

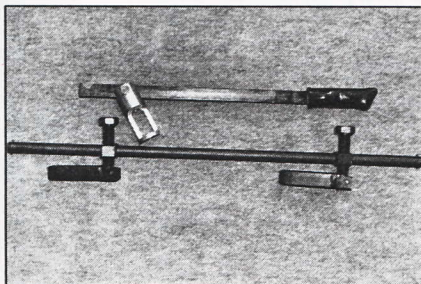
PROJECT 924

Part 17: Valve stem seals

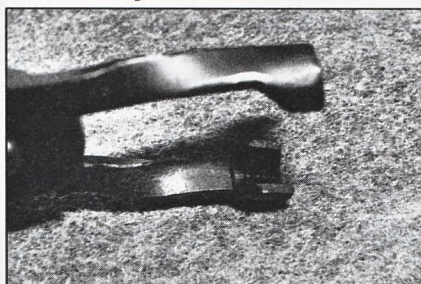
by Victor Max

PHOTOS BY THE AUTHOR

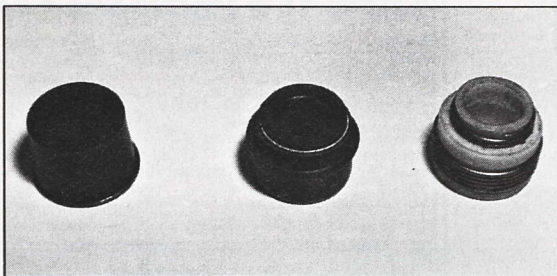
If your Porsche 924 uses oil, and sometimes puffs white smoke when you start it up, there's a good chance the valve stem seals need to be replaced. Valve stem seals mount on the top of the valve guides to prevent oil from entering the combustion chamber past the intake valve (the exhaust valves have valve stem seals too, but they're not as critical as the seals on the intake valve stems).



This Sir Tools lever (top) and pivot bar allow you to depress the valve spring retainers to remove the keepers.



Inside the jaws of the seal removers are serrations that grab stubborn seals.



The three types of valve stem seal (l-r): rubber, Viton, and Teflon.

When oil gets into the combustion chamber, it lowers the octane of the air/fuel mixture so the engine loses power and is more prone to pre-detonation. Having oil in the combustion chamber does nothing



These special seal removers are just about the only way to reach the valve stem seals on 924s, Volkswagens and Audis.



An adaptor such as this is needed to supply compressed air to prevent the valves from falling into the cylinder after you remove the valve springs.

good for the environment either, as the engine will run dirtier than it should.

Oil can get into the combustion chamber other ways, of course. If the rings are shot, oil splashed onto the cylinder walls will not be scraped off as the piston moves down in the bore, and all that oil that should be on the underside of the piston will be in the combustion chamber. The valve guides themselves can also be a problem: If the guides are worn out, the gap between the guide and valve stem will be so large that no seal will be able to prevent oil from entering the combustion chamber.

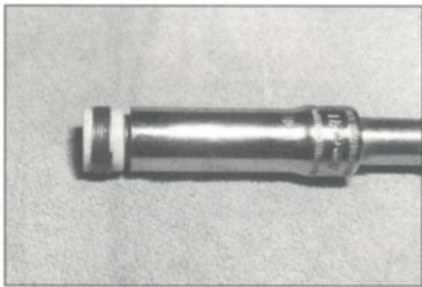
If either the rings or the valve guides are so worn that they are the cause of your oil consumption, the engine has to come apart to fix the problem. Valve stem seals can be replaced with the engine in the car, and with only minor disassembly. For a couple of bucks and in a couple of hours you can replace the valve stem seals and see if that corrects your problems. If not, you haven't lost that much.

Types of valve stem seals

In the olden days, valve stem seals were rubber. Rubber valve stem seals would harden and crack after being subjected to burning hot oil for a few years, and would stop sealing. Rubber gave way to white Teflon valve stem seals, which are not as flexible as the rubber seals, but which last

a lot longer. Because the Teflon seals are fairly rigid, dirt or improper installation can scratch the inner sealing surface, which allows excess oil into the valve guide and beyond.

