# Paruzzi Magazine

*Technical Publication for the classic Volkswagen*

07








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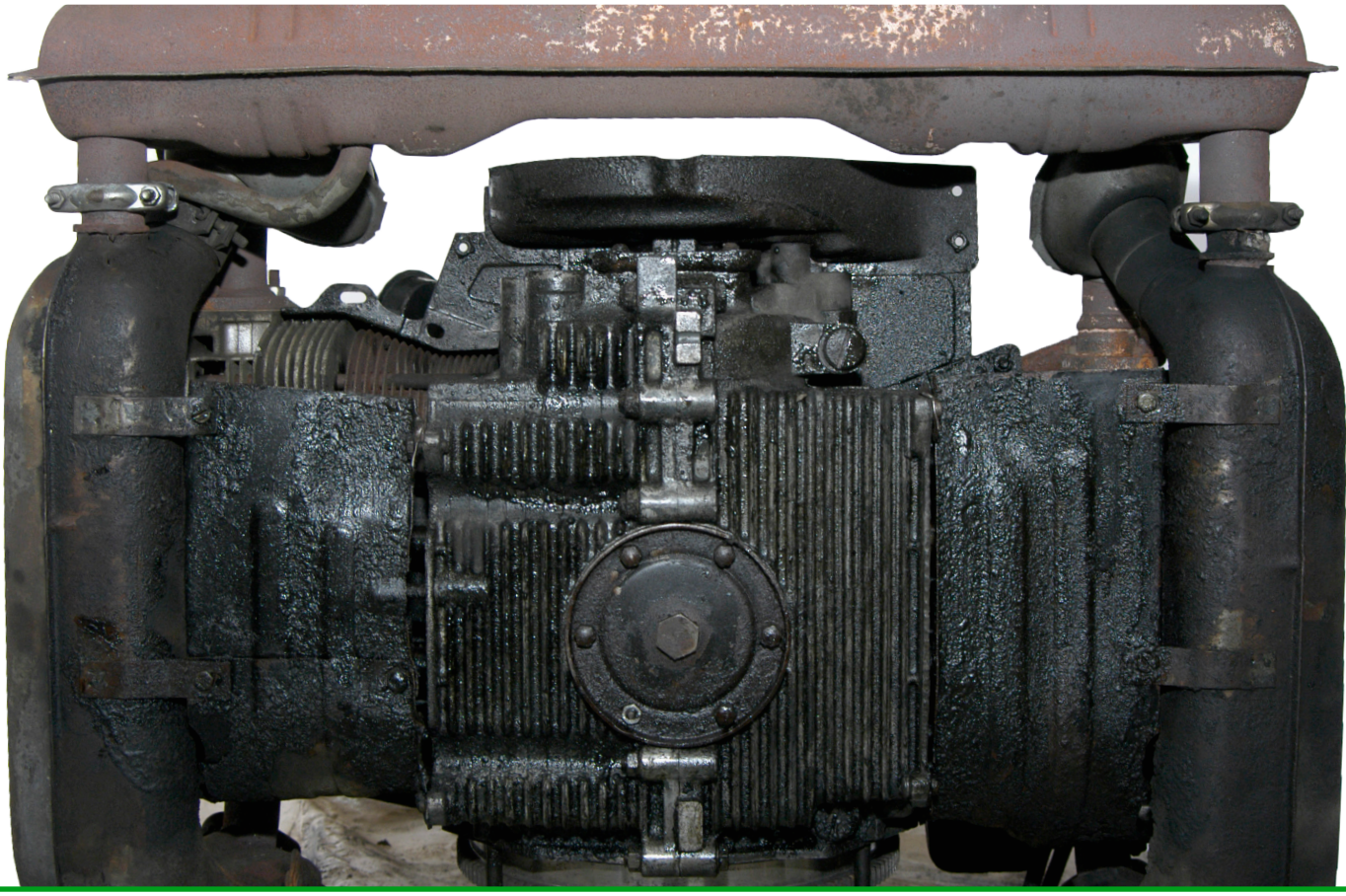
## Source of oil consumption

Looking under the engine lid is the first thing you will do when inspecting a classic Volkswagen for purchase. If you find a dirty mess under the car and under the engine lid, the car screams for attention. But, how bad is it? Do you need to plan a complete overhaul, and of course the budget that goes with it? Or will replacing a few gaskets or seals do the job? Is there an oil leakage somewhere within the crankcase, cylinders, cylinder heads, ...? Does that engine looks like the one we show on the picture below? The legend says that an air-cooled boxer engine "should" leak, it is inherent to its design. The four cylinders are horizontal, hence the name flat-4, this enhances oil leakage when the engine stands still. But, an air-cooled flat-4 engine can be leakage-free if you really want to.



# oil leakage

We will help you to find the source of oil leakage on your classic Volkswagen. Some oil leakages are easy to fix, other oil leakages will require a complete engine overhaul.

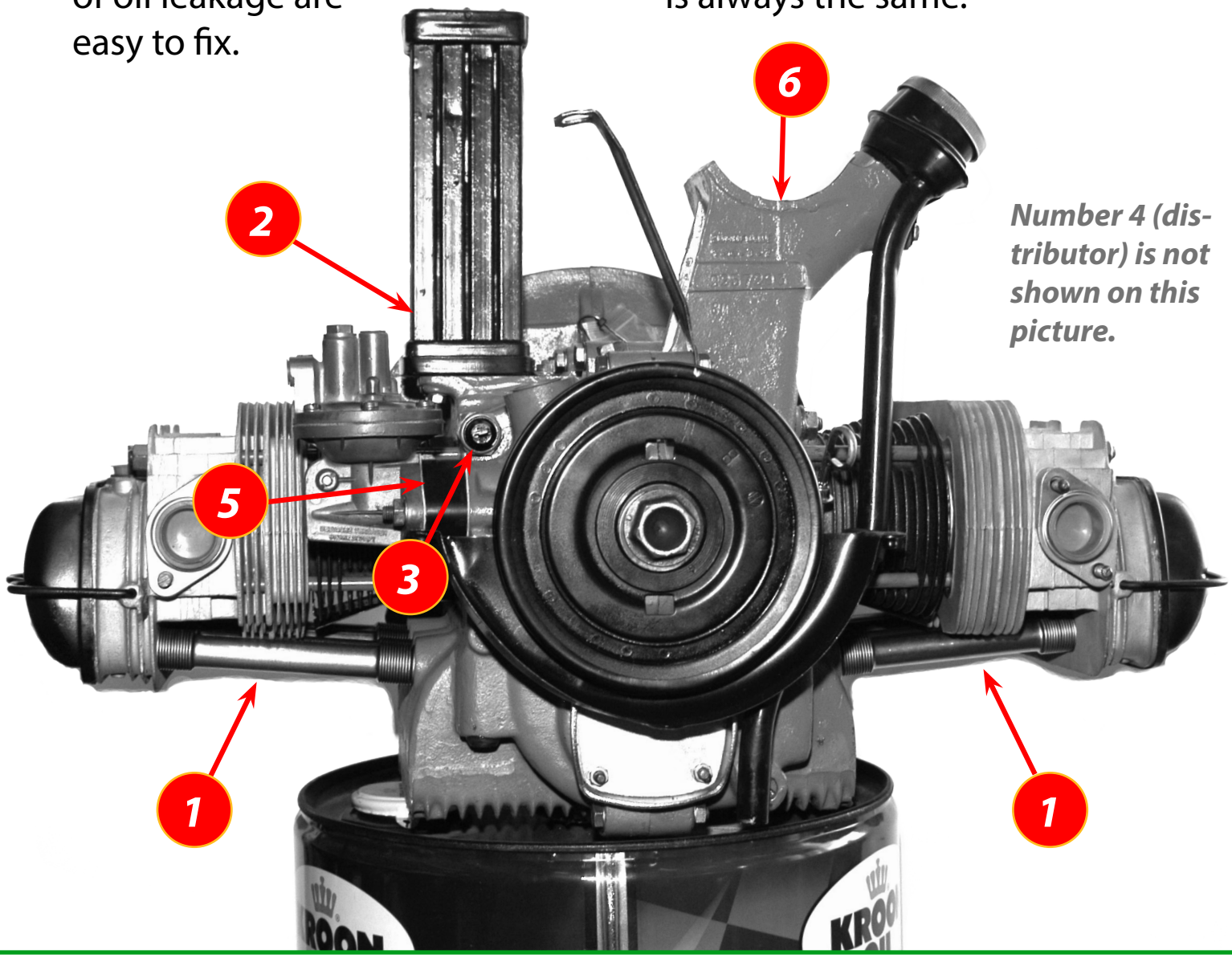
It will be necessary to clean the engine thoroughly before continuing, if possible. Once cleaned you take the car for a spin at about 3000 rpm. Oil leakage source(s) will be more visible on a clean engine.
If the engine oil level has dropped from maximum to minimum level on the oil dip stick after only 1000 km, this is a sign of high oil consumption. This doesn't always mean that the engine is consuming too much oil, but there could be oil leakages due to bad gaskets or seals. We will help you to locate the typical oil leakage sources on an air-cooled engine. We will discuss all "*easy to fix*" oil leakage sources with you now.


