

Armored Division

The head gasket serves as an armored division between the cylinder head and the engine block. This thin wafer of composite material maintains a state of relative peace and harmony between these two large chunks of often dissimilar metals.

Occasionally, the task becomes too great and the head gasket's ability to keep the peace breaks down. In a supreme act of self-sacrifice, the head gasket quietly dies so that its larger and more expensive neighbors to the north and south may live to see the day when peace is once again restored.

Gasket manufacturers have stated that an indestructible head gasket could be produced. This gasket would hold up under the worst conditions and never fail. However, the end result might be similar to sticking a penny in the fuse box. Without the protection of the armored division between the cylinder head and engine block, it would be all out war, and in the end, the casualties would be much higher.

Placing The Blame

The head gasket is usually the first casualty, so it often receives the blame for its own death. Instead of

looking at the failed head gasket as a symptom of a larger problem, a technician may consider the head gasket as the cause of the problem itself. Yet when a fuse blows, we seldom blame the fuse for blowing. We look for the electrical fault that caused the fuse to blow.

Did the engine overheat, then blow its head gasket? Or did the head gasket blow, causing the engine to overheat? Did persistent preignition or detonation cause the gasket armor surrounding the combustion chamber to fail? Or did the gasket armor protrude into the combustion chamber, causing the hot spot that lead to preignition?

These are the kinds of questions you'll need to answer the next time you're faced with a head gasket replacement job. Slapping a new head gasket on the engine without finding out who, what, when, where, and how is an open invitation for a repeat head gasket failure.

We're not going to tell you how to remove and install a head gasket on a Yugo engine. There are service manuals for that. But we will give you more than two dozen pointers that you can use to make any head gasket job both successful and profitable.

— By Karl Seyfert

Mating Surface Finish

Unless your shop has a fully equipped machine shop, you're probably farming out your cylinder head resurfacing work. Incorrect surface finish is one of the leading causes of head gasket failure. So when you get that freshly resurfaced cylinder head or engine block back from the machine shop, it's probably worth your while to take a careful look at these components before reassembly.

If the mating surfaces are too smooth, the head gasket won't have anything to grab onto. This may cause the gasket to move around excessively, and prevent a proper seal. If you have a surface profilometer, surface finish should not be smoother than 60 RMS (54 RA).

If the surfaces are too rough, the head gasket may not be able to conform to all the peaks and valleys on the mating surfaces. This also prevents proper sealing. The shearing action of the rough mating surfaces may also pull the gasket apart and cause it to fail, especially on bimetal engines. Once again, if you have a surface profilometer, 125 RMS (113 RA) is considered the maximum allowable mating surface roughness.

For best gasket performance, look for a surface finish range of 90-110 RMS (80-100 RA). A specially constructed plate called a surface comparator will soon be available through your Fel-Pro gasket supplier. The plate can be used for side-by-side comparisons to determine the approximate surface finish of the refinished engine component. While the simulated surface finishes on the surface comparator may not be as precise as a surface profilometer, it should be a lot less expensive.

Surface Flatness

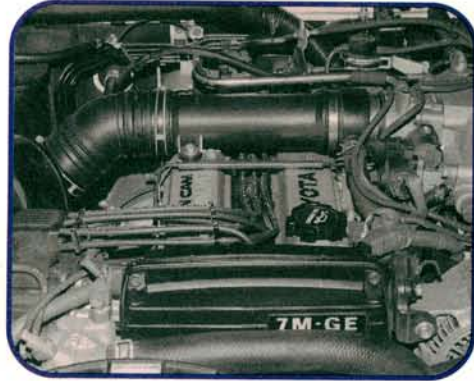
Many manufacturer's and aftermarket service manuals list maximum cylinder head and block out of flat specifications. If these specifications are not available, the following rule of thumb surface flatness specifications can be substituted:

	Length	Width
3 Cylinder and V6 Engines	0.003 inch	0.002 inch
4 Cylinder and V8 Engines	0.004 inch	0.002 inch
Inline 6	0.006 inch	0.002 inch

Cylinder Engines

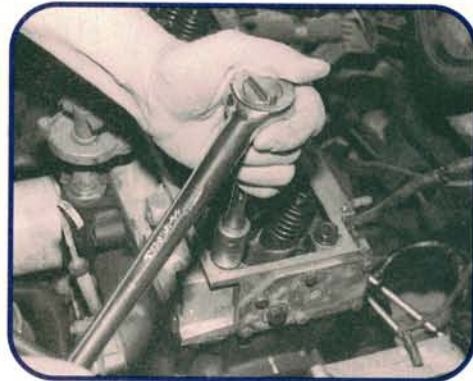
We've stuck to inch measurements here because the round numbers make it easier to see the relationship between the number of cylinders spanned and the allowable out-of-flat specification. For out-of-flat length measurements, add 0.001 inch for each cylinder spanned. The width measurement stays constant at 0.002 inch, regardless of how many cylinders are involved.