Over the last ten years or so, Teflon has given way to a substance known as Viton, which looks and feels like silicone, and is either red or green. Like Teflon, Viton also



There are special seal installers, but often a deep socket will work just fine as long as it pushes on the shoulder of the seal and not the top (shown here with a Teflon seal).

has excellent longevity, and Viton seals seem to control oil flow down the valve stem better than Teflon seals.

With all the major manufacturers having switched to Viton, and with the superior oil control of the Viton, it's natural to assume that Viton seals are the better choice for replacement seals. Unfortunately, Viton seals can be very difficult to install. What usually happens is that a sharp edge on the valve guide catches the Viton and peels it back, tearing the seal where it mounts on the guide. This bunched-up material accumulates at the top of the valve guide, preventing the seal from seating fully. Depending on your skill level and patience, it can take several tries to get a Viton seal properly installed on each guide.

For this reason, you may think about using Teflon guides and give up a little oil control in exchange for ease of installation. If you do choose the Viton seals for their improved performance, buy plenty of extras so you have enough to finish the job if you tear some of them during installation.

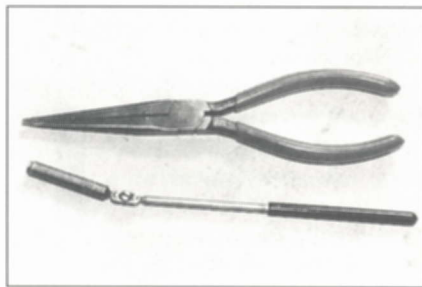
Special tools

To replace valve guide seals, you will need a few additional tools beyond the valve adjustment tools mentioned in Project 924, Part 3: First Maintenance and General Fix-up, in the November 1992 issue of European Car.

After removing the cam cover, the camshaft, and the cam followers, you will need a special tool to compress the valve

spring so you can remove the valve keepers, and an air compressor and an attachment for the spark plug hole to keep the valves up in place while you work.

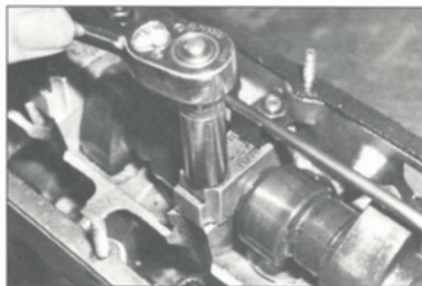
Because the seals are sunk deep in the cylinder head, you need special pliers to remove them. You will also need a special installation tool, although there are some deep sockets that work well for this (our



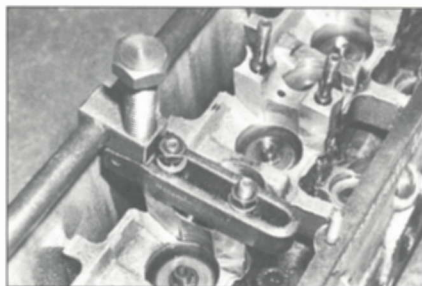
The magnetic wand (bottom) is very useful for removing the keepers; the needle-nose pliers are good for putting them back in.

11 mm socket does the trick for us). Also the package of valve stem seals you buy should contain one or more thin plastic covers, that slip over the valve stem temporarily to prevent damage to the inner (sealing) surface of the valve stem seal.

To get to the valve stem seals the camshaft must come out, so get a new gasket to go between the distributor mount and the rear of the cylinder head, and a valve cover gasket kit. It is also a good idea to have a new cam oil line elbow on hand. This is also a good time to replace the front cam oil seal,



After removing the valve cover, remove the cam bearing caps in the order specified.



Mount the pivot bar to the cylinder head using the cam bearing cap nuts and washers.

if your old one is hardened and leaking.

Reaching the seals

To reach the seals you have to strip just about everything out of the inside of the cylinder head.

