Guide to a PROFESSIONAL RING JOB

By Jim McFarland

FOLLOW THESE EXPERT TIPS FOR THE BEST RESULTS FROM YOUR NEXT RING JOB.

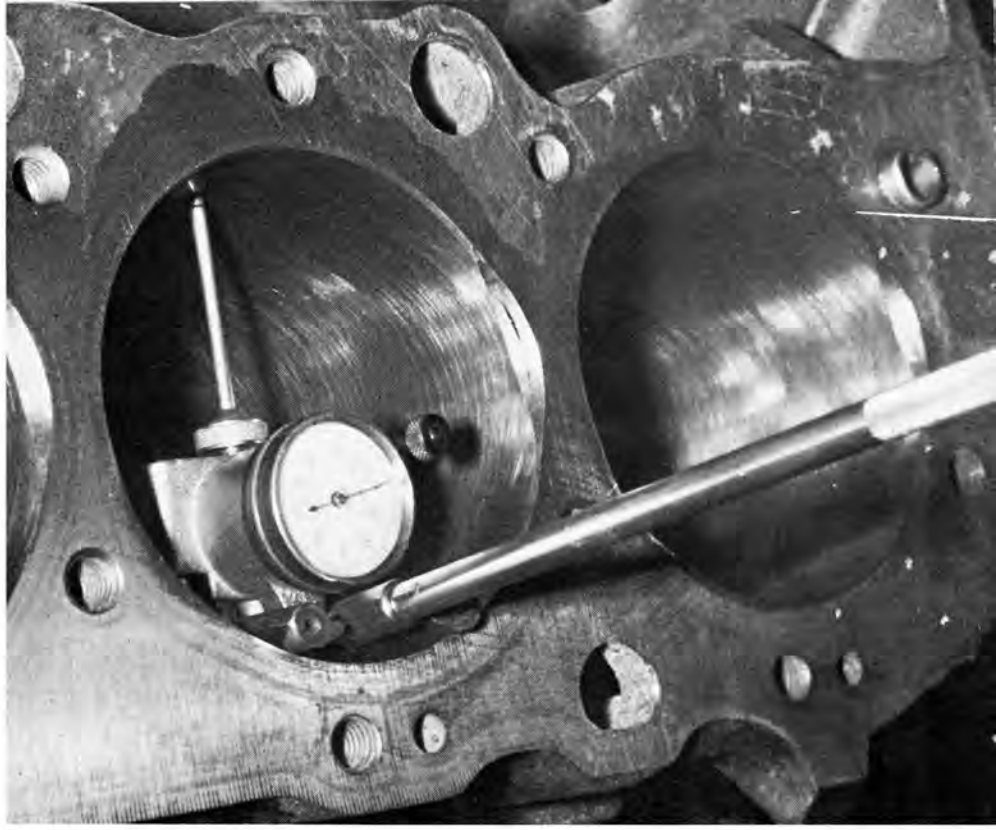
"Where there's smoke, there's fire," we've been told for more years than we'd like to remember. But when it comes to an automobile engine and the emission of billowy puffs through the exhaust pipe, it's frequently more appropriate that "where there's smoke, there's a ring job needed." It's our intention to provide some insight into the process of piston ring replacement, but we'll also discuss some other possible contributors to the "heap big smoke" / high oil consumption situation.

Let's point out first of all that a healthy engine is *supposed* to consume some oil. Tests indicate that an efficient engine will use as much as a half-quart per 1500 miles, the amount being dependent on the extent and severity of use. When performance equipment and its attending clearance alterations are added, oil consumption will normally increase. It's important to determine what's "normal" in the way of oil consumption for a given engine over a period of time. It's consumption *above* that level which can indicate unhealthy engine operating conditions requiring a ring job or other engine work.

Before proceeding with the step-by-step method of replacing a worn set of rings, let's discuss some of the other "gremlins" that increase expenditures for engine oil. Worn bearings can permit excessive oil to collect on cylinder walls. Valve guide/stem clearances that are greater than they should be also lead to that unwanted volume of oil. Even the dipstick can't be considered an infallible guide to oil quantity at a given time, for fuel may be mixed with oil if the diaphragm of the fuel pump has ruptured. In such situations the dipstick may register relatively constant levels of "oil" incorrectly.

