage should also extend to the mating surfaces elsewhere on the engine. The necessity of skimming them flat just as one would the deck of the block and the mating surface of the head should always be explored. To check for warpage in your garage, simply clean the mating surfaces and smear a very thin stain of machinist's bluing or petroleum jelly on them. In a smooth, perpendicular motion, place a clean plate glass or a mirror on the surface and then gently pull it away. Hold it up to a light and look for any gaps in the bluing/petroleum jelly outline. If you find any, you've got warpage. This technique will work with any mating surface. Get the mating surfaces flat and you'll have gone a long way towards having an oil-tight engine.

Paint the engine before reassembly with a thermoconductive enamel engine paint only. Hirsch has an excellent engine enamel which, being unique in that it was originally formulated for use on jet engines, will withstand temperatures up to F 600 and is an exact duplicate of the shade of red ("MG Maroon") used on the 18G through 18GK Series engines. It remains glossy almost indefinitely and can be applied directly to cast iron without primer. Hirsch has a website at http://www.hirschauto.com/ . Do not allow paint to get onto any gasket mounting surfaces or into any threaded holes. Do not paint the front face of the engine rear engine plate where it mates up with the gasket to the back of the engine block. Also, do not paint the area of the rear engine plate where the starter motor mounts, because the starter needs a solid electrical ground in order to work properly. Instead, these gasket areas should be masked off prior to painting. Once the masking is applied to the surface, place the component onto the plate and scribe around it with an Exacto knife, then simply peel away the masking from the area to be painted.

The most desirable engine blocks for a high output engine are the early 18V blocks of the 1972 through 1974 Chrome Bumper models. These later blocks have bolts instead of studs for securing their stronger main bearing caps. These can be readily identified by their engine numbers: 18V-584-Z-L and 18V-585-Z-L from the 1972 model year, and 18V672-Z-L and 18V-673-Z-L from the 1973 through 1974 model years. These later main bearing caps have shallow recesses for the heads of their mounting bolts while the earlier caps have deeper recesses for their washers and nuts. The later main bearing caps can be used in the earlier engines only if their appropriate mounting bolts are also used and only if they are line-bored.

Be aware that the later 18V blocks from the 1975 through 1980 Rubber Bumper models have a repositioned motor mount boss on the camshaft side of the block and so will not fit into earlier cars. These can be readily identified by their engine numbers: 18V-836-Z-L, 18V-837-AE-L, 18V797-AE-L, 18V-798-AE-L, 18V-801-AE-L, 18V-802-AE-L, 18V-883-AE-L, 18V-884-AE-L, 18V-890-AE-L, 18V-891-AE-L, 18V-892-AE-L, and 18V-893-AE-L.

The crankshaft with the best balance and wear characteristics is the flat-sided five-main-bearing cast iron version found in the early 18V engines (18V-584-Z-L, 18V-585-Z-L, 18V-672-Z-L, and 18V-673-Z-L). Although slightly weaker than the alternate steel crankshafts used in five-main-bearing engines and seven pounds heavier than the earlier three-main-bearing steel crankshafts (32 lbs Vs 25 lbs), it is strong enough for the streetable enhanced-performance engine that is the goal of this article. Advise your machinist that the crankshaft main bearing caps and the connecting rod end caps are individually matched paired sets and hence are not interchangeable. Following this, the crankshaft should be indexed and the lengths of its throws matched. Be sure to tell the machinist that you want the journals radiused at the web to reduce the chances of breakage under heavy loadings. Check both ends of the crankshaft for any grooves worn into it by the old seals. If they cannot be polished out by your machinist, then a Speedi-Sleeve will be necessary (Moss Motors Part# 520-515). Moss Motors has a website at http://www.mossmotors.com/ .

This having been done, the effective length of the connecting rods (eye center-to-eye center distance) should be matched. If possible, have the connecting rods balanced end-for-end. Have both the piston/ring/wristpin assemblies and the connecting rod assemblies matched respectively to within .10 of a gram. Pistons that use only three rings are lighter than the older-design four-ring and obsolete five-ring designs. The reciprocating masses having thus been matched, the crankshaft and the flywheel should then be dynamically balanced separately. Advise the machinist that you would prefer that the balance of the crankshaft be achieved by wedging rather than by drilling. These procedures are fundamental to producing the smoothest running engine possible and will provide a bit more power that would otherwise be lost to the production of vibration, in some engines perhaps as

much as 3 HP. Lightening the flywheel to a minimum weight of 16 lbs will cause the engine to pick up and lose RPM faster with the clutch disengaged and thus enable faster shifting, although at the price of increased vibration and a tendency for the engine to stall due to decreased flywheel inertia. Should you choose to have this done, advise the machinist that the material to be removed should be taken from the front and back faces and not from the clutch friction surface.

   Electropolishing and shot-peening of the connecting rods is necessary only if you're going racing. Note that exotic lightweight connecting rods such as those marketed by Carillo (590 grams) are primarily intended for racing use and are unnecessary for use in all but the most radical of street engines, although their lower reciprocating mass will reduce both horsepower loss and vibration. The obliquely split connecting rods first used in the three main bearing 18G and 18GA engines used a smaller-diameter (.750") wristpin. Both it and the obliquely split connecting rod of the five main bearing engine (18GB through early 18GH Series) weighed in at a ponderous 980 grams. Not only are they heavy, they are notoriously weak in highly stressed engines. The horizontally split connecting rods with balance pads used in the late 18GH through early 18V engines were a lighter 845 grams. The final version of the connecting rod used in the late 18V engines had no balance pads and were the lightest, weighing 760 grams. These can commonly be found on engines whose identification numbers start with 18V -883-AE -L, 18V -884-AE -L, 18V -890-AE-L, 18V-891-AE-L, 18V-892-AE-L, or 18V-893-AE-L. Be aware that the connecting rods used on the 18GB through 18GF engines use connecting rods that used the larger 13/16" wristpins that floated in a press fitted bushing in the small end of the connecting rod. This bushing was later eliminated in those of the 18GH through 18V engines. These later engines also used the larger 13/16" (.8125") diameter wristpins which were press fitted into the connecting rods, so your pistons must be chosen accordingly. However, the small end of the later connecting rods can be machined to accept the earlier bushing if floating pistons are desired. If you desire lighter connecting rods to further reduce vibration and its attendant power loss, the late Original Equipment ones without the balance pads found on the late 18V engines will fit this requirement at minimal cost.

   When installed, the oil squirt holes of the connecting rods must face the side of the engine opposite the camshaft to cool the piston and lubricate the load bearing surfaces during the power stroke. Failure to do this will eventually result in extreme piston pin wear within the piston itself, plus create the very real likelihood of piston failure, not to mention increased bore wear as well. Positioning the connecting rods so that the oil squirt holes face the camshaft is not necessary as the camshaft receives excellent lubrication from both the pressure galleries in which its journals spin plus residual oil flowing down the pushrod bores from the rocker arm assembles, as well as oil sprayed from the crankshaft's main bearings and connecting rod big end bearings at the crankshaft. Be aware that on some connecting rod bolts, only one side of the bolt head is chamfered to provide sufficient clearance for the camshaft, so note this fact when you reassemble them.

   Aside from matching the weights of the reciprocating components and dynamic balancing of the crankshaft and the flywheel, perhaps one of the best ways to create a smooth engine is to equalize the compression and thus the power impulses occurring in each cylinder. Once the crankshaft and the connecting rods have been indexed, this can be accomplished by making sure that the combustion chambers are of equal volume so that the compression ratio in each cylinder will be the same. The volume of each combustion chamber can be measured after the head has been skimmed flat by using a clear piece of sheet plastic with a small hole drilled in it. Simply put a bead of chilled grease around the edge of a combustion chamber and press the plastic down onto it so that the grease forms a seal. Using a syringe or an eyedropper with a scale of measurement on it, carefully fill each combustion chamber with light oil, keeping a record of how much is necessary to fill each one. Next, use a Dremel tool to gently remove small amounts of metal from the smallest combustion chamber. Work slowly. The walls of the combustion chamber should be kept perpendicular to its roof to ensure the best flow characteristics. The roof should be flat and finished with a sanding disc, care being taken to not undercut or groove the base of the wall where it adjoins the roof. Take care that in an attempt to unshroud the intake valve you do not attempt to remove too much material from the combustion chamber wall near it as this can lead to preignition and breaking into a coolant passage. Unshrouding is best left to experts. Instead, remove material evenly from the roof of the combustion chamber. Measure the volume of the combustion chamber repeatedly until it matches that of the largest one. Repeat this process on all of the combustion chambers until their volumes all match. You should now have equal compression on all four cylinders, making for a smoother engine.

   Be sure that both the mating surface of the head and the deck of the block have been skimmed flat and that the stud mounting holes are chamfered, or at best you'll ultimately experience a blown head gasket or at worst a cracked head. Flycutting lacks precision and should be used only as a cost-cutting measure for removing metal prior to the final precision cut. An end mill produces a superior finish for street machines, the grooves left behind by the end mill providing a surface that the head gaskets can bite into and thus produce a better seal. After milling, the ridges at the edges of the grooves left on surface of the deck of the block by the machining process should be removed. Surface grinding is good for racing engines that use only copper head gaskets and face frequent disassembly. Note that the deck of the block must be parallel to the axis of the crankshaft. The Original Equipment specification piston crown to deck depth is .040".

   It may be necessary to shim the rocker stands after the head has been skimmed so that standard-length pushrods can be used. If so, be careful to maintain the original symmetry of the thrusts of the opposing ends of the rocker. The edges of the combustion chamber and the valve seat recesses must be carefully deburred and smoothed to preclude the possibility of "hot spots" developing and thus prevent preignition from consequently developing.

   While all of the connecting rods used in the B Series engine use the same center-to-center length (6.500") to produce a connecting rod to stroke ratio of 1.86:1, they differ greatly in design details. Connecting rods from the 18GB through the 18GF Series all use floating wrist (gudgeon) pins that ride in small end bushings and are retained by circlips, while those of the 18GK and 18V Series use press-fitted wrist (gudgeon) pins, although the wrist (gudgeon) pins are of the same diameter (.8125"). These press-fitted pins typically require a 3 to 5 ton press to install. Prior to installation the ends of the pins should be checked to be sure that they have been lightly chamfered to prevent them from damaging their bores in the piston. The safest installation technique is to chill the pins in a deepfreeze overnight to cause the

metal to contract to a smaller diameter and to boil the pistons in water to cause the bore into which the pins fit to expand just prior to pressing in the chilled pins. Although the pistons themselves are interchangeable between the five-main-bearing engines due to their identical small end and big end bearing sizes, they must be installed complete with their appropriate connecting rods and wrist (gudgeon) pins. Pistons of the three-main-bearing 18G and 18GA Series engines used wrist pins of .7500" diameter and as such cannot be used in the connecting rods of the later five-main-bearing engines

Because of the B Series engine's relatively short connecting rod to stroke ratio of 1.86:1, the engineers at MG insisted on forgoing the use of the usual split skirt Lo-ex piston normally installed in other versions of the B Series engine intended for use in the more sedate family sedans and instead chose to specify solid skirted pistons to minimize the effects of the greater side thrust loadings resulting from the higher engine speeds attainable with dual carburetors, thus gauranteeing reliability. The Original Equipment Hepolite pistons are of excellent quality and need not be superseded by specialty racing pistons. They also have the distinct advantage of having their oversize number impressed upon the forward part of their crowns to ease reassembly. These are available from Advanced Performance Technologies. They have a website at http://www.aptfast.com/ . Prior to boring the block each piston should be measured with a micrometer to establish its optimum bore size. They should be fitted to a clearance tolerance of .003" to .0035". Because of the close proximity to the bore of the studs, the bores of the cylinders tend to distort slightly when the head is torqued down. Some machinists will try to compensate for this by sizing the bores to their maximum factory-specified clearance, but this will result in a shorter piston and bore life. The proper approach is to mount a blanking plate to the deck of the block and torque it to the same specifications as would be used when mounting the head in order to simulate the stress of a torqued head, then bore the cylinders. The top of the bore should be then be chamfered to reduce the development of "hot spots" that are precursors of preignition and to allow easier installation of the piston/ring assemblies. When using a hone to crosshatch the cylinder bore, bear in mind that it is the fine grooves created by honing that hold oil to lubricate the pistons and their rings. A groove angle of 120 degrees is optimum. After honing, use a plateau hone to clean off the ridges of the crosshatch grooves and thus facilitate easier seating of the rings. Afterwards, both the pistons and bores should be again precisely measured and the pistons paired to their optimum bores.

If you choose to install the Original Equipment 8.8:1 compression pistons with their 6.2 mm dished crowns of the earlier 18GB through 18GK engines with their connecting rods into the later 18V engine, then the smaller 39cc combustion chamber volume of the 18V heads will boost the compression ratio to about 9.4:1, presuming, of course, that the machinist hasn't removed too much material from the block or the head, in which case it will be higher. On the other hand, if the later low compression ratio pistons of the 18V engine (8:1) with their 16.2mm dishes are installed into an engine equipped with the head from an 18G through 18GK Series engine with their 43cc combustion chambers, then the compression ratio will be a very low 7.7:1. Fortunately, the UK/European market pistons for the 18V engines were available in a 9:1 compression ratio. Don't go over 9:1 on the compression ratio with unmodified combustion chambers or you'll most likely regret it when it preignites on America's newest federally mandated development: Oxygenated Gasoline. Without professionally modified combustion chambers, any increase in compression beyond 9:1 will give only a moderate increase in power at the expense of streetability.

Replacement of your ancient-and-probably-stretched-by-now head studs with new stock ones from Brit Tek (Brit Tek Part # HSK001) or stronger ones made of 8740 steel from ARP (Brit Tek Part # HSK002) is also recommended. Stretched head studs will not hold their torque settings and will lead to a leaking or blown head gasket and possibly a warped and/or cracked head. Repeated retorquing with stretched head studs will likely result in a cracked head. Retap the threads in the block prior to installing them with antisieze compound on their threads and do not attempt to torque the studs down as this may lead to cracking of the block. Torquing of the head compression nuts will accomplish this task just fine. Don't make the all-too-common mistake of running steel head studs all the way down into the block until they bottom out. Steel studs have a different coefficient of expansion than that of a cast iron block and preloading them will aggravate this factor. If they're bottomed out in the block they can cause the deck to distort as they expand more than the block, and that could lead to a blown gasket, or even a cracked deck of the block. When the block cools, being a casting it will tend to return to its original flat shape if it hasn't cracked. Never use a thread locking compound as it will result in damage to the threads whenever the studs are removed, rendering them useless. Should the stud spin in its threads when torquing, check to be sure that the studs aren't undersize.

Use either the original hardened thick head stud washers or replacement items of the best quality (thick and with machined faces) on the head, never thin mild steel ones. Make sure that the washer seating surfaces are machined flat with an end mill after the head has been skimmed so that they will be a parallel plane to the mating surface so that torque readings will be accurate. Put an anti-seize compound on the threads prior to installing the head compression nuts and torquing them to the head. While oiling of the threads is commonly done to protect from rust, but the antisieze compound will do an adequate job of protecting the threads from corrosion. If you're really paranoid about the threads corroding, then use acorn nuts!

A word about valve materials: For many years the standard exhaust valve steel was EN52. This steel was first introduced over 70 to 75 years ago and has a hardness of 25 to 31 HRc. Improved engine design has lead to increased compression ratios and higher operating temperatures, and improved fuels with an increased octane rating and the addition of tetra-ethyl-lead have lead to an increasing tendency to prematurely burn out the valve. This steel is classed as "semi" corrosion resistant as they are attacked by Chlorine and Sulfur compounds. As a result, this material is no longer considered suitable for exhaust valves, although it is still perfectly satisfactory for inlet valves when used with unleaded gasoline.

About 1960 a new steel, Austenitic 214N (Stainless), was developed. This steel has a hardness of 30 HRc and retains its hardness even up to temperatures of 800 Degrees C and possesses excellent rupture strength under high temperature conditions combined with good creep and impact values. Its high Chromium content gives good scaling resistance, and has greater corrosion resistance against Chlorine although is still not immune to sulfurous attack. This is the preferred material for use with the higher combustion temperatures attendant with unleaded gasoline.

A more recently developed material, Nemonic 80A, has a hardness of 32 HRc and has an increased operating temperature over Austenitic 214N as well as higher corrosion resistance. Due to its high cost, it is commonly seen only in very high compression ratio engines built expressly for racing.

Tufftriding (AB1 or TF1, the process used depends upon the specification of the valve) gives a hard layer of between 72 to 74 Rockwell 'C' over the complete valve of approximately 10 to 20 microns in depth, and gives excellent wear properties in a cast iron or bronze guide with the added benefit of stress relieving the valve. This type of treatment produces a black mottled finish all over the valve. Hard Chrome Plating gives the stem added durability by depositing chrome on the stem to guide area of the valve of approx. 32 to 72 microns in thickness. This gives good compatibility if the valve is made in Austenitic 214N (Stainless) and is used in a cast iron guide. This type of treatment is only applied to the valve stem. A Stellite 6 deposit can be applied to the exhaust valve seat face which will enhance the seat hardness (Rockwell 'C' of 38 to 42 HRc) which will enable it to be used with unleaded fuel or in highly stressed engines. A Stellite 12 deposit can be applied to the tip of the valve stem which will further enhance the tip hardness (Rockwell 'C' of 48 to 52 HRc).

When installed, all valves and valve guides should be of equal respective heights. Because valve guides will frequently distort when being pressed into their bores in the head, they should always be reamed to their manufacturer's recommended clearances after installation to assure a consistent internal diameter. Do not waste money on exotic tuliped valves. Due to the side draught configuration of the B Series Engine's ports, they will actually flow less than an Original Equipment flat-topped valve and will increase reciprocating mass in the valvetrain unnecessarily. Like a waisted throttle shaft, waisted valves are nice, but they really won't have much effect in a street engine. They're primarily for very-high-rpm racing use with a camshaft like a Piper 300 and full race heads. The risk with waisted valve stems is that they can vibrate like a tuning fork at maximum lift during high engine speeds. The vibration can cause metal fatigue to set in prematurely and then the valve stem will fracture, the valve head being sucked into the combustion chamber, there to do all sorts of evil things. That's why they're never reground and reinstalled by racers. Short Fatigue Life. Don't ever try to recycle them. Once the seating faces are worn, toss them in the trash. I would make one suggestion that Mr. Burgess does not mention in his book: for use in a street engine, once you've had the three-angle face made on the valve, it should be either stellite-plated or (preferably) tuftrided after lapping it in. Neither of these improvements is overly expensive and will help to ensure a long, long service life in street use.

