

Cam Cover Gasket Replacement

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1976 Jaguar XJ-S

Background

In a 25-year-old car, you can expect various gaskets and seals to leak. My cam cover gaskets, and probably the associated notorious half-moon seals, have been leaking for years. In addition to leaving oil on the garage floor, it tends to dribble down to the exhaust manifolds where it vaporizes, filling the engine compartment with oil vapor. I believe this is a major cause of a grimy engine compartment. And, it is at first disconcerting, then later simply embarrassing, when smoke begins billowing up from under the engine at a stoplight. Drivers in other cars honk and shout "your engine is on fire! So, these were the motivating factors when I finally tackled this job.

What Is Involved

When you look under the bonnet of an XJ-S most of the metal you see is that of the intake manifolds, Figure 1.



Figure 1 Engine with everything in place.

Underneath these are the cam covers, barely visible at each end of the manifolds in the picture. So, the basic job is to remove the manifolds, remove the cam covers, replace the gaskets and half-moon seals, and button it up, Figure 2.

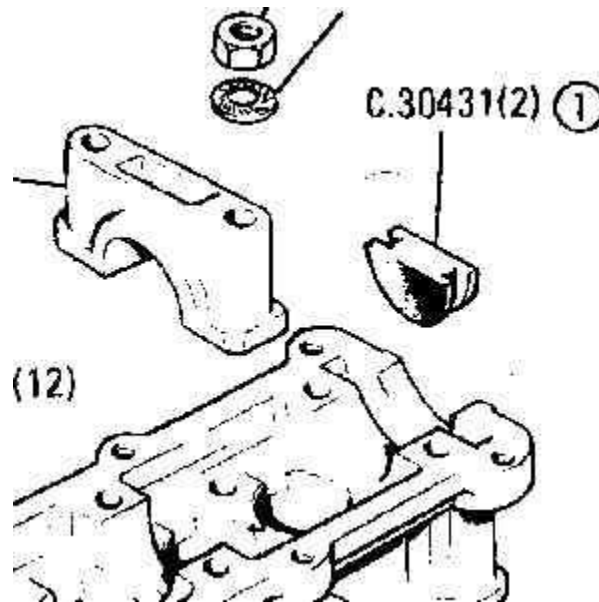


Figure 2 Cam cover, gasket, and half-moon seal (from parts book)

This alone would be a massive job. However, there are other things that have to be disassembled first. And it is likely you will experience "mission creep," since once you have done all the disassembly you begin to notice many other minor repairs that need doing and will never be easier. For one thing, with the cam covers off it is easy to replace the copper crush washers on the "banjo" connectors for oil feed to the cams, another identified oil leakage source. They are right below the cam covers on the tappet blocks, near the firewall, Figure 3.

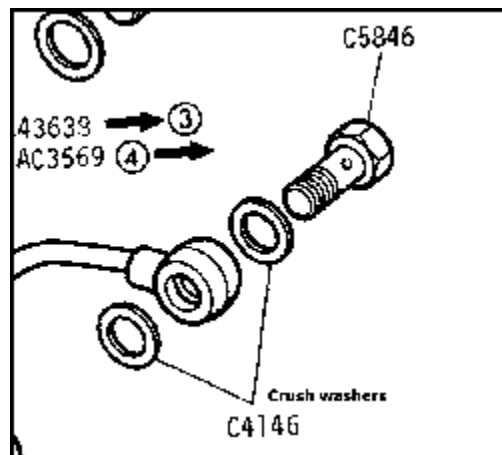


Figure 3 Banjo connector for cam oil (from parts book).

And you will surely want to replace any hose you touch, and probably many others that become accessible, e.g., the heater hoses. So even though you could do a straight gasket replacement in a couple days or less, prepare yourself for having the car in pieces on the garage floor for much longer. I tend to work slowly, so my project took 2- 3 weeks. Probably over half of the time was chasing parts, and another major fraction was devoted to cleaning and painting in the engine compartment.

A step-by-step procedure is given in the ROM, Sections 12.29.43 and 30.15.02/03. I won't repeat that material, so you might want to take a look if you have the ROM handy. Instead, I give the major steps, in approximately the right order, and mention where you can conveniently depart from the ROM procedure. Also, Kirby Palm's *Experience in a Book: Help For The Jaguar XJ-S Owner* has very helpful information on the V-12 cam cover and half-moon seal problems. You should definitely read it.