Remember, these specifications are for the combined sum of the cylinder head and engine block measurements. Out-of-flat conditions are usually associated with the cylinder head, but the sum of both measurements must not exceed the specifications recommended above.



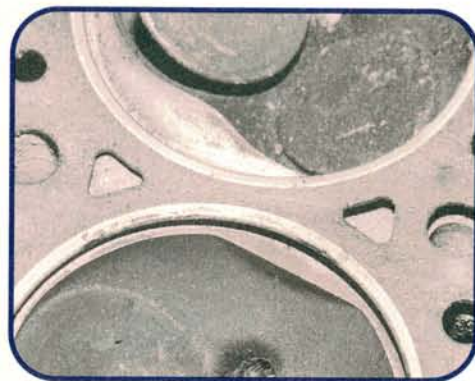
1

Allow the engine to cool completely before disassembly. Cylinder heads (especially aluminum heads) tend to warp if removed while they are hot. Heat also expands metal, making the head bolts more difficult to remove and more prone to breakage. There's also less chance of burning yourself on a cool engine.



2

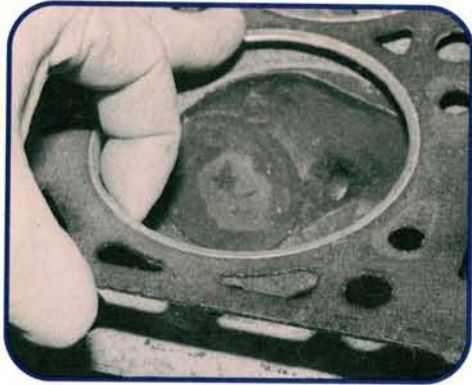
Once the engine has cooled, follow the torque sequence in reverse order to loosen the cylinder head bolts. Loosen the bolts in several steps so that the clamping force is evenly and gradually removed. A little extra time spent here will reduce the chances of warping the head.



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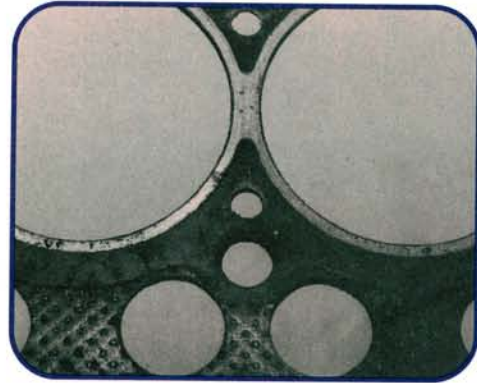
Take a good look at the old head gasket before you remove it. You may find important clues that will tell you the original cause of the failure. Is the gasket armor damaged? Is the gasket blown out between two cylinders, split, or otherwise damaged? Look carefully before removing the gasket.

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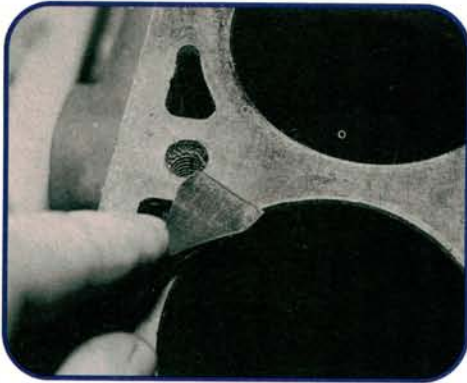
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Carefully remove the old gasket. It can tell you a lot about previous engine problems. How the gasket separates from the mating surfaces may help you find where the failure occurred. Replacing the gasket without finding and correcting the reason for the original problem may cause the new gasket to fail prematurely.



