REBUILDING YOUR FIRST ENGINE
BY JOE MONDELLO

Rebuilding an engine is involved, particular steps must be taken and confidence in the professionalism of your machinist is most important. The first thing is to research the exact cubic inch displacement, year, and type of engine that is in your car. Our technical reference manual will be a great help to you when rebuilding your engine. Always take photos of the engine and engine compartment. Pay special attention to brackets, accessory head bolts, wire looms, AC hoses, belts and special headed or stud type-mounting bolts. Before starting to remove your engine, cover the fenders, front grill and sheet metal with good fender covers or heavy blankets. Then disconnect the battery, fuel lines and drain all the fluids. You should remove the radiator first remembering to disconnect radiator hoses and transmission oil cooler lines to eliminate a big mess of dripping transmission fluid. The carburetor and distributor should then be removed. Connect a chain, engine cradle stop or carburetor plate adapter to engine and prepare to remove the engine. Disconnect engine and transmission mounts and remove the hood. Scribe or use a marking pen around the mounting brackets so hood replacement will be easier. Sometimes the removal of the rear transmission crossover-mounting bar will allow more of a tilt for easier engine and transmission removal. Always block the rear wheels so the car cannot move fore and aft. Always make sure your engine hoist and removing device is securely bolted down and is tight. If you have a 4-speed car, disconnect the clutch cross shaft and all the linkage. All shift cables, drive shaft, and transmission brackets must be removed and marked for proper reinstallation. After the engine and transmission are removed, unbolt the trans and torque converter from the engine also removing the flexplate. Once the engine is a long assembly, bolt it to your engine stand. Always remove your engine parts in groups, label them in groups and always clean them in groups. Start on the intake manifold and work down to the short block, removing valve covers, rocker arms and pivots, push rods, lifters, head bolts and heads, exhaust manifolds or headers should have already been removed including AC/PS and all brackets. I would remove the water pump, pulleys, and harmonic balancer. Use a puller to remove the harmonic balancer, not a hammer. The next thing is to remove the front cover and check for water erosion and pitting, replace as needed. The front cover being the water pump mounting plate becomes pitted over years of usage and can cause hard to find water leaks. If the front cover gets a pinhole in it, water and anti-freeze enters your engine.

After removing the above parts, check for blown gaskets, head, intake manifold, front cover and water pump, plus any large cracks, pitting or erosion of all surfaces. You should use a gasket remover and gasket scrapper on all surfaces before you can thoroughly check them. I recommend cleaning, hot tanking and bead blasting all parts, plus magnafluxing. Usually the rocker arms and pivots and sometimes the rocker pivot bolts need replacing. Check the bolts for stretching because they are usually over torqued by previous mechanics. The torque should be 25 foot-pounds. Next remove the oil pan, timing chain set, cam gear/bolt and both front oil galley plugs. Take these plugs and keep them in a safe place. One plug has a hole in it. Make sure the hole is opened up before reinstalling. These plugs will get lost if they go to the machine shop, believe me, I sell lots of them. The engine now should be turned up side down so you can number stamp the connecting rods. Stamp the rods on the side where the bolts go through towards the center of the engine, not on the pan rail side. Always number the rods as they come out of the engine 1-3-5-7 and 2-4-6-8. Turn the engine over and remove the cylinder bore ridge, located at the top of the bore with a ridge remover tool. Clean the tops of number 1-7 and 2-8 pistons. Then bring these pistons up to TDC and check the deck clearance. Measure from the top of the piston (not the dish) to the top of the block and record these figures. This can be done with a pair of dial calipers, dial indicator, or a set of feeler gauges. This will help you in knowing if your block is square, if your connecting rods are different lengths, and also in helping you in figuring your compression ratio. Roll the engine over now and start removing the connecting rod bolts on number one cylinder. Loosen the nuts, but do not remove. Using a brass or hard rubber shock hammer, tap on the rod nuts until the rod