Things to Take Apart to Get at the Cam Covers

Depressurizing the fuel rail is a good place to begin. Then disconnect the battery, as you will be working in the area of the main 12-volt power posts on the firewall. Also, you will have an easier time later if you remove the wing valance stays (fender braces). This gives more access space, and it just takes a minute.

In spite of the advice in the ROM you do not have to remove the fuel rails, injectors, or the air injection rails. All the fuel and air injection hardware can stay with their respective manifolds. In Palm's book, it is suggested that both manifolds and all fuel and air injection equipment can be removed as one assembly. I did not follow that suggestion because two manifolds at once just seemed too heavy and unwieldy for me. Instead, I removed each manifold and its injection equipment as units. I did a lot of cleanup work on the manifolds once out, which would have been very awkward if they were hooked together.

You can then disconnect the fuel feed and return system from the rails and disconnect the two air injection rails from the check valve at the rear of the engine. Remember that all the fuel and air injection hardware stay with the respective manifolds. However, you will have to disconnect the injector electrical connectors and pull the harness out of the way towards the front of the engine.

Disconnect all vacuum hoses, including those to the power brake vacuum system. You might want to take a picture or notes before you remove the vacuum hoses unless you have a good understanding of where they all go.

Remove the air filters, then the housings from the throttle bodies, I also removed the air balance pipe between the two manifolds, although the ROM seems to suggest that it is not necessary to do so. Disconnect the exhaust recirculation valves from the bottom of the manifolds.

At some point you will have to remove the throttle cable and rods. Mark them left and right so you put them on the same sides they came from.

Once the above steps are complete, the manifolds can be removed. The left and right units are basically the same. Twelve nuts with flat, spiral lock washers secure each manifold to the head. Take great care to capture each nut and washer as removed. The risk here is more than just losing a part. If a nut or washer is dropped and comes to rest out of sight on the manifold somewhere, it might fall off and drop down an intake port when you are lifting the manifold out. If this happens you might be lucky and have it drop into one where the valve is closed, so it can be fished out. On the other hand, if the valve is open, it is conceivable that a washer could slip under the valve and into the cylinder.

At any rate, after the twelve nuts and washers are removed the manifold can be lifted up and out, bringing with it the injectors, fuel rail, and air injection rail, Figure 4. The intake ports are exposed at this point, so they should immediately be plugged with small rags or paper towels to avoid dropping things into them.

Although the Repair Operations Manual (ROM) calls for depressurization of the air-conditioning system and removal of the silencer at the compressor outlet, this is not necessary. The problem here is the silencer is a bit in the way when you try to lift the right cam cover off. However, I found that the silencer can be loosened from its mount and gently lifted out of the way, albeit with slight bending of the pipe.



Figure 4 Intake manifolds.

Removal of the Cam Covers

The cam covers are secured with 12 ¼-20 NC bolts along the edges, plus 4 bright cap nuts over the timing chain gears. Remove and discard the 12 bolts, as they should be replaced, per Kirby Palm's book. Remove and save the 4 cap nuts and copper washers. The left cover can be lifted

off without interference. The right one will interfere with the compressor silencer, which must be loosened and bent a little to get the cover off.

The half-moon seals will be left behind in the tappet blocks, up against the firewall, when you remove the cam covers. The main bodies of my seals were easily removed by hand, but little strips of rubber separated and remained stuck to the tappet blocks. It took some work with a putty knife to clean them out.

Once the covers are removed there is great risk of dropping things down into the timing chain cavity. To guard against this awful mishap, stuff a rag into the space all around each timing sprocket.

Cleanup

Obviously, you will want to clean up the cam covers before replacement. Simple Green and water do a pretty good job. And the old gaskets will have to be scrapped off where they have stuck to the cam covers and the mating surfaces on the tappet blocks. In my case they lifted right off in places, while in others I had to work at it with a putty knife. I cleaned the entire gasket mating surfaces with solvent at this point but wound up doing it again right before reassembly because they got dirty again while cleaning the rest of the engine top. I also draw-filed the cam cover gasket surface because there were a few nicks. Since these were not fresh nicks, and I know this job has never been done on my car, there appears to have been a quality control problem at the factory.

