Piston Rings

Piston rings are some of the least considered components of an engine. When they are doing their job, we give them no thought. When we first sense indications of a problem, we often blame it on something else.

There are generally four indications that the piston rings may be an area for serious consideration.

Blue-gray smoke emanating from the exhaust is an indication that oil is getting into the combustion chamber and burning. Granted, oil can be leaking into the combustion chamber through the valves, and that possibility has to be checked, but don't discount the piston rings.

Water in the crankcase (along with white-gray smoke from the exhaust) can mean a head gasket leak. A slight leak will minimize the amount of water getting into the combustion chamber, and it will generally burn and be exhausted as steam through the exhaust. But a larger leak will allow water to leak past bad rings and into the crankcase. Check the dip stick; if tiny bubbles show up, drain the oil from the crankcase and check for water.

(Black smoke from the exhaust normally indicates too rich a gasoline mixture. That would indicate a problem with the carburetor, electrical system or ignition timing, but not generally having anything to do with the piston rings.)

A compression test is probably the best and easiest method for locating a bad piston ring, or set of rings. A low, steady compression reading is often an indication that you have blow-by – the compression is escaping from the (supposedly) sealed compression chamber and is escaping past the rings into the crankcase. Low compression results in decreased performance, increase in gasoline consumption and smoke escaping through the blow-by exhaust valve on the engine. Check the spark plugs; if they are fouled, you probably have bad rings or valve guides.

Using a stethoscope, with the engine running at operating speed (the noise will not generally be heard at idle), a light rattling sound might indicate a broken piston ring. Use a mechanic's stethoscope or a long-shanked steel screwdriver to amplify the sound. Be very careful not to touch any moving part or a spark plug with the tip of the screwdriver or stethoscope.

Other signs of failing rings may include increased oil consumption, an oily film on the tip of the exhaust pipe or on the rear bumper or an increase in blow-by coming from the oil filler tube.

A piston may have three or more piston rings. More modern engines use three rings; older engines may have three or more. Essentially, with a new engine or an antique, the purpose of the rings is similar: compression and oil scraping. Modern engines use newer materials; materials which are not necessarily suitable to older engines. Older engines generally used cast-iron rings. Modern rings may be constructed of a range of materials and coatings. The chances are that your local auto parts store will not stock, nor even be able to order, the correct size/material piston rings for an early-car/truck application. We recommend that you contact Dave Reed at Otto Gas Engine Works. (See ad page 30 of this issue.) Dave specializes in piston rings and will most probably have available exactly what you need.

Rather than try to paraphrase the types, construction and uses of the piston rings, I have opted to quote directly from Dykes Automobile Encyclopedia (1928). (Remember, the original Dyke's article is almost 70 years old. Some information has changed in the en-

suing decades.)

A piston must be fitted with piston rings. The piston is slightly smaller than the bore of the cylinder, in order that it will not stick to the cylinder wall (termed 'seizing') when it becomes hot and expands.

The purpose of the piston ring is to fill up or seal the gap clearances between the piston and cylinder walls, preventing the gases escaping into the crank case and an excess of oil working into the combustion chamber.

As these gases are under pressure, it is necessary that the rings not only fit snugly around the cylinder wall, but in the grooves of the pistons as well; otherwise the gas and oil work through behind the rings.

Since the rings are softer than the cylinder walls against which they are tightly pressed, and also present small wearing surfaces, they become undersize in time.

Piston rings also lose their pressure after long use and cease to press against the cylinder wall all around, and the compressed gases escape between cylinder wall and ring. If worn in groove, or if there is a loose fit in groove, a leak will occur around the ring.

Some piston rings are heat-treated after they are roughened out of the castings and before they are finished. (This also applies to pistons.)

To insure maximum power, together with minimum oil and gas consumption and the best all-round satisfaction, the rings should be renewed about once every 10,000 to 20,000 miles.

Ring grooves are cut in the wall of the pistons for the rings. The grooves are slightly wider than the ring. They should fit freely but without side play.

If the groove is too large, there will be a compression leak between the groove and the ring. If too narrow, the ring will stick in the groove and will not exert its pressure against the cylinder wall.

The fit of the piston ring in the ring groove is very important. If the ring has considerable up-and-down motion in the ring groove, it will shift up as the piston goes down, drawing oil under and behind the ring. It shifts down as the piston goes up, and forces the oil collected out over the top of the ring, and in this way acts as a small oil pump. Quite a lot of oil can be pumped into the combustion chamber in time. When the rings are worn the gas has an unobstructed path behind the ring.