bolts have come free from the cap. Remove the nuts completely and the rod caps. Insert some long shaft rod bolt protectors, rod boots or some 3/8 inch gas line hose over the rod bolts to protect the crankshaft from being dinged up. Remove pistons and rods by tapping on the connecting rod with a rubber hammer or brass punch until the pistons and rods are out of the block. Make sure to catch the piston and rod as it is exiting. Sorry, you must remove any windage trays, oil pump and oil pump drive shaft before stamping or removing the connecting rods. You can now remove the crankshaft. Loosen and remove the main bolts, using a hard rubber or brass hammer tap on the side of the main caps on both sides in an upward motion to loosen the caps from the block main line register. Once the caps are removed, remove the crank by lifting it straight up and setting it down standing up on it's flexplate mounting flange. Never lay a crank down flat for any period of time; it will become warped up to .010 to .015. Now you can examine the harmonic balancer hard rubber insulator for cracks or the slipping or rotating of the outer ring. A groove on the seal face of the balancer is minor. Our repair kit number DS-955 will fix it for less than $10.00. Examine the crankshaft for grooves, excessive wear, the thrust face (center main) for wear, this is usually caused by 4-speed cars, or defective torque converters. If your crank has a decent surface, some grooves below the surface will not hurt anything, you can polish it, cross drill it and it will be better than new. If you have to regrind your crankshaft you will have to reharden it using Tuff-tride or reheatreating. When you repolish your stock crank, as long as it is std-std it will retain it's stock heat-treated surfaces and all stock Olds cranks are factory heat-treated. You should now examine the condition and skirt wear of your pistons; you are now getting into an area where a good set of micrometers are going to be needed. Examine the connecting rods for straightness (bends are common in Olds engines). They have a low heat treat 20 to 22 on the "C" scale and they are soft. Detonation, pinging, gas or water hydraulicing, and over revving your engine will cause the rods to bend. Now examine your block for apparent wear, scratches and cracks. If you are going to use the same cam and lifters, put the lifters in a box with dividers or cut X's in a piece of cardboard and number each lifter to each respective cam lobe from front to rear. Examine the cam for pits on the nose, scuffing or just excessive wear, replace if needed. Check the bottom of the lifters with a straight edge. If they are flat or concave they are no good. They must be convex so you can see light under each side of the lifter face with a crown in the middle. Use a straight edge and lay it up right front to rear in the main bearing saddles of the block. If this is flat front to rear use a feeler gauge to check, the line bore is probably okay. Another way to check this is after the rods and pistons are removed, see if the crankshaft turns freely in the engine. Now it is time to load up your parts and take them to the machine shop for cleaning and general checking of all your parts to see if they are free of cracks and can be rebuilt, rebored or reground.

CYLINDER HEADS

Oldsmobile cylinder heads are unlike Chevy and Ford and take special care and tools to perform a good lasting valve job. The Olds engine has a non-adjustable valve train. Valve stem heights are very critical so you can obtain the correct lifter pre-load for your hydraulic camshaft. The installation of the hardened exhaust valve seats and K-line bronze valve guide liners also require careful machining and clearances. The aid of our catalog and technical manual will greatly help you and your machinist to choose the correct parts and proper machining procedures to prepare your heads. The use of our HG-455 valve stem height gauge is a must to do a correct Oldsmobile valve job. After your machinist has hot tanked, bead blasted and magnafluxed your heads he will be ready to start the reconditioning process. If you have a small block 1964 to 1972 with number 1 through 7a heads on it they will need hardened exhaust seats installed. If you have a big block 1965 to 1971 with letters A-B-C-D-E-F-H these will also require hardened exhaust seats. All other small block and big block heads already have either replaceable or induction heat treated seats and don't require replacement. When your machinist needs to replace your exhaust valve seats make sure he does not install small block Chevy exhaust seats or any seats thicker than .210. All Mondello exhaust seats are .187 thick and work very well. If an exhaust seat is thicker than .215 it is very likely you will hit water in your cylinder heads. A good quality exhaust seat like Lee-Alloy, Martite, Martin Wells, etc. is recommended. Mondello valve seats are available in two sizes and

are Martite alloy. If you are installing oversized valves or replaceable valve seats make sure your valve seat heights are machined at the factory heights in the combustion chambers.