Cleaning the manifolds is a much bigger job. Outside there are a lot of nooks and crannies to be brushed and scrapped. Again, Simple Green was my principal solvent for this task. Inside the manifold calls for stronger measures. Perhaps due to spit-back, or normal exhaust gas recirculation, I found the plenum and air passages (some more than others, strangely) to be coated with black soot. To remove it I used spray cans of brake cleaner, a bottle brush, and rags: spray, brush, and wipe. Doing this about 3-4 times for the plenum and each air passage got them pretty clean. But first you have to remove the end covers (overrun valves at front, throttle linkage mounting hardware at rear) so you can work inside the plenum. With these ends off, the bottlebrush can reach to the middle from each end, and you can ram a rag all the way through with a wooden dowel rod. The air passages can only be accessed from the outside end, so they are a bit more of a challenge. But again, the same technique works. The only difference is you can't use the dowel to ram the rag through because of the curvature. Instead, I used a long coil spring (actually intended for bending copper tubing). With it I could run the rag into the passage, saving an end so I could pull it back out.

Cleanup of the valley between the two heads is also called for. Here I made a mistake and used Gunk (emulsifying solvent). Although this does a good job of cutting grease, I sprayed it off with a garden hose, resulting in water seeping through the rags plugging the intake ports and getting down into the cylinders. This required removing the spark plugs and turning the engine over to

be sure it got pushed out. I should have stayed with Simple Green and water in spray bottles.

A Mystery

As with the manifold air passages, some of the ports in the heads were severely blackened. Figure 5 shows the ports on A-bank, where you can see that some are dirty while others are clean. These correspond to the cylinders with fouled plugs. My theory is that this was a result of collapse of the hose connecting the balance air pipe to the right intake manifold. The hose was original, judging from the clamp, and was as soft as jelly. This collapse would occur especially at the high vacuum of idle, starving the air to the right bank and making it run very rich. A secondary theory (if you like complex theories!) explains why ports 1A and 6A are clean and the plugs unfouled: the high vacuum causes the overrun valve to open, giving air preferentially to 1A, and 6A gets some extra air from the power brake vacuum line acting as a secondary "balance air" path. (If you don't like this theory, please let me know yours!)

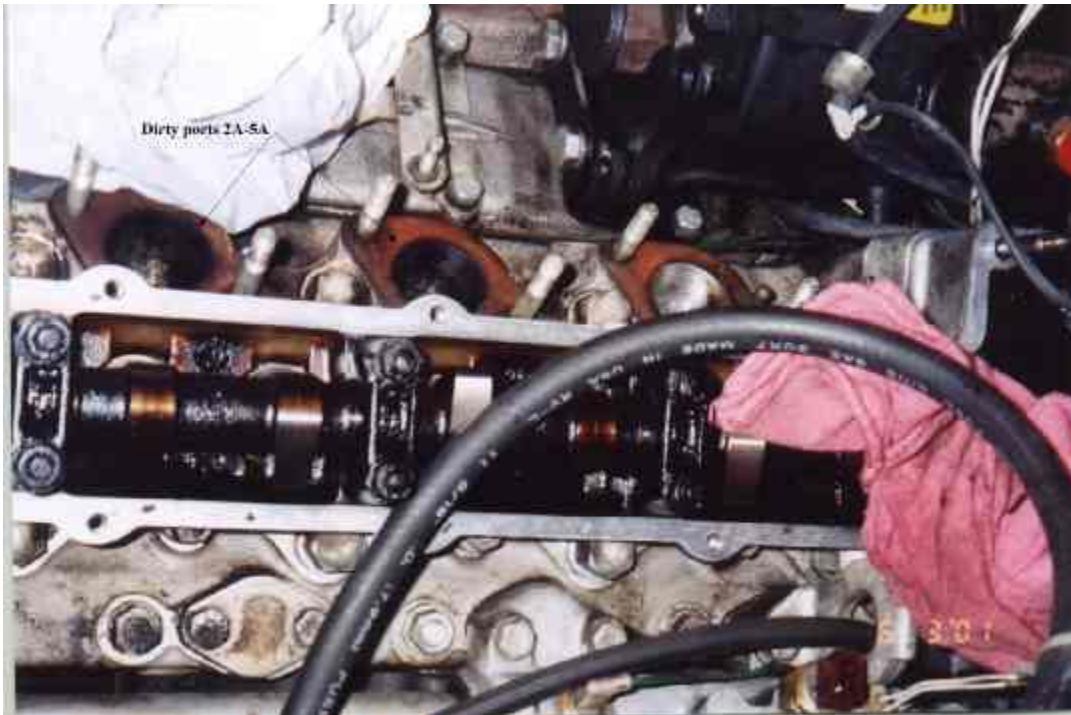


Figure 5 Dirty intake ports.

Reassembly

Cam Covers

The big issue with putting the cam covers back on are (a) dealing with the half-moon seals, and (b) choosing a proper bolt to replace the original 1/4 -20 flange head bolts. Both are dealt with extensively in Kirby's Book, where several approaches are mentioned. I took what I perceived to be the primary recommendation given there on each of these issues.