Don't be tempted into trying to repair a cracked head by taking it to a welder. Welding cast iron is a very tricky thing, requiring the right tools. Contrary to what some welders might tell you, as a former Tool & Diemaker I can explain why it can't be done on a bench in the garage. The problem lies in the fact that a casting is essentially just a bunch of bubbles held together by metal. There is always the risk, even though the alloy of the block and the alloy of the welding rod may be the same, that the density of the weld will be different from that of the density of the casting. This results in different rates of expansion and contraction when the casting heats and cools. If the density of the weld is not the same as that of the head, the casting will crack where it adjoins the weld and you'll find yourself back where you started.

However, because creating a weld is nothing more than a matter of heating the metal alloy of the rod to the point that it flows into and heats the metal of the casting to the point that it liquefies and blends with the molten alloy of the welding rod, it is possible to achieve the same density if certain conditions are met. First, the temperature of the molten metal of the welding rod should be no higher than that necessary to attain a molten state. Second, the casting should be heated in a heat treating furnace until it almost melts. The white-hot casting then is removed and the weld applied, then the casting is quickly placed back in the furnace and very slowly brought down to room temperature in controlled stages. Although this controlled cooling process will help to allow stresses to even themselves out, the casting may be warped and require machining.

Why is it so necessary to heat the casting in a furnace instead of just heating it with a torch on a welding bench? So that the temperature of the weld will be as close as possible as that of the casting. Why is that so important? First, because of the density issue already described above. That requires a degree of precision control that a welder can't attain with a blowtorch, even though he may sincerely believe that he can. Face it, the man is a welder, not a trained Tool &Diemaker or a trained Mechanical Engineer. He simply does not know any better. Secondly, because the thermal stresses created by the extreme heat of welding will be minimized and not be isolated to the area immediately around the weld due to the fact that the heat differences are not as localized. Cast iron conducts heat very slowly, so the closer the temperature of the iron of the casting to that of the weld when the welding process begins, the less thermal stress is generated in the areas adjacent to the weld. This elaborate procedure is necessary to eliminate the possibility of cracking due to induced thermal stress, which is a separate issue from that of weld density. The whole idea behind the process is often called "stress relieving," a process that I'm sure that you've heard of. Now you understand just what it is.

Needless to say, this process is expensive. If the problem is with a crack in the head, I would just scrap it. There are many used heads available in good condition for far less than what the above-described process costs. You'd have to pay for the machining costs on the head either way that you choose to go, so why bother?

The better shops will do most or all of the aforementioned machining and engineering procedures as a matter of course. If the shop you're considering can't provide these services, they are merely tradesmen rather than professionals: go elsewhere.

I would also suggest that you use the later type of crankshaft oil thrower that is common to all five-main-bearing engines and its matching timing cover which uses a neoprene seal rather than the leak-prone felt seal of the earlier timing chain cover. A duplex-type camshaft drive chain tensioner, the 3/8" pitch duplex camshaft drive chain and sprockets of the 18G through 18-V-584-Z-L and 18-V-585-Z-L Series engines, plus a nitrided rocker shaft (Advanced Performance Technologies Part # RSB-T) will aid in achieving long-term durability. In addition, an adjustable sprocket (Brit Tek Part # PGS001), although expensive, will enable you to easily keep the camshaft operating in phase with the crankshaft as all camshaft drive chains wear and thus "stretch." However, the same objective can be attained in a less expensive manner by using offset keys to adjust the timing of the standard camshaft sprocket, although adjustments made in this manner are far more troublesome and tedious. The reuse of old camshaft

drive sprockets is false economy. A set of worn sprockets will result in uneven and accelerated wear of a new camshaft drive chain, thus causing its length to oscillate. This will accelerate wear of the camshaft drive chain tensioner. The oscillation of the chain will cause both the valve and ignition timing to "wobble" inconsistently, playing havoc with performance. Install a new slipper pad on the camshaft drive chain tensioner and check that the mechanism is functioning properly. Be sure to inspect the bore of its adjuster body for ovality (+. 003" max.). Should it prove to be worn out, a new one can be obtained from Advanced Performance Technologies (APT Part # BCT-1).

Replacement or refurbishment of your tired old harmonic balancer is highly advisable as it reduces torsional stress on both the crankshaft and the camshaft, as well as reducing wear of the camshaft drive chain, coolant pump, and alternator due to reduced oscillating stress loadings. Advanced Performance Technologies' stainless steel version (APT Part # 18CSP-2) has provision for easy removal. However, your Original Equipment harmonic balancer can be rebuilt by a specialist (Damper Dudes, 6180 Parallel Drive, Anderson, CA 96007 (800) 413-2673).

Although the 18V-672-Z-L and later versions of the 18V engine sacrificed dual valve springs for single valve springs in an effort to reduce production costs, it should be remembered that these later engines reached their maximum power output at the notably lower engine speed of 4,800 RPM than the earlier engine's 5,400 RPM and thus spring surge was not a problem. However, at the higher peak operating speeds and greater valve lifts that a power-enhanced engine attains, a single valve spring is inadequate to avoid valve bounce and spring surge. Spring surge can result in a valve failing to close rapidly enough to avoid clashing with the piston on the upstroke, while valve bounce can lead to a broken valve. Dual valve springs are thus a necessity for an enhanced-performance engine in order to control spring surge at the high engine speeds which can be achieved, especially if a hotter camshaft that relocates the power output peak to a higher RPM is utilized.

Be aware that the early type spring caps with square groove cotters used on the 18G through 18GF/2159 non-overdrive and 18GF/530 overdrive engines will not work with the later type round groove valve spring stem cups. Larger valve sizes with the square groove machined for the earlier size keepers are not available. This is just as well, as the round groove type is better. You will therefore need to use the later type dual spring caps used on the 18GF/2160 non-overdrive and 18GF/531overdrive through 18V-585-Z-L engines to go with the round groove keepers. You will also need the valve spring collars of the 18G through 18GK Series engines to go under the inner valve spring in order to locate it properly.

Old pushrods can be trouble. Because of the fact that the central axis of each of the tappets is offset from that of the camshaft and the the tappets have a .002" dome on their faces which bear against lobes' surfaces which are obliquely slanted away from the
rotational axis of the camshaft, the tappets spin in their bores when being lifted by the lobe of the camshaft, thus reducing both friction at the tappet/lobe interface and consequent wear. Should a pushrod become bent, it will prevent the tappet from rotating in its bore, ruining the tappet/camshaft interface and rapidly wearing out the lobe. (You weren't really going to reinstall those ancient pushrods in a blueprinted engine, were you? Know what metal fatigue is?) If you should choose to reuse your old Original Equipment pushrods, they should be inspected for signs of bending and excessive end wear. Remember that the ball ends of the pushrods have mated to their individual tappets and rocker arm ball adjusters (11/32") have mated to the cup ends of the pushrods over the years, so when you take them out, keep them in ordered sets and make sure that they are oriented as they came out of the engine (cup end up). Because the rotating faces of the rocker arms have also mated to their adjacent rocker stands over the years, even if you intend to replace the old pushrods with new ones, be sure to keep them in the same order as that in which they were previously installed or you may have problems aligning the center of the thrust faces of the rocker arms over the valve stems.

Clean the pushrods thoroughly, then put a very thin coat of machinist's bluing or petroleum jelly on their shafts. Roll each pushrod on a clean piece of plate glass and then examine the stain on the glass for gaps. That'll tell you if the pushrod is bent. Be aware that a bent pushrod can cause its tappet to stop rotating, resulting in uneven wear of the tappet, which in turn will make accurate setting of the valve clearances impossible and eventual ruination of the lobe of the camshaft. When reinstalling them, make sure that you put some fresh motor oil onto the upper end of the tappet and also down the pushrod passages to lubricate the cups on the pushrods and the tappets.

Unlike Original Equipment pushrods, tubular chrome-moly pushrods do not deflect at the higher engine speeds that an enhanced-performance street engine can produce, plus they have less reciprocating mass and thus will give more accurate valve timing at high engine speeds. This is a problem for both the early short pushrods (72 grams) used in the 18G through 18GK Series engines and the later long pushrods (88 grams) used in the 18V Series engines as they tend to deflect as much as 5/64" at high engine speeds. Crane makes an excellent set of 5/16" diameter 18V pushrods (64 grams) for this purpose (Crane Part # 905-0004) and can supply them in custom lengths if necessary. They have a website at http://www.cranecams.com/ . Due to their larger diameter (.3125" Vs .280"), it will be necessary to relieve the passages in the head for the pushrods in order to eliminate interference. Be aware that simply boring these passageways to .660" to accomplish this may leave insufficient material to permit portwork to be done.

The shorter (1 1/2" length), lighter bucket tappets (45 grams) introduced on the 18V-584-Z-L engines will also assist in the goal of reducing reciprocating mass. Due to their having identical diameters of 13/16" (.8125"), the early long barrel tappets (81 grams) and the later short bucket tappets are interchangeable when paired with their length-appropriate pushrods. The later OE tappet/pushrod assembly is 13% lighter than the earlier OE long barrel tappet (2.298")/short pushrod (8 3/4") combination used in the earlier 18G through 18GK Series engines. The reduced deflection angle of the longer pushrods (10 1/2") decreases side thrust loads on the tappets and thus enhances their lifespan. Crane's lighter chrome-moly pushrods will also reduce inertia in the reciprocating mass of the valve train by about 20% when compared to that of the later Original Equipment 18V short bucket tappet/long push rod combination and by 30% when compared with the earlier Original Equipment 18G through 18GK Series long tappet/short pushrod combination.

Be aware that the heads used on the 18G through 18GK Series engines and those used on the 18V Series engines are of different thicknesses due to the different depths of their combustion chambers and redesigned coolant passages of the 18V Series engines. As a result, the heads used on the 18G through 18GK Series engines are taller (3.172") than those of the 18V Series engines. As a consequence of this, their pushrod/tappet combinations have different included lengths (277mm 18G through 18GK, 274mm 18V). As a result, if you should choose to install the later 18V bucket tappets and longer pushrods into an engine equipped with one of these earlier heads, it will be necessary to screw their rocker arm ball adjusters 3mm further towards the bottom of their travel. This will result in an increase in the effective length of the fulcrum arm of the rocker, with a consequential slight decrease of valve lift.

If coupled with new Original Equipment-specification dual valve springs and their valve spring cups as used in the pre-18V engines, this reduction in reciprocating mass should be sufficient to easily protect the engine from valvetrain float and valve/piston clash up to at least 6,700 RPM when used in concert with camshafts and rocker arms that have the standard amount of lift, plus reduce both camshaft and tappet wear as a result of their lower inertia loads. These valve springs should have a free length of 1 31/32" (inner spring) and 2 9/64" (outer spring), and for proper preload they should have an installed length of 1 7/16" (inner spring) and 1 9/16" (outer spring). Taken collectively, all this should ensure more accurate valve timing resulting in a smoother, more powerful output at high engine speeds.

Although simply fitting a stiffer set of valve springs as a less expensive alternative to reducing reciprocating mass in the valvetrain is possible, in reality it's a poor practice. The additional pressure on the cam lobe/tappet interface and the increased stress on the camshaft drive chain and sprockets will result in accelerated wear of these components. In extreme cases the increased torsional stress can also cause the camshaft to distort along its axis at high rpm, playing havoc with valve timing and risking the breakage of the camshaft itself. Should you elect to use a camshaft with an amount of lift greater than .450" you should consider further reduction of the reciprocating mass further by substituting a set of lightweight alloy spring caps for the heavier steel Original Equipment items. Should you choose to employ them, light alloy spring caps should be checked for deformation at the time of every valve adjustment in order to prevent the valve from pulling through the cap, resulting in a dropped valve. Always use valve springs with rates and lengths that are recommended by the manufacturer of the camshaft. If the installed lengths of the new springs are to be greater than that of the Original Equipment items (Inner: 1 7/16", Outer: 1 9/16"), it will be necessary to counterbore the spring seat surfaces in the head to the proper depth to attain the manufacturer's recommended preload setting length for the springs. Many amateur engine builders will attempt to prevent the springs from binding by being sure that when they are installed they have a certain minimum of .XXX" clearance between the coils. Unfortunately, there is no such "magic clearance figure" that will universally insure against this. Always follow the spring manufacturer's recommendation on this issue, just as you would on the issue of installed height. Peter Burgess recommends a .050" difference between the compressed height when the valve is at full lift and the fully compressed height to avoid valvetrain compression damage.

Just as gasoline is the food of an engine and its cylinders are its lungs, so oil is the life blood of an engine and the oil pump is its heart. I cannot overemphasize the importance of this fact. If your engine is to live a healthy life, its oil pump must be immaculately rebuilt. Unless you're building a highly stressed high output engine, your Original Equipment-specification oil pump will be adequate to the task. This is due to the fact that its design is of the eccentric rotor type. Its rate of flow increases in direct proportion to the engine speed. Any increase in pressure beyond that of the oil release valve spring rating results in the opening of the oil pressure regulating valve and the excess oil falling into the oil sump. Properly rebuilt, it should deliver 60 to 70 PSI at idle when oil temperature is 200 degrees Fahrenheit. The early version of this pump used on the three-main-bearing version of the engine had a problem of having its pressure fall off above 5,500 RPM, an issue which was addressed on the five-main-bearing engines by machining the pump cover and providing a second inlet port to the sump.

A high-volume/high-pressure oil pump will only require more power to function as well as increase stress and consequent wear on both its spindle gear and its drive gear on the camshaft as well as increasing torsional stress on the oil pump drive shaft. Because such an oil pump is of additional benefit only at low engine speeds on an Original Equipment-specification block, it will do little for any engine other than one whose oiling system has been comprehensively modified to suit a high performance specification. Should you choose to pursue this objective, it would be prudent to install a bronze spindle gear to preclude the rapid wear that attends such applications and to preclude breakage at high engine speeds. This can be obtained from Cambridge Motorsports.

Remove any and all burrs that you can find in the pump body and make sure that the pressure regulating valve operates freely. It should have a satin finish chrome plating on it to prevent galling. Be sure to lap it into its seat to ensure idle pressure and to flush out the lapping compound completely before reassembly. The relief valve spring should have a free length of 3 inches. Using your factory service manual, check the clearance tolerances on the rotor and make sure that the passageways in the body and delivery arm have no sudden steps or angles to inhibit oil flow. These can often be removed with a Dremel tool and a polishing bit. Doing so should eliminate the risk of a loss of oil pressure resulting from cavitation at operating speeds up to 6,800 RPM.

The Special Tuning Manual mentions, amongst other modifications, machining an extra feed port into the bottom end cover of the oil pump to improve flow. Today's replacement pumps already incorporate some of these modifications, but do not include the extra feed port. Some specialist suppliers offer pumps fully modified with the extra feed port according to the Special Tuning Manual specifications for use in engines that attain very high engine speeds. The disadvantage of this modification is that when the engine is shut off the extra feed port then becomes a drainage passage. Oil that is inside the pump body flows back into the sump. At each cold startup, it will require an extra second or two for oil pressure to build up. In addition, after every oil change it will take longer to build up oil pressure (about 20-30 seconds or more) because draining the oil sump exposes the oil pickup, and this helps drain the oil out of the pump through the extra port. While this is not a problem on a racing engine that will be

disassembled and inspected several times during a season, on a street driven car it can contribute to severely shortening the life of the journals of the crankshaft as well as that of the engine bearings. Unlike racers at a track, few owners of street-driven cars will be willing to go through the procedure of repriming the oil pump every time that they want to start their engines.

  Be aware that two different diameter oil strainers (105mm and 135mm) were used to protect the oil pump, the larger of the two being the more desirable due to its larger strainer area. When mounting it to the oil pickup extension of the oil pump, take care to ensure that its top surface is flat against its gasket and is well sealed so that no air leak can occur. Under normal operating conditions this area is below the level of the oil, but under hard cornering it can become exposed to the air, resulting in air bubbles being pumped into the bearings and in consequent hammering of the bearing surfaces. If you have a tendency to push the car very hard through curves and turns, this later oil strainer was introduced on and is common to all five-main-bearing versions of the engine. If you have a tendency to push the car hard through curves, have a baffle plate welded into the sump pan to prevent oil surge and thus ensure a ready supply of oil for the pump. A blueprint for a sump baffle plate can be found on page 457 of the Bentley manual. If you do not have access to the means to create your own baffle plate, one may be purchased from Cambridge Motorsports. They have two versions available, one compatible with the 105mm oil strainer of the 18G and 18GA Series engines and the other with the 135mm oil strainer of the 18GB through all 18V Series engines.

    It is possible to install the larger capacity 12H3541 oil sump of the 18GA through 18GK engines onto a 18V engine to take advantage of its 50% larger oil capacity (9 pints Vs 6 pints). Although the earlier oil sump has a bulge at its rear to allow for drainage from a slot in the earlier rear main bearing cap, its lip will match the flange of the later engine. Both oil sumps have the same bolt hole pattern and use the same gasket. However, the later 18V sump is not usable with the earlier 18GA through 18GK engines due to its lack of the bulge at the rear.

    While the oil supply created by an Original-Equipment oil pump and oiling passages in the block is adequate for use within the normal operating speeds of a stock-output engine, if an increased-output engine is called upon to operate at higher than normal engine speeds or under heavier loadings, such as when a Piper BP285 camshaft is installed or the engine is modified to Big Bore specifications, it becomes prudent to modify the oiling system. This is due to the fact that the oil flow from the front main bearing supplies the number one cylinder's connecting rod big end bearing, oil flow from the rear main bearing supplies the number four cylinder's connecting rod big end bearing, and the flow from the center main bearing supplies both of the connecting rod big end bearings for cylinders number two and three. The oil passages from the main oil gallery to the main bearings are all the same diameter, thus for the same oil pressure they all have the same flow capacity. However, the center main bearing has almost twice the flow requirement because it is oiling three bearings (the center main bearing and two connecting rod big end bearings) as opposed to only two bearings for each of the front and rear cylinders (one main bearing and one connecting rod big end bearing).