We will of course discuss the "*less easy to fix*" oil leakages and oil consumption sources in a future edition of this technical magazine.

# #19 Buying a VW

You need to fix any oil leakage you detect as soon as you can. An oil leakage will make your engine dirty and it will make it very difficult to see the oil leakage source(s). Any additional oil leakage will not be discovered fast on a dirty engine. Some sources of oil leakage are easy to fix.

We will show the oil leakage sources using some pictures, just as the one below. Watch the matching chapter numbers and the numbers on the pictures. We will show engines from different years, so your engine could look a little different, but the concept is always the same.




*Number 4 (distributor) is not shown on this picture.*

# oil leakage

## 1. Push rod tubes

Push rod tubes (1) can lose their sealing capacity after a few years due to rust, or because the plastic seals (1b) get hard or crack. The metal push rod tubes have to expand and shrink every time the engine gets hot and cools-off, this will cause the push rod tubes to wear down.

Oil leakage via the push rod tubes on the crankcase side or on the cylinder head side doesn't mean your engine needs a complete overhaul, it just tells you that your engine gets old or that the push rods (1a) and/or push rod seals (1b) are of a poor quality.



We show where to locate the push rod tubes on the picture on the left page. There are eight push rod tubes, two per cylinder. The push rod tubes are hidden behind the engine metal sheets under the engine.

## 2. Oil cooler seals

If you see oil dripping below the fan shroud it could be caused by the oil cooler (Type 1 engine). You can only confirm this when you remove the Type 1 engine from the car and after you remove the fan shroud. If the oil cooler is leaking for quite some time, you should also see oil leaking at the bottom of the engine. It is then very difficult to know if the leakage is caused by the oil cooler or by the crank seal on the flywheel side.

# #19 Buying a VW

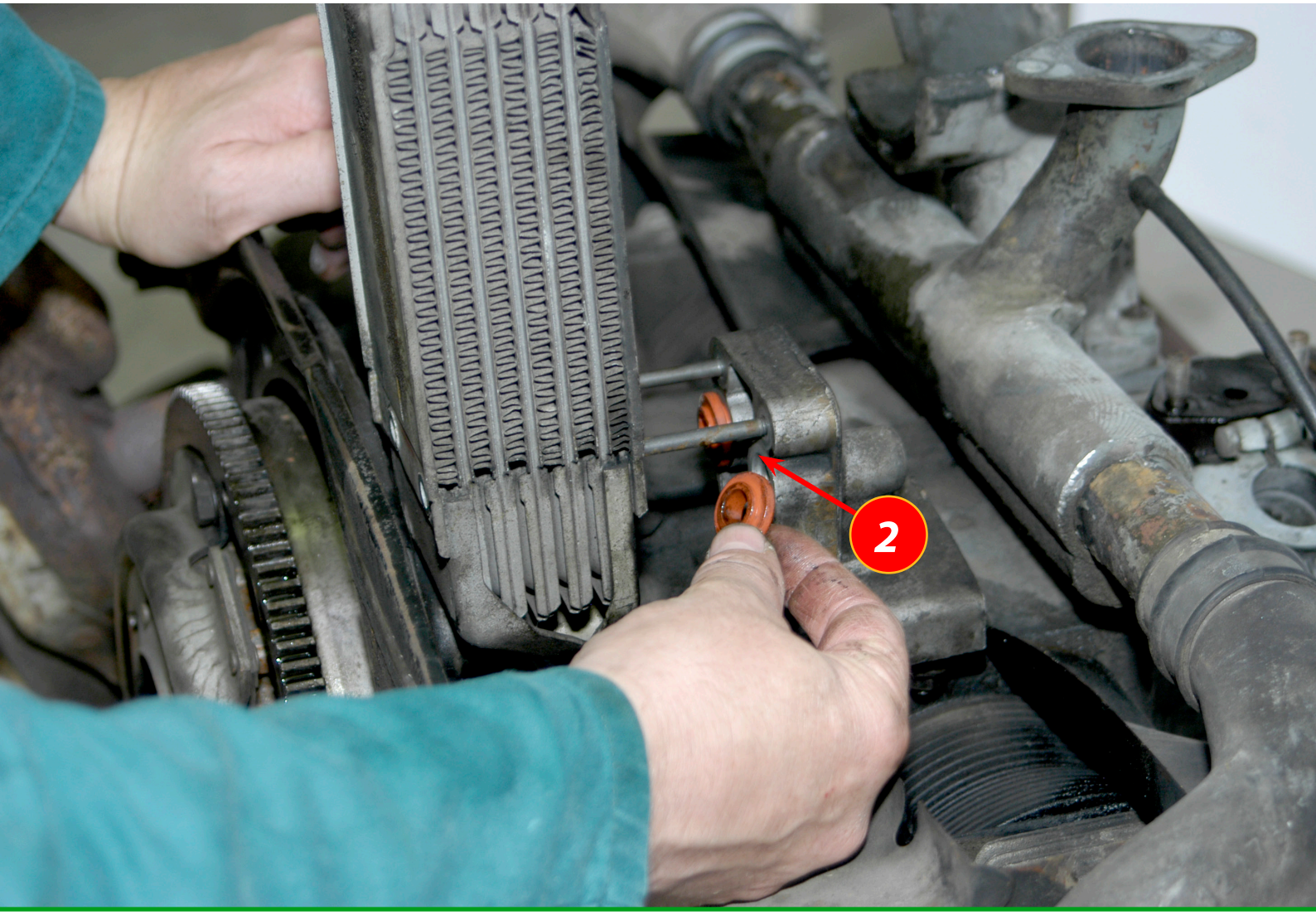
You can try to find out if there is some oil dripping on the back of the fan shroud while the engine is still in the car, if there is oil there then you could conclude that the leakage is caused by the oil cooler. Anyway, cleaning the engine carefully could help to detect the exact cause of the oil leakage.

Fixing an oil leakage from the oil cooler seals will require the engine to be removed. We show the oil cooler on a VW 1200 below and on the picture on the right page the oil cooler on a 1600 cc engine. The seals (2) are located on a different place on each engine, but the concept is the same. If the seals are cracked or hard because of the hot engine then replacement is necessary.

# oil leakage

The engine oil is thick in a cold engine and shouldn't pass through the oil cooler. If the oil pressure regulation is broken, it will cause a high pressure in the oil cooler, this will damage the oil channels and cause leakages. The oil pressure control valve can be broken, this doesn't happen too much though.

Removing some metal sheet is enough on the Type 3 and Type 4 engines to replace the oil cooler seals, so you don't need to remove the engine. You will need to remove the fan shroud on a Type 1 engine which means you need to remove the engine. We explained all VW engine types in edition 02 on page 2, just have a look if you need to know more about this.