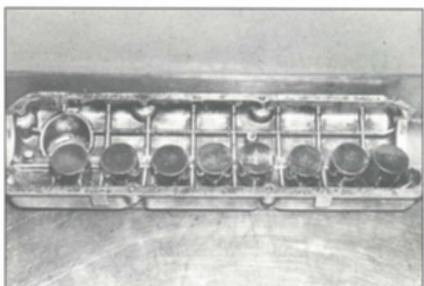
1. Set the engine at TDC

Because you're going to have to retime the engine when you are all done, it is easier to set the engine at TDC for cylinder one before you start, and then lock it there. When the engine is at TDC for cylinder one, the mark on the front pulley will be in alignment with the pointer at the front of the engine, the mark on the cam pulley will be in alignment with the indicator on the cam cover, the TDC mark on the flywheel will be in alignment with the edge of the bell housing opening, and the distributor rotor will be in alignment with the mark on the top edge of the distributor housing. After you set the engine to TDC for cylinder one, put the transaxle in high gear (fourth gear for four-speeds, fifth gear for five-speeds), and set the parking brake.

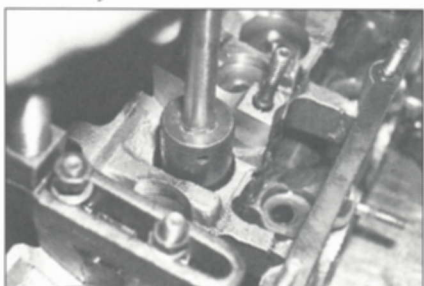
2. Remove the cam cover

With a 10 mm socket, remove the nuts and washers that hold the cam cover to the cylinder head. You will note that some of the nuts hold down brackets for the plug wires and fuel lines. These nuts do not have washers beneath them, while the other nuts have a wavy washer between them and the cam cover.

3. Remove the spark plugs and distributor



Keep the cam followers in order at all times so they can be put back where they were before disassembly.



After removing the cam followers and applying compressed air to the cylinder, give the retainer a couple good smacks to loosen its hold on the keepers.

PROJECT 924

Unplug the spark plug wires at the spark plugs, and then remove the spark plugs.

Unplug the high tension lead from the distributor at the coil and swing it out of the way. Unclip the distributor cap (complete with the spark plug wires and metal static shield). The metal shield has a grounding wire that either clips or screws to the distributor body. Unclip or otherwise remove this wire so the distributor, wires, wire brackets, and static shield can be lifted out of the way.

On the right side of the distributor is a plug with wires that run from the distributor to the ignition module. Unplug this wire (you may have to peel back the rubber boot first).

Note the general orientation of the distributor. On the 924, the distributor can be put in facing just about any way you choose, but everything works best if it's positioned so the vacuum canister points to the right. On the upper lip of the distributor housing there's a mark that denotes where TDC should be (you may have to remove the rotor and the black plastic shield to see it). On late model Turbos with no vacuum canister, the TDC mark on the distributor points back to the left, toward the driver.

Remove the hold-down nut and clamp at the base of the distributor and lift the distributor out.

4. Remove the distributor mount

The distributor mount (at the rear of the cylinder head) fastens in a somewhat unusual way. Two of its mounting bolts

attach to the cylinder head and one attaches to the rearmost cam bearing cap. Additionally, the mount can be installed in either of two ways, although only one is correct (of course). Examine the distributor mount before you remove it, noting which of the two sets of holes is used. Make a diagram if you need to.

After removing the three bolts, you must slide the mount rearward slightly to get it clear of the cylinder head. It's okay to rotate the mount if needed to break it free. Remove the old gasket, noting how much stayed with the mount and how much remained stuck to the cylinder head. You will have to remove all traces of the old gasket before installing the new gasket.

5. Remove the cam belt

Remove the adjustment bolt for the alternator and remove the alternator belt. If your car still has the cam belt cover on it, remove the water pump pulley as described in part 11 of Project 924, which appeared in the July 1993 *European Car*, then remove the cam belt cover. Loosen the cam belt idler pulley, swing in down and out of the way, and remove the cam belt.

6. Remove the cam oil line

Remove the cam bearing cap nuts and washers off the left side of the numbers 2, 3, and 4 cam bearing caps, and lift off the cam oil line. Replace the nuts and washers for cam bearing caps 2 and 4, but do not torque them down.