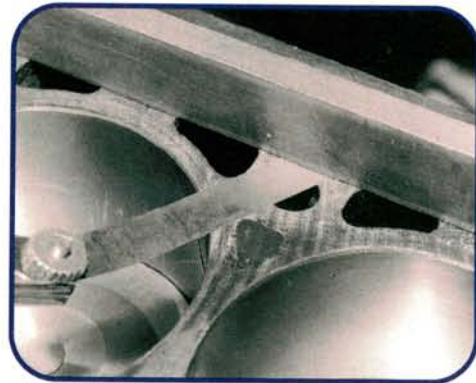
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Is the gasket blackened or is it abnormally flattened? This may indicate that the engine has overheated. When the engine overheats, the metal mating parts expand beyond normal limits and flatten the head gasket. Head bolt clamping force is reduced and the gasket won't seal properly after the engine cools.



6

Clean the head gasket mating surfaces. Any debris can prevent a good seal and may damage the block, gasket, or head. A scraper and abrasive wheel are okay on iron components. Use a plastic scraper on aluminum components to prevent damage. Special cleaning chemicals may be necessary to remove troublesome gaskets.



7

Check the head and block mating surfaces for warpage and distortion. Follow manufacturer's recommendations whenever possible. We've included some general rule of thumb measurements in our introduction to use if specs aren't available. Remember, these are combined specifications for the block and head.



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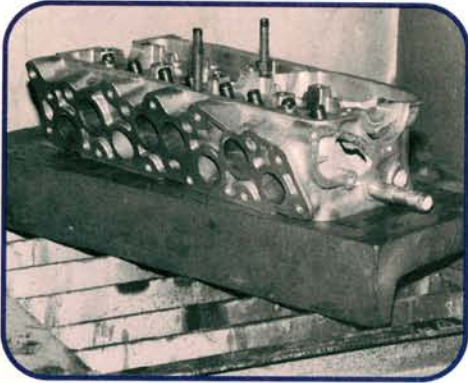
The head and block may require resurfacing to remove gouges, scratches, or corrosion damage. Any of these surface irregularities can prevent a proper head gasket seal and may provide a channel for coolant, oil, or combustion gases. Badly warped or cracked castings should be replaced.



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Check the manufacturer's cylinder head thickness specification. No resurfacing is permitted on some heads, as it may weaken structural integrity or cause other problems. These may include detonation, mechanical interference, casting misalignment, and retarded valve timing on overhead cam engines.

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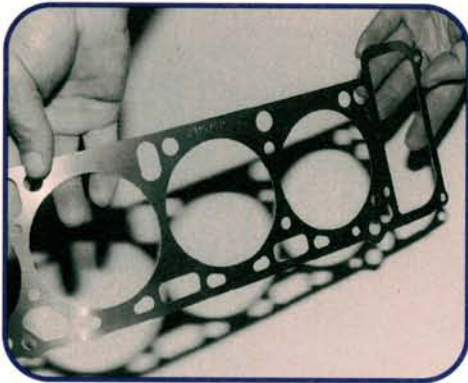
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Machining the bottom surface of a warped OHC aluminum head may cause misaligned cam bearing bores, and a seized cam. Oven heating and straightening is an alternative to head resurfacing. The camshaft bearing bores are returned to proper alignment, before removing any material from the head.



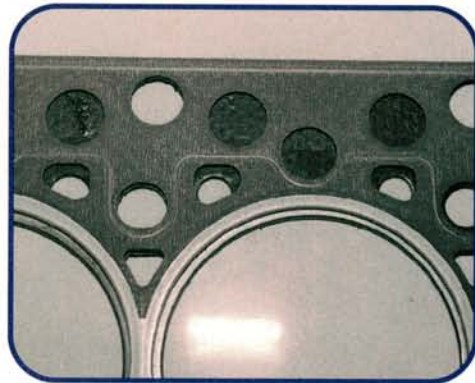
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Some aftermarket head gaskets are manufactured slightly thicker than OE gaskets. This extra thickness is intended to compensate for the change in thickness if the cylinder head has been resurfaced. This maintains the proper spacing between the head and block, avoiding the problems we've mentioned.



12

Spacer shims are available for installation with the head gasket. The 0.020 inch copper shim restores the proper spacing between the block and head to save a machined head that might otherwise have to be scraped. Install the shim between the gasket and block and use a non-hardening supplementary sealer.



13

Check the new head gasket for proper fit. Compare the old gasket to the new gasket. They may not look identical. Time may have eroded the old gasket's coolant passages, making them appear larger. The size of the coolant passages in the new gasket may have also been changed to alter the coolant flow.