Now about that ring job. First step is to drain oil and water from the engine. Block drain plugs should also be removed. We hope you thought to move the car out of the working area before pulling all the plugs—otherwise, you've undertaken a floor-mopping job as well as a ring job. Exterior pieces which stand between you and the inner engine components have to come off. We'll tell you how to hook 'em back up later on. Tie-rods and other front-end pieces may need to be disconnected in order to remove the oil pan. If working room is at a premium, it may be simplest to remove the engine from its compartment.

With the heads and oil pan removed, take a short breather and clean the gasket surfaces. Granted, this could be done later, but it's best to go ahead and do it first off. We don't want to take any chances when it comes to the possibility of depositing gasket particles and accompanying residue into cylinders that have just been fitted with cleaned pistons and



Overall cylinder wear (taper) can be checked by use of direct-read dial indicator or by snap-gauging and micrometer measurement. Take measurements at top and bottom of cylinder at points 90 degrees from installed piston pin axis.

new rings. Incidentally, while the heads are off, give some thought to any head or valve work which might be needed. Now's an opportune time.

With the old gaskets out of the way, wipe off excessive lube and remove the ridges at the top of each cylinder. These protrusions are the result of normal cylinder wear but they should be carefully cut away just below the ridges (don't cut beyond the bore diameter). This procedure is vitally important; otherwise, a ring land can be cracked or broken as the piston/ring unit is driven out or that the new ring will slam into such a ridge at the time the engine is fired up again. The carbon buildup won't be difficult to remove, but the metal shoulder underneath will probably require use of a ridge reamer. This task can be handled at your local machine shop if you don't have access to a ridge reamer. If a cylinder bore job is part of your plan, the boring bar will also take care of the ridges.

Crawl under the car now and check rods and rod caps for numbering or mark them if they aren't already marked. Check rod position (which one is in which cylinder), pin offset or the direction each is facing (front or rear of engine). Write down the pattern on a slip of paper. Piston tops are frequently marked to assist in the keeping-straight process.

Let's get back to the take-apart procedure. Remove a rod cap and both halves of the bearing, put a short piece of hose (windshield wiper hose or other similar size big enough to cover threads) over each rod bolt and tap the rod assembly out the top of the block. The hose pieces will protect bolt threads and crank bearing surfaces. Any accidental nicks should be polished with some crank cloth. Removal of the rod assemblies should be done carefully; deep gashes in crank bearing metal will require a machinist's services. Bearing halves should be wiped clean and placed in order of engine location to one side until time to reassemble the engine.

Pistons and rods should now be scrubbed and checked. Mac's parts solvent (No. 9006) is recommended for hot tank cleaning and is preferable

Ring installation is more critical than you might think. Use of a ring expander is highly recommended, since "twisting" or "spiraling" the rings into position can cause permanent warpage or "set" in the operating ring.

Removal of cylinder material just above maximum travel point of top ring is called ridge-reaming. Driving pistons out of worn cylinders (before ridge removal) can cause rings and ring lands to be cracked or chipped.

to wire brush scrubbing. Aluminum-alloyed pistons shouldn't be put in strong alkaline cleaning solvents.

Ring bearing surfaces (areas of contact with cylinder wall) should be shiny throughout the circumference. Major and minor thrust areas of the pistons should be a grayish color. Any variation in color from this gray tone usually indicates improper skirt contact with cylinder walls. Knurling is recommended to bring piston skirts up to proper clearances. The knurl grooves carry oil to cylinder walls during the ring break-in period. During normal engine operation, ring lands won't come into contact with cylinder walls, but abnormally high combustion temperatures and excessive piston wobble can smear piston metal into ring land areas. If damage isn't too severe, a lathe and attending equipment can be used to increase the width of ring grooves before installing spacer rings. These spacers fill the gaps which result from groove dressing; they're positioned above the rings.

Staggering of ring end-gaps is also important, usually involving a separation angle of 45-50 degrees (on one of the piston's thrust sides).

Addition of extra ring expander stock (under compression) rings is a performance-type trick designed to further aid high cylinder pressure seal.

Oil drain holes in ring grooves can be cleaned quite readily with a drill bit (just the bit, not by using the drill apparatus). The bit should be rotated gently by hand. Residue should be removed afterward by a solvent bath. A commercial groove-cleaning tool is best used for ring groove cleaning, although some mechanics have made their own tool by saving a ring from each groove in a piston and grinding them carefully to produce a hand tool. The groove-cleaning process is a delicate one: *only* carbon deposits and other combustion by-products should be removed, not metal surface. We feel the commercial tool facilitates this process more reliably.