This is usually something most machine shops overlook, but it is very critical when trying to obtain proper valve stem lengths, which ends up allowing you to achieve the correct lifter pre-load. The use of the HG-455 is very handy when trying to achieve these measurements. The installation of valve guides in Oldsmobiles or rebuilding stock valve guides need special machining clearances. Nearly all Olds heads have a dual heat cross over passage for stock automatic chokes and tremendous heat generation is created in these center exhaust ports. Cylinders number 3,5,4 and 6 are the big troublemakers. If the exhaust valve guide clearances are set up too tight, the exhaust valves especially the center ones will stick. They will not stick enough to gaul the stems, but enough especially above 180-degrees to cause severe damage to camshaft lobes, eventually causing permanent cam lobe damage. The valve guide clearances on all Olds heads with knurled, cast iron, steel, bronze, K-liners or factory stock integral guides are as follows; intake valve guide clearance .0015 to .002. Exhaust valve guide clearance .002 to .0025. Do not let your machinist set your valve guides up any tighter than this or they will stick. The valve guide of my choice is a bronze bullet liner by K-Line. The valve seat angles and seat widths are important for performance and added longevity. Oldsmobile heads usually have 45-degree valve seat angles with a few exceptions that are 30-degree. Most 455-4 barrel heads have 30-degree intake seats, 1972 and 1973 G heads have a 30-degree exhaust seat and a few small-block heads (1972 and later) have 30-degree exhaust seats. In the late sixties we changed the 455 Olds intake valve seats from 30-degree to 45-degree and gained 8-10 horsepower. I prefer 45-degree valve seat angles over 30-degree, regardless of opinions saying 30-degree is a better low lift flowing valve seat angle. Overall we have made more streetable and performance horsepower with 45-degree valve seat angles. I like 45-degree valve seats and valve angles for both intake and exhaust. The valve seat angles and the valve seat widths are as follows: I like the valve face width to be .010 to .015 wider than the valve seat width in the cylinder head. You should undercut the intake valves between 18-degrees and 24-degrees and the exhaust valves 15-degrees to 26-degrees and this will depend on the valve shape and radius under the head of the valve. The intake valve seat width in the head should be .050 to .065 and the exhaust seat width .060 to .080. I like on both intake and exhaust valve seats in the head to have the following angles: 33-degree to p cut, 45-degree primary cut, 58-degree undercut, 70-degree bottom cut. The top cut and the undercuts can be changed depending on chamber shapes and valve bowl shapes. I like 45-degree angles on the valves also, I do not like or use interference angles. I always recommend the replacement of any valve stem that is worn top to bottom more than a .0005. Oldsmobile has made several different length valves depending on the year. These different valve lengths can get you into a lot of trouble when trying to achieve correct valve stem lengths. Our catalog and tech manual have valve charts and correct stem lengths. Always measure the valves that come out of your heads and replace them with the correct length. The use of positive type rubber or Teflon valve seals are recommended, umbrella seals are okay, but I do not like or use them. Always replace your valve keepers-locks when doing a valve job. Your valve springs should match your camshaft design. I like 90 to 125 pounds of seat pressure and 275 to 330 pounds of open seat pressure. These pressures will work with all factory or stock replacement camshafts. Always resurface your heads for a good gasket seal and thoroughly wash and scrub your heads and all parts before final assembly. If you happen to be a victim of a bad valve job and cannot obtain the correct lifter pre-load, we have lots of adjustable remedies. Adjustable pushrods, rocker pivots and rocker arms.

BLOCK PREPARATION

The preparation of your engine block is very important and a well-machined block will mean a long lasting engine that will give you many miles of performance and enjoyment. Your block by now should be cleaned, magnafluxed, all bolt holes tapped clean, plus all head bolt and main bolt-holes need to be bottom tapped. If you have a low mileage 50K or less engine it is likely you might get by with just honing the stock size cylinder bores and using your old pistons. As long as you do not have more than

.0025 to .003 piston to wall clearance after honing you can use your stock piston set up. I recommend file fit rings especially in this situation because stock end gap rings tend to have too much end gap clearance. A zero gap ring like Childs & Albert or Total-Seal also works great on performance or stock rebuilt street engines. If you need to overbore and hone your engine, make sure the machinist has the pistons for your engine, before he starts his machine work. I know a lot of guys who call me and say I just had my block bored .030 over and I need a set of pistons. Odds are the pistons will probably be too tight in the cylinder bores, especially if they are forged T.R.W., Speed-Pro, Arias, etc.. I recommend .003 to .0035 on T.R.W. or Speed-Pro forged and .0045 to .005 on Arias forged Silicon pistons. On all cast pistons, even hypereutectic .002 to .0025 is recommended. We are allowing a little extra piston to wall clearance because of today's unleaded gasoline. I even like a little more ring end gap, of course unleaded fuel, plus we have found out that the ring pressures between the top and second and second and oil rings is much better, giving you better oil control and compression. I only use these ring end gaps for standard type rings, not zero gap. Top ring .018 to .022, second ring .024 to .028, oil ring chromed rails ideal is .020 to .025, acceptable .020 to .050 clearance. As I mentioned earlier, be sure to save your oil galley plugs. Usually on Oldsmobile's that have not been abused the main saddles (line bore) is usually okay. If you have to get your block aligned, honed or line bored make sure you check the center-to-center distance between your crankshaft and camshaft. This is very important to assure you of choosing the correct length timing chain set. We have .005-.010 and .015 undersize Cloyes True Roller chain sets if you run into a problem. All of these specs and checking procedures are found in my Technical Reference Manual. The next very important part of your engine preparation is the deck surface. Always make sure there are no dings, scratches, excessive water pitting in the water jackets, etc. Olds blocks are usually pretty square and parallel to the main line housing bore. If you are building a performance engine, I do recommend assembling the short block, measuring all four corners 1 and 7 and 2 and 8, then square cutting the block so the pistons are .005 to .010 below the deck surface of your block for a good gasket seal. Do not sand the deck if you get it resurfaced at the machine shop.