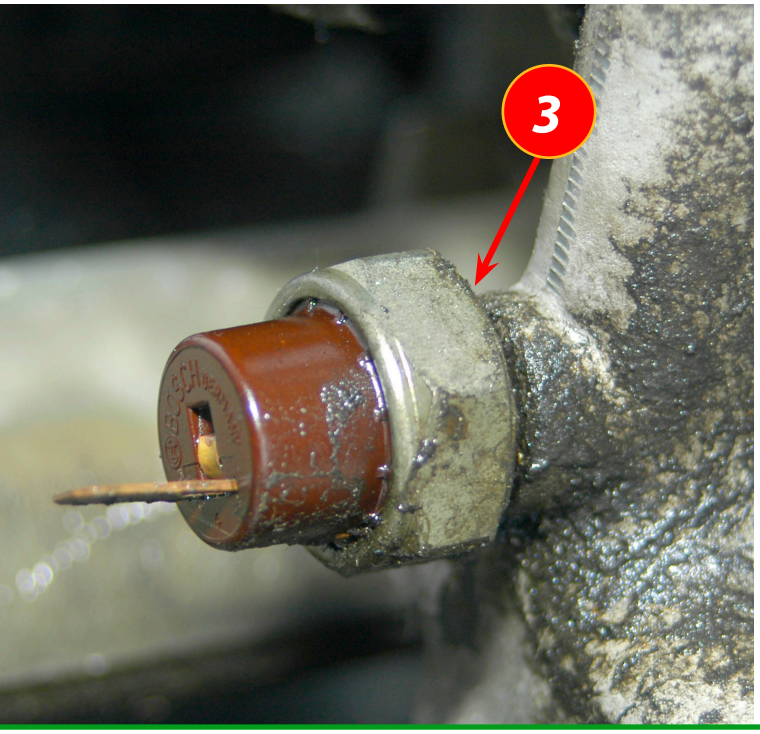


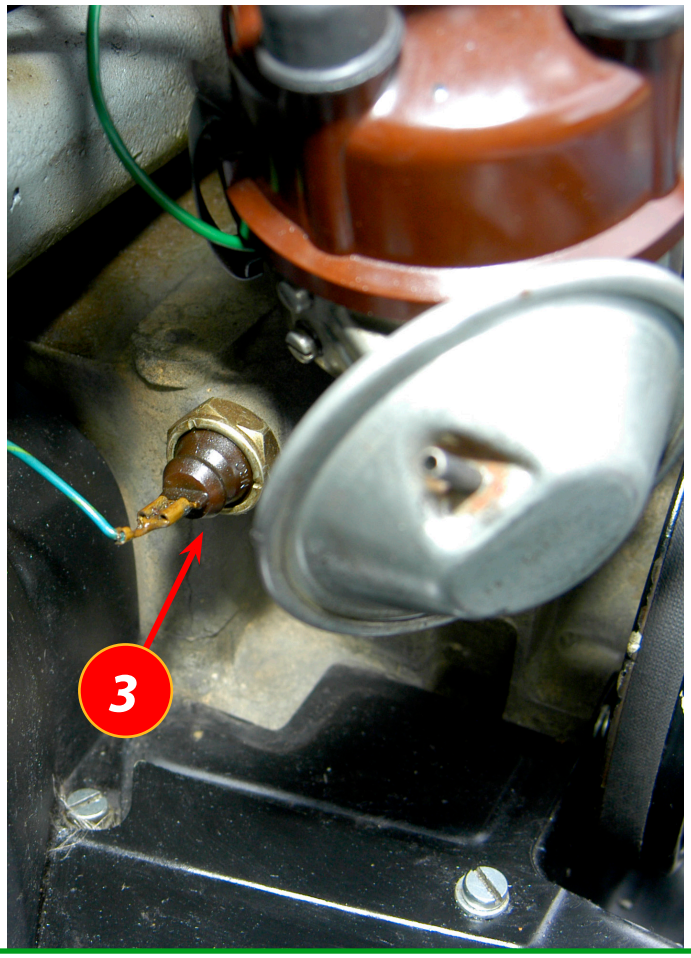
## 3. Oil pressure switch

Oil leaking from the oil pressure switch (3) is quite common. There could be a small crack in the crankcase, or the switch is not well secured, or it is too tight, or the switch is damaged.

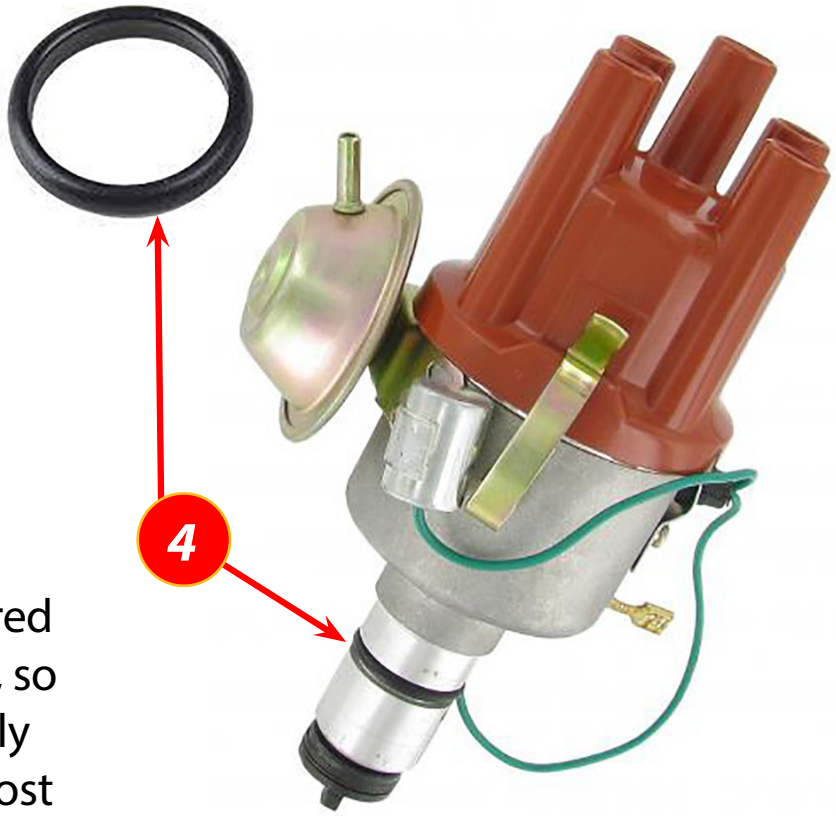
We see that VW enthusiasts tend to tighten the oil pressure switch too hard, this can damage both the switch and the crankcase.

The oil pressure switch has a conical shaped fitting, you can install the switch without gasket or seal, the oil pressure switch will seal without having to put too much momentum. Use a small torque wrench to secure the switch with 10 Nm, not more. The oil pressure switch will not fully touch the crankcase but that is normal.