    To compensate for this, open up the oil passage from the pump to the oil outlet at the rear of the block to 1/2" (.500"), the same size as the outlet on the oil pump. A special 1/2" Internal Diameter oil feed line using -10 Aeroquip adapter fittings will need to be custom-fabricated to enable the increased oil supply to flow efficiently to the oilfilter stand. The oil passage to the center main bearing will then need to be enlarged from its original 5/16" (.3125") to 11/32" (.34375") diameter and the main crankshaft journals #2 and #4 cross drilled and center grooved. This grooving should be accomplished by grinding rather that by turning on a lathe to prevent the creation of stress risers that could result in breakage of the journal. The journals for the connecting rods cross should then be drilled 110 degrees back from Top Dead Center with the drilled passage intersecting the original oil passage to prevent lubrication failure resulting from centrifugal forces at high engine speeds. Remember that whenever any journal is drilled it will need to be chamfered and reground afterwards. The crankshaft should then be hardened. With these modifications, a high volume oil pump becomes useful as the extra flow through the bearings provides additional cooling under conditions of high load and sustained high engine speeds and you should be able to reliably run the engine to 7,000 RPM. However, if you desire higher operating speeds than 6,500 RPM, you will have to fit rocker arms which run on needle bearings as the standard bushings will fail. Cambridge Motorsport offers these items as roller rocker arms in either the Original Equipment 1.426:1 or 1.625:1 high lift ratios with the option of either central or offset oil feed. Both types are located by tubular steel spacers to prevent the rocker arms from "walking" at high engine speeds.

    Be aware that there are essentially three types of bearings available to support the crankshaft. The first and best of the two is a trimetal type with an Indium overlay while the second type is Lead/Bronze or Lead/Copper, and third the A or SA material normally used in OEM engines, primarily due to their lower cost and the fact that they withstand with dirty oil better. The first two types are acceptable for long term use in a high performance engine.

  The 18V models of the B Series engine progressively underwent several changes in order to reduce production cost. Amongst these was the deletion of the oiling passages in both the rocker arm and in the tappet adjusting screw which provided ample lubrication to the cupped upper end of the pushrods. These engines had camshafts that were made with the same lobe profile as before, but its timing was advanced by four degrees. In its initial versions with a head that had a larger intake valve to compensate for the retiming of the camshaft, the 18V-584-Z-L, 18V-585-Z-L, 18V-672-Z-L, and 18V-673-Z-L versions made slightly more power at the same engine speed as the previous 18G through 18GK series engines. However, the subsequent versions reverted to the original smaller intake valve which relocated the power peak lower downward and thus the additional lubrication provided by the passages in the rocker arms and ball end adjusters were deemed unnecessary. However, on an enhanced performance engine the retrofitting of these earlier-specification items can in some cases be a wise move for prolonging the lifespan of these components.

    While the radiator performs the function of cooling the head and cylinders, it is the oil that cools the internal parts of the engine. To assist in this function, as well as to help protect the lubricating qualities of the oil from breakdown, an oil cooler was fitted to all MGBs except during the 1975 through 1980 production years when power output was chopped in an effort to meet emissions regulations. US market cars had a 13 row cooler, and this should be considered to be the minimum for an enhanced

performance engine. If your car has one, be sure that it is hot tanked along with the other components and thoroughly cleaned out before reinstalling it. If you are replacing it or installing one for the first time, use one that has at least 16 rows and install a 200 degree Fahrenheit thermostatic bypass valve as overcooled oil can rob power and lead to accelerated wear. An excellent thermostatic bypass valve with 1/2" NPT threads is available from Perma-Cool (Perma-Cool Part# 1070). Perma-Cool has a website at http://www.perma-cool.com/ .

Another item that is used to help reduce oil temperature is a larger capacity finned die cast aluminum oil sump. These have integral vertical internal baffle plates to preclude oil surge. The optional removable aluminum alloy baffle plate covers are available for both 105mm and 135mm strainer sizes. Primarily intended for racing use, these are rarely seen on street engines as they are expensive and, being an aluminum casting, vulnerable to damage by debris thrown from the front tires. However, they have an additional advantage of adding greater rigidity to the block. They are available in both aluminum and magnesium in both baffled and unbaffled form from Cambridge Motorsport. Should you decide to use one, be mindful of the fact that they use a large rubber O-ring for sealing instead of a gasket and as such will require that you have the mounting flange on your engine skimmed flat and the mounting holes chamfered and retapped with a 1/4"-20 tap or it will certainly leak and crack. These are also available with a compatible sump baffle plate from Cambridge Motorsport.

Of course, when it comes to protecting your engine, there is no substitute for an effective oil filtration system. The felt element used in the early oil filters is technically obsolete. It simply can't filter as effectively as the filtering mediums used in modern spin-on cartridge-type oil filters can. Fortunately, the oil filter head introduced on the late 18GH engine that uses a cartridge-type oil filter can be fitted to the older engines. If you have an earlier engine, obtain the filter head and its rubber O-ring that fits to the block, the bolt and copper seal that attaches the adapter to the block, and the copper washer and adapter for the oil hose that goes in front. This last item may not be needed as there are two types of oil hose fittings: one that uses a large banjo bolt and one that uses a screw on fitting off the line. You will need the oil hose adapter only if yours doesn't use the banjo fitting. Make sure that the filter head still has the anti drain tube fitted. Avoid using filters that are taller than necessary, otherwise when the engine is shut off any oil above the stand tube will drain out of the filter, leaving an air pocket that must be filled before oil pressure can be achieved. The choices of filters available are almost endless, the best of these including those from Mann (Part# W917) , Purolator Pure One (Part# PL20081), AC Delco (Part# PF13C), and Motorcraft (Part# FL300), but the most effective is also the easiest to install: the K&N Performance Gold Oil Filter (K&N Part# HP2004). If your is a pre-1968 generator-equipped engine, you might prefer to convert to the spin-on oil filter adapter offered by Moss Motors (Moss Motors Part# 235-940) as it mounts the filter cartridge in a downward position and can accept long filters with a substantially greater filtration media surface area. This adapter will accept filters made by AC Delco (Part# PF60), Purolator (Part# L20064 &Part# L24457), and K&N (Part# HP 2009).

An Old-Timey-Mechanic's trick is to use a large rubber band to secure a powerful magnet to the oil filter to capture metal particles caught in the oiling system, thus protecting the finely-machined surfaces of the engine. This is particularly beneficial during the break in period. Although the block is invariably cleaned out after all of the machining operations are done, sometimes this is not done as diligently as one would hope. In any case, there's always a little bit left lurking in the recesses that are the most difficult to clean, just waiting to do harm at some future date. I've seen these flakes appear in the oil of engines that had over 50,000 miles on them. A fine-straining filter may stop them, but such a filter gets clogged up earlier and then then its bypass valve opens, allowing everything to circulate with the oil, be it dirt, grit, metal particles, bits of old dinosaur bones, you name it. If it doesn't have a bypass filter, then the pressure crushes the filtration element, pulling its ends away from their sealing seats, and the oil simply flows around it into the engine. Another good precaution is to install a magnetic oil sump plug (Moss Motors Part # 328-282). I've been using both methods for over thirty years and am always surprised at what gets caught by the magnets. Of couse, the magnets are no substitute for a good, fine-straining filter!

Simply put, an engine creates power by inhaling a fuel-air mixture, combusting it, and then exhaling it. There is no point in trying to get more fuel-air mixture into an engine if the hot combustion gases can't get out efficiently, so let's tackle the subject of exhaust systems first.

The standard pre-1975 factory exhaust manifolds, of which there were two models, are surprisingly good performers. The exhaust manifold used with the SU HS4 carburetors' intake manifold have a mounting flange thickness of 9/16" and can be readily identified by an external casting number of 12H709, while the exhaust manifold used with the SU HIF4 carburetors' intake manifold has a mounting flange thickness of 7/16" and can be readily identified by an external casting number of 12H3911. I highly recommend electropolishing to improve the flow capacity of a cast iron exhaust manifold. Electropolishing is an electrochemical process used to smooth metal, usually prior to plating. It is commonly performed on a precision casting (such as a window winder handle) or on prepolished sheet metal after it has been formed to shape (such as a bumper) prior to plating it. The item to be electropolished is thoroughly cleaned, then emersed in a chemical bath. A current is then run through and the highest points on the surface of the metal are removed. In a sense, it's the reverse of plating in that metal is removed instead of deposited. The advantage of electropolishing a cast iron exhaust manifold is that because the item is completely emersed, the process can get inside the manifold, reaching into every crevice so that it will polish the interior of an exhaust manifold quite nicely where human hands and mechanical tools can't reach, the smoother surface making for reduced turbulence in the exhaust gas flow just like the smooth walls of an exhaust manifold constructed of tubular steel. Be sure to instruct the firm doing the electropolishing to protect the gasket surfaces with plater's tape as an overly smooth mating surface may give sealing problems when used with some gaskets. I sincerely believe that a 1 3/4" tubular steel exhaust manifold won't flow any better than an electropolished OE cast iron exhaust manifold if they have the same basic design. It can also be beneficial to electropolish combustion chambers and exhaust ports (reduced carbon buildup, for example). Because of the lesser heat conductivity of the cast iron and the decreased surface area, the electropolished exhaust manifold will radiate less heat into the engine compartment. Its greater mass will also have the side benefit of reducing noise to a level less than that attainable with a tubular steel header.

Another technique for attaining a smooth interior surface in the exhaust manifold is called Forced Extrusion Honing. In this

technique a dense mixture of abrasive clay is forced through the interior of the manifold, polishing the surfaces to an even greater degree than can be achieved on a casting through electropolishing. I've seen a head in which both the intake and exhaust ports have been subjected to this process and it is very impressive.

   Reducing temperatures inside the engine compartment is beneficial for power output. For every 3 degrees Centigrade (5.4 degrees Fahrenheit) that the air injested by the engine is lowered, power output is raised by 1%. Although wrapping the exhaust manifold in insulating tape (sometimes called lagging) may seem to be a good idea in principle, it is a very bad idea in practice. Why? The heat can't escape from a wrapped cast iron exhaust manifold and both the head and the exhaust manifold will consequently run hotter. The heat will just build up and up, far beyond what the factory engineers designed it to handle, with the result that the exhaust manifold will warp. In addition, the heat is also transfered to the head, heating the walls of the intake ports and thus reducing the density of the incoming fuel/air charge. Peter Burgess mentions this problem in his book "How to Power Tune MGB 4-Cylinder Engines." Even worse, the coolant passages in the head were not designed to remove so much heat, thus preignition of the fuel/air charge can become a problem and valve seat life can be shortened. In extereme cases, the head can actually warp beetween #2 and #3 cylinders. In the case of tubular steel headers, the metal will become so hot that it will spall and form flakes that will eventually disintegrate to form a hole in the area where the heat accumulation is greatest, usually at the junction of the pipes. The tape also becomes a moisture trap, accelerating the rusting process that can plague exhaust manifolds.

   Instead of wrapping the exhaust manifold, get it Jet-Hot coated. Jet-Hot coating is a ceramic coating that can be applied to coat both the interior of the exhaust manifold as well as the exterior. The heat will have nowhere to go except out through the exhaust system, thus it will greatly reduce underhood temperatures. The biggest advantage of this is that the air being inhaled into the engine being denser, more fuel can be mixed with it to result in a more powerful fuel/air charge. Another benefit is that the setting of heat-sensitive SU HIF4 carburetors can remain more consistent. One word of warning to those considering Jet-Hot coating or any other type of ceramic coating: Be sure that the entire surface of the manifold, both the interior as well as the exterior of the manifold and that of the flanges is coated so that the heat of the exhaust gases will pass on through the system instead of being absorbed and trapped in the metal of the manifold, otherwise the manifold will create the same problems as in the case of wrapping the manifold with insulating wrap. Jet-Hot has a website at http://www.jet-hot.com/ . Should you decide to use a tubular exhaust manifold that is not Jet-Hot coated, be sure to use a rubber gasket on the rear tappet chest cover as cork gaskets tend to fail under prolonged exposure to the extreme heat radiated by such headers. Use of the more warpage-resistant rear tappet chest cover from the 18V-883-AE-L, 18V-884-AE-L, 18V-890-AE-L and 18V-891-AE-L engines will assist in this as well.

   When using a gasket with a metalized face to install the exhaust manifold, it is wise to install the metalized side of the exhaust manifold gasket facing toward the exhaust manifold so that the mating surface of the exhaust manifold can expand and contract along the metalized face of the gasket. However, it is best to use the gasket available from Advanced Performance Technologies (APT Part# CMG-02) as it has excellent compressibility and oversize holes for modified ports. Its graphite-impregnated material allows for superior ease of expansion and contraction of the exhaust manifold and also makes for very easy removal.

   As good as the OE exhaust manifolds are, the rest of the exhaust system can be improved upon, and for this the Peco exhaust system is a high-quality choice. There are plenty of aftermarket exhaust systems on the market, but those made by Peco seem to be the ones that live up to its manufacturer's promises and hence has become increasingly popular. It's the only header whose design takes into account the critical fact that the head uses a siamesed port for the exhaust valves of the middle two cylinders and hence has an oversize center branch pipe. Their quality control is very tight for that of an aftermarket manufacturer, so their system always seems to fit without a lot of bending, hammering, and cursing. It also performs well on both modified and stock engines, which usually can't be said for many of the others: they either work well only on stock specification engines, or work well only on engines that have been modified according to a specific recipe which will consist of other components made by the same company (which, of course, the advertisers never get around to pointing out before you spend your money on the #@!! thing!). The Peco system is street legal. Often a performance exhaust will sound good at idle and while accelerating, but then turns into a howling monster while cruising on the highway and literally drives you out of the car, ears ringing. This might be acceptable in a race car, but not in a street machine. At highway speeds the Peco system is actually quieter than an Original Equipment system, emitting a rich baritone sound rather than the ear-pounding basso profundo or the rasping tenor of some other systems. The gray system will fit the Original Equipment 1 3/4" pre-1975 exhaust manifolds without modification while the red 2" Big Bore system will require the use of the Peco 2" Big Bore header. The Big Bore system is actually intended for use on larger bore engines (1868cc or larger) or smaller-bore engines fitted with flowed heads and hot camshafts such as the Piper BP285. When fitted to smaller bore engines with Original Equipment camshafts they will result in a bit more high-RPM power at the expense of some low-RPM tractability. This is due to the larger bore of the exhaust system reducing gas velocity which in turn reduces scavenging effect in the combustion chambers. In addition, radiant heat from the tubular steel of the header is much greater, exposing the air in the engine compartment, the intake manifold and carburetors, and the fuel system to more heat, thus reducing fuel/air charge density and hence reducing power output. Jet-Hot coating of the header is therefore highly recommended. The lack of any middle resonator simplifies the Peco system and allows you more ground clearance (something every 'B' can use!) and allows the fitting of a slip-and-clamp American-made performance catalytic converter where the middle resonator used to be and thus satisfying the emission laws of many localities. However, if local regulations require it, or if you simply choose to rebuild the engine to Original Equipment specification, an excellent quality replacement twin muffler system is made by Falcon and can be had from Brit Tek (Part# FES001, MGB 1962-1974; Part# FES002, MGB 1975; Part# FES003, MGB 1976-1980). Brit Tek has a website at http://www.brittek.com/

   Just as a less restrictive exhaust system is necessary to permit a high performance engine to breathe, restrictions in the intake tract will likewise need to be reduced. For a Chrome Bumper car this is not a problem. A pair of 3 1/4" deep K&N airfilters (APT Part# SD23-319) will permit increased airflow without sacrificing protection. with proper jet adjustment, these larger aircleaners are worth about 3 HP on their own. When attempting to build a deeper-breathing engine, they are a prerequisite. The

B Series engine with its Siamesed 5 port design causes some very powerful shockwaves within the induction system. The volume and depth of this large filter dissipates these very effectively. Both cone and pancake type filters reflect these shockwaves back into the induction system, causing induction pulse problems which will increasingly disrupt airflow above 3,500 RPM. One thing that I might suggest would be the fitting of a pair of Advanced Performance Technologies stub stacks (APT Part# SS51) between the carburetors and these custom aircleaners. This additional refinement won't create a perceptible increase in power (about 2 HP increase), but they will make both the throttle response and the engine running characteristics slightly smoother by reducing turbulence at the mouth of the intake tract, thus providing more efficient fuel atomization and allowing the greater flow potential of the larger airfilters to be fully exploited. They might even eventually pay for themselves by thus slightly improving fuel economy (maybe). The Original Equipment aircleaner boxes incorporate stubstacks into the airfilter housing design, so it's obvious that the engineers at the factory saw the value in them.

When coupled with a Maniflow intake manifold (British Automotive Part# SUB4-2) the improvements become even more impressive. If you choose to use this intake manifold with SU HIF4 carburetors you will need to use either the early version of the UK/European Market SU HIF4 carburetors with the vacuum takeoff fitting on the carburetor body for provision for a ported advance mechanism, or, if you use the North American Market SU HIF4 which lacks provision for a vacuum takeoff, you will need to use the thinner Advanced Performance Technologies' carburetor spacers (APT Part# MFA338) which come suitably modified to provide fittings for the vacuum lines to a manifold advance distributor, as well as the later exhaust manifold (Casting# 3911) as both have a mounting flange thickness of 7/16". This spacer with the vacuum takeoff incorporated into its design is a Maniflow item intended to be used with the Maniflow intake manifold which has no provision for vacuum takeoff on its crossover balance tube. A companion unported spacer of the same thickness is also available from Advanced Performance Technologies, although a second spacer with a vacuum takeoff may be substituted to allow the use of a vacuum-assisted servo for a power brake system. Advanced Performance Technologies also offers the option of welding in a nipple on the crossover tube which would allow the use of an anti-run-on valve. Because both the angle of this intake manifold is higher (20 degrees) than that of the Original Equipment intake manifold in order to enhance its flow characteristics, and variances in production tolerances of the bodyshell of the car, in a few cases larger diameter aircleaners will not allow the installation of an underhood insulation pad, hence the thinner design of the Advanced Performance Technologies spacers.

Why not stay with the OE intake manifold? Due to the sudden change of cross section that occurs in the area of the balance tube intersection, the airflow within them is markedly disrupted. The resulting turbulence causes the fuel/air mixture to condense somewhat and also impedes airflow. While smoothing the inside the manifold can reduce this, it can't take the place of the better design of the Maniflow intake manifold.