Once you have the cylinders done, honed or rebored, the main line checked and or align honed, the deck surface cleaned or resurfaced it is time to check other areas of the block that may need attention. The front of the block where the camshaft turns against sometimes gets badly worn. I have three bearing bronze spacers to repair this problem and they come in .041-.085 and .125 thick. I have sold hundreds of these to Olds dealers to save customers blocks over the past 35 years. I make a thrust button kit that will eliminate this from happening and it contains a cam spacer, crank spacer and thrust button that rides against the front cover eliminating the cam from moving back and forth in the engine. If your block is worn measure the depth of the wear and give us a call, our spacer will fit in the worn spot without any needed machine work. The stock main and head bolts especially if they have been retorqued a few times become stretched. If your bolts will not accept the correct torque replace them with OEM bolts if you can find them, or we have a complete selection of ARP aftermarket head and main bolt kits. If you have any stretched accessory bolts (these are the ones that have a fine threaded area on the top of them), they are nearly impossible to find. We do have some new and used OEM accessory bolts. I recommend you purchase a block brush cleaning kit, Mondello, Milodon, Mr. Gasket and Moroso have them, so you can clean every bolt hole, oil galley crevice, cylinder bore, etc., before final block assembly. I recommend a clean solvent first then Simple Green or Castrol Super Clean, use hot water with any soapy cleaning agent, rinse with clean hot water and blow air dry. Do not use rags or towels, because they will leave lint behind that can stick the bypass check valve in your oil pump or oil filter housing adapter. Once the block is clean and dry use a light film of automatic transmission oil in the cylinder bores and spray a light film of WD-40 on the deck and main line housing bores. Now remember the plugs I told you to save, install them in the front oil galleys using 3H Aviation permatex or Locktite lock and seal. In the rear of the block on the left oil galley inside the block you must install a 3/8" pipe plug with a .040 hole in it. If this plug does not have a hole in it you will wear out your cam and distributor gear. If this plug gets lost (the stock one has a 5/16 square female socket and a .040 hole in it) we have one, part number PP-40. Install your soft plugs (freeze plugs) using 3H Aviation permatex, install the rear 3/8 outside pipe plug

(no hole) and the 29/32 cup freeze plug, left side. If your engine builder or machine shop installs this 29/32 freeze plug, make sure there is a 3/8 pipe plug with a .040 hole in it screwed into the block. This may sound repetitious, but I have a lot of customers who phone me with real low or no oil pressure, guess what, their Chevy machinist, which most of them are, left the plug out. Install the 5/16 cylinder block deck dowel pins and you are now ready to assemble your short block.

SHORT BLOCK ASSEMBLY

We now have a nice clean well-machined engine block to go ahead and start preparing our parts and pieces for final assembly. Your reciprocating assembly crank, rods and pistons should be cleaned and set on a workbench on clean newspaper ready for final assembly. Always make sure that you have run your brush cleaning kit through all of the crankshaft oil holes – using clean solvent – then washing with hot water and Simple Green, then rinsing with clear hot water and blow air dry the parts. Do not use rags or paper towels. Remove all burrs, scratches, sharp edges, etc. from all connecting rods, surfaces, piston skirts, tops of pistons, etc. Use a deburring knife, 600 grit wet and dry sandpaper in a clean solvent bath and then go over all the deburred parts with very fine Scotch Brite or Brite Rite from Standard Abrasives. Always use the same final cleaning procedures. Install the pistons upside down in the clean cylinder bore and using a feeler gauge, measure the skirt clearance between the wrist pin and the bottom of the piston skirt. You should follow the piston clearances that we recommended earlier on. The connecting rod side clearance should have been checked by now, either by you or the machine shop machinist when he did your connecting rod resizing and preparation. A good connecting rod side clearance for a stock engine is .008 to .014. If you are going to build a street strip engine use .016 to .022 connecting rod side clearances. If you have inside and outside micrometers you should use them to check all of your engine clearances. If you do not have micrometers you must use feeler gauges and plasti-gauge to check your clearances. Clean the main bearing shells and install the main bearings in the block with a very light film of light-weight oil – 10-30, Marvel Mystery Oil, etc. Then install the crankshaft. Install a small piece of plasti-gauge on top of each main journal, and then install the main caps with the main bearings installed with a light film of oil. Oil main cap bolts or studs and torque the fasteners to the recommended torque values. Do not turn the crankshaft during this test procedure. Carefully remove all main caps using a hard rubber or brass hammer, tapping on each side of the main cap, until they come loose from the block registers. On the number 5 main (rear main) use a puller like our DSP-109 or any puller with a 3/8 coarse male end and a slide hammer. Measure and record all clearances. Reinstall no. 1 and 5 main caps with bearings installed so you can now check your rod bearing clearances with plasti-gauge. Also at this time check your rod side clearance measurement when both rods are bolted together on their proper crankshaft journal. When checking rod bearing clearance with plasti-gauge, use a light film of oil and install the plasti-gauge on the bearing that is in the rod, not the cap. Install the rod and piston very carefully, not causing the plasti-gauge to crush before the rod cap is torqued to the recommended torque values. Always install two rods on the crank journal before checking rod bearing clearances. Use a screwdriver, pry bar or wedge to hold rods apart on the crank throw, before torqueing to final recommended torque values. If you do not do it this way the rods will rock back and forth giving you an inaccurate clearance measurement. Only do two rods at a time. Loosen the rod nuts and gently tap on the nuts until the rod bolts come loose in the cap, then remove the cap, the piston and rod from the engine to check the bearing clearance by measuring the plasti-gauge width. After the clearances are checked on all the rods, install the center thrust bearing and torque to 25 lbs., tap on each end of the crank with a heavy brass or hard rubber hammer. Use a small piece of wood and a metal hammer if this is all you have to center the thrust bearing. Increase the torque in 25 lb. Increments until you reach the recommended torque values, tapping the crank back and forth with each torque increase. Using a pry bar, pry the crankshaft forward in the engine and measure the clearance (with a feeler gauge) between the crankshaft and the bearing and record the clearance. The clearance should be between .004 and.010. When you do your final assembly repeat this procedure torqueing all the caps in 25 lb. increments, until recommended torque valves are achieved. If you do not center the thrust bearing in an engine, premature crankshaft failure may occur. After all the