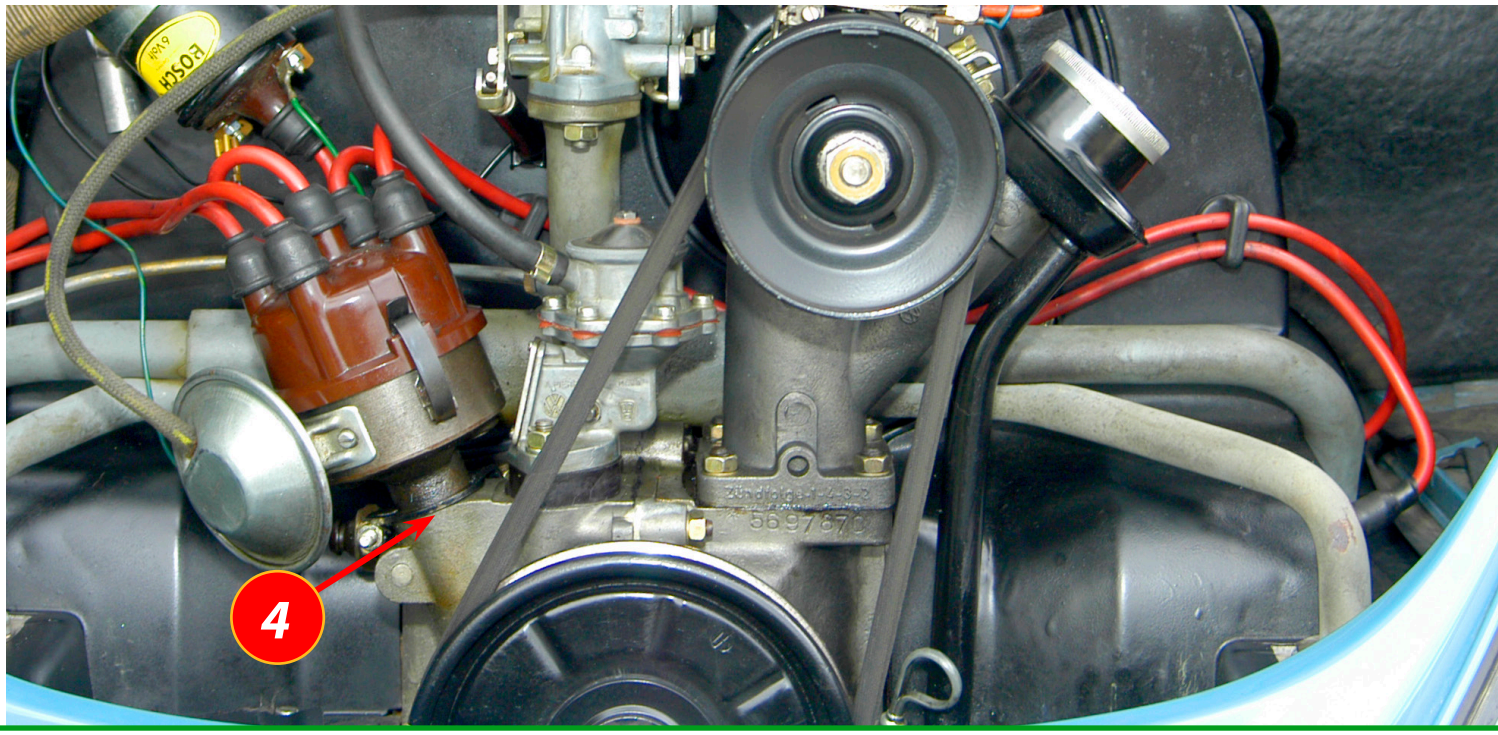


## 4. Distributor

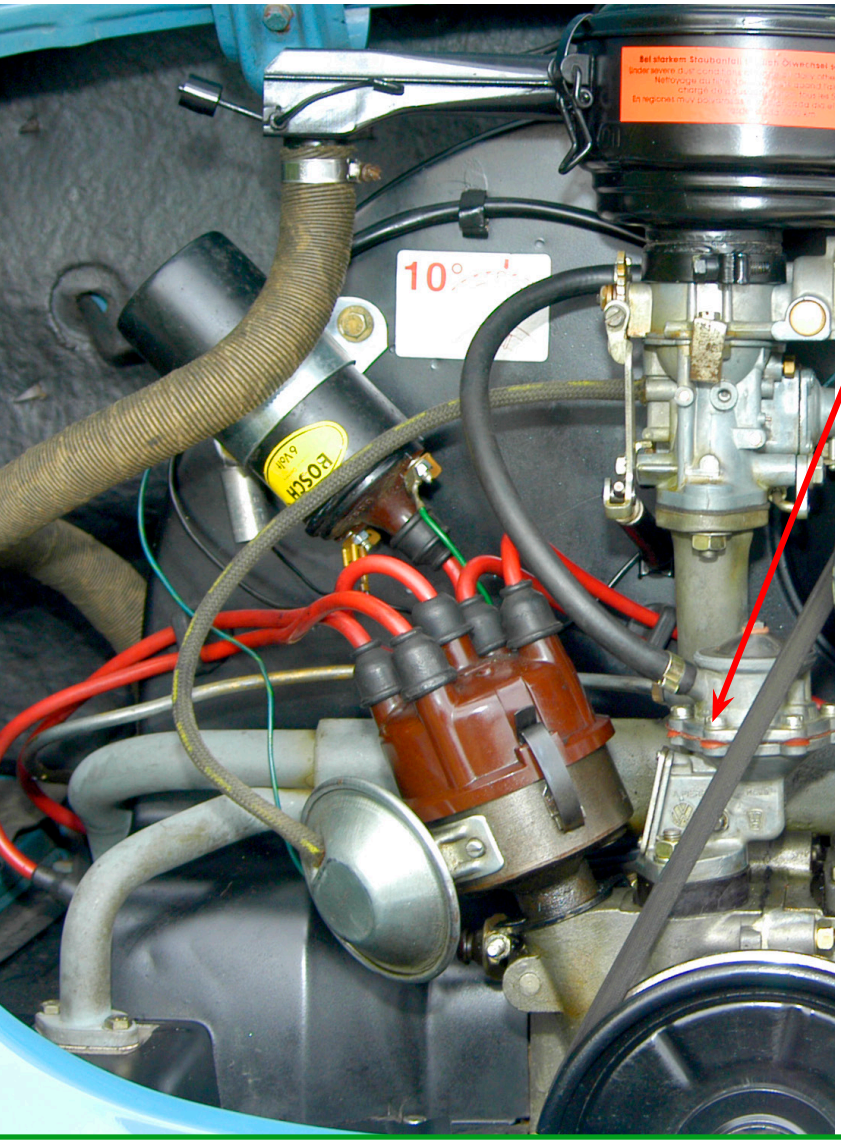


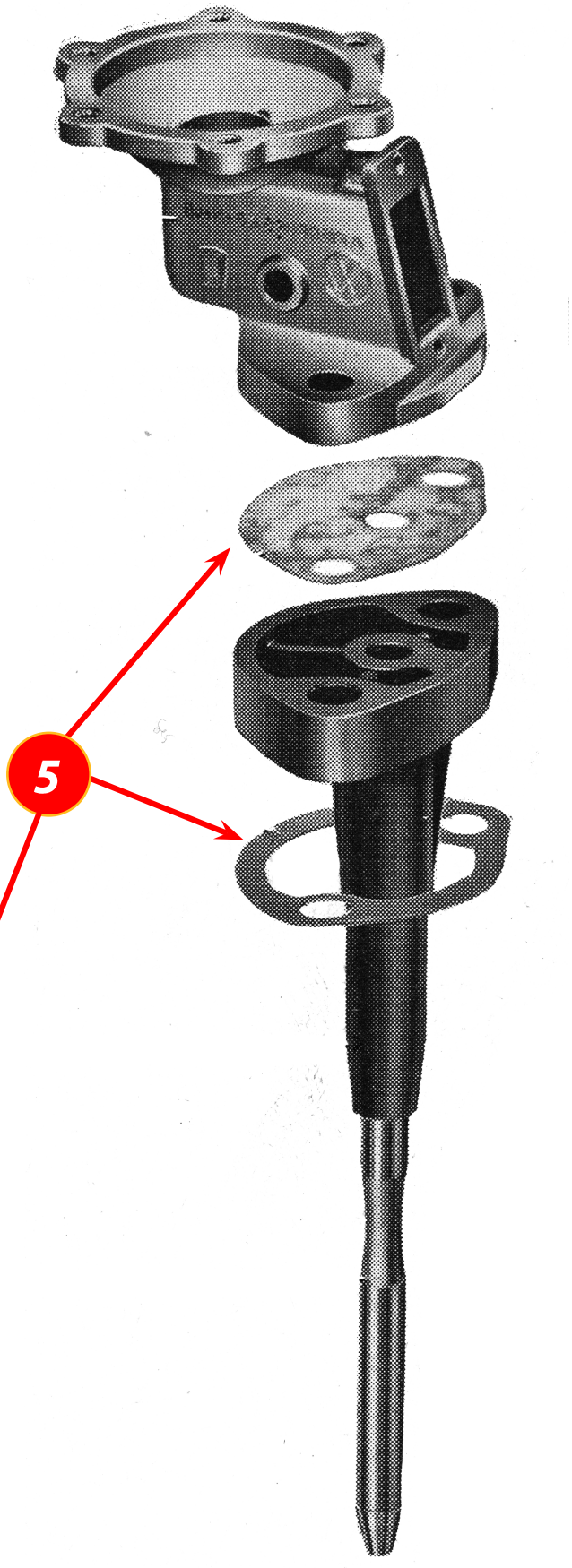

Oil can leak via the distributor drive shaft seal. The bottom of the distributor fits into the crankcase, the distributor drive shaft is driven and lubricated by the engine. You don't want that the engine oil leaves the crankcase, so a rubber seal (4) is installed on the drive shaft. This rubber seal is not always delivered together with a new distributor, so don't forget to order it separately if necessary. The seal might be lost or is worn out. Anyway, if your distributor leaks oil, check the drive shaft O-ring (rubber seal).

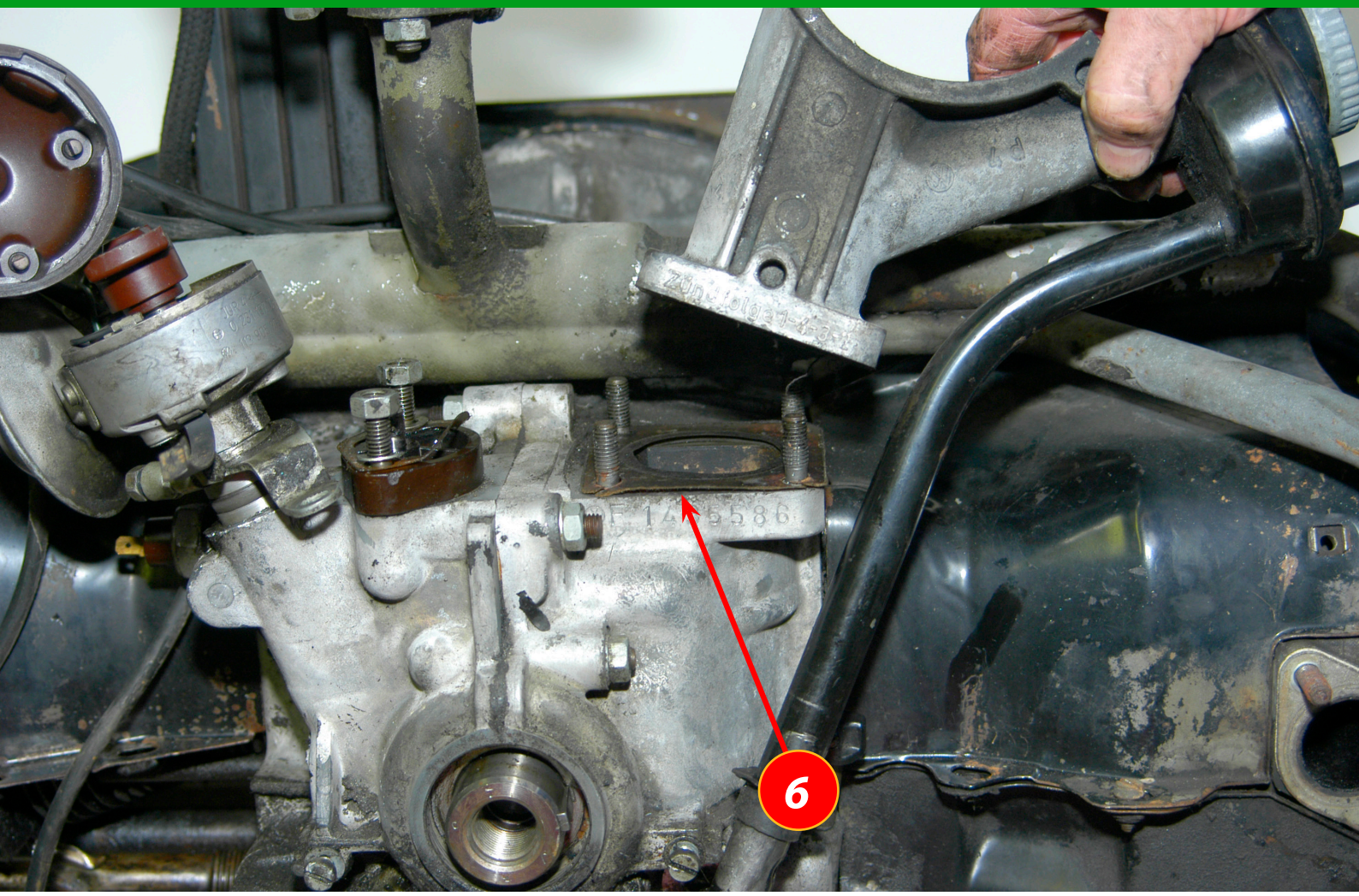


## 5. Fuel pump

The fuel pump drive shaft also gets its lubrication from the engine oil. The visible part should stay dry, that is why two gaskets (5) are installed, one below the fuel pump flange and one above. An oil leakage can be caused by bad gaskets or also by a broken fuel pump flange.