The Original Equipment dual carburetor intake manifolds are insulated from the heat of the head by a pair of thick phenolic spacers. Unfortunately, these are only partially effective at their task of keeping heat out of the induction system. Because the intake manifolds are made of aluminum, the heat is rapidly transferred to the incoming fuel/air charge, reducing its density and decreasing performance. However, this rapid transfer of the heat does effectively prevent it from reaching the carburetors. To eliminate this hindrance to performance, Jet-Hot coating of the intake manifold is highly recommended.

When seeking improvements in airflow capacity, things become considerably more complicated when trying to fit aircleaners on a Rubber Bumper car that has been modified to use dual carburetors. Unfortunately, the way the servo-boosted master cylinder projects from the bulkhead forces most conventional owners into the use of conical airfilters when installing dual carburetors. The problem with the conical airfilters is their shallowness which creates induction pulse problems, their small internal volume which will not allow the fitting of a set of stub stacks, and their small surface area. The K&N airfilters all use the same filtering medium, so the smaller the surface area of the filter, the less the airflow potential will be. Conversely, the bigger the surface area, the greater the airflow potential. This is why the 6" X 3 1/4" deep filters are preferred by those who go for serious power increases with a B Series engine. Induction pulse problems aside, the airflow capacity of the little conical or pancake filters is more appropriate to a mildly power-enhanced A Series engine, such as is fitted to the MG Midget or the Austin Healey Sprite. In addition to this problem, the remote floatbowls of the SU HS4 carburetor will interfere with the master cylinder, thus such a conversion requires the use of a set of SU HIF4 carburetors.

Retrofitting the earlier non-boosted master cylinder is the common solution, but this is not a bolt on affair as its mounting flange is turned 90 degrees so the mounting holes of the pedal box won't line up, and the appropriate earlier pedal box assembly is radically different, even having a different mounting hole pattern at its base that requires drilling a new pattern in the body of the car. This is just one of the reasons that it's unusual to see a Rubber Bumper model with an uprated B Series engine: It's much more work. When somebody wants to go for really dramatic power increases, he swiftly comes to think that he'll need to retrofit the earlier brake master cylinder and pedal box assembly so that he can mount airfilters that have a decent airflow capacity onto the carburetors like the Chrome Bumper model owners do. "After all," he reasons, "it's not that difficult, really, it just requires some persistence and time, plus another master cylinder and the earlier pedal box assembly. If my boosting servo and master cylinder are in good shape, then I can always sell them as a unit to help cover the cost of the earlier master cylinder and pedal box assembly because the servo is getting harder and harder to find." And, to the conventional, orthodox thinker, this reasoning holds true. However, read on-

Fabrication of a plenum chamber to go on the carburetors and running a large diameter breather duct hose to a remote aircleaner housing would enable the retention of the existing boosted brake system. From the aircleaner housing the intake hose can be run to the air passages neatly provided beneath the bumper in the vented front valance of the 1972 through 1974 1/2 models of the chrome bumper cars. You'll need to do some scavenging in the junkyards to find the right box (more work) and then figure out a mounting system for it (still more work), but the larger, more commodious engine compartment of the later Rubber Bumper models should make it a relatively easy task. To equal the airflow capacity of a pair of 6" diameter 3 1/4" deep round airfilters you'll need

an airfilter housing box with a filter that has an area of about 122 square inches (11" X 11").

Now for the subject of the fuel system: Fuel pumps and carburetors are precision instruments that do not take well to the presence of dirt. As such they should be well protected. Install a transparent fuel filter in the feed line just prior to the junction that feeds both carburetors, then install a second transparent fuel filter in the feed line that runs from the fuel tank to the fuel pump. If the transparent filters that you elect to use should happen to have glass housing bodies, these can be easily protected by sliding a short section of transparent thick wall tubing over them. A petcock-type valve will simplify replacement in the future, preventing fuel from the carburetors from draining into the boot when the fuel line is disconnected from the filter. Whenever you see debris in this filter simply replace it with the one that is before the carburetors and then install the new filter in the line before the carburetors. By using this approach you can best protect the carburetors and the fuel pump as well. With a pumping capacity of 12 U.S. gallons per hour, the Original Equipment SU fuel pump is adequate for feeding the requirements of any streetable B Series Engine.

The use of the Weber DCOE 45 carburetor on street MGBs came about as a result of their use on the factory team's racers. This fact, of course, produced a "monkey see, monkey do" mentality amongst those seeking more power for their street MGBs. Why did the factory race team choose the Weber over the tried-and-true SUs? It has to do with the design differences between the two. The SU is a Variable Venturi type, which makes for smooth although slightly slow throttle response and excellent fuel economy. The Weber DCOE 45, on the other hand, is a Fixed Venturi type. It has the advantage of having an injector pump to shoot raw gasoline into the venturi when the throttle opens rapidly and thus makes for very fast throttle response. This was a definite advantage on the race track, so that's part of the reason why the factory race team chose it over the SU. Remember that on a race track, smoothness and economy must be subordinate to responsiveness, as its responsiveness that makes aggressive driving possible. Victory is what counts on the track, and nothing else will substitute.

This fast throttle response produces the illusion of more power and so purchasers of this unit tend to experience what Psychologists call the "Halo Effect": they've paid out the big money, sweated the installation, spent more money to convert their ignition system to a centrifugal advance distributor (Weber carburetors don't have provision for a vacuum takeoff for working with vacuum advance ignition systems: read the fine print!) and so they're already predisposed to feel the power increase even before they drive. When the quick throttle response creates the illusion of more power, they're like religious converts! In reality, all other factors being equal, there is no worthwhile difference between them in terms of power output on the dynamometer readouts unless a radical camshaft is being used. Should you decide to use this carburetor, you would be well advised to use a Soft Mount kit to protect it from the effects of vibration (APT Part # SMW-45).

Unfortunately, the Weber's intake manifold imposes a major drawback: In order to facilitate the mounting of an aircleaner with adequate flow capabilities, its 9.5 cm length is short. This shortness forces the use of a very curvaceous path between the carburetor and the intake ports, which in turn causes the fuel charge to be biased towards the ports for the outer cylinders (#1 & #4). The result is that the outer cylinders (#1 &#4) tend to run richer while the inner cylinders (#2 & #3) tend to run leaner, the differential between the two increasing with engine speed due to the increasingly greater inertia of the fuel. The Weber 13 cm swan-necked intake manifold, or the similar one offered by Oselli, will reduce this tendency while being more appropriate to camshafts whose designs are oriented toward producing more low rpm and midrange power at the expense of high rpm power, but to fit an efficient aircleaner you will need to rework the inner body panel with a soft mallet. This was never a problem for the factory race team, but many private owners will take exception to the idea of hammering away at their engine compartments. Consequently, the combined inlet manifold, carburetor, and air cleaner assembly should not exceed 13 3/4" in depth as this is the maximum allowable for inner fender clearance.

It should be understood that torque characteristics are not determined by the length of the intake manifold or of ram pipes. Instead, they are determined by the camshaft. The main function of ram pipes is merely to reduce turbulence in the incoming fuel/air charge. If you look into the mouth of your Original Equipment aircleaner boxes you will see what is called a "stub stack." They are there specifically to reduce turbulence. A Weber DCOE carburetor has a fair amount of turbulence at its mouth, so a ram pipe is used to reduce it. It is of significant importance to have the appropriate length of the intake tract for the characteristics of the camshaft. A camshaft that produces a powerful low end torque output functions best with a long intake tract, while a camshaft that produces a powerful horsepower output at high engine speeds functions best with a short intake tract. A Weber DCOE 45 can use different length ram pipes to achieve this rather than forcing the owner to spend more money for different length intake manifolds. If the racer is going to drive on a slow, twisting track where low and midrange power output is critical to victory, he can change his camshaft and tappets, change the metering in the Weber DCOE, and change to a longer ram pipe. If he is going to race on a faster track, he can change his camshaft and tappets, change the metering in the Weber DCOE, and change to a shorter ram pipe to obtain higher output at high engine speeds. There is, however, a major drawback to the use of ram pipes: the carburetion can be very sensitive to small errors in metering, running rich or lean if the adjustment is off by only a small amount. As such, it is not quite as good as using a longer or shorter intake manifold, but for an amateur racer, it is much more affordable. For professional racers who do have the optimum length intake manifold for the track that they are racing on, they can fine tune the intake tract by experimenting with different length short ram pipes during practice laps. The availability of different length ram pipes is one of the reasons that the Weber DCOE is so popular with racers. However, while these factors tend to make the Weber DCOE carburetor the most popular choice for racing applications, they are largely irrelevant when building a streetable engine.

Be advised that neither the Weber nor the Oselli intake manifolds have a balance tube to modulate pressure fluctuations between the two intake tracts which is necessary to prevent "robbing." This unmodulated pressure fluctuation, which is aggravated in the individual intake tracts by the uneven breathing resulting from the 180 degree opposed throws of the crankshaft, is the reason that these manifolds have no provision for a vacuum advance takeoff. The advance plate in a vacuum advance distributor would be rattling back and forth so violently that consistent ignition timing would be all but impossible to achieve. This is

turn forces the use of a pure centrifugal advance distributor. Expect poor part-throttle response, high engine temperatures, a tendency to burn valves, a tendency to preignition under heavy loads, decreased fuel economy, and a ragged idle. On the other hand, the Cannon 801 intake manifold has provision for the installation of a primitive balance tube.

There is, however, a considerable difference between the Weber and the SU in the process of setting them up. The SU has only one needle and one jet, so you can modify it in your driveway. The Weber, on the other hand, has a multiple choice of replaceable venturi sizes, six jets (starter air correction jet, starter jet, idle jet, main jet, accelerator pump jet, and air correction jet), plus an emulsifier tube! As Peter Burgess rightly points out in his book, carburetors are rarely properly set up as delivered (but people rip a Weber out of its package and slap it on their engines in sheer ignorance of this fact). This multiplicity of jets and venturi sizes does, however, make it almost infinitely adaptable, even to practically any exotic camshaft lobe profile, and this is another reason why the factory racing team used them. They could more easily tailor the engine's performance characteristics to the type of track that they were about to race on. However, unless you're using a radical camshaft, have access to a dynamometer, and you really understand how a carburetor works, take my advice and use the 1 1/2" SU! The bigger 1 3/4" SUs might make for a bit more power at high engine speeds (above 6,000 RPM) due to their higher flow capacity, but unless you're mounting them to meet the demands of either a 1950cc engine with ported heads or a smaller bore engine with a Piper 285 camshaft and ported heads, you'll get it at the price of less power at low engine speeds (which is where a street engine spends most of its operating life), a lumpy, vibrating idle, and difficult cold weather starting. If you do choose to use them on the aforementioned engine types, mount them on the Special Tuning intake manifold available from Burlen Fuel Systems. On a standard displacement engine they will sacrifice as much power below 4,000 RPM as they will gain above that point.

Don't buy SUs from an aftermarket outlet. Cut out the money-grubbing middlemen and have Mr. Burgess get them direct from the Burlen Fuel Systems factory and set them up to fit his headwork, or buy them yourself at http://www.burlen.co.uk and follow his instructions on which needle and jet combination to use.

There's another reason to use the SU: aesthetics. They look right, especially when used with K&N or Original Equipment aircleaners. The sidedraft Weber DCOE 45 looks as though it's been adapted and, due to clearance problems, changing the aircleaner element is no fun at all. Just as the fuel suspended in the incoming fuel/air charge is denser and heavier than the air, its inertia thus causing it to go towards the outside of the curved intake manifold, biasing the fuel towards the intake valves of #1 and #4 cylinders and thus creating a richer mixture for those cylinders, the intake manifold shape for the downdraft Weber DGV carburetors is actually even worse. The Weber downdraft DGV 32/36 makes the engine look as though it was pirated from a Russian tractor. Its usually included adapter manifold has the flow characteristics of a bathtub with a hole in each side. This is due to Pierce Manifolds, its distributor, bundling their own poorly designed intake manifold with the carburetor and selling the resulting package as a kit. As a result, virtually every example of this combination that I've encountered or ever heard of had a "flat spot" in the powerband from 1,500 to 2,500 RPM where throttle response was poor. This "flat spot" can be eliminated by using a Cannon intake manifold instead. However, this will not eliminate the problems imposed by the restrictive airfilter that Pierce Manifolds supplies with it in its kit. Its cousin, the Weber downdraft DGES 38/38, mounts on the same intake manifold and gives more torque at low engine speeds, but can make the engine difficult to start in cool weather.

If you are refitting a post-1974 single carbureted engine with dual SU carburetors, be aware that the two carburetor types, SU HS4 and SU HIF4, use different intake and exhaust manifolds. The SU HS4 intake manifold can be readily modified for provision for distributor vacuum takeoff and has a mounting flange thickness of 9/16". In fact, the intake manifold of the SU HS4-equipped 18GK engine already has this modification. The HIF4 intake manifold also has provision for distributor vacuum takeoff and has a mounting flange thickness of 7/16". There are also two different exhaust manifolds with mounting flange thicknesses that are respectively paired with these intake manifolds. Should you elect to install a header rather than an Original Equipment exhaust manifold, be sure to check the thickness of its flanges before you make your purchase, otherwise you'll be likely to find yourself fabricating custom half-moon shims!

Also be aware that the advance mechanism of the distributor used with the pre-1971 North American Market SU HS4 carburetor takes its vacuum from a connection on the carburetor, while the advance mechanism of the distributor used with the SU HIF4 carburetor takes its vacuum from the intake manifold. These two systems result in highly different ignition advance characteristics. Manifold vacuum continuously varies as the throttle is being opened. Only when it is wide open is the vacuum at a minimum, but even then there is still some present because of restrictions in the throat of carburetor and air cleaner box. It depends on the vacuum capsule specification as to when vacuum advance ceases to be applied and can be as low as 3in Hg or as high as 10, depending on which vacuum advance mechanism it uses. Manifold vacuum cars have maximum vacuum at idle, and hence have maximum advance at idle because this allows a smaller throttle opening and hence lower emissions for the same idle speed, at the expense of ease of starting and initial throttle response. Carburetor or ported vacuum cars have no vacuum at idle and hence no advance at idle. However, as the throttle opens the vacuum rapidly increases to become the same as that produced by the gradual fall in vacuum in manifold vacuum cars. Thereafter they are the same. The pre-1971 North American Market SU HS4 system uses vacuum produced when the throttle opens to advance the ignition timing, resulting in easier starting and quicker off-throttle response. The North American Market SU HIF4 system uses manifold vacuum to advance the ignition timing while the throttle is closed, resulting in harder starting and slower off-throttle response, but lower exhaust emissions and better fuel economy while idling. The hard starting problem of this system can be easily overcome by simply opening the throttle all the way while cranking the engine. Once the throttle opens, the vacuum is the same on both types. If you want to use a set of SU HIF4 carburetors while retaining the advantage of the superior off-throttle response of the SU HS4 ignition advance system, the UK/European market versions used the ported vacuum of the SU HS4 and can be ordered Burlen Fuel Systems. Of course, your distributor's ignition advance mechanism will have to be compatible with whichever version of the vacuum system you choose to employ.

There has been a great deal of discussion of the relative merits and vices of the SU HS4 carburetor and those of its

successor, the SU HIF4 carburetor. Advocates of the SU HS4 point out the greater ease with which the jet can be changed with the carburetor in place on the engine and the metering advantage of its concentrically mounted needle and jet. Some feel that its remote float bowl design gives it a "Vintage" appearance. However, the SU HS4 is not without its vices. It requires the removal of its aircleaner boxes to enable the use of a special short wrench to effect mixture adjustment, which results in a richer mixture when the aircleaner boxes are refitted. It also has a tendency to leak gasoline from its floatbowl junction. In addition, it has a tendency to run rich or lean under conditions of rapid acceleration and deceleration, during hard cornering, and when on a steep road. The SU HIF4 largely addressed these problems by having its float bowl integral with its body, thus allowing the float to surround the jet and hence more consistently meter fuel under high angles of tilt and under conditions of heavy cornering stresses.

Although more time consuming to set up and more expensive than the SU HS4, the SU HIF4 is easier to adjust and has superior performance potential due to its higher maximum flow rate which gives somewhat better performance at high engine speeds. This can be improved by retrofitting the throttle disks from the earlier pre-1968 SU HS4. These earlier throttle discs lack the flow-obstructing poppet valve of the later versions and also greatly improve engine braking, but you will have to file a notch in the bottom to facilitate airflow to the jet. Replacing both its piston with its biased needle and its dashpot with the earlier piston with its concentric needle and a mating dashpot from the pre-1969 SU HS4 (a simple "drop in" parts swap) improves its long term performance further. Just be sure to refit the phenolic spacers and heatshield when you install them or the fuel will percolate in the floatbowls, causing the engine to run lean and all but refuse to restart after being parked for a while when hot. Should you decide to reuse your old heatshield, be sure that its insulating pads on the side facing the intake manifold are in good condition. If they are not, new insulating material can be obtained at any Speed Shop frequented by the local Hot Rod set. Be aware that the heatshields used with the SU HS4 carburetors (Victoria British Part # 10-35) and SU HIF4 carburetors (Victoria British Part # 3-5742) are not interchangeable.

During routine adjustment its mixture can be modified from above with nothing more than a simple screwdriver, hence removal of the aircleaner boxes is not necessary. Its thermosensitive mixture control makes for easier cold weather starting. Those who have converted their cars from the SU HS4 to the SU HIF4 usually report a 1 to 2 mpg increase in fuel economy. Unfortunately, it must be removed from the intake manifold to change the jet and its thermosensitive mixture adjustment control can cause it to run lean if underhood temperatures rise badly in heavy traffic on hot summer days. Consequently, Jet Hot coating of the exhaust manifold is a worthwhile investment. If you're thinking of replacing a set of worn Original Equipment SU HIF4 carburetors with a set of SU HS4s because they cost less, think again. It can be done, but it's not an easy bolt on swap. You'll need an HS4 heatshield, distributor, cables, plus the linkages and a lot of other little bits and pieces that aren't commercially available anymore, so you'll spend a lot of time scrounging around trying to get them. If it's the lower price of the HS4 that seems attractive, be aware that when you get through buying all of the hardware necessary to do the installation correctly, the difference in cost won't be anything like what you hoped it would be. Whichever version of the SU carburetor you choose, you will find it helpful to obtain copies of the "SU Reference Catalogue" and "The SU Workshop Manual" from Burlen Fuel Systems.