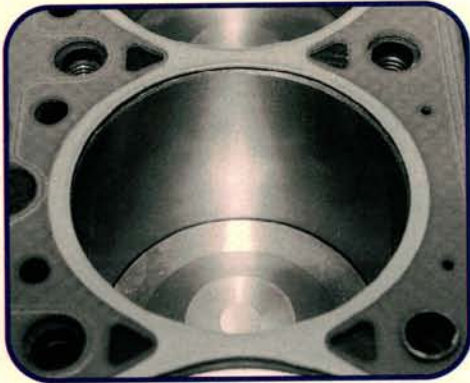
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Lay the new gasket on top of the block. The cylinder armor diameter should be slightly larger than the cylinder bores. Check the armor's bore spacing. If the spacing is incorrect, one side of the armor may be too far away from the cylinder bore, while the armor on the opposite side may protrude into the bore.



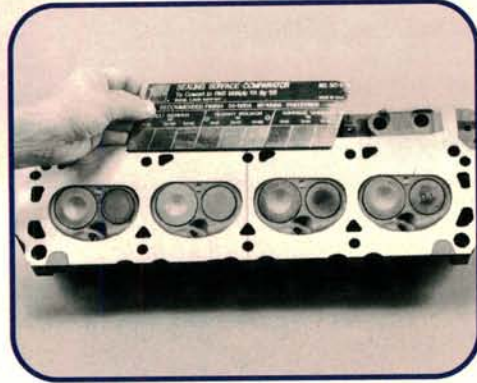
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You may find holes in the head or block that are not repeated in the gasket. These are casting holes that are used during manufacturing and do not affect operation. Make sure that all of the head bolt holes in the block are visible through the gasket when it's installed on the locating dowels.



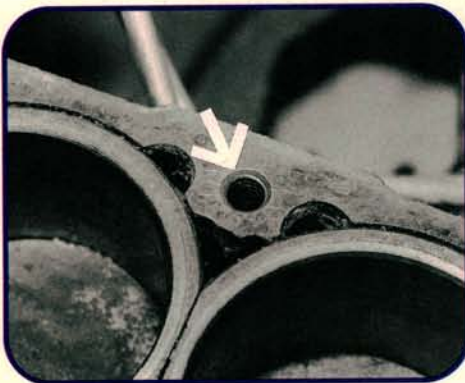
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Make sure the diameter of the gasket armor is large enough to allow a good seal and prevent interference on overbored engines. The chamfer should be 0.035 inch wide all the way around and cut at a 45 degree angle. A sloppy chamfer job may cause the armor to protrude into the cylinder.



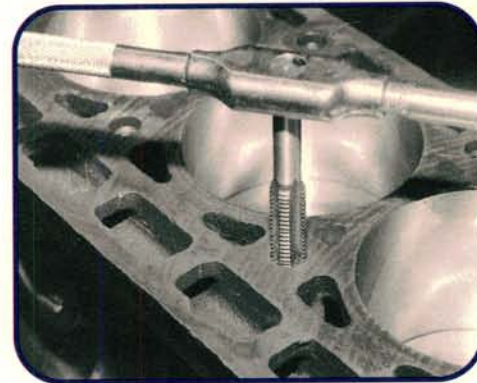
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If the head or block surface finish is too rough, shearing action may damage the gasket during heating and cooling cycles. This is especially important on bimetal engines due to their different expansion rates. Conversely, an extra smooth surface doesn't give the gasket anything to adhere to and it may not seal properly.



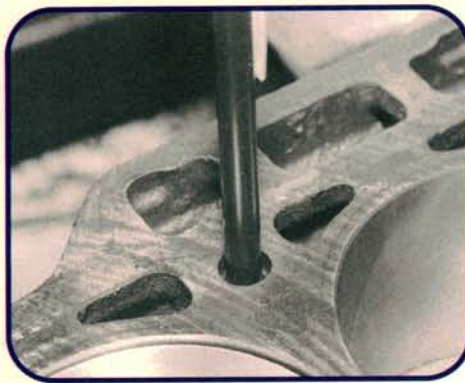
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If the head or block has been resurfaced, the ends of the thread holes should be chamfered and cleaned with a tap. If you skip this step, the top threads may be pulled above the surface when the head bolts are tightened. This reduces clamping force and may cause a head gasket failure.