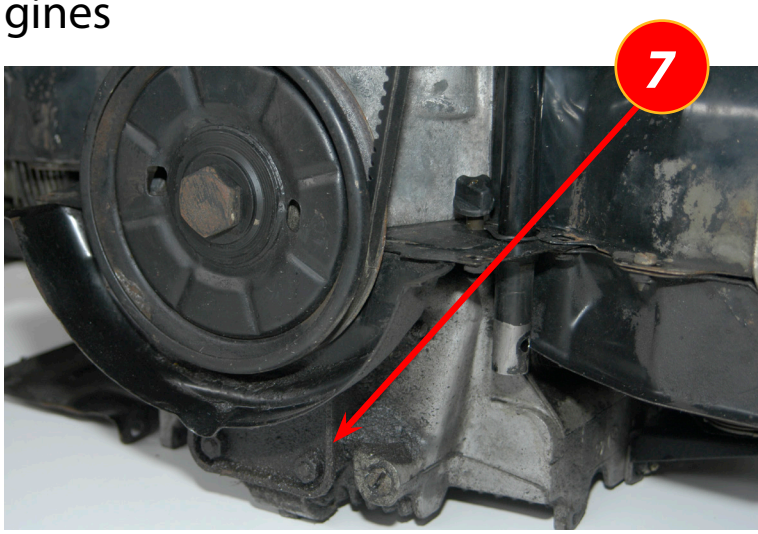

## 6. Generator stand

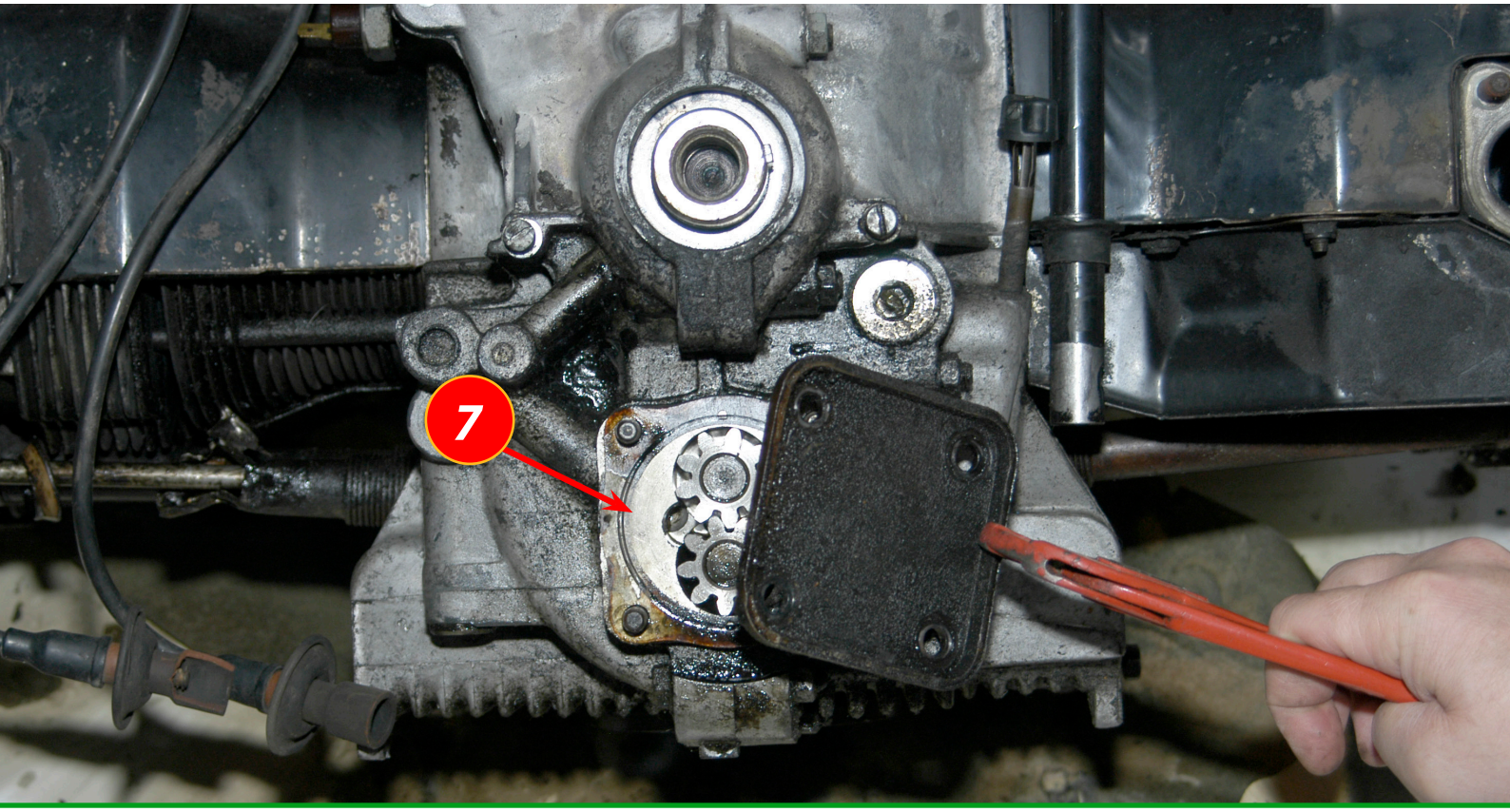
The generator stand (generator= dynamo or alternator) on the oldest VW's is not removable, it is one with the crankcase. We show that type of engine on the first page of this article, the generator stand is marked as number 6 on that picture. No oil leakage possible on these early engines. All later engines have a separate generator stand, mounted onto the engine crankcase. A gasket (6) is installed on the bottom of the generator stand to avoid oil leakage, more than one gasket is used on some type of engines. A paper gasket is used on engines until August 1967, a metal gasket is used on engines starting August 1967.

## *7. Oil pump*

The oil pump (7) is located below the crankshaft pulley (on Type 1 and Type 3 engines). The oil pump is located behind the fan on Type 4 engines. An oil leakage can occur via the gasket between the oil pump and the crankcase or via the gasket between the oil pump and the oil pump cover. Replacing the gasket should solve the leakage problem, if the oil pump cover is not bent beyond repair of course.

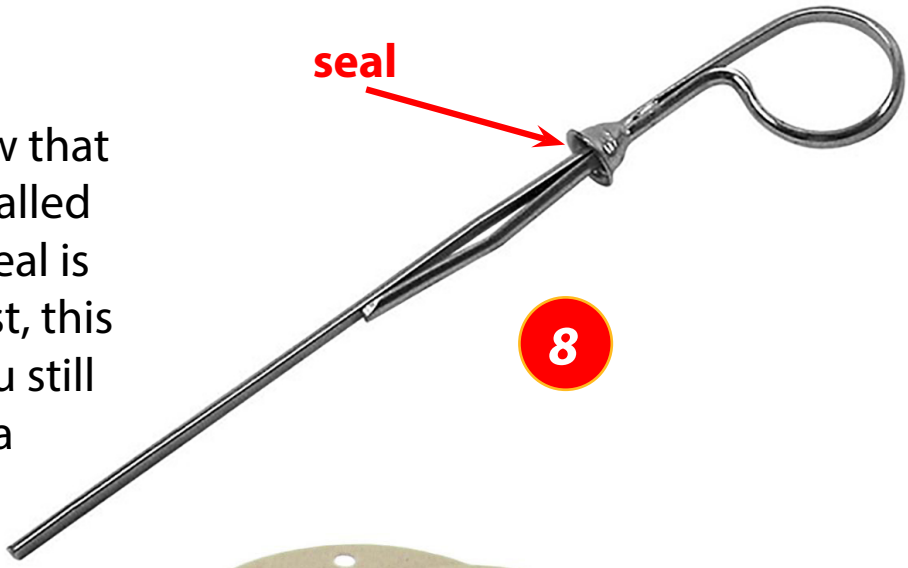
You will need to remove the crankshaft pulley on Type 1 engines to replace the oil pump gaskets. You will need to remove the fan on Type 3 or Type 4 engines



## 8. Oil dip stick

Not many VW owners know that there is a small seal (8) installed on the oil dip stick. If this seal is not present anymore or lost, this will cause oil leakage. If you still experience oil leakage via a new oil dip stick seal you may have too much pressure in your engine, or the crankcase ventilation is not sufficient. We will discuss both issues in a future edition of this technical magazine.