To help you get your jetting and needles spot-on right, you will find an investment in an SU Needle Profile Chart worthwhile. As I'm sure you're aware, the needle controls the fuel mixture in stages according to engine speed and vacuum. An engine that's been modified to breath more deeply will have greater fuel needs as engine speed increases, so you'll need the right needles to avoid running performance problems. If you contact Peter Burgess and tell him which camshaft you're using and what head modifications you have he'll give you the correct needle code number so you can start the fine-tuning process. The SU Needle Profile Chart will be invaluable in making the engine sing as it should. Go to the Burlen Fuel systems website at http://www.burlen.co.uk/ and click on "View our latest news", then scroll down the page until you come to the yellow words "Catalogues and merchandise" and click on that. Its item # ALT 9601. Once you've got the carburetion properly fine-tuned you'll be amazed at how sweetly the engine will run!

The North American Market MGB engine used four different head castings over the course of its career, all of which used the same size 1.344" exhaust valve. The first version was used on the 18G, 18 GA, and 18GB engines, used a 1.565" intake valve, and can be identified by its head casting number of 12H906. The second version was used on the 18GF, 18GH, and 18GK engines. It also used the 1.565" intake valve, was given a slightly improved intake port design and mounting bosses on the spark plug side of the head for the mounting of air injectors, and can be identified by its casting number of 12H2389. Both of these head castings had identical an identical combustion chamber height of 11mm and a combustion chamber volume of 43cc. The third version of the head, used on early 18V engines, used larger 1.625" intake valves and revised ports to produce a bit more power at high engine speeds, although at the expense of a small loss of torque at low engine speeds. The fourth version of the head reverted to the original smaller size 1.565" intake valve that was used on the first two head castings, but had offset oil feed on the rear rocker stand to accommodate redesigned cooling passages to assist in preventing overheating of the rear cylinder. This necessitated relocating the oil passage in the rear rocker shaft stand, which means that if you should choose to install it on an earlier engine block you're going to need the later rear rocker shaft stand with the offset oil port. They both have the smaller combustion chambers of 39cc volume and 10mm combustion chamber height, and can be identified by their casting numbers which are to be found on the top deck of the head, underneath the rocker arm cover. These new head castings had coolant passages with greater surface areas to assist in dealing with the higher combustion chamber temperatures that resulted from efforts to reduce air pollution. In addition, the extra material provided created both the indentations behind the spark plug holes and the mounting bosses provided for mounting air injectors for the exhaust ports on these head castings, along with a shelf on the edge of the casting on the same side, had the additional benefit of making them more resistant to cracking and the blowing of head gaskets due to warpage.

Casting number 12H2923, which uses the larger intake valve, is commonly found on engines with the engine numbers 18V-584-Z-L, 18V-585-Z-L, 18V-672-Z-L, and 18V-673-Z-L, all of which it was Original Equipment for. Casting number CAM1106,

which uses the smaller intake valve and the rear rocker stand with the relocated oil feed passage, is commonly found on engine numbers 18V‑797‑AE‑L, 18V‑798‑AE‑L, 18V‑801‑AE‑L, 18V‑836‑Z‑L, 18V‑837‑Z‑L, 18V‑802‑AE‑L, 18V‑883‑AE‑L, 18V‑884‑AE‑L, 18V‑890‑AE‑L, and 18V‑891‑AE‑L, all of which it was Original Equipment for. If you are going to have professional headwork done, specify the earlier large intake valve and use the latter casting as it is preferable due to its cooler running characteristics. It will be necessary to fabricate a blanking plate to seal off the outlet for the water choke fitting exclusive to this head casting.

Be aware that due to their shallower combustion chambers and lower overall height, if either of these two later heads are fitted onto the block of any pre-18V engine (18G through 18GK Series), it will then be necessary to machine recesses into the deck of the block in order to prevent the exhaust valves from hitting the block. These deeper counterbores will need to be cut with a 1 17/32" (1.53125") diameter end mill to have a 1/16" (.0625") radius at their edges and be recessed at a minimum to provide a 1/16" (.0625") clearance when the valve is at full lift. The depth of the recesses in the deck of the block should not exceed .200" below the original height of the deck, otherwise the combustion flame will be directed onto the top ring of the OE style pistons, resulting in severe ring damage and ring land breakage on the pistons. In the case of all of these head designs, the two coolant holes at the rear should be checked for size and, if necessary, enlarged to a diameter of 9/16" (.5625") to maximize coolant flow through the head, the two corresponding holes at the rear of the deck of the block on 18G through 18GK Series engines being enlarged to match (an old MG Factory Race Team trick).

If it were my engine, I wouldn't spend any money on a camshaft except as a final modification to compliment the headwork, and only if I wasn't satisfied with the results of the sum total of the previous modifications. To change the camshaft before doing the headwork is putting the cart before the horse. The specifications of the standard pre-1975 factory camshaft are hard to improve upon for general duty use. Also, realize that changing the camshaft to one with more radical lift and/or more duration will increase wear on the tappets, camshaft lobes, valve guides, and valve stems by means of the increased side thrust loads. Should you simply wish to move the existing power curve to suit your driving style, you might consider retarding or advancing the timing of the stock camshaft a very few degrees (4 degrees maximum, beyond that point the gains are increasingly small while the losses become increasingly excessive) to respectively move the power up or down the scale as much as 400 RPM. If you move the power downward, with professional headwork you should still have at least as much power at high engine speeds as an Original Equipment specification engine.

Because the teeth of both the distributor drive gear and the oil pump drive gear have mated to the teeth of the old camshaft drive gear, it should be noted that if they are reinstalled with a new camshaft, wear of all of the associated gear teeth will be accelerated. Thus, replacement of both the distributor drive gear and the oil pump drive gear with new ones is recommended. On the 18G through 18GK Series engines it's necessary to remove both the oil pump and the distributor drive in order to remove or install the camshaft. However, on 18V Series engines only the distributor drive need be removed.

If you absolutely insist on changing your camshaft, use new tappets (always!) and the Piper BP270 Camshaft that Peter Burgess recommends as it will give excellent power right up to 6,000 RPM with a stock configuration head and up to 6,400 RPM and yet more power across the entire powerband when used with fully ported heads. Best of all, you can retain your standard ignition curve and avoid the worst of the excessive side thrust loads produced by more radical camshafts as it uses only 12% more lift than a stock camshaft. You will, however, need to either use stronger valve springs to handle the greater inertia loads resulting from the more rapid openings of the valves or, preferably, lighten the reciprocating mass of the valvetrain to reduce the inertia loads. Although it may seem that simply fitting stronger valve springs produces an inexpensive solution to this problem, it will be at the expense of the tappets hammering the camshaft lobe when closing and greater pressure loads upon opening, thus accelerating wear of both the tappets and the camshaft lobes. In the interests of long term durability, lightening of the valvetrain is the preferred approach to the problem.

Avoid the camshaft bearings as sold by Moss, et al. They are formed from a flat strip and rolled into shape. They have to be reamed after installation. Instead, get a set of DuraBond or Federal Mogul MGB camshaft bearings. They are manufactured as a single piece and require minimal fitting.

Note that much of the performance increase that can be gained by going this route could be achieved at a far lesser expense and with much better streetability simply by having quality headwork done by a professional such as Peter Burgess. The rocker arms with internal oil passages and rocker adjustment screws with holes in their ball ends will give superior oiling of both the pushrods and the tappets and are of sufficient strength for use with the Piper BP270 camshaft.

More radical camshafts, such as the Piper BP285, will produce more power at notably higher engine speeds but will also sacrifice so much low end torque that the loss of tractability at low engine speeds will make normal driving in heavy traffic difficult. If you choose to follow this path, expect a lumpy, vibrating idle and a change to both a pair of 1 3/4" SU carburetors with their larger intake manifold as well as a switch to an Aldon-modified pure centrifugal advance Lucas 45 distributor (Aldon Part # 101BR1). Starting the engine in extreme cold weather will also become something approaching an art and often an exercise in frustration. Piper has a website at http://www.pipercams.co.uk/ .

If you choose to install a more radical camshaft than the Piper BP270, you should first read "How To Build And Power Tune Distributor Type Ignition Systems", "How To Build And Power Tune SU Carburetors", and "How To Choose Camshafts &Time Them For Maximum Power", all of which are available from Veloce Publishing at http://www.veloce.co.uk/newtitle.htm so that you will be properly prepared to make the most out of your choice without an undue compromise in reliability.

Be aware that if you choose a camshaft that extends the powerband into or beyond the 6,500 RPM range when used with ported heads (such as the Piper BP285), in the interests of long term reliability you should have the shop cross drill and center groove your crankshaft journals #2 and #4, cross drill the journals for the connecting rods 110 degrees back from Top Dead Center with the drilled passage intersecting the original oil passage to prevent lubrication failure resulting from centrifugal forces at high engine speeds, chamfer the drilled holes then regrind the bearing journals, harden your crankshaft, plus modify your oil

pump, oil filter head, and oil feed passage to the center main bearing. The use of a high performance ignition system, a 2" Big Bore exhaust system, recessed valve spring seats, lightweight valve spring caps, custom valve springs and valve guides, lightweight tubular chrome-moly pushrods and the lighter 18V bucket tappets, solid rocker adjustment screws (the ones without the oil hole) and solid rocker arms will be needed for their additional strength, a high velocity camshaft drive chain (Kent Part# HV19), plus stronger outer rocker shaft stands that support the outer rocker arms from both sides of the rocker shaft will all become desirable at this point as well. Scatter pattern camshafts are ineffective in the MGB when their duration is less than 300 degrees, and any camshaft with a duration greater than this is simply too radical for a street engine.

Be sure to have the top of the head skimmed flat and parallel to the plane of the bottom mating surface of the head. Upon reassembly, take care that you insert .005" shims under each of the two center rocker stands to impart a very slight arc to the rocker arm shaft. This will aid in preventing excess wear by keeping the rocker shaft from moving back and forth. Replacement of the rocker arm spacer springs with tubular steel spacer pieces is highly advisable when using a high lift camshaft that extends the powerband beyond 6,500 RPM in order to preclude "walking" of the rocker arms at such high engine speeds. Tubular rocker spacers are normally found only on race engines, but their omission in a street engine intended to be operated at higher than normal engine speeds can be a mistake. Because a race engine gets torn down quite often, so there's no problem with crud accumulating inside the tubular rocker spacers and between them and the rocker arms. The factory used spring spacers to allow crud to be washed free from the rocker shaft. Due to their potential for inducing rapid wear on the sides of the rocker arms should their shims wear through before being replaced, they're rare on a street engine.

To help offset the wearing effects of the higher pressures resulting from the use of higher lift camshafts, Doug Jackson of British Automotive has developed a version of the 18V bucket tappet that has provision for additional lubrication (Part # 2A13/HP). These are made of carburized low carbon steel which is an ideal tappet material, providing a shock resistant inner core with a much harder than normal external "skin" to resist wear. This is the same technology used in the rocker arms. While chilled iron tappets have a greater Rockwell Hardness, they lack the additional lubrication provided by Doug Jackson's tappets and are more appropriate for high revving engines with radical camshaft lobe profiles such as the Piper 300 that are intended for exclusive use on a racetrack. They are also compatible only with steel camshafts. British Automotive has a website at http://www.mgbmga.com/ . These are a worthwhile addition to any engine as they reduce wear on both camshaft lobes and tappet faces. Whichever design tappet you elect to use, have each one tested to be sure that it has a Rockwell Hardness of at least 50 or you'll be faced with a ruined camshaft.

Although the tappet bores receive copious lubrication, they can eventually wear to the point that they become oval due to side thrust from the pushrod which is tilted toward the head. Sould this proove to be the case, sleeves will have to be custom fabricated and press fitted into place, then reamed afterwards. Honing a new crosshatch pattern into the tappet bores at an angle of 45 degrees will further promote lubrication of these critical parts. After honing, clean off the ridges of the crosshatch grooves to prevent wear of the tappets.

Remember: if you change either the camshaft profile or timing radically, you'll most likely have to alter the ignition curve. Probably the worst distributors that you can use are the North American Market specification Lucas 45DE4 or 45DM4 as they use so much advance and retard to meet US emissions standards that they eliminate any hope of getting real performance from the engine. The European specification Lucas 45D4, however, is excellent for this purpose. This is available from Brit Tek as their Eurospec distributor (Brit Tek Part # ESD-001). A Lucas unit that has been recurved by Aldon Automotive is even better. These are available from Brit Tek as their Stage II distributor (Brit Tek Part # SSD001). They have a website at http://www.brittek.com/ . Aldon makes an entire range of converted Lucas distributors for different specifications on the MGB. The difference between the Aldon distributors and the Original Equipment distributors is their spark advance curve. The Original Equipment distributors have a spark advance curve that is designed for long term reliability. That is, if the ignition timing is somewhat out of phase with the crankshaft the engine will still be reasonably reliable. You can probably go about 6,000 miles before the engine will run so poorly that you will be forced to reset the timing, which is about as long as a set of ignition breaker points will last. Hence, the entire "tune up" can be comprehensively done all at the same time. The engineers at the factory were instructed that convenience and long term reliability were of a higher order of priority than maximum power, so this was appropriate for most owners, although a different spark advance curve would have given more power. The Aldon distributors have a spark advance curve that is calculated to give more power. As such they are more appropriate for an engine that is being modified for a higher level of performance. If installed on an otherwise stock engine the different spark advance curve will result in an increase in midrange torque. One model is for stock engines equipped with the HS4 carburetor with ported vacuum advance (Aldon Part # 101BY1). Another is for stock engines equipped with the HIF4 carburetor with manifold vacuum advance (Aldon Part # 101BY2). Yet another (Aldon Part # 101BR2) is for engines fitted with a Piper BP270 or BP285 camshaft.

Use of a non-vacuum advance distributor (Aldon Part # 101BR1) is undesirable due to poor part throttle response and the risk of burning the valves, not to mention increased fuel consumption. Non-vacuum advance distributors are appropriate for competition use only. Vacuum advance distributors have the advantage of advancing the timing of the ignition spark beyond that attained with a pure centrifugal advance in order to initiate combustion earlier when the engine is not under full load, thus giving a fuel economy improvement of 10 to 20 per cent. Aldon also markets both optically and magnetically triggered points replacement systems for Lucas distributors under the Pertronix brand name. Aldon Automotive has a website at http://www.aldonauto.co.uk/

Some may wish to develop a customized spark advance curve to meet their individual needs. If you seriously want to leave this option open, a distributor that has an adjustable advance curve is desirable, such as the one made by Mallory. It is available in both vacuum advance and centrifugal advance versions (Victoria British Part #'s 17-501 and 17-500, respectively). Victoria British has a website at http://www.victoriabritish.com/ . In both versions, the centrifugal advance mechanism is adjustable from 16 to 28 degrees by means of a simple Allen wrench, the vacuum advance curve of the vacuum advance version of the distributor

is adjustable by using a 3/32" Allen wrench and inserting it into the hose connection nipple and altering the tension value on the diaphragm. An advance curve kit consisting of both an assortment of centrifugal advance weight springs and the Allen wrench is readily available (Moss Motors Part # 143-236). It also has the advantage of having a dual point spark triggering system. In this type of system both sets of points are joined by a wire so that when the first set of points open, nothing happens until the second set of points open. The second set of points open just as the first set are closing. This quick closing of the circuit (approximately 5 degrees) gives the coil a maximum amount of dwell time (72 degrees) to charge, thus increasing the voltage of any given coil. This makes the system highly appropriate for engines equipped with a camshaft designed for high engine speed applications. However, other than the ability to have the spark advance curve custom tailored to work with almost any camshaft, there is no practical advantage to the increased coil charging time of the Mallory distributor when used on a four cylinder engine. For the MGB with a special camshaft, however, a custom spark curve can help exploit that last bit of potential power and deliver better response to changes of the throttle. A six cylinder engine fires 50% more often and an eight cylinder engine fires twice as often. In such engines equipped with radical camshafts, the increased coil charge time can become critical at high engine speeds. Both versions are also available as Unilite distributors with solid state triggering (Victoria British Part #'s 17-503 and 17-502, respectively). Moss Motors has a website at http://www.mossmotors.com/ .

In developing a custom spark curve, the object is to achieve peak combustion pressure. Although engine speed can vary, the fuel/air mixture combusts at a fixed rate. Therefore, the fuel/air mixture has to be ignited progressively earlier as engine speed increases. However, if ignition occurs prematurely the pressure wave inside the combustion chamber will reach the piston crown while the thrust axis of the connecting rod is aligned with throw of the crankshaft, overcoming the pressure of the oil in the bearing and thus causing engine knock and resulting in damaged bearings, journals, and even a collapsed or broken piston crown. However, should ignition occur later than the optimum moment, the pressure wave will reach the piston crown too late for maximum power to be achieved. As a reasonable starting point, the static setting should be 14 degrees BTDC and the maximum mechanical advance setting should be 20 degrees BTDC for a total of 34 degrees of advance. If a very hot camshaft is used, more advance may be necessary to obtain the best idle. With these initial settings in place as a starting point, you should be able to develop the optimum ignition advance curve for your engine. Be sure to use no more advance than is necessary to obtain optimum power or you'll risk burning the valves.

While the Weslake-designed kidney-shaped combustion chamber renders its best performance when the ignition timing at full advance is set at 34 to 35 degrees BTDC, the best ignition timing for setting the idle is dependent upon which camshaft is used. A Piper BP270 camshaft idles best with a total advance ignition setting at 10 to 12 degrees BTDC at 600 to 700 RPM while the Piper BP285 camshaft idles best with a total advance ignition setting of 13 to 15 degrees BTDC at 950 to 1,150 RPM. Regardless of which camshaft you choose, the ignition should reach full total advance no later than at approximately 3,500 to 3,700 RPM.