It is important that a piston ring exert equal pressure against the cylinder wall at all points of its circumference. Right here is one of the most important duties of a piston ring. If it fails to do this, then the part of the ring which does not press against the cylinder wall is bound to permit the compressed gas to pass into the crank case and oil into the combustion chamber, causing a loss of compression, resulting in a loss of power, fouled spark plugs causing misfiring and carbon deposit.

Requirements of a piston ring: (1) permanent pressure; (2) uniform wall pressure; (3) not too much pressure to cause undue wear and friction, but enough to seal the clearance; (4) maximum flexibility; (5) oil control; (6) correct material and workmanship; (7) gas-tight at all times.

The ring gap is provided on all rings in order that it can be fitted to the piston groove and so that it can expand and exert pressure equally against the cylinder walls at all points of its circumference.

Cylinders are reamed, honed, ground, or reground as the case may be, for the purpose of making the bore round, smooth, and straight, so that an accurately machined piston ring will fit perfectly and conform to the cylinder without setting up any severe stress or strains while in operation and thus sealing the clearance between the cylinder wall and piston and holding a maximum compression.

For many years, various manufacturers have tried to make a piston ring to fit properly an out-of-round and tapered cylinder, and consequently the 'flexible type' of piston ring was originated.

Many repairmen are of the opinion that if a cylinder bore is round, smooth, and square with the base, the connecting-rods aligned and perfect ring grooves in pistons, an accurately and properly made 'one-piece-ring,' often termed a plain ring, with a 'step-

cut-joint,' will give perfect service. 'With proper lubrication (oil changed every 500 miles), such a ring under those conditions should run 10,000 to 20,000 miles.

This does not mean that only the plain one-piece ring should be used. Flexible rings of proper construction could probably be used with greater efficiency than the one-piece ring under some conditions.

Material: Piston rings are usually made of cast iron, and manufacturers have different formulae and treatment. Rings are softer than cylinder walls. The cylinder walls soon become glazed and hardened.

There are usually two or three piston rings above the piston pin (sometimes four, or even more) and quite often an oil groove is in the skirt of the piston.

The oil control ring is sometimes placed in lower ring groove and sometimes in the top.

On some engines, there are two or three piston rings above the piston pin and one oil-control ring below.

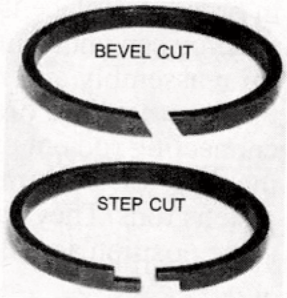
On the Ford, there are two piston rings above the piston-pin and one below. Ford rings are tapered in order to prevent an excess of oil getting to the combustion chamber.

A piston ring is not a complete circle; it is a ring of metal with a split. The metal of the ring is under spring tension. When fitted into the cylinder bore, the ends of the ring are forced toward each other, yet press against the cylinder wall. The gap ends should not touch. There has to be a gap between the ends. The gap is determined either by the correct service manual for the vehicle, or by a rule of thumb. Dyke's recommends that some manufacturers suggest a gap of between 0.002" - 0.012". Another suggestion is that the gap be dependant on ring diameter:

2" - 3"	gap clearance 0.006"
3" - 3½"	gap clearance 0.007"
3½ - 4"	gap clearance 0.008"
4" - 4½"	gap clearance 0.009"

If the gap is too small, the ends of the rings can be dressed with a fine file. Most cylinder bores are tapered - larger at the top than at the bottom. This is due to the nature of the engine, and is not uncommon. If the taper is excessive, the cylinder must be rebored. In those cases, an oversized piston and rings will have to replace the orignal parts. The machine shop that does the cylinder boring will advise the oversized parts required.

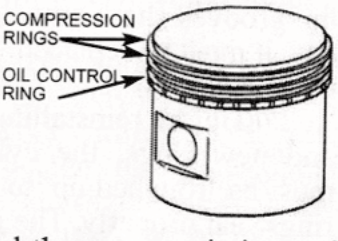
If the taper is within spec, the cylinder should be measured at the center and at the bottom of the bore. Take at least two measurements 90° from each other to check for cylinder out-of-round. If out-of-round, the block may require reboring.