7. Remove the cam and cam followers

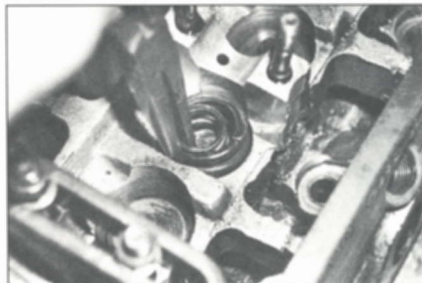
Note: Failure to follow this procedure could result in a broken camshaft.

If you examine the caps, you'll see they face a certain way. Make a diagram of which caps go where (they're numbered), and what their orientation is. Remove the nuts and washers for cam bearing caps 1, 3, and 5. Note that cap number 5 has two additional small bolts that must be removed as well. Lift off these three cam bearing caps, leaving cam bearing caps numbers 2 and 4 to hold the cam down. If the caps do not simply lift off, tap on them from the side while wiggling them. As you lift off each cap, set it on the workbench in the same order and facing the same way it does in the cylinder head. If you switch caps, or if you rotate them on reassembly, you can ruin the camshaft and cylinder head.

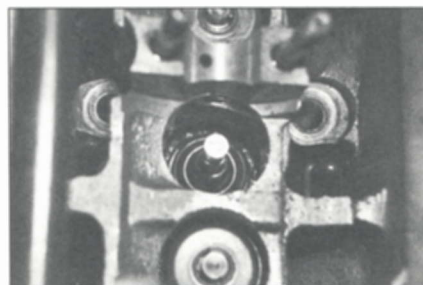
The camshaft is not still under tension from the valve springs, and is being held only by cam bearing caps numbers 2 and 4. To release the tension and prevent damage to the cam, gradually remove the four remaining cam bearing nuts, working in an X-pattern. Loosen each nut one turn or so, then do the same with each of the other nuts. The camshaft and cam bearing caps should rise of their own accord until all tension is released. If either cam bearing cap sticks during this procedure, tap lightly



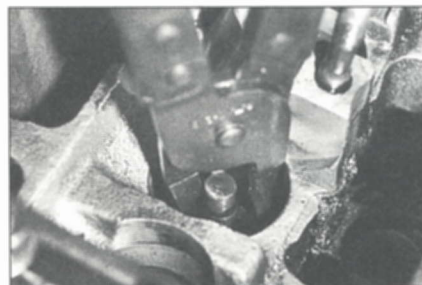
While depressing the retainer with the lever, fish out the keepers with the magnetic wand.



Remove the valve springs.



The view inside the cam follower bore.



Remove the old seal with the special pliers.



Protector tubes help ensure that the inside surface of the valve stem seal is not marred during installation.

on the side of the cap until it frees up, then continue gradually removing the nuts.

Lift off the remaining two cam bearing caps, and place them among the other cam bearing caps, in order, and facing the proper way.

Lift the camshaft out of the cylinder head and set it aside where it will not be damaged.

8. Remove the cam followers

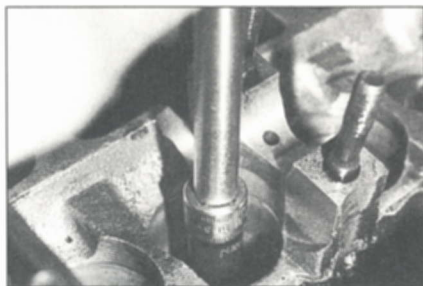
As with the cam bearing caps, the cam followers must be replaced in the same order they were removed. They simply lift out, but do not mix them up. If you need to, mark the tops with a grease pencil.

Replacing the seals

9. Removing the valve retainers and springs

For the next four steps, you will be working on one cylinder at a time. Insert your adapter into the spark plug hole and connect it to your compressed air source. This must be done to hold the valves closed after you remove the valve spring retainers. Without the compressed air, the valves would fall into the combustion chamber. When the piston is at TDC, this is not a major deal, but when the piston is at BDC things get interesting. You do not need a lot of air pressure to hold the valves closed, and in fact the more air pressure you have the more the engine is going to try to turn. If the transaxle is in gear and the rear wheels are on the ground, this can pose a safety threat. If you cannot hold the engine from turning and the rear wheels are on the ground, take the transaxle out of gear; the only difference is it will take you a little longer to time the engine when you're done.