Of course, a greater fuel/air charge requires a stronger spark to properly ignite it, so use a more powerful coil (40 Kilovolts should be fine up to a compression ratio of 9.5:1) paired with its manufacturer's recommended silicone waterproof spark plug leads which will prevent any electromagnetic interference with your stereo system. Be aware that installing an unballasted coil of more than 20Kv will result in accelerated erosion of ignition points, thus making the pursuit of an uprated ignition system an exercise in frustration. For this reason the Crane/Allison XR700 distributor conversion is highly recommended as it uses an optical trigger and so has no points, thus permitting the use of the more powerful ballasted Crane PS20 coil and greatly reducing maintenance. This should allow you to open the gap on your spark plugs to at least .038" and, with the XR700 conversion, have a nice powerful spark of 300 microseconds duration, enough to handle any streetable engine's ignition requirements and make for much easier cold weather starting. Another advantage of this conversion system is that it can be used on either the Lucas 25D (Crane Part #700-0231) or 45D (Crane Part #700-300) series distributors. A variant of the XR700 system (Crane Part #700-0309) can also be used to eliminate the notoriously short lived dual points in the Mallory distributor as well. If you choose to use one of these units, mount the control module under the dashboard to keep it away from the heat that accumulates in the engine compartment. Crane has a website at http://www.cranecams.com/ .

The limiting factor for camshaft lobe design is the maximum acceleration rate of the valvetrain. Should the acceleration rate be fixed by limiting factors of either the rocker ratio or tappet diameter, then increases in valve lift at critical piston velocities can only be achieved through using a camshaft lobe profile that results in an increase in duration. This is due to the geometries involved. Opening the valve further at any given point in the rotation of the crankshaft will require that the opening point will have to occur earlier. Conversely, it will also have to close later. This is the reason for high lift racing camshafts for the MGB having such long timing phases (300 to 320º). Unfortunately, this has a tendency to result in both overlap and intake valve closing points that will produce a very narrow, peaky power curve with little in the way of usable low end torque. The dilemma is that although the desired amount of lift at the critical periods of high piston velocity is attained, it is achieved at the expense of the valve being open at times when it is detrimental to performance. The solution is either the use of a larger diameter tappet, a roller camshaft lobe profile and roller tappet, or a rocker arm with an increased lift ratio.

Remachining the tappet bores in the block and installing larger diameter (.936") stock MGC bucket tappets is not the simple solution that it may initially seem to be. While the base thickness of the MGC tappet is the same as that of the 18V bucket tappet (5mm), its seat for the pushrod and the ball end of the pushrod are of a different design, even though the cup end and rocker arm ball adjusters (11/32") are the same. The MGC pushrod has a shorter length that that of the 18V pushrod (269mm Vs 274mm), so this approach has the disadvantage of requiring custom made pushrods and installing extra strong springs which will result in rapid wear of the camshaft due to the ponderous weight of the stock MGC tappet. Racing engines are disassembled and inspected several times during a racing season, but this is obviously not a practical solution for the streetable engine which is the goal of this article. However, a lightweight version of the MGC tappet for use the BMC B Series engine is available from Cambridge Motorsport. An MGC tappet is larger in diameter than a standard MGB tappet, so its heel engages the ramp of the camshaft lobe a little earlier in the stroke and disengages a little later, thus the valve both opens and closes both a little earlier and

a little later, plus valve lift is greater at most points in the stroke. Maximum lift stays the same, of course, but by beginning and ending that process both earlier and later than would otherwise be possible for a camshaft with such a small radius to its base circle, valvetrain acceleration becomes more gradual, thus reducing inertia. They also allow the use of a camshaft lobe with more lift without the lobe running off the edge of the tappet and gouging it. The tappet bores have to be carefully bored in order to get them to work on the proper tappet axis, but this, combined with the greater surface area created by the larger diameter of the MGC tappet, in turn reduces side thrust loading on the tappet and permits it to rotate freely at very high engine speeds, thus preventing failure. It's an old racer's trick. However, because both the duration and overlap of the valve openings are increased, they will require a faster idling speed and the powerband will narrow somewhat, although maximum power output will be enhanced. In short, the engine will become more "cammy", but the idle will be rougher than it would be with the same camshaft and Original Equipment specification tappets. Because most of these improvements can be achieved on a streetable engine by simply substituting a different camshaft and the side thrust loadings on standard-diameter MGB tappets would still not be excessive on an engine with a streetable camshaft, this expensive and radical approach would be of little value to anything other than a race engine intended to operate at very high engine speeds.

    Roller tappets would require machining away substantial material from the bridge section in which the tappets are mounted in order to accommodate their greater length, thus reducing the bearing area for the shanks of the tappets which in turn would require fabricating and press fitting custom sleeve extensions to provide adequate bearing area. It would also require custom length pushrods and the development of a custom camshaft lobe profile, as well as increasing valvetrain inertia, so they are also undesirable.

    Fortunately, an increase in rocker arm lift ratio is a relatively simple approach which, as an alternative to changing the camshaft and ignition timing, is perhaps one of the best options for increasing power (aside from headwork). The use of a set of high lift ratio rocker arms will allow the valve to open further without changing the opening point and will also keep the valve closed during periods when it would be desirable, thereby increasing cylinder pressure and making for a broader, and hence more tractable, increase in power. The advantage of this more expensive alternative to changing the camshaft is that because the valves will still open and close at the same time as before, you can retain your stock ignition curve while gaining roughly 10% more power. Due to this being an expensive modification, this method of attaining more power output is normally resorted to only after a three angle valve job and professional headwork. Should you choose to employ this method, you will find that it complements a three angle valve/seat and headwork well.

    There are two different basic types of high lift ratio rocker arm systems. The first type is the simplest and least expensive. It consists of a set of rocker arms in which the lift ratio is increased by means of a shorter pushrod lift arm. While this simple approach permits the use of the Original Equipment rocker stands, it has the disadvantage of increasing side thrust forces on the tappets due to the necessary inclination of the pushrods, as well as on the valve guides and valve stems, resulting in accelerated wear of the valve train. When used in conjunction with high lift camshafts, it is possible to damage the tips of the valve stems. With this type of high lift ratio rocker arm you will also need to relieve the pushrod passages in the block in order to avoid bending a pushrod.

    The second type is a system which uses special rocker stands in which the rocker shaft axis is relocated and different rocker arms in which the lengths of the arms have been altered to achieve the desired increase in lift while reducing the side thrust forces on the tappets by keeping the pushrods closer to their original vertical orientation in comparison with the simpler system. Because of the wider radius to the arc of travel of the valve arm, side thrust loads on the valve stem are reduced in comparison with the simpler system, thus keeping valve guide and valve stem wear within acceptable limits. While obviously more expensive, this is the preferred system for long term use. If you decide to employ this type of rocker arm make sure that they use bushings to ride on the rocker shaft. Needle bearing rocker arms are a for-race-only item due to their short operational life. Before installation look to see that the oiling grooves of the bushings are on the bottom and that their ports are aligned properly with the oil passageways. Once installed, they will need to be reamed to an internal diameter of .616" to .620". These rocker arms are manufactured by Piper and are available from Brit Tek (Part # PRROO1). Due to their having a higher lift ratio (1.625:1) than that of the Original Equipment rocker arms (1.426:1), these will achieve the goal of opening the valves further (about 14.5%) and more rapidly, but will require stiffer valve springs to handle the greater inertia loads resulting from the increased acceleration of the valvetrain mass. They also make use of tubular spacers rather than the Original Equipment spring spacers in order to preclude "walking" of the rocker arms at high engine speeds. Many of these systems make use of a roller bearing on the valve end of the rocker arm to reduce friction. Although the body of such rocker arms are almost invariably made of aluminum, the heavy steel roller bearing at the end of the rocker arm results in them actually having greater rotating mass. Consequently, the use of the both lighter and more rigid tubular chrome-moly pushrods, lightweight valve spring caps, and late model 18V bucket tappets is also advisable to contain valvetrain inertia whenever such rocker arms are employed.

    Should you choose instead to use a more radical camshaft that extends the powerband to 6,500 RPM or higher, a nitrided rocker shaft and stronger outer rocker stands that support the outer ends of the rocker shaft will be mandatory to contain the thrust loads on the rocker assembly at high engine speeds. The increased valve lift will require counterboring the decks of both the block in order to recess the valve spring seat surfaces and that of the head to accommodate the required longer valve springs so that they won't bind. In addition, you will need to shorten the upper section of the valve guides to provide the necessary clearances to accommodate the increased valve lift and avoid damage caused by valvetrain compression.

    At this point I'd like to debunk an old myth about the BMC B Series engine. The inner cylinders do not run richer than the outer cylinders. In reality, the pressure waves in the siamesed intake port that result from the 180 degree throw difference of the crankshaft has a definite influence on fuel/air mixture separation and fuel condensation in the arriving fuel/air charge in the siamesed port, and this is what creates the impression that the inner cylinders run rich. The so-called "rich mixture" in the inner cylinders is in reality the consequence of the problem of interplay between the resulting stuttering flame propagation and reduced

atomization of the gasoline caused by the return pressure wave. The color striations in the carbon deposited in the combustion chambers resembling sand ripples on a beach indicate interrupted flame propagation in cylinders 2 & 3, while the combustion chambers of 1 & 4 cylinders are much more evenly colored and grade out from the spark plug to the opposite wall of the combustion chamber. The solution to this problem lies in careful attention to the contours of the port and the area around the throat where in the approach to the valve seat. Upon examination, there is always a carbon-free area on the chamber walls around the inlet valve. This denotes that fuel has condensed and has literally "washed down" the walls of the combustion chamber on the intake stroke. This absence of carbon evinces a lack of combustion in that area of the combustion chamber. The solution to this problem is modification of the combustion chamber to unshroud the intake valve.

   One crucial bit of advice about Do-It-Yourself heads: Be Careful! Once you remove metal, you can't put it back. To use a Dremel tool with a flap sander attachment to smooth the existing contours is one thing, but to alter the contours is something else. Peter Burgess gives some crude drawings and simple instructions in his book "How to Power Tune MGB 4-Cylinder Engines" and says that you can do it yourself, but a Master often forgets how hard it is for a rank beginner. He gives a much fuller and more detailed description of what is actually involved in his later book "How To Build, Modify, &Power Tune Cylinder Heads" which should be read prior to deciding to set out on such a venture. Remember, the B Series head is special. Siamesed ports are an antiquity in this modern era of separate ports, and there are very few people who truly understand the subtleties of them. This is no Ford or Chevrolet V8 head we're talking about here! Serious work on these heads entails specialized knowledge. Just removing the valve guide bosses is very tricky due to the fact that the difference between removing just enough metal and breaking into the cooling passages is very, very small. If you don't have genuine blueprints of the ports in the particular head casting that you're working on (there were four that were used on US Market engines), complete with dimensions, radiuses, etc., and the appropriate precision measuring tools, then you're taking a big gamble with all of the odds stacked against you. You'll need a Flowbench, too. This is a machine equipped with sensing probes that draws room temperature air in through the intake ports and blows combustion temperature air out through the exhaust ports. It's a must-have for getting the flow rates of the ports individually matched. Many well intentioned local Good 'Ol Boy Hot Rod Motor Builders (the ones that the local pimply Hot Rodders call "experts") have reduced MGB heads to scrap metal. Once this happens you'll spend at least as much money buying another head and getting the parts for it as you would have spent shipping the head to a qualified professional, having him do the work, and then shipping it back again, complete with insurance. The one thing that you can't cheapo your way through on an engine is the headwork. Without access to a flowbench, blueprints, measuring instruments, and the specialized skills, the likelihood of an amateur doing it correctly on a first attempt is so small that it makes me shudder. How do I know? About twenty-three years ago I worked for Rockwell International making valves for use in nuclear power plants. The valves had to be flowed on a bench to be government certified for use in a nuclear installation. This meant custom work, all done by hand with a die-grinder-type Dremel tool. It took about three years of prior experience and a practiced eye to be able to do it right every time, and this was working with a flow bench, repeatedly making small corrections on every individual port! Recontour ports in my garage? Hey, my name isn't Peter Burgess! Ship the head to Peter or purchase one from him outright, you'll be glad you did. After all, you wouldn't try to bore your cylinders in the garage with a file, would you?

   Peter offers multiple levels of headwork suitable for an easily streetable engine: Standard Leadfree, Econotune, Fast Road, and Fast Road Big Valve. The simplest is his Standard Leadfree specification which features bronze valve guides to aid heat removal, stainless steel exhaust valves, EN52 inlet valves, leadfree compatible exhaust seat inserts and 'top hat' style inlet valve stem oil seals. The seats are cut using three angles.

   The Econotune specification adds bulleted inlet guides, and the combustion chambers, valves and valve throats are modified to enhance flow and smooth combustion. The valve and port sizes are not increased, thus the resulting high port and seat velocities produce a broad spread of very useable power from idle to a maximum of around 4,800 RPM. This results in a power increase at 3,000 RPM of approximately 30% and maximum power is increased by approximately 18% at 4,800 RPM.

   The third level is the Fast Road specification in which the head is fully reworked before the lead free seats and bulleted bronze guides are fitted. The inlet and exhaust ports are modified to enhance air flow without increasing the port sizes to any great extent. This keeps the port velocities high and aids the production of low end torque. Power is increased from idle with a gain of approximately 25% at 3,000 RPM and a maximum increase of approximately 30% at 5,200 RPM (with a standard camshaft and K&N filters). Beyond that point the power will fall off much more gradually than with a stock head, so you can say good-bye to that frustrating "after-that-the-engine-seemed-to-run-into-a-wall" experience. If you add a Peco exhaust system it will extend the peak further (to about 5,500 RPM) with yet more power which will decline less precipitously after that. The head also takes beautifully to a Piper BP270 camshaft, the combination sacrificing a little power down very low in the powerband where you rarely go anyway (below 2,000 RPM) and singing merrily all the way to 6,000 RPM. As you can see, the Fast Road Head should be considered to be the jumping-off point when it comes to a quest for really serious power. It's the foundation that everything else is built on. To do it last is putting the horse behind the cart. This specification of head performs well with a standard camshaft and shows even more impressive gains not only with the Piper BP270 camshaft, but also with the Piper BP285 camshaft as well. While the head works extremely well with the standard twin SU's, it will also show worthwhile gains with twin 1 3/4" SU's. The Piper BP285 camshaft is recommended to compliment this increase in carburetion.

   The Fast Road Big Valve head features larger inlet valves and is ideally suited to a Fast Road camshaft such as the Piper BP285. The increased breathing capacity of the head will show good returns with twin 1 3/4" SUs or a Weber 45 DCOE. With a Big Bore engine conversion the head is well suited to restore the peak horsepower RPM to its original position. BHP increase is approximately 25% at 3,000 RPM and 35% at 5,300 RPM when used with a standard camshaft and K&N filters.

   Peter offers a fifth option which, although not falling into the "easily streetable" category, is mentioned here for the sake of completeness. The Fast Road Plus head is fully modified and is fitted with one piece 214N Austenitic stainless steel tuftrided

1.72" inlet valves. The combustion chambers are dressed back to increase flow and the inlet ports are very slightly increased in size to allow the engine to rev out more. The head has been developed for very fast road use with 'hairy' camshafts and increased carburetion. Although not really suitable for standard/mild camshaft use, BHP increase is approximately 25% at 3,000 RPM and approximately 38% at 5,300 RPM when used with a standard camshaft and K&N filters. It is highly appropriate for use on Big Bore engines.

Peter offers these heads on both an exchange basis wherein you ship your head in to him to be modified, and as an outright purchase wherein you purchase a head without shipping yours to him. For those faced with transatlantic shipping charges or for those whose heads are unreclaimable, this is often the most economical approach.

If you don't want the extra expense of professional porting, remove your old valve guides, use a Dremel tool with a #80 grit and then a #120 grit sander to gently smooth the existing port contours. A mirror finish is not only unnecessary, but is actually undesirable as it will lead to the fuel condensing on the port walls and a consequent loss of power. Have installed at equal depth lead-free fuel tolerant three-angle nickel-chrome seats and three -angle 214N alloy Austenitic stainless steel valves with tuftrided stems and stellite tips (don't panic, they're common and not very expensive), tapered valve guides (be sure to use manganese silicon bronze guides on at least the exhaust valves to help get rid of the extra heat that always comes with extra power. This material transfers heat some two and a half times more efficiently than the close-grain cast iron Original Equipment valve guides which results in greater reliability, especially when used with the higher combustion temperatures attendant with the use of lead-free fuel), a set of the highly superior Fel-Pro umbrella-style valve stem seals (FelPro stem seal # SS 70373 for Chevy Vega 4 cylinder 140, '86-92 Ford 351 Windsor, also Advanced Performance Technologies Part # 70373), 1 1/2" SU carburetors with richer needles, 6" diameter X 3 1/4" deep K&N aircleaners, and a 1 3/4" Peco exhaust system. Be aware that bronze valve guides have closer operating clearances and thus valve stem seals are not only unnecessary on the exhaust valve guides, but are actually undesirable as they reduce lubrication of the valve stem. Be sure to carefully blend the port to the seat. This will get you started with a relatively small investment and you'll be both surprised and impressed at the improvement.

An item that has gained some acceptance amongst the racing crowd is the aluminum alloy head. These expensive items shave about twenty pounds off of the weight of the engine and tend to run cooler under the high stresses of racing. They also require that washer-like steel shims or steel collars be placed under the springs to protect the aluminum material of the head from galling by the springs. Because the cast iron of the block and the aluminum alloy of the head have different expansion rates, the use of a high quality resin type head gasket is mandatory.

Aluminum alloy heads come in two types: an aluminum alloy version of the standard cast iron head, and a seven port crossflow head design. Unless you are replacing a cracked head, there is little practical advantage to the extra expense of using the aluminum five-port design in a street application. At present there are two versions of this design. One is the American-made head offered by Pierce through multiple aftermarket suppliers such as Brit Tek, Moss Motors, and Victoria British. The other is the UK-made head available exclusively from Brown &Gammons, the latter having a superior port design that has significantly more tuning potential.