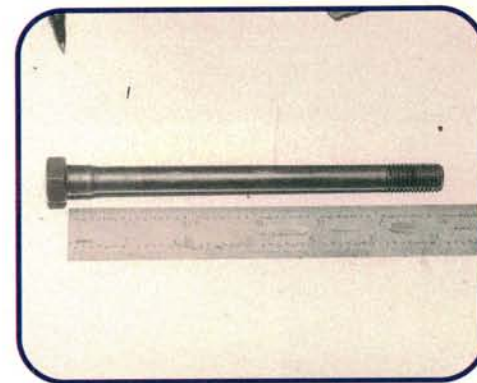
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Clean and tap the threads to the bottom of each of the head bolt holes. Remove any loose material from the bottom of blind holes to prevent the head bolts from bottoming out and reducing clamping force. A bottomed out head bolt will give a false torque reading and may cause a head gasket failure.



20

If the bolts have stretched or the head has been resurfaced, the bolts may be too long and may bottom out in the blind holes. Measure the hole depth with a pencil, then compare it to the length of the head bolts. To prevent bottoming, place a hardened steel washer under the bolt heads during assembly.



21

Torque-to-yield head bolts may have stretched and should be replaced when specified by the manufacturer. Reusing old bolts risks further stretching, improper bolt torque, and possible bolt breakage. New bolts may be supplied with the gasket sets when their replacement is required.

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Check the threads on all reusable head bolts. Thoroughly clean the threads with a wire brush. Lightly lubricate the clean threads and the underside of each bolt head with engine oil before assembly. Dry, dirty, or damaged bolt threads can decrease the bolt's clamping force by as much as 50 percent.



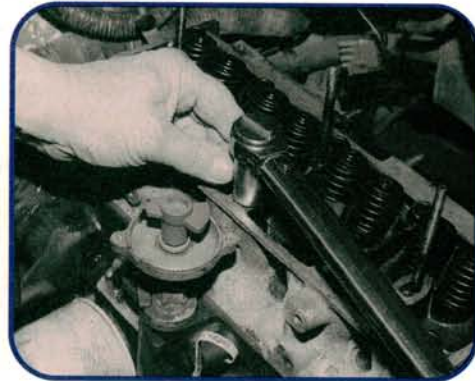
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If any of the head bolt threads extend into coolant passages, coat the bolt threads with a non-hardening sealer. This will stop coolant seepage around the bolt threads. Seeping coolant can also get into the engine oil or cause other damage that could lead to engine failure.



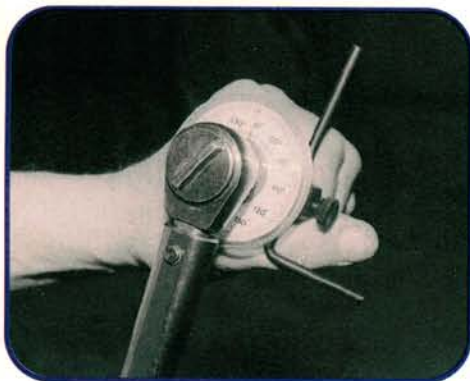
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Lay the new head gasket in place. Follow any "Top" or "Front" gasket markings to assure proper placement. Unless specified by the manufacturer, the new gasket should be installed dry. Additional sealer may stick the gasket to the mating surfaces, preventing normal movement during heating and cooling.



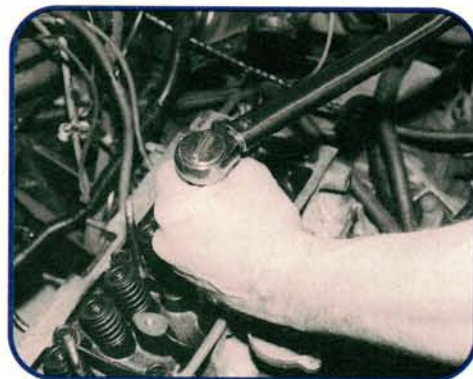
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Follow the manufacturer's recommended head bolt torque sequence. Some torque sequences call for several passes to gradually bring the bolts up to the final torque specification. Use current specifications. Manufacturers may change torque specifications after the engine has been in production.



26

If the engine uses torque-to-yield head bolts, use an angle gauge to finish the job once the final torque is reached. Follow the same torque sequence during angle tightening. The torque to yield procedure produces a more uniform clamping force on the head for better gasket sealing.



27

After completing the reassembly, run the engine and check for fluid or combustion leaks. Some head gaskets require retorquing after running the engine for 15 minutes. Check the manufacturer's recommendations. With aluminum heads, the engine must cool to room temperature before retorquing the head bolts.