High cylinder pressures exert tremendous force on piston metal; therefore, pistons should be thoroughly checked for cracks around pin bosses, in grooves, and on ring lands. Two methods of removing any doubt about cracks are Magnafluxing and Zygloing. Don't try to save money by keeping a "slightly cracked" piston; in the long run it'll cost more.

The target for our next attention is the cylinder. Dark spots in the ring travel area will reveal any one of the following undesirable conditions: plugged or partly blocked area in the water jacket of the block, improperly torqued main bearing cap bolts or unevenly tightened cylinder head bolts. Check carefully for any such spots and remedy the situation. Deep scratches in cylinder walls must be smoothed out. A minor bore job may be required. Excessive oil consumption is what we're trying to eliminate, and major scratches in cylinder walls will allow oil blow-by even after new rings have been installed.

Cylinder taper must be checked next. So-called "normal" cylinder wear depends on rod/crank relationship, time, piston wobble and/or thrust characteristics under combustion pressures. The diameter will therefore vary over the length of piston travel, and taper must be checked to make sure the cylinder will help maintain a satisfactory ring seal Measurements should be taken at right angles to the crankshaft axis of rotation: one at the lowest and one at the highest point of ring travel. The difference between the bottom and top readings is the amount of taper, and the tolerable limit is .010-inch. Greater deviations may produce inadequate ring seal. It's also a good idea to use a micrometer to determine the original bore size. Measure the circumference of the bore below the area of ring travel and the variance in bore diameter as the result of wear (taking readings within ring travel). Cylinder

enlargement of .012-.015-inch necessitates repair work by boring. Check with a machine shop.

There are a number of currently popular methods of cylinder bore finishing. There are some rules of thumb, regardless of method, and we'll try to cover the basic ones. *Never* dry-hone a cylinder. Kerosene or some commercial cutting fluid must *always* be used. The cutting stone should be saturated and particles flushed from cylinder walls throughout the honing process. A medium (200 grit) grade hone stone, an electric drill with 3/8 or ½-inch chuck and cutting fluid should be used to break the glaze on cylinder walls. Once the walls have a consistent, shiny appearance, the finish cut can be made.

Opinion differs in this area of finish cutting. The tiny scratches left in the surface will usually create a mild abrasive action that helps in conforming ring faces to the cylinder wall surface. Small amounts of oil are also held in the minute scratches; the oil prevents overheating and seizure of rings during the seating process. A cutting stone of around 400 grit, cutting fluid and a drill are needed. With a hone rotational speed of 750-800 rpm, pass the cutting apparatus up and down the cylinder at about 25-30 cycles per minute to produce a crosshatch pattern of the proper micro finish. Some advocate use of a stone grit of 180, an rpm of 450 or less and running the tool through the cylinder at about 70 cycles per minute. A commercial cutting oil should be used for this method; check at your automotive parts house. Crosshatch patterns averaging 30 degrees at the separation angle between scratches are produced by this method. Cutting speeds will vary somewhat from bore size to bore size and block to block, especially if you're working with a gray cast iron block. Aim for the 30-degree crosshatch angle pattern. After the honing process is complete, hot soapy water should be used to wash the cylinders. Gasoline or comparable solution should *not* be used, for it will embed particles of metal deeper in the walls. Let the soapy water run through the engine, then dry the cylinders with a clean cloth and apply a light coat of oil.

Now's the time to get out the new set of rings. Don't discard the package just yet. Take out a new ring, invert a piston, and use it to press the ring a half-inch or so below the top of the cylinder. This method will square the ring in the cylinder and facilitate end-gap measurement with a feeler gauge. Read the spec sheet included in the ring package and follow any

Correct cross-hatch pattern of finish-honed cylinder is largely responsible for success or failure of ring jobs. Minor angle between marks is usually 40-50 degrees, produced by both hone rpm and traverse of stones in and out of cylinder. Hot water/detergent scrub of block (following hone job) is a must.

Ring/ring groove clearance check is vital. Oil pistons (to be reused) and have excessive groove clearance corrected by machine lathe turning and the addition of spacers which bring clearance back into spec. (Not recommended for a "racing ring job".)

Oil hole routing (cleaning) in oil ring groove is easily accomplished by hand-held twist drill. Don't remove metal and enlarge drain holes.

Butt-gap (end-gap) resizing can be accomplished by careful perpendicular filing of ring ends or by use of "trick" gappers like the one shown here.

Ring groove depth is especially important for performance type ring jobs. Generally, ring manufacturers give specifications for their particular ring design. Look on the instruction sheet (if all else fails).