Mount the valve spring compressor pivot to the cylinder head, using the studs for the cam bearing caps as well as the cam bearing cap nuts and washers. It's better to mount the pivot so the bar is on the right, as this allows fuller motion on the valve spring compressor bar. These tools are fairly easy to find; we got ours from Sir



Install the new seal, making sure it is fully seated.

Tools in Paradise, California.

You'll note when mounting the pivot that there are all kinds of studs in the way, and that once the pivot is mounted, it's difficult to work on all the cylinders. The pivot can be installed in such a way to clear all the studs, but you will have to unmount and remount it to reach all the valve springs.

Before you start with the valve spring compressor, take a socket (we used a 22 mm impact socket) on an extension, and give both of the valve spring retainers a couple of good pops to break them loose from the keepers. It's easy to tell when you have broken them loose: When the retainers and the keepers are locked up, pushing down on the retainer activates the valve, which will release compressed air from the cylinder (the compressed air you're supplying through the spark plug hole, that is) into the intake or exhaust system. After you've broken them loose, the retainers will move without activating the valves, so you will not hear air escaping the cylinder.

With the retainers broken loose, use the valve spring compressor to press down on the retainer. Using a magnet or needle-nose pliers, reach down past the valve spring compressor and fish out the keepers. Then release the valve spring compressor, lift off the retainer, and remove the inner and outer valve springs.

10. Remove the old seals

Note the distance from the top of the valve stem to the top of the seal, so later when you're installing the new seal you'll have some idea how far down it has to go before it's fully seated.

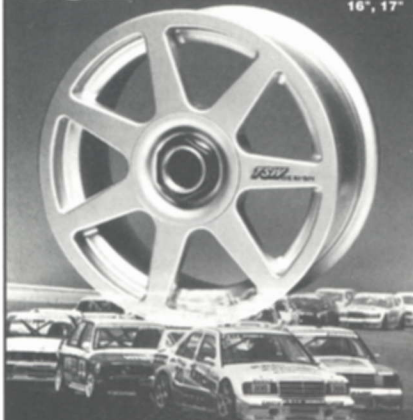
Reach down around the valve stem with your special pliers and remove the old valve stem seal. Sometimes they almost fall out, but do not be surprised if you have to wrestle with them a little bit. If you do have to fight to get them out, check the valve guide with a flashlight to ensure that you have not left behind any pieces of the old guide before you install

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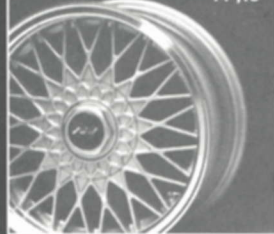
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This is an excellent time to replace the front camshaft seal, if needed, although it requires the removal and replacement of the cam sprocket, which can be difficult.

the new one.

11. Install the new seal

If you have seal protectors, slide them over the tops of the valve stems, apply a little silicone lubricant, and then slide on the new seal. Push the seal down with your seal installer until it's fully seated (compare against an old seal), and then remove the seal protector. Often, the seal protectors are longer than they need to be, to the point that when the seal is installed it still rides on the seal protector. Trim the protector so this does not happen with subsequent installations.

12. Replacing the valve springs and retainers

With the new seals in place, put back the inner and outer valve springs, and rest the retainers atop the springs. Using the valve spring compressor, depress the retainer while installing the keepers one at a time. If you have bony fingers you can do this by hand, otherwise you will have to use needle-nose pliers.

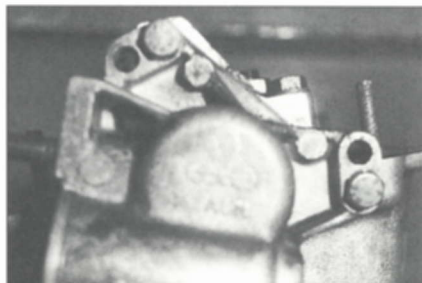
After you get the springs, retainers, and keepers in on both valves, remove the air pressure from that cylinder and move your adapter to the next cylinder and repeat these four steps until all the seals have been replaced.