With regard to the seals, the recommendation is that a silicone gasket sealer be used *all around the half-moon seal*, and on the tappet block and cam cover flat surfaces near the half-moon seal. I used the Permatex Ultra Blue product, a more readily available RTV silicone sealer with temperature specifications close to the British Hylsil product mentioned in The Book. The only tricky part is the stuff sets fast, so you have to plan carefully so you are ready to drop the covers in place immediately after applying the Ultra Blue. So, clean the surfaces and get all your bolts ready (i.e., apply anti-seize) before applying the Ultra Blue to *anything*. Also, you might want to make a dry run at slipping the cam covers into place. I did and discovered some interference with the heater hose and harnesses on the right side of the engine bay near the firewall. I tied them up to the cowl to keep them out of the way.

When all this is done, smear the Ultra Blue to the curved surface of the half-moon seal and slip it into place in the tappet block. Then, apply the stuff to the flat top of half-moon seal and surrounding area of the tappet block. The Book recommends "one inch towards the front." Then put the cam cover gasket on and coat the same area of the top of the gasket with Ultra Blue. Then drop the cam cover on and immediately bolt it down.

According to the Book the bolts should be replaced. You can read about the reasons and the several alternative replacements there. I took the suggestion used by Kirby, namely 1 1/2" 1/4-20 NC socket head cap screws, fitted with #12 flat washers and 1/4 split lock washers. My cheap torque wrench would not go down to the recommended 8-10 foot-pounds, so I just tightened them well with a 3/8" ratchet.

Intake Manifolds

When the intake manifolds are off you will get used to all that space and room to work, in the valley especially. Therefore, you will be compelled to think carefully about what you should do before putting them back on. If you have not replaced the spark plugs, wires or distributor cap recently, you may want to consider doing so. This is especially true if you have removed any of this to do cleaning in the valley, as I did. And use the opportunity to oil the center shaft of the distributor mechanical advance and check the vacuum advance. All of this is very easy with the top of the engine so exposed. However, I elected to not reinstall the plug wires before the manifolds, as I did not want to be bumping into them as I was trying to gently drop the manifold onto 12 studs.

If you have a pre-HE, as I do, you will have a problem with the new intake manifold gaskets. The problem is they are now available only as a single gasket for each bank, as opposed to the original individual gaskets. These work fine for HE engines, in which the spark plugs are angled

inboard, but the gasket material between ports interferes with the pre-HE plug access. They clear the plug OK, so the whole thing would reassemble fine until you tried to put the spark plug wires on. So before putting the gaskets on the engine you should cut them apart as shown in Figure 6.



Figure 6 Cutting intake manifold gaskets.

I could see no need for using any kind of gasket dressing here. The new gaskets are thick, rather soft paper and should seal well.

The manifolds themselves slip into place nicely. Figure 7 shows the right manifold positioned for dropping onto the studs. The only real challenge is getting the washers in place and the nuts started without dropping them. I use my very long needle nose pliers to drop the washers onto the studs. To get the nuts on I tore a narrow strip of newspaper and laid it over the nut before sticking it into a 6-sided socket. The newspaper holds the nut so it doesn't drop out while getting it started. Worked great! I could find no reference for torque for these nuts, so I pulled them down to about 12-15 foot-pounds, about the lowest setting on my torque wrench.



Figure 7 Installing right intake manifold.

Other Tasks

Here are some other tasks I did as part of this project.

Cam Oil Feed Crush Washers

Each cam has an oil feed line attached to the rear end of the tappet block with a "banjo" style connector, Figure 3. These connectors use two copper crush washers as seals. They are reported to be another source of oil leakage, although it's really hard to tell because of their location. You can get a view of them with a dentist's mirror, but even if they are grubby you probably won't be able to tell if the leakage is from the banjo connector or the half moon seal right above it. Nonetheless, they are much easier to replace once the cam covers and other parts are out of the way.

First, remove the center bolt. Extracting the old washers can be a bit of a problem because they can stick to the banjo fitting or the tappet block and it's hard to tell if they are still in place, or perhaps have fallen behind the engine. A dentist's mirror will help see the situation, and a pocketknife or the like will help pick it loose. The next challenge is cleaning the sealing surfaces. I used Simple Green and a toothbrush, followed up with a paper shop towel slipped between the block and the banjo connector.