Commonly there are two types of edges to the split in the rings: one type is a bevel cut; the second is a step-cut.

Removal of the pistons is not a simple job. In most cases, to access the rings, the piston and connecting rod must be removed. This means removal of the head and the oil pan. The connecting rod caps will be accessible from the bottom. Do not mix up the caps, and do not reverse them. They are fitted, through wear, to the crankshaft. Hang a sign on the steering wheel that there is no oil in the crankcase. It is a good reminder when you are ready to restart the engine.

With the piston and rod removed, the old rings can be removed, the piston cleaned, and the new rings installed.

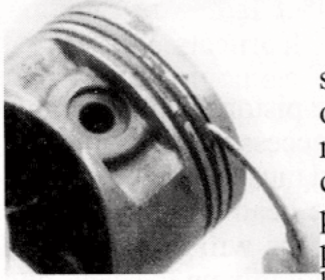


Essentially there are two types of piston rings: compression and oil scraping. There may be more than one of each type, and there are variations of each type that may be used in conjunction with each other. When you purchase a set of

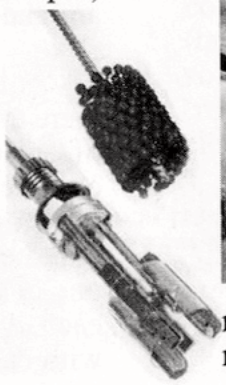
matched rings, the correct compression and oil rings will generally be included in the set. Oil rings can very a great deal. Purchasing a set of rings will generally include the correct rings.

The compression rings are generally at the top of the piston and seal the compression chamber from the piston bore and crankcase. The oil scraper rings remove the oil from the walls of the cylinder bore.

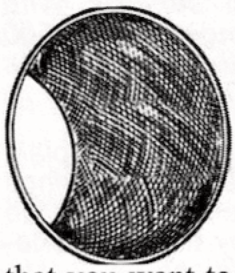
It would take a complete article to cover the variations in the removal of a piston in order to replace the rings. We will assume that you can punch mark the big ends and caps for reassembly and remove the rod caps. Set the caps aside in order. Slide the piston and connecting rod out of the bore, either through the top or bottom. Do not mix up the pistons/rods. They have to be reinstalled in the same position as removed.



Before even considering replacement of the rings, the piston must be thoroughly cleaned. Remove the piston rings from one piston. All of the baked-on carbon must be removed from the piston face (top) using a plastic scraper and chemicals. Do not use a wire brush or a wire wheel. Use a special groove cleaning tool or a broken ring to clean the grooves. All foreign material must be scraped out. Even the smallest particle remaining in the groove can cause failure in the ring. Examine the piston (and the wrist pin) for wear or damage. If the piston or the grooves show any sign of damage, it must be replaced.



Before reinstalling the piston and new rings, the cylinder bore must be 'roughed up' to let the new rings seat properly. The glaze of the cylinder has to be removed. This procedure is done with a hone. There are several types of hones. The result

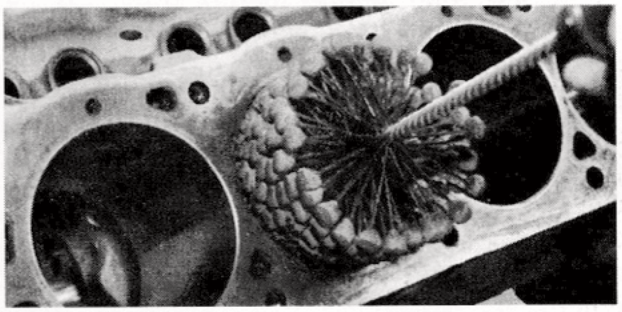


A cross-hatch pattern on the cylinder wall will help the new rings seat to the bore. If the cross-hatch is in good condition when the cylinder is cleaned, honing may not be necessary. If the cylinder has to be honed, a minimum of honing should be done - just enough so that the cross-hatch pattern is distinct.

that you want to see is a cross-hatch pattern on the cylinder wall.

There will be a lot of abrasive created during the honing process. It is extremely important that the crankshaft be protected from the grit. Covering the crankshaft with clean rags or paper towels below the cylinder that you are working on is generally adequate. And afterward, wash the crankshaft and cylinder with a rag dipped in clean kerosene.