With its independent intake port design, the crossflow head has greater performance potential, but will require the additional expense of special tuning by a professional and bigger 1 3/4" SU HS6 or HIF6 carburetors and a larger diameter custom intake manifold or (preferably) dual Weber DCOE Carburetors and a pair of custom manifolds in order to fully exploit that potential. Be aware that the carburetors will overhang the distributor, so conversion to eliminate the contact breaker points is advisable. Also, removing the oil filter will be a memorable experience, requiring removal of the air filters and their boxes, the carburetors, and the intake manifolds. While this might prompt thoughts of converting to a downward-hanging oil filter from a Morris Marina, unfortunately, that stubby oil filter just doesn't have the flow capacity required for such an engine. The reduced surface area of its filtration element would actually restrict the oil flow. Instead, a remote oil filter similar to that used in an MGB GT V8 would be quite adequate. This conversion will require the installation of a simple spin-on bypass cover with 1/2" NPT threads (Summit Racing Part # TRD-1013) in place of the oil filter and a single remote oilfilter bracket with 1/2" NPT threads (Summit Racing Part # TRD-1045). This will allow you to conveniently continue to use either your choice of standard MGB oil filters or larger capacity units. Summit Racing has a website http://www.summitracing.com/ . Special oil lines will have to be custom-fabricated. Due to the extra stresses on load-bearing surfaces resulting from the increased power output that is possible with this modification, the installation of both a higher-pressure oil pump and a matching relief valve spring is advisable to protect the bearings from the increased pounding.

Currently, there are two crossflow designs available: The Pierce and the HRG Derrington. Neither of them has provision for mounting the OE Heater Valve. However, this drawback can be overcome by simply installing a threaded "L" tube into the water port in the head beneath #3 Intake Port on the HRG Derrington head or in the water port on the rear of the Pierce head, and running a hose to an MGC heater valve (Victoria British Part #2-378) mounted with its bracket (Victoria British Part # 12-4808) on the heater box, just like a 1968 MGC. The right hand spigot (as seen from the front) of the heater core will need to be shortened to mount the heater valve onto the heater box. An MGC heater cable (Victoria British Part # 6-7985) can then be run from the dashboard control knob. The Pierce head is available with a custom heater valve.

All other factors being equal, an unmodified HRG Derrington head produces 15% more power @ 3,000 RPM than that of an unmodified cast iron 5 Port early 18V head with a 1.625" intake valve. In as -cast condition, its high RPM flow is roughly equal to that of a fully reworked 5 port head. Reworking of the head by a professional yields proportional improvements in power output directly comparable to those of a stock head reworked in the same manner without sacrificing any of its advantage in midrange torque production. Once the head has been fully modified the current production version of the HRG Derrington crossflow head produces 40% more power @ 3,000 RPM than that of an unmodified cast iron 5 Port early 18V head with a 1.625" intake valve. Dual Weber DCOE 45 carburetors seem to meet its needs best, probably as a result of the plethora of jets available for them. Interestingly, both the 5 port head and the HRG Derrington head will outflow the Pierce head when fully reworked due to the

Pierce head utilizing the smaller valves of the MGA! Brown & Gammons are the distributors for this item. They have a website at http://www.ukmgparts.com/ .

Unfortunately, the poor thermal efficiency of aluminum forces the use of increased compression of about one point to produce the same amount of power. This, coupled with the obsolete kidney-shaped combustion chambers creates in turn a problem with preignition when running on the gasoline available at a gas station unless considerable and frequent attention is paid to the maintenance of precisely correct ignition and carburetor settings. In addition, careful attention to the cooling system is a necessity as aluminum has a severe tendency to warp should it overheat. If this should occur, the temper of the alloy will have been ruined and thus the torque settings of the head stud nuts will not hold, the head having become just so much scrap metal. You don't get something for nothing!

Yet another item that has become popular with the racing crowd is the cast aluminum rocker arm cover. These are normally deeper than the OE cover to better accommodate high-ratio rocker arms and thus require longer mounting studs. Available in differing finishes, it is often advertised as having the advantage of reducing engine temperature. However, outside of racing applications it is doubtful that the difference in this area would be significant. One problem they present is the difficulty of remounting the original heater pipe in its original position above the block. Another is that if the mating surface of the head is warped, there exists the danger of the cover cracking if overtightened, and leakage if it is installed loosely to avoid this possibility. Thus, it is highly advisable to have the upper mating surface of the head skimmed flat if you desire to install one. Be aware that few of them have provision for the mounting of a restrictor vent tube to permit it to be connected to the adsorption canister. However, there is one practical advantage to their use on a street engine: some of them, such as the ones produced by Kimble Engineering and Oselli, do reduce valve clatter noise.

Much advertising has been done over the years by vendors of overbore kits. Claims of massive increases in power output that spark mental images of acceleration powerful enough to rotate the earth are really just so much propaganda. The truth is that these kits seem to most commonly come in two sizes: 1868cc and 1950cc. The 1868cc kit uses +.060" oversize pistons, which means that when the day comes that you need new pistons you will most likely need to either have the block sleeved (Cost: $500 and up), obtain another block (cheaper if you can find a good one), or bore it out to 1900cc-1950cc category and incur the expense of retuning the engine all over again, including the cost of larger carburetors and intake manifolds. The additional displacement of the 1868cc engine works out to slightly more than an additional 4 cubic inches, which in and of itself just doesn't give enough additional displacement (about 4.5%) to justify any of these long term hassles. In short, unless you've already reached the factory's maximum overbore size of +.040" (which will give a displacement of 1840cc) and are willing to perform other power enhancing modifications, don't bother spending the extra money for trick oversize pistons. If the head is stock, the additional displacement will result in high fuel/air charge velocities occurring earlier in the powerband. You'll have more torque at low engine speeds, but the engine will also attain its peak power output earlier. With a Fast Road head, the engine can continue to wind out nicely after the point where a stock head would seem to run into a wall.

The 1950cc kits do produce more low end torque when used in combination with stock heads, camshafts and modified stock carburetors, but without spending the money required for professional headwork with oversize intake valves such as in Peter Burgess' Fast Road Plus specification, a Big Bore header and exhaust system, and 1 3/4" SU carburetors plus a special intake manifold to accommodate the larger displacement, the potential of the increased displacement just can't be fulfilled.

Due to the variances in cylinder wall thickness that are the result of a less-than-optimum casting process, it's necessary to torque the block to a reinforcing plate prior to overboring to prevent the finished bore from being distorted. Fitting of the 1950cc Big Bore pistons requires boring the cylinders out so far that the side thrust loading of the piston against the thin cylinder walls of some blocks can cause the bore to distort, the consequent loss of compression becoming a headache. Sonic testing of the block to determine cylinder wall thickness prior to boring becomes a necessity at this point. Another downside is that the future reboring and fitting of oversize pistons can't be done as the cylinder walls will be too thin. However, both of these drawbacks can be overcome by offset boring of the block and fitting oversize sleeves with adequate wall thickness. This involves offset-boring cylinders #1 and #3 to the front, and cylinders #2 and #4 to the rear in order to maintain sufficient clearance between the cylinders, prevent the blowing of head gaskets, and the development of 'hot spots' which can cause cylinder distortion. Sleeves have the additional advantage of being made of spun cast iron which is of better quality than the 'block-type' cast iron. If the sleeves are shrink-fitted and silver-soldered into place the heat distribution should be as good as that of a normal cylinder of equal wall thickness, although the ultimate rigidity at the cylinder/block interface will be less. A higher-pressure oiling system can assist in protecting the bearings from the additional pounding of the increased power output. Of course, this implies that the engine would have to be built as oil-tight as possible, but all of these have been done before, so dealing with these issues would hardly involve blazing new trails into uncharted territory. All this, of course, is not to mention the problems of the excessive heat that would be produced with such an uprated power output, which in turn will require modifications to the cooling system. For anything other than use on a racetrack, a fully developed Big Bore engine is likely to prove to be financially impractical. A compromise displacement of 1900cc-1926cc is probably the practical limit for a fully developed street engine. No matter what you do, the ignition timing and the carburetion have to be scrupulously maintained or you'll have problems with a Big Bore B Series engine.

Most 1950cc kits use +.040 oversize 83.57mm domed Lotus TC pistons to produce an additional 8.2% (9 cubic inches) of displacement more than stock. These pistons have tops that are approximately .090" closer to their wristpins than standard MGB pistons, thus it is necessary to mill the deck of the block .100" in order to achieve a reasonable compression ratio of 9:1 with the 39cc combustion chamber of the heads used on the 18V engine. This will place the deck of the block very close to the cooling passages, resulting in a risk of cracking in some blocks. Because this shortening of the thickness of the deck of the block will decrease the number of threads available for the head studs, the depth of the threads will need to be carefully examined prior to redecking to determine that they will still be able to offer sufficient grip without incurring the risk of cracking the deck when the head is torqued. These pistons also require the use of the later connecting rods that have no balance pads in order for the

wristpins to fit properly and to counter the greater reciprocating mass of the larger pistons.

Unfortunately, the domes of the Lotus pistons interfere with flow and combustion characteristics. If the bore is increased radically, then the squish area also increases and flame propagation becomes a problem, especially if domed pistons are used. Let's face it: A domed piston design and the Weslake kidney-shaped combustion chamber design aren't exactly in harmony with each other. Domed pistons present enough problems in a hemispherical combustion chamber, but in a Weslake kidney-shaped combustion chamber they're bad news.

The combustion chamber volume of a Big Bore engine is relatively smaller in relation to the cylinder volume on a Big Bore engine than on a 1868cc engine, so the pressure rise within it is faster than on the smaller bore 1868cc engine, resulting in the greater tendency of the Big Bore engine to detonate. In addition, the larger squish area of the Big Bore engine creates too much turbulence for flame propagation to be smooth and even, inhibiting flame propagation in the areas near the roof of the combustion chamber, a factor aggravated by the dome of the Lotus TC piston. Due to the positional relationship between the circular cylinder and the kidney-shaped combustion chamber, the increased squish area increases the velocity of the turbulence in the direction of the spark plug, thus guaranteeing that the turbulence around the valves will be at the lowest in that location due to the direction of the moving fuel/air charge being biased toward the spark plug. The position of the spark plug also plays a big part in the detonation problem. The flame travels outwards towards the lobes of the kidney-shaped combustion chamber, creating a pressure wave. As the pressure wave at the border of the combusting fuel/air charge advances, the unburned fuel/air charge in front of it is compressed against the roof of the combustion chamber. When the pressure wave arrives in the vicinity of the hot exhaust valve last, its velocity and pressure is at its greatest just as the remaining volume available for unburned fuel is decreasing at its fastest rate. Because the area around the exhaust valve is the hottest region of the combustion chamber, its conditions are best for producing preignition and detonation, and the arrival of the pressure wave compressing the fuel/air charge against it triggers the event. While opening up the combustion chamber to decrease the squish area will alleviate these problems, the resultant increase in combustion chamber area can decrease the likelihood of preignition at the expense of a lower compression ratio which in turn will prevent the potential of the engine from being attained. Obviously, it is difficult to reach a happy medium, so the distance between the piston crown and the head is critical to producing the correct amount of squish turbulence. It would seem that the most practical clearance is .012". This will create a problem when selecting a high-lift camshaft as it may become necessary to relieve the deck of the block to a depth greater than that of the piston/head clearance. The edge of the compression ring may be directly exposed to the heat of combustion, leading in turn to premature ring failure and piston land breakage.

These problems could be minimized by using less spark advance, a lower compression ratio, and a mild camshaft such as the Piper BP270, but this solution would in turn result in the engine reaching its peak output at a less-than-optimum engine speed. Due to the increased displacement, higher port velocities occur at lower engine speeds, resulting in a flatter power curve which reaches its peak at substantially lower RPM. What is really needed is either a Piper BP285 camshaft or a Piper 270 camshaft coupled with a 1.69" intake valve in order for the engine to reach its power output potential and keep the power peak where it should be in order to retain the standard gearbox ratios and a compression ratio of 10.5:1 to keep the power output at a worthwhile level.

So, as you can see, there's still a problem to be solved: Find a way to use a compression ratio of 10.5:1 and still enable the engine to run reliably using the 93 Octane Oxygenated fuel.

The best pistons to use for a Big Bore engine are flat-topped JE pistons, but, being forged pistons, they have a greater expansion/contraction coefficient than cast pistons due to their lower silicone content (silicone doesn't like being forged), so they have to be fitted with greater cold running clearances which can accelerate wear somewhat. They're also heavier, so the balance factors have to be modified and the engine will vibrate a bit more due to the greater weight pumping up and down inside the engine. Of course, the extra weight could be compensated for by using Carrillo forged chrome-moly alloy connecting rods, but they're very expensive ($$$$$). Due to the height of their piston crowns being .040" greater than that of Original Equipment pistons, they will not require redecking the block to the point that there's a risk of hitting a coolant passage. In addition, their crowns are thick enough (.415") to allow the machining of a dish to custom tailor the compression ratio and the bottom shape of the combustion chamber to individual specifications. Fortunately, there is a solution: JE offers the service of custom-machining their pistons to order, thus the piston can be made with a dished crown which, when coupled with a professionally reworked combustion chamber, will accomplish the combustion chamber shape needed to decrease the tendency toward preignition. The desired compression ratio can then be attained by milling the deck of the block to the appropriate height. Of course, that automatically implies that the pushrods will have to be shortened in order to maintain proper rocker arm/ valve stem geometry, but Crane Camshafts offers that service too, so that isn't a problem.

For those who truly lust after power, an aluminum block Rover 3.9L V8 conversion would be much better (200-260hp), but that is a subject for another article. If this thought tickles your fancy, Roger Parker has an excellent website on how to perform this conversion at http://www.mgcars.org.uk/v8_conversions/rogv8.html and a British website for purchasing the Rover V8 engine itself in different displacements and various states of tune can be found at http://www.rpiv8.com/ .

Another even more dubious possibility is that of a "Stroker" engine. Increasing the stroke of an existing engine shortens the connecting rod/stroke ratio. Although the side thrust loadings on the pistons and cylinder walls increase, this results in the piston accelerating faster down the bore, thus increasing the pressure differential between the outside and the cylinder. This increased difference in atmospheric pressures thus occurring earlier in the stroke results in higher velocities in the fuel/air charge. This higher velocity results in a larger charge filling the cylinder. However, to accomplish this on an existing engine requires a shorter distance from the axis of the wristpin to the piston crown to avoid hitting the roof of the combustion chamber and a shorter distance from the axis of the wristpin to the bottom of the piston skirt to avoid hitting the crankshaft. The end result of this shortening of the piston is a decrease in its load bearing surface area coupled with a tendency towards "piston slap." Combine

these factors with the increased side thrust loadings along with the decreased surface area of the piston and the result is accelerated wear. Such an engine will obviously be harder on its oil and lower end bearings as well, although offsetting the bores will help avoid the worst of the lower end loads somewhat. I doubt that it would be possible to offset the bore of a B Series enough to make this approach worthwhile. Also, because the piston both accelerates and decelerates more rapidly, a different camshaft lobe profile would have to be custom-developed, the maximum permissible engine speed would have to be less due to maximum permissible piston speed being attained at lower RPM, and balancing would become an important issue unless you're willing to tolerate some of the additional power being dissipated in the form of increased vibration. In addition, the shaft of the camshaft would have to be of minimal diameter to provide clearance for the connecting rod assembly. Reducing the diameter of a standard camshaft would be a poor idea at all as this would weaken it to the point that both flexure and breakage would be likely. To accomplish this would require the use of an alloy that would have a high chromium content (for rigidity), molybdenum (to avoid molecular shear), and vanadium (to control distortion), plus it would have to be heat treated to a hardness that might cause its small diameter to snap under the pressure of high RPM stress. This approach would be expen$ive. To go from a displacement of 1.8L to a displacement of 2.1 by increasing the stroke alone would require an increase in stroke of 16% to 17%, which is not possible without relocating the camshaft. To retain the original camshaft position would require a radical overbore, sleeving the cylinders to withstand the increased side thrust loads, and a set of Big Bore pistons. The small increase in stroke would not result in a sufficient increase in power output to justify the hassles and the expense. A well-developed 1.8L would be far less expensive and would live far, far longer. The only rational justification for a stroker 2.1L B Series engine would be in the eyes of those who want the ultimate in B Series power for use on a dragstrip. If you want maxipower for the street, fit a Rover V8 instead.

     Of course, an engine that produces more power also makes more heat. This is where your cooling system becomes crucial. The function of the thermostat is to maintain a stable engine temperature, keeping the running tolerances of the engine constant and thus prolonging the engine's lifespan. The only advantage to using a blanking plate is that there's no thermostat to stick in the closed position and overheat the engine. However, you need to understand that a blanking plate is intended for racing use. In racing, the engine pulley size is reduced to lower the pump speed to engine speed ratio so that the pump will turn more slowly and thus allow the coolant sufficient time to absorb heat from the block and release it through the radiator. On a street machine, installing a blanking plate while leaving the pulleys the original diameter usually results in hotter running and much longer warm up periods.
     The early three main bearing B Series engines had cooling passages between all of the cylinders, but the cooling passages between cylinders 1 & 2 and 3 & 4 were deleted when the engine was redesigned into its five main bearing version. These coolant passages within the block extend to just below the height of the piston rings when the piston is at Bottom Dead Center. Never use plain water as a coolant in the cooling system. It will rust the cooling passages inside the engine. Rust will act as an insulator, trapping heat inside the engine. Instead, use a mixture of antifreeze and distilled water. Use a 165 degree thermostat for summer use or a 195 degree thermostat for winter use. You would be well-advised to use the "fail-safe" type that locks in the full-open position should it fail in order to preclude overheating in the middle of nowhere. Moss Motors sells a "fail-safe" type 180 degree general purpose thermostat (Moss Motors Part# 434-205). Be advised that at highway speed it is primarily air pressure that forces air through the radiator and not the fan. Air pressure tends to take the path of least resistance, moving through any and all open spaces in and around the radiator mounting diaphragm rather than through the radiator. Therefore, if you want the cooling system to function to maximum effect, be sure that all of the spaces around and above it are well sealed.
     While an electric fan is 10% more efficient when used as a puller fan mounted behind the radiator than it would be when mounted in front of it and used as a pusher fan, in either position it merely inhibits airflow through the radiator matrix at speeds above 35 MPH. Instead, install one of the two versions of the seven-bladed cooling fan for more effective cooling. The early version (MG Part# BHH1604) is of smaller diameter with coarse pitch blades which do an excellent job of cooling at low RPM but tend to "stall out" at high RPM, resulting in little movement of air, and is commonly found on the 18GD through 18GJ engines intended for use in hot climates. The later version (MG Part# 12H4230) is of larger diameter with steel reinforced finer pitch blades and does a much better job at high RPM. It is commonly found on 18GK through 18V-673-Z-L engines, although it wasn't introduced on North American Market models until November of 1972 on the 18V-672-Z-L and 18V-673-Z-L engines. Mounting either is a simple matter of removing the fan pulley from the coolant pump and using it as a jig to drill four holes through the boss of the plastic fan that will align with those of the fan pulley. Due to their higher aerodynamic efficiency, these fans draw more air through the radiator rather than expending most of their energy just stirring it around inside the engine compartment like the older paddle-bladed metal fans, require less power to perform their function, and are actually quieter. Because they are lighter, they have less inertia and thus absorb slightly less power and put less strain on the pulley belt whenever a change in engine speed occurs, thus prolonging belt life. To install these fans on a MKI model it will necessary to either mount the short-nosed coolant pump of the later 18V engines or install the radiator of the 1972 through 1975 MKII models along with the complimentary thermostat housing. In either case you will need to mount a shorter pulley to maintain proper alignment with the alternator. In a few rare cases the distance between the fan and the radiator will be insufficient to permit the mounting of this more efficient fan and so the shorter pulleys of the 1972 through 1974 models (BMC Part# 12H 3700) will be necessary to provide the needed clearance. A fan shroud will maximize the effectiveness of the fan. If your car is a 1976 or later model, it will be necessary to both mount an earlier pulley wheel in order to mount the fan and fabricate a custom fan shroud.
     Next, take the car to a competent radiator shop and have the components of the entire system, including the engine, radiator, and heater core, flushed and descaled to remove the 20+ years accumulation of muck, rust, and mineral deposits which act as insulators that keep heat from being dispelled by the cooling system. You'll be surprised at how much cooler the engine will run in

the summer and how much warmer the heater is in the winter. Install a coolant pump with the earlier cast iron body as it has the more efficient die cast impeller which has less of a tendency to cavitate at high engine speeds. Do not use silicone-based Permatex blue RTV sealant on any of the engine gaskets as it is prone to failure under hot operating conditions. Instead, use Permatex Aviation Form-A-Gasket sealant. Make sure that the system is refilled with a mixture of a good ten year antifreeze and distilled water. Why distilled water? Because it won't coat the interior of your cooling system with mineral scale. Why the more expensive ten-year antifreeze? Because it has special additives that will extend the life of your water pump and because you don't really want to do all this all over again next year, do you? You don't have to take this extra step, of course. When your cooling system fails due to a lack of proper care, you can always send Moss Motors $229.95 for a new radiator and $94.95 for a new water pump, plus shipping.