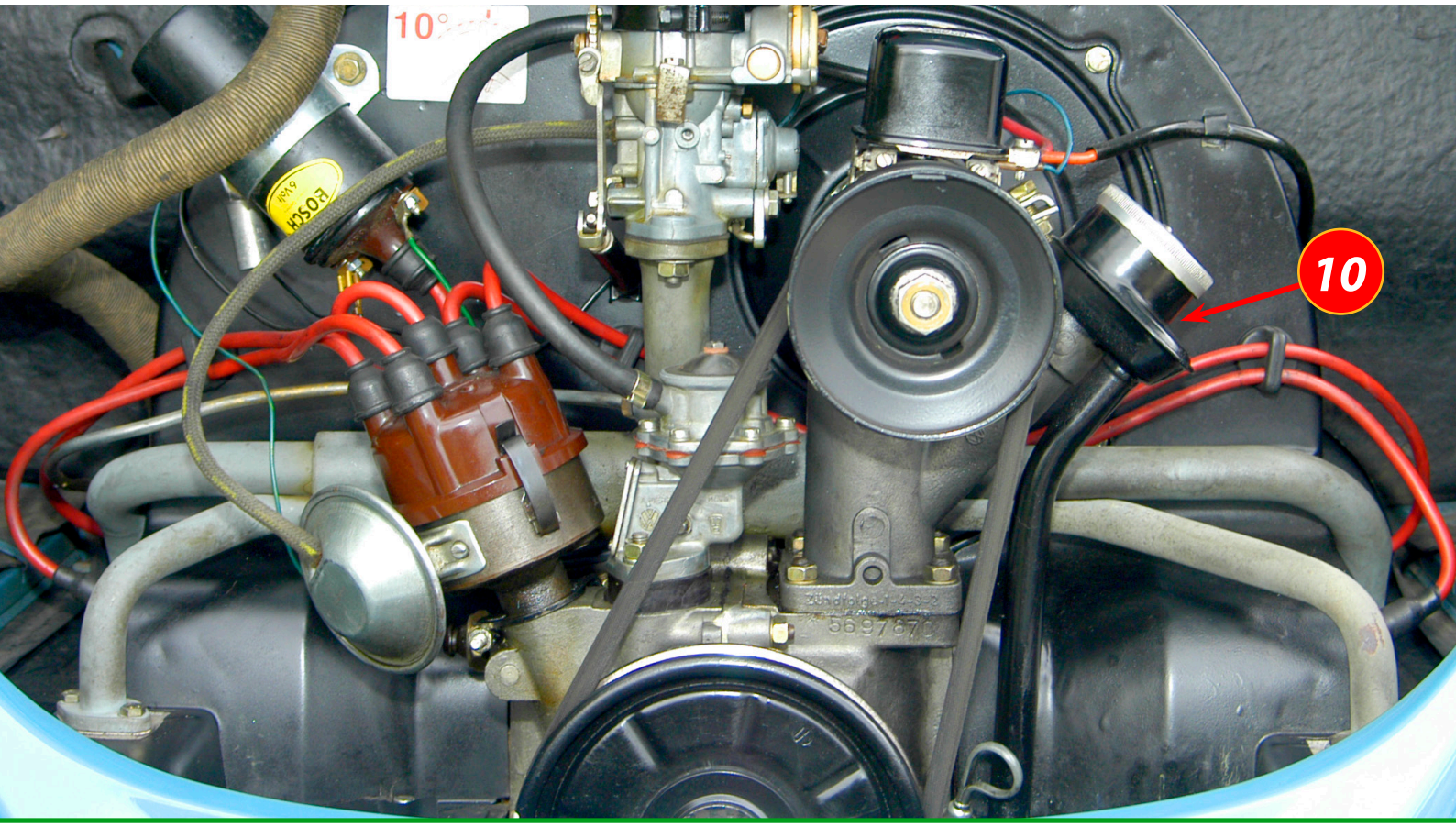



## 9. Sump plate

Oil can leak (9) via the small copper washers, paper gaskets or via the big copper washer from the drain plug (the drain plug is not present on all engine types). The oil leakage caused by a default of the sump plate seals can generate a massive oil loss. Replacing the copper washers and gaskets should solve the issue, if the sump plate is not bent of course.


## *10. Oil filler cap*

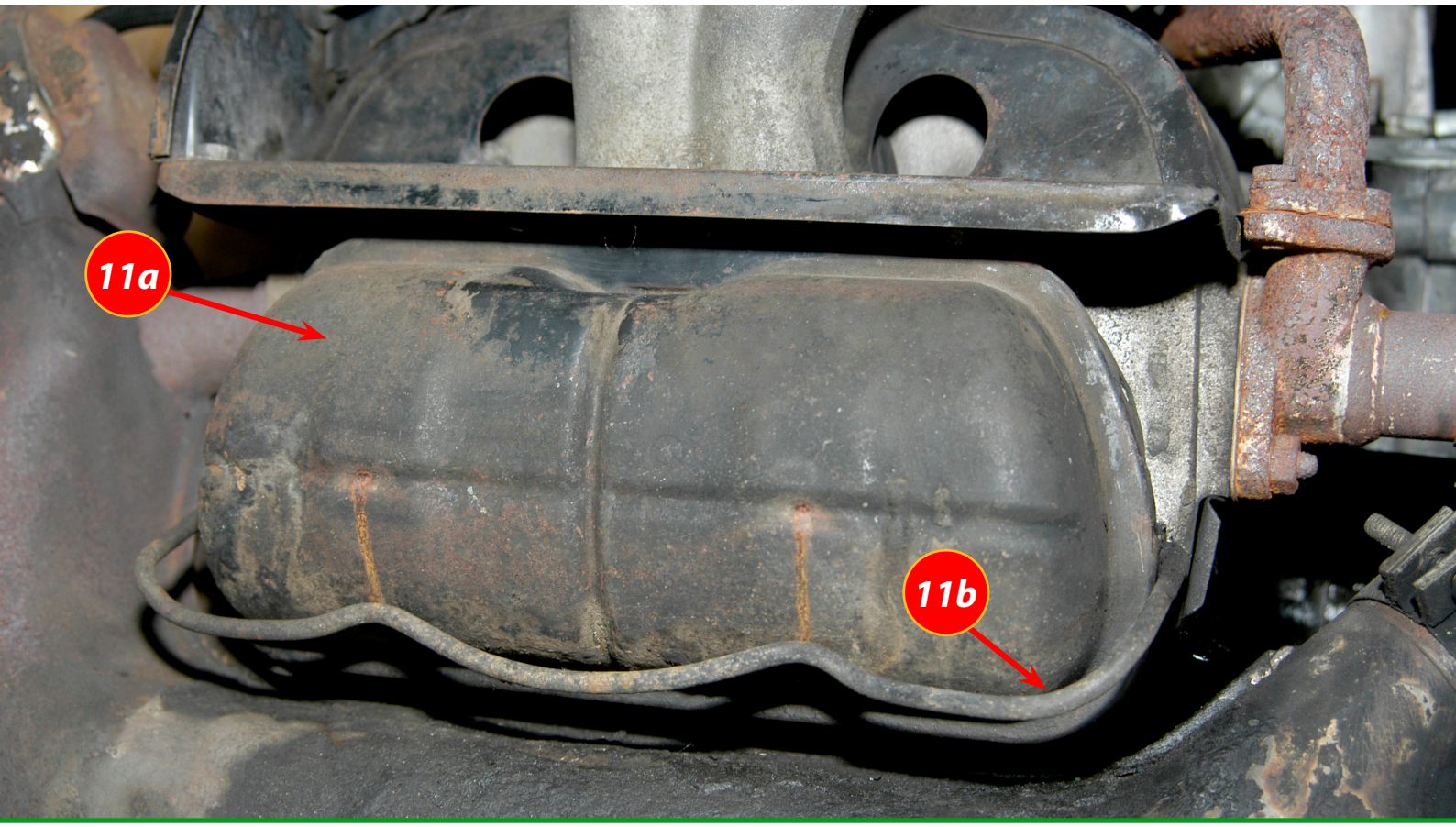
Oil leakage occurs frequently via the oil filler cap (10). Some are metal caps, so very sensitive to corrosion. The condensation from the engine tends to stay within the oil filler cap and creates rust. The cap gasket should be in good shape to guarantee a 100% seal. We talk more about the condensation issue in the engine in a future article.



## 11. Valve cover

Engine oil can leak via the valve cover gasket (11a). The leak can also be generated by bent valve cover bails (11b). You can replace the valve cover bails with new ones, trying to "reshape" the worn-out bails will not be successful in many cases because the metal the bail is made from will lose its elasticity after some years.