clearances are checked deburr all bearings with a deburring knife, sand all surfaces lightly with 600 grit wet and dry and then use very fine Scotch-Brite or Brite-Rite in a solvent bath. After cleaning with solvent, blow air dry the bearings. I mentioned before about the choice of piston rings, recommended end gaps for unleaded fuel and not to use cast iron rings with today's unleaded gasoline. Sealed Power and Speed Pro have a real good ring selection of cast moly and plasma moly ductile ring sets. We offer a great selection of all types of rings in the Mondello Olds Catalog. You can now obtain from Speed Pro a plasma moly ductile ring set in standard gap so ring end gapping is really a thing of the past. If you have to file fit your rings, Sealed Power makes a ring filer, part number MT-135-C, and Mondello also has one, part number RF-102. If you are using a stock bore with stock pistons and your bore size and piston clearance is marginal, I recommend you use an oversize ring set and file fit your rings to fit your application. Always check ring end gaps in your cylinder bores before installing the piston and ring combination. When the rings come out of the box there is a very sharp edge where the ring gap is. Use a little fine hand stone or Mondello RS-103 ring deburring stone to remove this sharp edge. Once your rings are end gapped and deburred with a stone, clean them in clean solvent and air dry. Install them on the pistons using a light film of oil between the ring grooves and the rings; do not put oil on the face of the rings. Install the top ring on the right bank No. 2-4-6-8 with the piston arrow facing forward at 8 o'clock, second ring at 4 o'clock, the oil expander at 6 o'clock, the bottom oil rail at 9 o'clock, and the top oil rail at 3 o'clock. On the left bank of the engine cylinders No. 1-3-5-7 install the top ring with the piston arrow pointing forward at 10 o'clock, the second ring at 2 o'clock, and the oil rings the same as the right bank. Now we are ready to assemble our short block. Make sure the cam bearings are in the block, your block is clean and the cylinder bores are coated with automatic transmission oil. The first thing we install is the crankshaft rear main seal in the block. If you are using a factory rope seal, make sure you have a factory tool to tap it firmly in the block and rear main cap, or get a piece of PVC plastic pipe the size of your crankshaft main journal and pack it tightly into the block and rear main cap. Always trim off the excess ends flush with block and main cap with a new sharp single edge razor blade. If you are using a neoprene rear main seal, leave one side of the seal higher than the block surface – about ¼" – and do the same in the rear main cap. Use Permatex 3H Aviation sealer on the backside of either seal and coat the edges where the seal ends come together. I always use a little dab of Permatex 3H between the edge of the seal and the back of the block on the rear main cap for a double precaution against leaks. Install the clean main bearings in the block, use a good engine assembly lube – Pro-Long, Torco MPZ, HRL, Pro-Blend, Childs & Albert, etc. on all moving internal engine parts. Make sure to lube the thrust sides of your thrust-bearing surface. After all the bearings are coated with lube, install your clean crankshaft and all of your main caps and bearings coated with assembly lube. Install your oiled main bolts, nuts, washers, etc. and torque in sequence as mentioned earlier in this article while adjusting and centering your thrust bearing. Once your main caps are torqued to recommended torque values, you are now ready to install your rod and piston assemblies. Always install rod bolt boots, so you won't nick the crankshaft and make sure all the ring end gaps are lined up in the proper order. On all early engines with rod bearing squirt holes, these should be installed with the squirt holes facing the opposite cylinders and camshaft. On all 1964 or later small block or big block engines with or without squirt holes, install the connecting rod with the bearing tangs towards the camshaft only. Install the rod bearing in the rod and install the ring compressor around the pistons and rings. Apply a coat of engine assembly lube on the skirt of the piston; lube the rod bearing and rod bolts; install the rod bolt boots, then install the piston with the arrows pointing forward. At this time only, hand-tighten the rod nuts. Do not torque to final torque values. Next, install the camshaft; lubricate all journals and cam lobes; install the timing chain set; line up the dots on the cam gear and crankshaft gear. Most people think that when Number 1 Cylinder is at top dead center compression, the dots on the timing gears line up; this is not true. When Number 6 Cylinder is at top dead center, the marks line up with the cam gear dot at 6 p.m. and the crankshaft gear dot at 12 p.m. We have a brush cleaning kit, part number BK-130; an engine assembly kit with assembly lube, rod bolts, wet and dry, Scotch-Brite, etc., part number AK-140, and an engine sealant kit with Permatex Aviation 3H sealer, part number SK-300.