Should the power output of your engine be so great that it overwhelms your cooling system, have your local radiator shop recore your radiator with an aluminum core fully 1" thicker than standard (it will still fit without further modifications) and insist upon the highest number of fins per inch available. The L-type core offered by Modine is excellent for this purpose. They have a website at http://www.modine.com/ . Relocating the oil cooler to a new position behind the front valance will provide unobstructed airflow to the radiator while mounting the vented front valance from the 1972-1974 1/2 models will in turn provide adequate airflow to the cooler.

Beware of cheap radiator hoses. Due to poor wall strength, they can collapse at high pump speeds and restrict the coolant flow to the coolant pump, resulting in overheating. A quality Kevlar reinforced hose (available from Victoria British) should not compress or distort any more than is necessary for mounting.

Refilling the system so that there will be a reduced likelihood of air pockets is easy once you know how: First, fill the radiator and block by pouring the coolant in through the thermostat housing and refit its outlet cover, then disconnect the heater hose where it connects to the forward part of the pipe that runs along the top of the rocker cover. Insert a small funnel into the hose. Holding the hose above the height of the heater box, pour in the coolant until it flows out of the pipe from the rocker box, then remove funnel and reconnect the hose to the pipe. This will minimize the amount of air in the system. If your car is equipped with an overflow tank, fill it 2/3 full and check it when the engine cools off after breaking in the camshaft.

Prior to starting the engine it is essential to prime the oil pump. Failure to do this will result in all of your handiwork being destroyed due to a lack of oil flow and oil pressure. Install a magnetic oil sump plug (Moss Motors Part # 328-282) and fill the sump with the most inexpensive 20W/50 oil you can find. Pour a tablespoon of oil down the pushrod wells to lubricate the tappets and another tablespoon of oil into each spark plug hole to lubricate the rings, then oil the rocker arms and valve stems. Next, pour oil down the vertical tube of the oil filter stand to fill the high pressure oil gallery and supply oil to the main bearings, then install the oil filter. Finally, if your engine is not equipped with an oil cooler, disconnect the large external oil line that goes to the back corner of the block at the oil filter stand and pour oil into it to supply oil to the oil pump. If the engine is equipped with an oil cooler, before installing the oil filter, disconnect the large external oil line that goes to the back corner of the block from the oil cooler and, holding it above the height of the head, pour oil into it to supply oil to the oil pump, then reattach it to the oil cooler and pour oil down the aperture in the oil filter stand to fill the oil cooler as well as down the tube of the oil filter stand to supply oil to the main bearings, then install the oil filter. Rotate the engine backwards (counterclockwise) to draw the oil into the oil pump. Once the pump is primed, disconnect the power supply to the fuel pump and turn the engine until your oil pressure gauge gives a reading. Now you may reconnect the electrical power to the fuel pump and start the engine.

At this point it is critical that the camshaft and its tappets be properly bedded in to avoid ruining them. Hold the idle of the engine at 2,500 RPM for twenty minutes, occasionally varying engine speed gently between 2,000 and 2,700 RPM. After this process is completed, change the oil and the engine will be ready to be broken in on the road. Drive for 100 miles and retorque the head, change both the oil and the oil filter, then again at 500 miles to complete the bedding in of the new camshaft and lifters, let it cool and then retorque the head using the proper sequence pattern. You will find some nuts almost tight, some can take almost a quarter turn. Run the car for another 100 miles again. You'll find that this time the studs have not lost quite as much torque. Run an additional 500 miles and retorque. During this period do not exceed 4,000 RPM or 45 MPH, operate the engine at full throttle, or allow the engine to labor in any gear. Until the next 1,000 miles total has been completed, limit engine speeds to around 4,500 RPM when shifting gears. Cruising on the highway should be limited to no more than 3,500 RPM. Keep varying the throttle opening and engine speed. The secret is to constantly vary the speed and load without creating excess heat through full throttle laboring and high engine speed operation. After 1,000 miles of following this procedure, change the oil and oil filter and refill the sump with a quality oil such as Castrol 20W/50. After another 1,000 miles the engine will be properly broken in and ready for service.

At this point, I'd like to point out a piece of equipment that doesn't deal directly with the engine's power output, but plays an essential role in getting it to the rear wheels: the clutch. Yes, a more powerful engine is indeed harder on the clutch. The Original Equipment Borg &Beck clutch should be capable of handling the power of the engine detailed above, but you may find that its lifespan is compromised more than you would desire. Of course, there are heavy duty clutches available for the MGB, but almost all of them were originally designed for use in trucks. Yes, this transmission was in fact used in trucks! That's why they last so long in our light little cars. They make use of a more powerful diaphragm spring and hence will increase clutch pedal pressure. Due to the MGB weighing less than the trucks in which they were intended to be employed and the take-up coil springs in the Driven Plate being stiffer, some of these clutches tend to feel "grabby," some engaging almost like an on/off switch. There is a better alternative: simply replace the Original Equipment Driven Plate with one from a Triumph TR7 (Roadster Factory Part# GCP253). Its splines are identical with those of the original, thus it will fit without modification. Having been designed to be used with a more powerful engine, its greater surface area will ensure all of the grip that you will need. When used in stock engines they tend to last 140,000 miles, which is considerably better than the 80,000 mile life expectancy of the Original Equipment clutch. At present, other than for racing application, there appears to be no advantage to substituting any of the currently available

alternative throw out bearings for the standard carbon version.

Another concern will be that of the driveshaft. While the standard 2" MGB driveshaft has a wall thickness of .064" and is of more than adequate strength for reliably transferring the power output of a stock engine, it is wise to consider that the driveshafts of the more powerful MGC and the MGB GT V8 are of a more stout .095" wall thickness (Victoria British Part # 5-5916), plus it has a beefier flange, yoke, and U-Joints to handle the additional stresses of their more powerful engines (Victoria British Part #'s 5-5950, 5-5951, 5-552, respectively). Long term reliability counts, especially on a street machine!

Axle tramp problems are the curse of high torque engines coupled to leaf spring rear suspensions. When the torque arrives at the differential, the axle tries to twist along its lateral axis, causing the springs to wrap until the tires lose traction, whereupon the axle is snapped back into its original position by the unwrapping leaf springs. The process is then rapidly repeated, the violent result being axle tramp. Actually, while this could be minimized by the installation of a pair of antitramp bars, those currently available for MGBs are all junk. They are all solid bars which, being of fixed length, cause the leaf springs to bind when the axle to which they are attached moves rearward as the suspension compresses. To keep the springs from binding, each of the antitramp bars should be of two-piece telescopic design, just like the ones made for Chevys and Fords. Upon full extension they should travel no further than the rearmost position of the axle when the leaf spring is at its limit of upward compression, and upon full compression they should travel no further than the forwardmost position of the axle when the leaf spring is at its limit of downward extension. That way when the torque tries to twist the axle there's some limitation factor, yet the springs can perform without interference. On a V8 model, that's the solution.

However, the torque effect isn't as severe with the engine used in the MGB. Late model MGBs used seven-leaf rear springs and a rear stabilizer bar, both of which helped tame axle tramp considerably. I found that the axle of my car with its power enhanced engine will tramp only when I stress the hell out of it in a fast takeoff from a standing start. Even then it isn't terrible, just a hopping feeling instead of the noisy, shuddering, banging that characterizes the no-rear-stabilizer-bar, six-leaf suspensions of the Chrome Bumper cars. The seven leaf springs increase resistance more at extreme compression and thus are less prone to wrapping. The rear stabilizer bar is a spring in its own right and, while willing to twist on its axis, resists flex considerably, thus functioning as a semi-antitramp bar. If you want to go this route, try a 7/8" front stabilizer bar and a 5/8" rear stabilizer bar so that the handling will be neutral. This is presuming that the car hasn't been lowered. Of course, you can always have a machine shop make up the two-piece telescopic antitramp bars, fabricate mounting brackets, and weld the brackets in.

As a final note, I'd like to point out that while much has been said about the somewhat eccentric gear ratios in the B's four-speed transmission, it's not commonly understood that the gearboxes did not all contain identical gear ratios. Some of the combinations are more appealing for performance-oriented driving then others:

1962-1967 (MKI) (Non-Synchro first gear)
1st 3.6363:1
2nd 2.2143:1
3rd 1.3736:1
4th 1.101:1

This made for the following ratio gaps:
1st-2nd 1.442
2nd-3rd .84077
3rd-4th .2726

1968-1974 (Early MKII) (Top Fill Version)
1st 3.440:1
2nd 2.167:1
3rd 1.382:1
4th 1.000:1

This made for the following ratio gaps:
1st-2nd 1.273
2nd-3rd   .785
3rd-4th   .382

1975-1976 (Mid MKII) (Side Fill Version)
1st 3:036:1
2nd 2.167:1
3rd 1.382:1
4th 1.000:1

This made for the following ratio gaps:
1st-2nd .869
2nd-3rd .785
3rd-4th .382

1977-1980 (Late MKII) (Side Fill Version)
1st 3.333:1
2nd 2.167:1
3rd 1.382:1
4th 1.000:1

This made for the following ratio gaps:
1st-2nd 1.166
2nd-3rd .785
3rd-4th .382

     The ratios are obviously chosen for Daily Driver applications: A very low first gear (Excepting the 1975-1976 transmission) for starting off on a steep hill with a heavy load on board. A relatively low second gear ratio for puttering in downtown traffic. A third gear ratio suitable for urban roads. A fourth gear that is essentially an overdrive for use back in the days before Motorways (Interstate Highways). An optional Laycock de Normanville overdrive unit was available for those who desired their cars to be appropriate for high speed use. Because of its taller first gear, the ratios used in the 1975-1976 gearbox have the smallest jump between 1st and 2nd gears and are much sought-after by performance-oriented drivers.

     There are other options for those seeking alternative gear ratios. The MGC used essentially the same 4-synchro gearbox, of which there were two basic models. These are different from the MGB only in their bellhousings, the clutch fork, the clutch fork boot, the output flange, and the ratios of their gearsets. Everything else is the same. The ratios of the gearsets used on the 1968 model without Overdrive are the same as for the 1968-1974 MGB. However, for the Overdrive equipped 1968 model, and the 1969 model, both with and without Overdrive, they are unique:

1st 2.980:1
2nd 2.058:1
3rd 1.307:1
4th 1.000:1

This made for the following ratio gaps:
1st-2nd .932
2nd-3rd .860
3rd-4th .307

     However, for those who want to keep their B as original as possible and retain the quaint usefulness of the Laycock de Normanville overdrive unit, yet still yearn for a close ratio gearbox, Cambridge Motorsport offers close ratio gear sets for the MGB's transmission. The ones for the All-Synchro transmissions use straight-cut gears which absorb less power, but are extremely noisy.

     Should you decide that you would prefer to use the later cranked gear lever of the
1977-1980 models with the overdrive switch mounted in its shift knob, be aware that, with minor modification to the remote control housing, the gear levers are interchangeable with those of the earlier four-synchro transmissions. This is due to the fact that the remote control housings are different and the ball end of the gear levers are different. The remote control housing of the earlier 1968 through 1976 transmissions uses two pivot bolts to align the gear lever while that of the later 1977 through 1980 transmissions use single pivot bolt. This being the case, the remote control housing of the earlier transmission will need to have one of the bolts removed in order to mount the cranked gear lever. The alternative is to install the appropriate remote control housing. The earlier gear lever has a 3/8" threaded shaft while the later cranked gear lever has a 7/16" threaded shaft, thus the shift knobs are not interchangeable.

     Be advised that two different types of Laycock de Normanville overdrive units were used on the MGB. The first was the D type unit that produced a third gear ratio of 1.101:1 and a fourth gear ratio of .802:1. This unit was used on the three-synchro transmissions and had an external linkage for the solenoid. It can be readily identified by its identification numbers 25/3308 (sometimes 63308). The LH type unit was used on the four-synchro transmissions and came in two versions. The black label unit used from the 1968 through the 1974 model years with an identification number of 22/61972 which had a white speedometer drive gear appropriate for the 1280 tpm speedometer. The later blue label unit used from the 1975 through the 1980 model years with an identification number of 22/62005 with a red speedometer drive gear appropriate for the 1000 tpm speedometer. When engaged, both versions of the LH unit produced a third gear ratio of 1.133:1 and a fourth gear ratio of 0.82:1, but on 1977 and later models, due to the use of a switch in the shift mechanism inside the remote control housing, the overdrive unit could be engaged only with the transmission in fourth gear. Aside from their different speedometer drive ratios, the LH Overdrive units are interchangeable. However, their white and red speedometer pinion drive gears are not interchangeable. You have to perform a complete disassembly of the unit to replace the driving gear on the output shaft as well as the pinion gear. Be aware that the later blue label LH overdrives have a weaker thrust washer for the sun gear. Instead of combining the input shaft bushing and the thrust washer into one piece, the later O/D units use a two piece assembly consisting of a spacer and a thin phosphor-bronze washer with oil grooves in it. These washers tend to fracture along the oil grooves. This thrust washer cannot be replaced. The only method of repair is to have the casing modified to accept the earlier and sturdier one-piece thrust bushing of the black label version.

The final ingredient in the recipe for putting more power on the ground is the rear axle and differential. During its lifetime the MGB was equipped with two different rear axle/differential assemblies: The Hardy-Spicer Banjo three-quarter floating axle and the Salisbury tube-type fully floating axle. The Hardy-Spicer axle has its differential mechanism assembled into a carrier that is separate from the axle and bolted onto its front and its hubs are press fitted onto the axle shafts. The Salisbury axle has its differential mechanism built directly into the axle casing which is sealed by a cover plate and its hubs are bolted onto the axle shafts. A three-quarter floating axle has its outer bearing positioned between the wheel hub and the axle, thus eliminating bending loads of the car's weight, while the fully floating type axle has an additional bearing between the hub and axle to handle the side-thrust of heavy cornering loads. In the case of an MGB powered by a B Series engine, either axle is adequate for street use. A Quaife Engineering torque-biasing limited-slip differential will assure that the extra power safely gets to the pavement. Quaife has websites at both http://www.quaifeamerica.com/ (USA) and http://www.quaife.co.uk/ (UK).

Well, that's about it. I could say a lot more, but Peter Burgess has said most of it such as the intricacies of camshaft lobe design and combustion chamber modification) in his books. Buy them and give them a thorough reading. Beyond this I assure you that if you build your engine as Peter Burgess recommends in his books, your engine will amaze you with how smooth, durable, and powerful it is. If you have any other questions or feedback, drop me a line. MG owners have been improving their cars since day one. In fact, the entire history of MGs goes back to the days when mechanics at Morris Garages (now you know where the name "MG" comes from) would take a standard Morris automobile and "improve" it for discerning customers who wanted a little better performance. MGs have always been enthusiasts' cars, and it's just in the nature of things for enthusiasts to improve their cars. Only the most rabid of purists would object to an owner doing period-correct modifications to it. What entails "period-correct" modifications, you ask? Quite simply, anything that was being done to the cars when they were still in production, including really interesting work done by the factory race team. This includes, but is not limited to, changes such as: camshaft, headwork, valvetrain work, exhaust system work, carburetors, intake manifolds, aircleaners, distributor modifications, suspension modifications including different springs, damper rate modifications, stabilizer bars (both front and rear), lowering the chassis, adding a Panhard rod, changing transmission and differential gear ratios, wheels, tires, and just about anything else that the mind had conceived of in those days, which is a lot. I've never met an MG owner who has actually done all of these things to his car, but if I ever do, you can bet he'll be wealthy. I can see no reason for any MG enthusiast to have a problem with pointless ignition, better headlights, better brake friction materials, radial tires, or anything else that is a reversible "improvement." To those enthusiasts who take pleasure and pride in tinkering with and improving their MGs I say: "You are the true keepers of the MG Heritage." To those who insist that an MG should be exactly as it was when it left the factory at Abingdon, I can only say this: "You're missing the whole point of the Marque and its history."