If the bore is in good condition, and the cylinder walls are smooth or glazed, a ball hone can be used to 'scratch' the cylinder's walls. Ball hones are available in a variety of sizes designed for the various bore sizes. The ball hone should be run in an electric drill at a fairly low speed - about 850 rpm. It should be lubricated with a little motor oil and run up and down the cylinder in a smooth continuous motion without pause or stopping. It should take about one second for the hone to make one trip, either up or down the cylinder - that means moving it pretty quickly. The hone should be removed from the bore before shutting off the drill. Wipe the cylinder wall clean, and examine the hatch marks. They should be a distinct cross-hatch pattern at about 45° to the vertical. Hone as little as possible. Do not hone the cylinder for

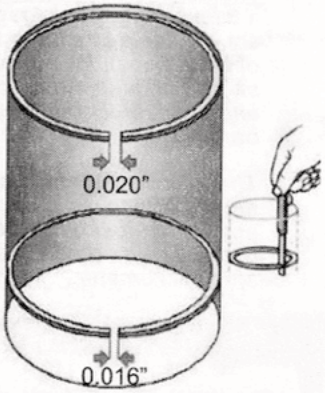


more than one minute per bore (that a maximum of 30 up and 30 down motions).

After honing and cleaning, the bore should be carefully examined for raised areas or rust spots. If rust is evident, a more aggressive type of hone will be required. It is important that the bore not become oversized by honing. Just eliminate the rust spots.

Once the cross-hatch pattern is satisfactory, the bore and the crankshaft must be cleaned thoroughly - and then cleaned again. Any grit that remains is going to cause damage.

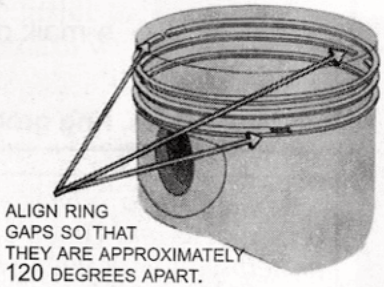
Continue this procedure for each cylinder. When finished, clean everything again. Cleanliness cannot be stressed enough.



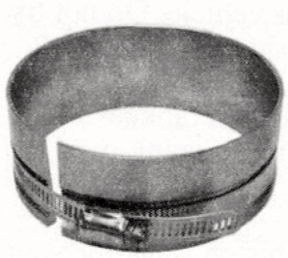
Fit the piston ring(s) into the bore (without the piston) and measure the gap between the edges. Measure the gap halfway down the bore using a knife-blade feeler gauge. If you measure at the top of the bore, the normal taper might indicate too much gap. Dress the ring(s) until the correct gap is obtained.

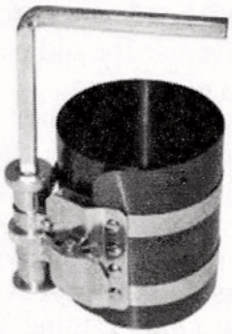
Note that the top of each piston (often) has an arrow; that arrow points to the front. Pistons must be installed in the same bore from which they were removed.

Gently fit the ring over the piston, and slide it down to its proper groove. Ring installation tools are available to make the job easier. Align the rings so that the gaps are approximately 120 degrees from each other.


ALIGN RING GAPS SO THAT THEY ARE APPROXIMATELY 120 DEGREES APART.

Use a light coating of assembly lube or

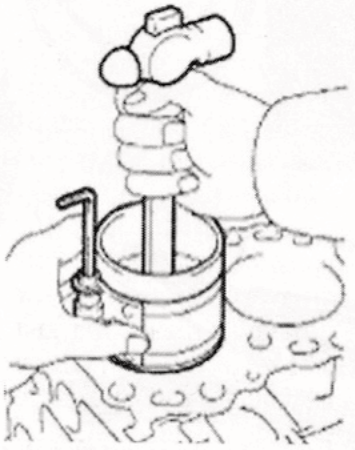




ABOVE: SINGLE RING COMPRESSOR

RIGHT: MULTIPLE RING COMPRESSOR

clean motor oil in the bore and on the piston/rings, and fit the connecting rods into the bore (arrow on piston faces foward). It will require a ring compressor to allow the rings to fit into the bore. A ring compressor is actually a tubular clamp designed to squeeze one or more rings so that the gap is reduced and the diameter of the piston/rings is slightly less than the diameter of the bore. Compressors are available in a range of sizes, like the hones, depending on bore diameter. Be sure that the rings are fully compressed before using any force to fit the piston into the bore or you will end up with a broken ring. If the piston doesn't slide into the bore readily, use the wooden handle of a hammer to apply pressure to the piston top. It is often easier to use a single-ring compressor, fitting one ring at a time into the bore, although it might be possible to use a multiple ring compressor and fit the entire piston/rings into the cylinder in one operation.