SHORTBLOCK ASSEMBLY

The installation of your camshaft, timing chain set and cam retention parts is very important for power and torque. The camshaft is the heart of your engine and if it isn't installed properly, the whole engine will run sour. Camshaft degreeing is the one most important thing you can do to your engine. If you install your camshaft and use an inexpensive "stock-type" timing chain or a cheap brand roller timing chain set and you don't degree your camshaft, odds are it will usually be too far advance or retarded. As you have probably noticed, I only recommend Cloyes "True Roller" timing chain sets, because of their extremely accurate timing marks and cam timing events. Regardless of whose timing chain set you use, I still recommend that you properly degree your camshaft. I will be supplying you a step-by-step method of how to degree your camshaft in this article. The retention of your camshaft is very important and most of the time, overlooked. If your camshaft can move back and forth in your engine, you are losing power. When your camshaft moves forward, your ignition timing becomes retarded, which makes your engine run sluggish. When installing your cam, make sure it turns freely in the cam bearings before applying the break-in cam lube. After you check, and everything fits well, apply cam lube, install your camshaft and timing chain set, lining up the zero marks on your timing gears. The crankshaft gear zero mark should be at 12:00 p.m. and the camshaft gear zero mark should be at 6:00 p.m. with No. 6 cylinder at top dead center compression stroke. If you are going to degree your camshaft, now is the time to do it, if not, make sure the timing gear zero marks are lined up and your timing chain set is well lubricated.

CAMSHAFT DEGREEING

To realize the maximum potential of the camshaft in your engine, it must be degreed in order to compensate for machining errors in the camshaft or timing chain set. Valve timing is one of the most important tuning procedures to increase horsepower. In order to properly degree your camshaft follow the steps below:

1. Turn the engine to TDC (Top Dead Center). The No. 1 cylinder should be at top dead center compression stroke.

2. Install the camshaft and timing chain set. Align the "0" marks on the timing gears as closely as possible.

3. Bolt a degree wheel to the front of the crankshaft. Securely bolt a pointer to point to TDC (0^{o}) mark on the degree wheel. You can make one by using a welding rod, coat hanger, etc.

4. To determine TDC, install a dial indicator on the deck surface over No. 1 cylinder and turn the engine clockwise until No. 1 piston begins coming up on the compression stroke. Make sure the piston is centered in the cylinder bore the best you can while checking. Using the dial indicator, check the piston for maximum travel. When the piston is at it's highest point and the dial indicator briefly stops moving, that is TDC. Then align the TDC mark on the degree wheel with the pointer.

5. When using the piston stop method with a mechanical piston stop screwed into the spark plug hole or a piston stop strap, rotate the engine clockwise until it stops. Mark the balancer or degree wheel. Then rotate the engine counter-clockwise until it stops and place another mark on the balancer or degree wheel. The true point of TDC is the distance halfway between the two marks (shortest distance) on the balancer or degree wheel. After finding TDC, you may remove the mechanical piston stop.

6. Next, bring the engine to TDC on the compression stroke, with both valves closed and the lifters on the heel (back side) of the camshaft lobe. Insert a solid or mechanical lifter or a checking lifter bar on the No. 1 intake lobe. Then, install and zero the dial indicator on the lifter or lifter bar so that it will measure the lifter's rise.