Bad valve cover gaskets (11c) or a bent valve covers can generate massive oil loss at idle, so driving at full speed could damage your engine. Keep track of any small oil leakage around the valve cover area, as this is crucial for your air-cooled engine.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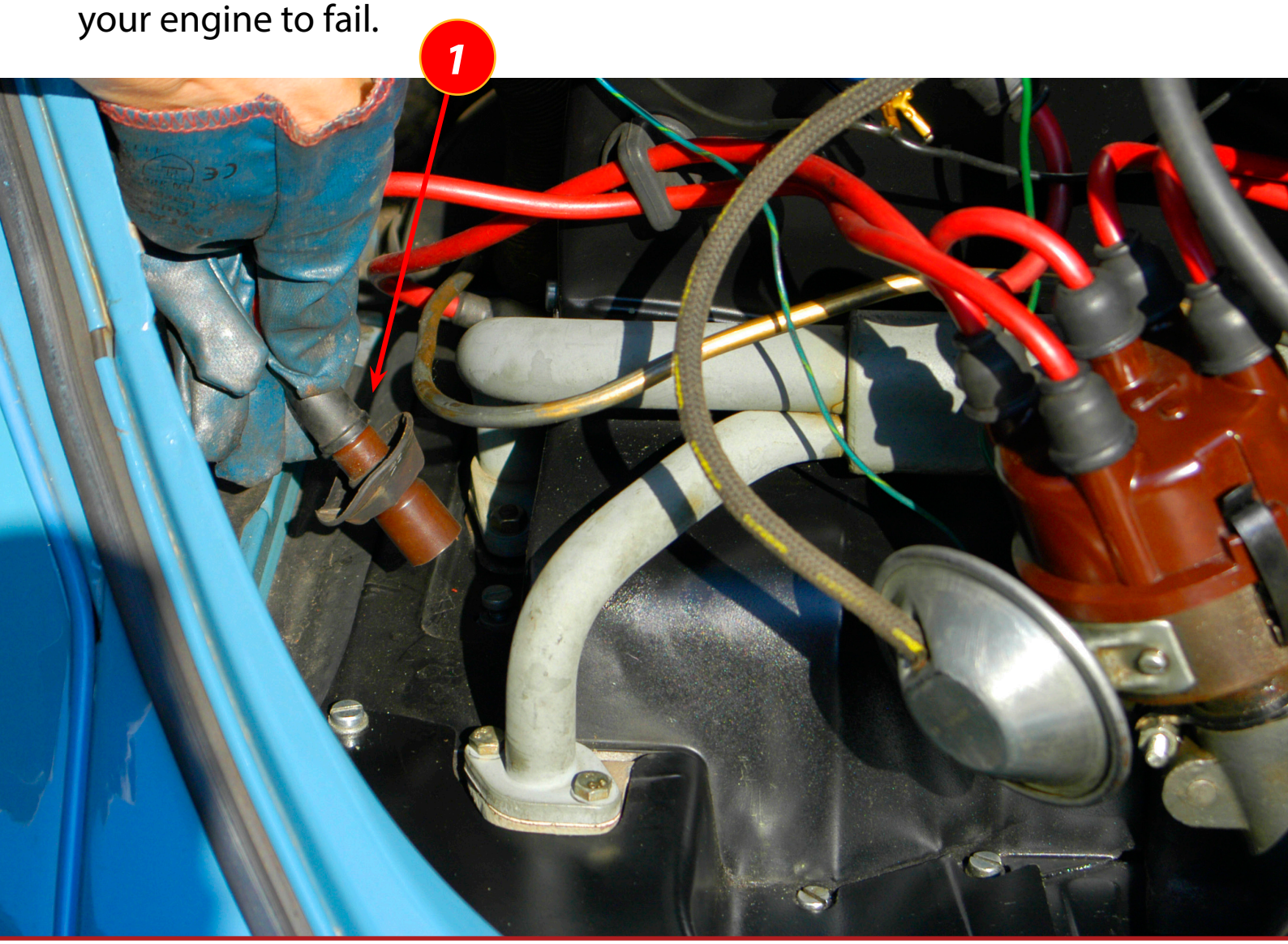
## Remove the spark plugs

Replacing the spark plugs on a classic Volkswagen seems to be a routine job. We experience that a few things can go wrong while removing the spark plugs and also while installing the new spark plugs. The spark plugs are an essential part of the ignition circuit, if they fail it can cause your engine to fail.

We advise to remove the spark plugs when the engine is cold. First, working on a hot engine is hazardous, you may burn your hands or arms badly. Second, the spark plugs are easier to remove when the engine is cold.



# spark plug installation

You need to remove the spark plugs while the engine is hot (at operating temperature) to measure the engine compression, read the feature about measuring the engine compression in edition 06.

You will need to unplug the ignition wires to be able to remove the spark plugs (1). Only use the spark plug boot (1) to pull the ignition wire, never pull the ignition wire. Pulling the ignition wire could damage the wire or in worst case brake the cable.

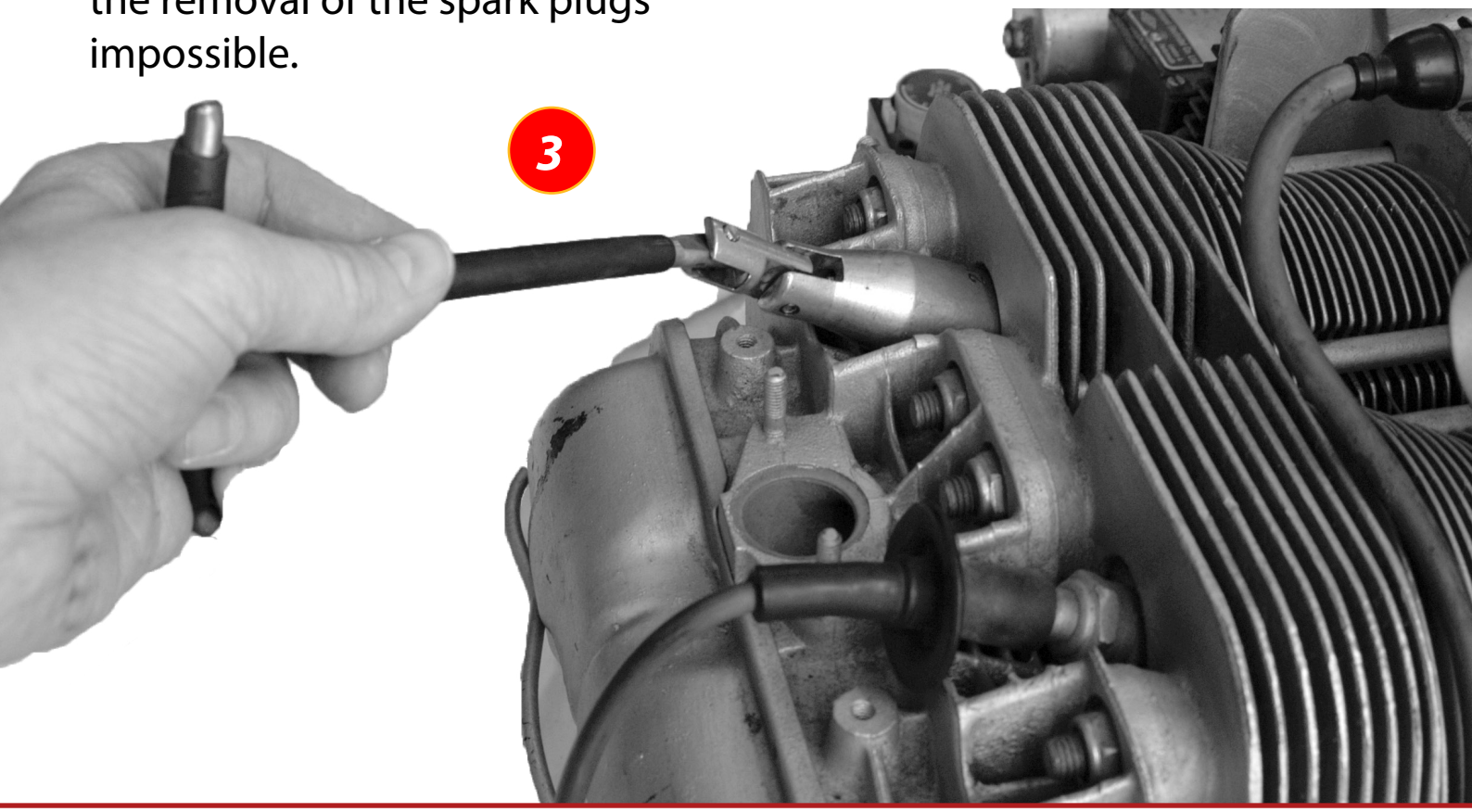

If you are not very familiar with the cylinder numbering and how the ignition wires should be connected from the distributor to the spark plugs, just use labels to mark the ignition wire cable that you just unplugged.

Remove the spark plug using a spark plug wrench as shown below (2). This wrench has a T-shaped swivel handle for easy access to the difficult to reach air-cooled spark plugs (2). The rubber insert of this special spark plug wrench protects the spark plug insulator. If you use a general purpose socket wrench without a rubber insert, you will damage the fragile spark plug insulator. The rubber insert will also help to remove the spark plug from the cylinder head, the spark plug should "stick" to the wrench so to say, it will avoid the typical beginners error of losing the spark plug under the engine metal sheet.

Remove the spark plug now using the special spark plug wrench (3). A spark plug can be very resistant after some years of hard work, you will need to use some force in many cases. It is very difficult to reach the spark plugs on the younger VW Beetle models and the Type 4 engines. The fuel injection engines are probably the most difficult ones I worked on, you will need to remove some engine parts before your can reach the spark plugs. Don't hesitate to remove hot air tubes or anything that will make the removal of the spark plugs impossible.