The challenge I getting it back together is slipping the bolt through two washers and the banjo connector without dropping the washers. You might want to slip a thread through the washer between the connector and the block to help hold it in place.

Throttle Plate Adjustment

When the manifolds are in place you have to stand on your head to see where to put the feeler gauge as needed to set the throttle plates. It's a lot easier to do this job with the manifolds on the bench. Mine were OK, as I had done the job recently, but it was comforting to check them.

Replacing the Heater Hoses and Valve

While the heater hoses can be replaced with cam covers in place, it is a lot easier with them off. It is still a challenge getting a screwdriver to the hose clamps. In my case the clamps had hex head screws, so a 1/4" drive socket with a flex joint and a long extension worked nicely. I managed to cut the old hoses off without damage to the heater pipes using a utility knife. The new hoses slipped on without too much difficulty after I lubricated them with coolant. I replaced the heater valve and its vacuum hose while I was there, even though the old one looked to be in good shape. I also took the opportunity to install a "flushing tee" in the heater inlet line, between the engine and the heater valve.

Cleaning and Painting the Engine Compartment

With the air filter housings and intake manifolds off you will be able to see the sides of your engine compartment like never before. If your cam covers have been leaking, chances are these surfaces will be covered with grime, and you will never have a better opportunity to clean it up. As with my parts cleaning, I used two spray bottles, one with water and the other with Simple Green. This plus scrubbing with various brushes and rubbing with rags and paper towels got them clean.

Once clean I was able to see that an engine detailer had put a lot of black paint where it shouldn't be, covering the original body color as well as dirt. I could not resist the temptation to remedy this. I bought a pint of body color paint (fortunately, I had the code from when the car was painted 12 years ago) and an airbrush. The latter proved to be pretty useless in my inexperienced hands, so I wound up using a brush. There isn't room for a spray can here, even if you were lucky enough to get your body color in one. Frankly, I am not proud of my brushwork, but it is a lot better than when I began.

Painting the air Filter Housings and Other Things

Since the air filter housings are off it is not too much extra work to clean them up and apply a new coat of paint. While I was at it I painted the wing valance stays, and a few other black items that had been removed. This is easy work with spray cans, and you will be pleased at how good it looks afterwards.

Replacing the Remote Header Tank and Other Cooling System Repairs

When I started the teardown, I noticed some coolant drips on the left side of the engine. It turned out there were several sources, one of which was the remote header tank, although it had been replaced once before in the life of the car. I replaced it with an aftermarket stainless steel unit from Cathouse Spares (Sydney). Excellent part.

Results

I've been watching it very carefully in the 2-3 weeks back on the road. There is no visible leakage from the cam covers. Regrettably, stopping major leaks always draws one's attention to smaller ones. I think I see some seepage from under the tappet blocks, although it is very minor. Also, judging from the catch-pan on the garage floor, I definitely have some leakage from the rear main. (I replaced the front crankshaft seal last year.)

As you can see from Figure 1, taken after the job, everything looks pretty good under the bonnet!

Acknowledgements

Although I do think things through myself, I also seek advice as widely as possible. The XJ-S Lovers list is always the best source. The Book provided a lot of valuable insights and information. Even in cases where I found my own way, I definitely benefited from this wonderful source.

Parts Required

When I began, I carefully thought out what I would need: cam cover gaskets, half moon seals, and intake manifold gaskets. These were promptly ordered. Predictably, once into the job I wound up placing orders at Jag parts houses at least three more times, and made countless trips to local auto parts stores. To save you some of this trouble, here is an almost complete list of parts for all the things I did:

Cam Cover and closely related things:

1. Cam cover gaskets: EBC-9627/9628
2. Half moon seals: C30431
3. Intake manifold gaskets:NNA-3020BA
4. Hoses for air balance pipes: C42093(2), C42042, C41373, C42090 (NAPA 10080), C41372
5. Crankcase breather elbow C44386
6. Check valve hose: C35099 (Note: I had recently replaced other hoses C34632(2))
7. Oil sealing washers: C4146
8. Throttle base gasket EBC-9635(2)
9. Fuel hose. Check condition of all hoses to and from the fuel rails and buy enough to replace all that are hard.

Unrelated items:

1. Remote header tank: Cathouse Spares CAC 4337
2. Flushing kit: NAPA 720-1286
3. Heater hoses:
4. Vacuum line for heater valve
5. Air filters: EAC1828
6. Ignition wire set
7. Spark plugs (Champion N9YC)
8. Two spray cans brake cleaner for cleaning intake manifolds.
9. Simple Green