7. Rotate the engine until the lifter begins to rise. Continue rotating the engine clockwise until the dial indicator shows the lifter at the lift the camshaft is to be checked at (usually .050", will be stated on your

camshaft's specification card). Record the position of the degree wheel, this number is the intake opening event.

8. Continue rotating the engine and record the dial indicator's maximum lift. This is the intake lobe lift of the camshaft.

9. Continue rotating the engine until the dial indicator shows the lifter dropping down to the checking height (.050" before the valve would become fully closed) and again record the position of the degree wheel. This number is the intake closing event.

10. Return the engine to TDC and re-check your TDC mark.

11. Next, move the checking lifter or lifter bar to the exhaust lobe, rotate the engine to TDC compression stroke and reset the dial indicator at zero. Check it using the same method as the intake, recording the opening, closing events and the maximum lobe lift.

12. Continue to check as many lobes as you like. You may wish to check No. 8 cylinder also to check the accuracy of your camshaft.

13. To calculate the valve lift, multiply the lobe lift by rocker arm ratio. Oldsmobile rockers are 1.6:1, so if the measure lobe lift was .340" then the valve lift would be .544" per the following equation:

.340" (lobe lift) **x 1.6** (rocker ratio) **= .544"** (valve lift)

14. To calculate the duration, add the opening event to the closing event plus 180°. An example for a JM 28-29 camshaft checked at .050" lift would be:

Measured Intake Opening 20° BTDC
Measured Intake Closing 48° ABDC

Then the duration would be: **20° + 48° + 180° = 248° @ .050"**

Measured Exhaust Opening 60° BBDC
Measured Exhaust Closing 18° ATDC

Then the duration would be: **60° + 18° + 180° = 258° @ .050"**

15. Compare these figure to your "cam card" to check the accuracy of the camshaft. In a sense, you have just created your own "cam card" with the measured values on your camshaft as it was installed in your engine with the crankshaft and timing chain set. You may also do this to get specifications for a camshaft that you bought used or don't have timing specifications for.

16. You may now wish to advance your camshaft timing, depending on your application. Advancing your camshaft 1° - 2° is preferable even for stock applications, as it will help compensate for chain stretch.

CAMSHAFT BREAK-IN NOTES

- Always use a recommended camshaft break-in lube or moly lube on your camshaft and lifters during final assembly.

- To break in a camshaft, run the engine between 1500-2000 rpm for 20-30 minutes with good oil pressure.

- Do not allow the engine to idle down during the break-in period.

- Do not rev or race the engine to high rpm's during the break-in period.

- Take extra care to properly set valve lash or lifter preload.

ASSEMBLY

After you have degreed your camshaft, your next step is to check and correct your camshaft end play. Using Gasgacinch, glue your front cover gasket to your block so you can measure your camshaft end play. Most front cover gaskets that come in a rebuild gasket set are between .010"-.015" thick, but a Mondello front cover gasket is .030" thick. We have several camshaft thrust buttons, cam spacers and crankshaft spacers available to eliminate all camshaft movement. Our most popular camshaft thrust button is our TB-745, which is used when no front block wear is present and you are using a replacement timing chain set, not a Cloyes "Hex-Adjust" timing chain set. If your have any block wear, where the camshaft rides on the block, then use our CS-120 cam spacer with a TB-740 camshaft thrust button and our CS-40 crankshaft gear spacer. This will not fit a Cloyes "Hex-Adjust". Phone our technical support line when using a Cloyes "Hex-Adjust" or obtain a Mondello Catalog. All of our camshaft retention parts are made to be used with a Mondello .030" thick front cover gasket. If you do not use our front cover gasket, Minor sanding or machining of the thrust button or camshaft bolt may be necessary. Install and torque your cam bolt thrust button and measure with a carpenter's square or straight edge, using a feeler gauge to check the clearance between the straight edge and the front face of the thrust button. The best clearance is 0-.010" with .015" being the maximum. Once this is finished, use a good grade Loctite on the bolt and torque to 65 ft. lbs. Lube all parts and install your front timing cover, using the correct sealants. The next step is to mount your oil pump, oil pump driveshaft, windage tray and oil pump pickup tube. If you are using our PB-300 oil pan baffle, bolt that in place. Install (not permanently) the oil pan gasket on the block. Using an adjustable carpenter's square, measure from the bottom of the oil pump pickup tube screen to the oil pan gasket and record this measurement. After this measurement, using the adjustable carpenter's square, measure from the oil pan gasket surface on the oil pan to the bottom of the pan where pickup tube would be located and record this measurement. Subtract the first measurement from the second measurement and that will show you the clearance between the oil pump pickup tube and the bottom of the oil pan. I like this measurement to be between .200"-.400" or in layman's terms, 1/4 – 3/8". Rotate your engine assembly and make sure your crankshaft counterweights, connecting rod bolts, and nuts clear your oil pump housing and windage tray. After you have checked all clearances, make sure your oil pan clears everything and your dipstick indicator slides in without hitting anything. You are now ready to seal up and install your oil pan. Refer to the Mondello Technical Manual for proper sealing procedures.