End-gap check is made by installing ring in cylinder (near top) and measuring with feeler (strip) gauge.

suggestions there. Additional gap will be obtained by filing ring ends squarely. If a cylinder has been bored, end gap is particularly important.

Ring installation is best accomplished by use of a brass-jawed bench vise. Wrap a rag around the rod prior to inserting in the vise if brass jaws aren't available. The piston and rod assembly should be clamped in very carefully. Exact placement in piston grooves should be determined by reading the instructions contained in the package of rings. A ring spreader is preferred to the "curl-on" method. A little oil should be squirted in each ring groove as installation proceeds. If there's a marcel in oil ring assemblies on the ring in question, it should mate on a piston's thrust side. Oil scraper ends should align alternately with piston pin bore, as should the compression rings on the upper part of the piston. Spacers should be installed on top of any rings with grooves that have been machined for such spacers. A ring compressor should be used to compress the rings after they have been staggered properly around the body of the piston and oil has been generously applied. Rings all in place? Good; let's start reassembling everything.

Using those hose sections mentioned earlier, cover the rod bolts. Use Lubriplate or a similar product to coat the rod half of the rod bearing and insert it in its proper place. Put the piston in the right direction and lower the assembly into the cylinder. The ring compressor should land on the block surface. Gently tap the piston into the cylinder, assisting the crank end of the rod to its place over the journal. If the road journal is positioned at the bottom of the piston's stroke, rods won't contact the crank before all rings are safely in the cylinder, and the whole procedure will be easier.

Look at the markings on the rod cap half of the rod bearing. Face the cap in the right direction and put it onto the rod. Next tool to be used is the torque wrench; follow poundage suggestions of your engine's maker.

The oil pump can be installed again, after all rods are connected and torqued properly. Check the fit of the new pan gasket *before* applying adhesive. Smear the adhesive on the block surface and the block side of the gasket, letting it set for a couple of minutes, then stick the gasket to the block. Following this procedure will leave you two hands for rehooking the oil pan–a somewhat tricky operation if you're struggling with a shifty gasket at the same time. Reconnect suspension members, starter and any other leftover equipment in this area.

The head surface has already been cleaned, right? Great. Now hand-crank the engine until the No. 1 piston is at top dead center (TDC) position and the No. 1 cylinder's valves are seated. If the engine in question is the OHV type, check valve lifters for seated

positions. Use a gasket sealer, then ease the head(s) into position. Bring head bolts to required tension, checking proper torquing sequence. To insure even gasket material packing, 20-30 ft.-lb. increments are usually recommended. Heads will need retorquing after the engine has been run some. Exhaust manifolding may have to be taken off when this retorquing step has to be done, but a blown gasket may well result it you omit the step. So do it!

With TDC position maintained, drop the distributor gently in the block. With whatever direction the rotor points as the No. 1 wire in the cap, plug in remaining wiring in accordance with the proper firing order. Fill the radiator, add the proper amount of engine oil and check things carefully to make sure everything's been reconnected. Remove the coil wire and turn the engine a few times to facilitate oil circulation. The first few minutes of life are critical to successful new ring operation.

Just about everyone has his own best method of breaking in a new set of rings. WE'll add ours. Once you've fired up the engine, accelerate the car in high gear on a straight, open stretch of road from 10-60 mph. Remove your foot from the accelerator and let the car return to 10 mph without use of brakes. Oil will be drawn into the area which was just washed by an overdose of fuel by cylinder pressures created during the acceleration run. Repeat this procedure a dozen or so times.

Some odds and ends related to ring jobs come to mind. We'll pass them on for what they're worth. If cylinder wear was found to be greatest near the center of ring travel, the old rings were probably too tight or received too little lubricant.

End gap checking should follow the suggestions of the ring maker. Top rings will generally run hotter than lower ones on the piston body. A gap of about .003-inch per inch of bore diameter should exist as a general rule of thumb in absence of manufacturer's instructions to the contrary. A vertical clearance of .002-.003-inch is necessary between rings and grooves. Side clearance on top rings can be as much as .005-inch without requiring spacers. A good way to detect space between cylinder walls and ring faces is to put a light bulb below a cylinder during end gap checks. The limit in this area is .0015-.002-inch. Honing is required to correct any greater deviations. Piston skirt clearances in thrust areas and toward the piston's lower section should also be checked.

After the new rings have beeen in use for a few hundred miles, get out the compression-checking equipment and check to make sure pressures are what they should be in each cylinder. This is the best means of proving all this work has been successful, 'cept of course the absence of smoke rings through the tailpipe.