Finishing up

13. Replacing the cam followers and camshaft

Put the cam followers back into their bores in exactly the same order they came out, so each lobe of the cam is riding on the cam follower it was used to riding on.

To avoid damage to the camshaft, the procedure for putting it back in is the opposite of that for removing it. Place the camshaft in position in the head, with the cam at TDC for cylinder one. Mount cam bearing caps numbers 2 and 4, making sure they're facing the right way. This is critical, as the cam bearing caps are not symmetrical, and trying to run the engine with any of the caps on backwards will



The distributor mount can bolt up two ways; make sure it is rotated as far counter-clockwise as possible so the distributor will clear the hood.

ruin the camshaft and the cylinder head.

Start four of the nuts and washers, and thread them down until they're all at the same height on the studs. Then, using a wrench, turn each nut approximately one turn in an X-pattern, gradually depressing the camshaft into position (do not worry about the cam oil line for right now).

Once the numbers 2 and 4 cam bearing caps are fully down, mount the remaining three cam bearing caps. Use two nuts on both the numbers 1 and 5 cam bearing caps, and one nut on the right side of the number 3 cam bearing cap. Once you have done this, you can remove the two left side nuts and washers from cam bearing caps numbers 2 and 4, fit the oil line,

Project 924 articles

Part 1: Introducing Project 924 (Sept. 1992)

Part 2: Buying a 924 (Oct. 1992)

Part 3: First Maintenance and General Fix-up (Nov. 1992)

Part 4: Rear Brake Shoe Replacement (Dec. 1992)

Part 5: Alternator Bushing Replacement (Jan. 1993)

Part 6: Valve Adjustment (Feb. 1993)

Part 7: Improving Hot-Start Performance (Mar. 1993)

Part 8: Cooling System Maintenance (Apr. 1993)

Part 9: Exhaust (May 1993)

Part 10: Race-Tech Head Studs (June 1993)

Part 11: Cam Belt Replacement (July 1993)

Part 12: First-Year Anniversary (Aug. 1993)

Part 13: Cooling System Revisited (Sept. 1993)

Part 14: Security (Oct. 1993)

Part 15: Suspension (Nov. 1993)

Part 16: Brake System Improvements (Dec. 1993)

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and then replace the nuts and washers to the left side of cam bearing caps numbers 2, 3, and 4. Torque all ten nuts to 14 to 18 lb/ft (18 to 25 Nm). The two additional bolts on the number 5 cam bearing cap are torqued to 7.4 lb/ft (10 Nm). Make sure the cam oil line elbow is fully inserted into the oil feed hole on cam bearing cap number 1.

14. Replacing the distributor mount

Fit a new gasket to the distributor mount and fit it to the rear of the cylinder head. Note that there are two complete sets of holes, so the mount can be attached to the head at either of two angles — only one of which is correct. If you forgot to make a diagram, examine the holes carefully. The set that has been used will often be clean, while the other set will have an accumulation of dirt inside them. The three bolts that hold the distributor mount to the cylinder head (and number 5 cam bearing cap) are torqued to 7.4 lb/ft (10 Nm).

15. Timing the engine

If the engine is still at TDC, install the cam belt so the mark on the back of the cam sprocket aligns with the pointer on the valve cover. If not, turn the engine to TDC for cylinder 1 and then proceed. If you are uncertain of the steps, refer to Project 924, Part 11, which appeared in the July 1993 *European car*.

16. Buttoning up

With the engine still at TDC for cylinder one, replace the distributor so that the rotor points toward the mark on the distributor housing, replace the cam belt cover, replace the spark plugs, replace the distributor cap and spark plug wires, and replace the valve cover, using a new valve cover gasket kit. Don't forget to reconnect the distributor to the ignition system. And, even though nothing should have changed, it is not a bad idea to run the engine until it is at operating temperature and then check the valve adjustment.

With a new set of valve stem seals, less oil will be entering the combustion chamber, which makes for a cleaner burning, better running engine. Just as important, however, reducing oil consumption makes it easier to avoid running the engine out of oil, which could result in an expensive overhaul. ☘

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