FINAL ENGINE ASSEMBLY

We are now going to install the cylinder heads. Make sure the block and head surfaces are clean and free of all oil, lint or anything that could make your head gaskets not seal properly. Most head gaskets supplied today have their own sealing compound on them right out of the package. On Fel-Pro Blue head gaskets, I still recommend the use of VHT SP-21 Copper Gasket Sealer, especially in a marine application. Your Olds head bolts do not screw into water jackets, so there is no need to use a sealant on the threads. I do recommend a good grade racing oil or moly lube that is usually supplied by the fastener manufacturer. The cylinder head water jackets need to be blown out thoroughly to remove any dust, dirt or rust scales. If your water jackets have a lot of debris still left in them, use some shaving cream (Gillette Foamy is the best) and fill the water jacket holes on the head surface before installing the heads. Install the heads now and hand tighten your head bolts or studs. Following the bolt torque sequence in the Mondello Technical Manual. Start torque at 40 ft. lbs., increasing torque in 20 ft. lb. increments per sequence until the final torque is reached. If these are new bolts or studs, they must be torque cycled a total of 3 times. To properly torque cycle your fasteners, torque them to final recommended torque, then

back them off one at a time and re-torque two more times. This allows the fastener to obtain its maximum stretch and clamping force for a better head gasket seal. Once the heads are on, you are now ready to install your valve train parts, pushrods, rockers, rocker pivots, rocker balls, studs, guide plates, etc. It is always easier to check pushrod clearance and adjust the lifter pre-load without the intake manifold installed. Check and adjust your lifter pre-load, pushrod clearances, rocker arm geometry and valve spring coil bind before final lubrication of your parts for final assembly. After everything has been checked and it fits properly, then you can adjust and set the lifter pre-load. When you are checking all of your clearances, make sure your rocker arms will clear the inside oil baffles of your valve covers. Remember one thing, hydraulic lifters, without oil, will bleed down approximately 3/16". You will need to use a mechanical lifter for this checking procedure, or oil prime your engine so the hydraulic lifters will become pumped up. This can be a real surprise if you think you have lots of clearance until your lifters pump up and your rocker arms hit your valve covers.

The next thing is to make sure your intake manifold gaskets and bolts fit before applying sealant to your gaskets. If you are using a "turkey tray" bathtub gasket or a windage tray, check all clearances, especially pushrods and the bottom of your intake for areas of contact. I recommend that you install all the bolts and hand tighten them to make sure they all fit properly and are not too long, especially when using aftermarket bolts. Once everything fits properly, remove the intake manifold, then trim and properly fit the gaskets to all of the intake ports and water jackets. Refer to the Mondello Technical Manual for proper torque specifications and sealing instructions. There is only one proper way to seal an Olds intake manifold, make sure you have installed them in their proper position. I have always recommended that you glue the valve cover gasket to the valve cover with 3M Yellow contact cement or any good contact cement to hold them securely to the valve cover. I like to apply a thin layer of DC-86 Dow Corning Silicone on the valve cover gasket surface. Allow these sealants to cure for 24 hours. The use of valve cover studs or washer headed bolts work best for proper clamping pressure. Do not ever tighten your valve covers, especially when using cork gaskets. Always oil-prime your engine with our oil primer tool No. OP-100. While you are oil priming the engine, rotate the engine 90° every 15 seconds until you see oil coming out of all of the pushrods and rocker arms. Always use a good racing oil and E.O.S. (Engine Oil Supplement) from any GM dealer for proper lubrication and camshaft break-in. **DO NOT USE NON-DETERGENT OIL, it will cause premature camshaft and lifter damage.** If you haven't by now installed all of your accessories (carburetor, exhaust manifolds, headers, water pump, distributor, power steering, air conditioning compressor, brackets, etc.) do so now. Make sure all your fluids are full: water, oil, transmission, etc. and your distributor is installed at cylinder No. 1 TDC, gasoline in the tank. Start your engine, set the timing and run the engine at a constant rpm between 1800-2000 rpm for 20 minutes. Do not allow the engine to idle and do not vary the engine rpm during this procedure. Well guys & gals, I hope I have got you going in the right direction by sharing with you some of my 40+ years of experience and tricks to help you build an engine better than the average bear.