From this point on, it's a matter of reassembly. Reconnect the connecting rods and caps to the crankshaft. Clean the oil pan and use a new gasket and reinstall it. Use a new head gasket (the top of the block and the head should have been completely cleaned while you were cleaning the pistons). Contact Olson's Gaskets for a new pan gasket and a

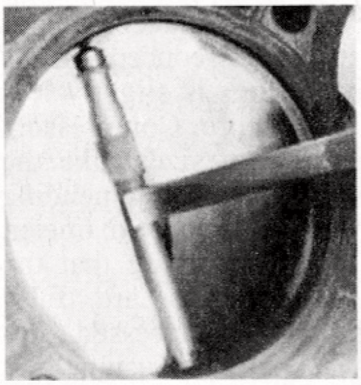
new head gasket for your vehicle. Do not try to re-use the old head gaskets.

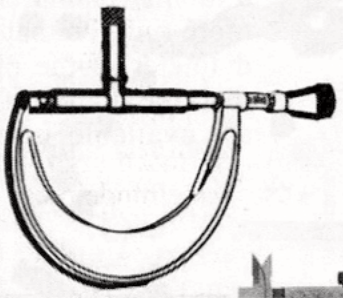
Remember to fill the crankcase with fresh oil before attempting to crank over the engine.

As to the type of piston rings for your car, and the proper size, contact Dave Reed at Otto Gas Engine Works at 410-398-7340 or by e-mail at otto@ringspacers.com. Have the piston diameter, ring groove depth and width, and bore size available when you contact him. He will advise the best rings for your car. As stated earlier, modern material/plated rings might not be best for an older vehicle. Configuration of modern engines vary from the older engines and the rings too, are designed and engineered for new motors not our older cars or trucks.

There is a lot of dispute about the best way to break in new rings, It seems the recommended procedure is to run the engine at low (1,500-2,000 rpm) for about twenty minutes. When you first drive the car, drive it gently, allowing a variation of rpm; use the engine speed to slow the engine down occasionally. After about an hour, with enough variation in engine speed/rpm the rings should be reasonably well seated.

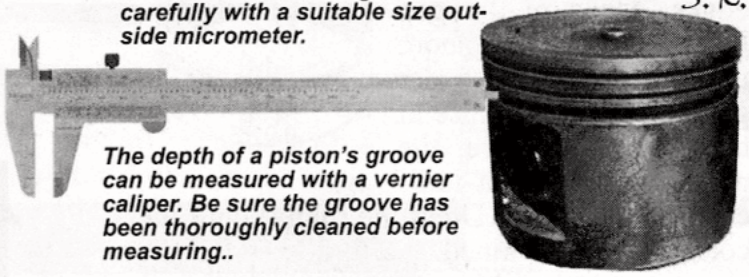
S.K.



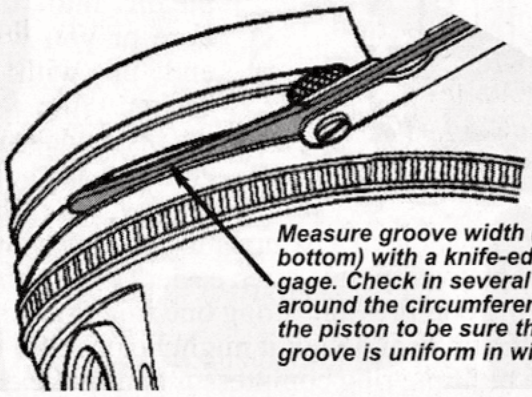


The bore should be measured with a telescoping gage (gage lengths are available in sets to fit a variety of bore sizes). Measurement should be taken in several places and in several positions within the bore

The telescoping gage should be removed after each measurement and its set-locked length measured carefully with a suitable size outside micrometer.



The depth of a piston's groove can be measured with a vernier caliper. Be sure the groove has been thoroughly cleaned before measuring..



Measure groove width (top-to-bottom) with a knife-edge feeler gage. Check in several spots around the circumference of the piston to be sure that the groove is uniform in width,

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