Take your time to do this, this is an important job that needs to be done with care, we are working on old cars remember.

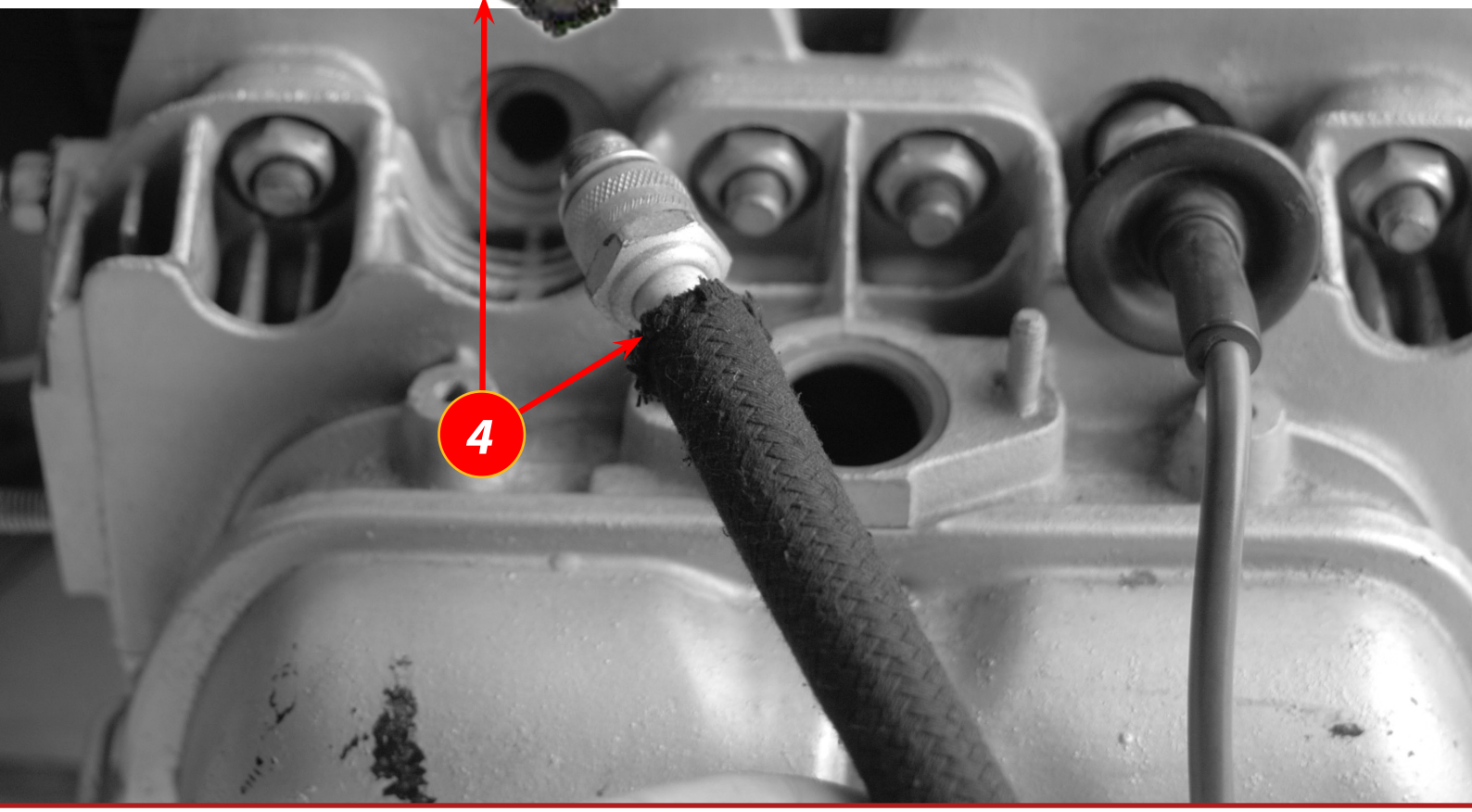
If your Volkswagen has a high mileage or if it didn't get timely maintenance, then you could have troubles removing the cylinder 3 spark plug, this is the cylinder that gets the most heat on a Type 1 engine. If the previous owner used grease to ease the installation of the spark plugs, this can cause the spark plugs to get stuck.



# spark plug installation

Grease will have the opposite affect of what one would imagine, because of the extreme heat in the cylinder head.

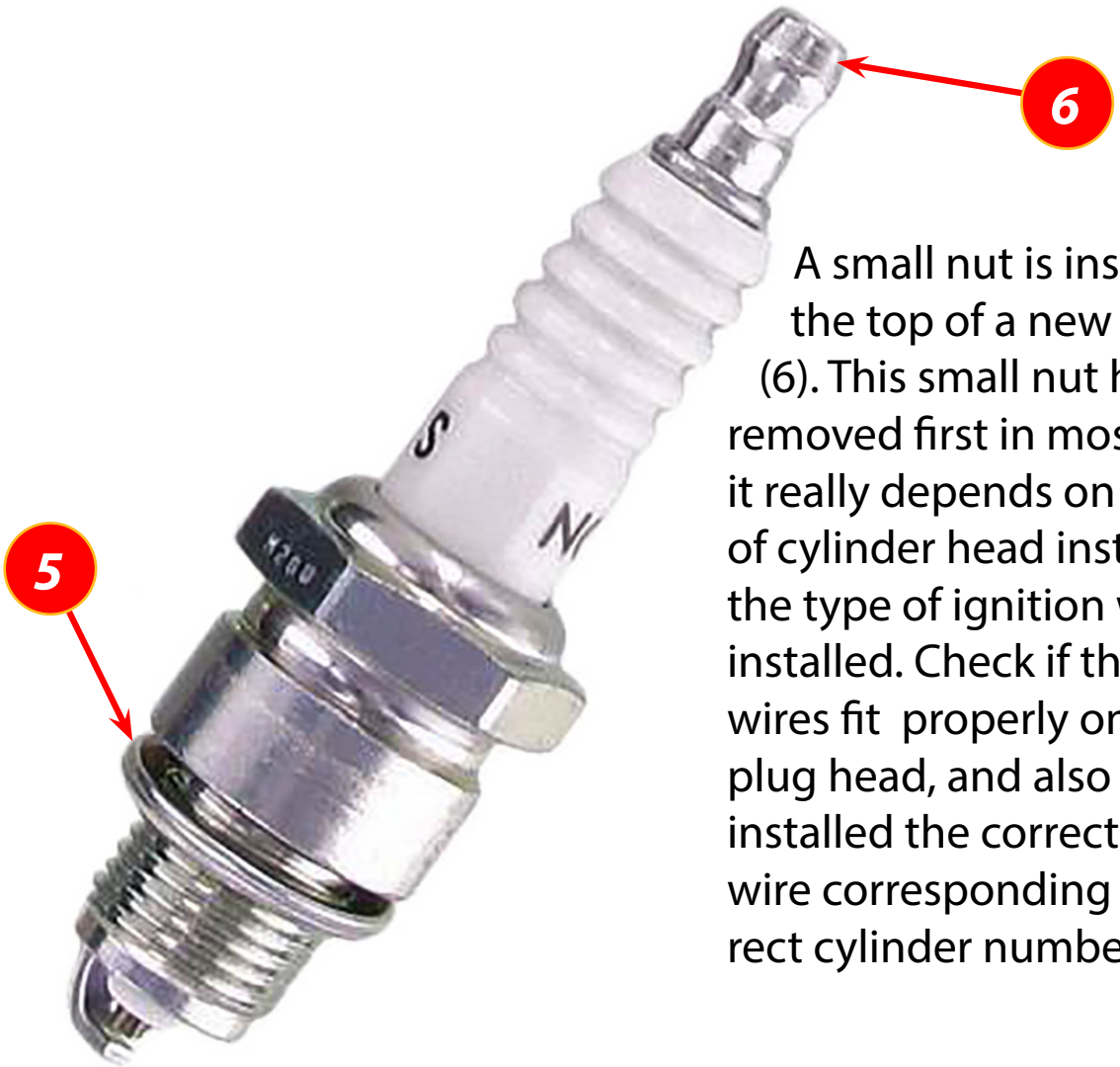
Once the spark plug is loose it should be possible to rotate the spark plug without the wrench. I tend to use a fuel hose (4) to remove the spark plugs once the hard work has been done by the special wrench. This special technique will allow you to remove the spark plug without forcing, if at some point you encounter a difficult point when removing the spark plug you tend to use force using the wrench, this could damage the spark plug thread in the cylinder head. Remember that the cylinder head is made of aluminum (or contains aluminum) which is a very soft material. You are not able to use great force with the fuel hose, and you will never lose the spark plug.



## Installing the spark plugs

Check the seal or shim (5) of the spark plug before installing, if the seal is already completely compressed you shouldn't reuse it. Use a new shim or a completely new spark plug if you figure that the spark plug is not reusable.

Don't use general purpose grease to facilitate the installation of the spark plug, you may use a little graphite grease if necessary. The use of grease has the opposite effect as we mentioned earlier, the high operating temperature in the cylinder and the cylinder head will cause the spark plugs to seize.

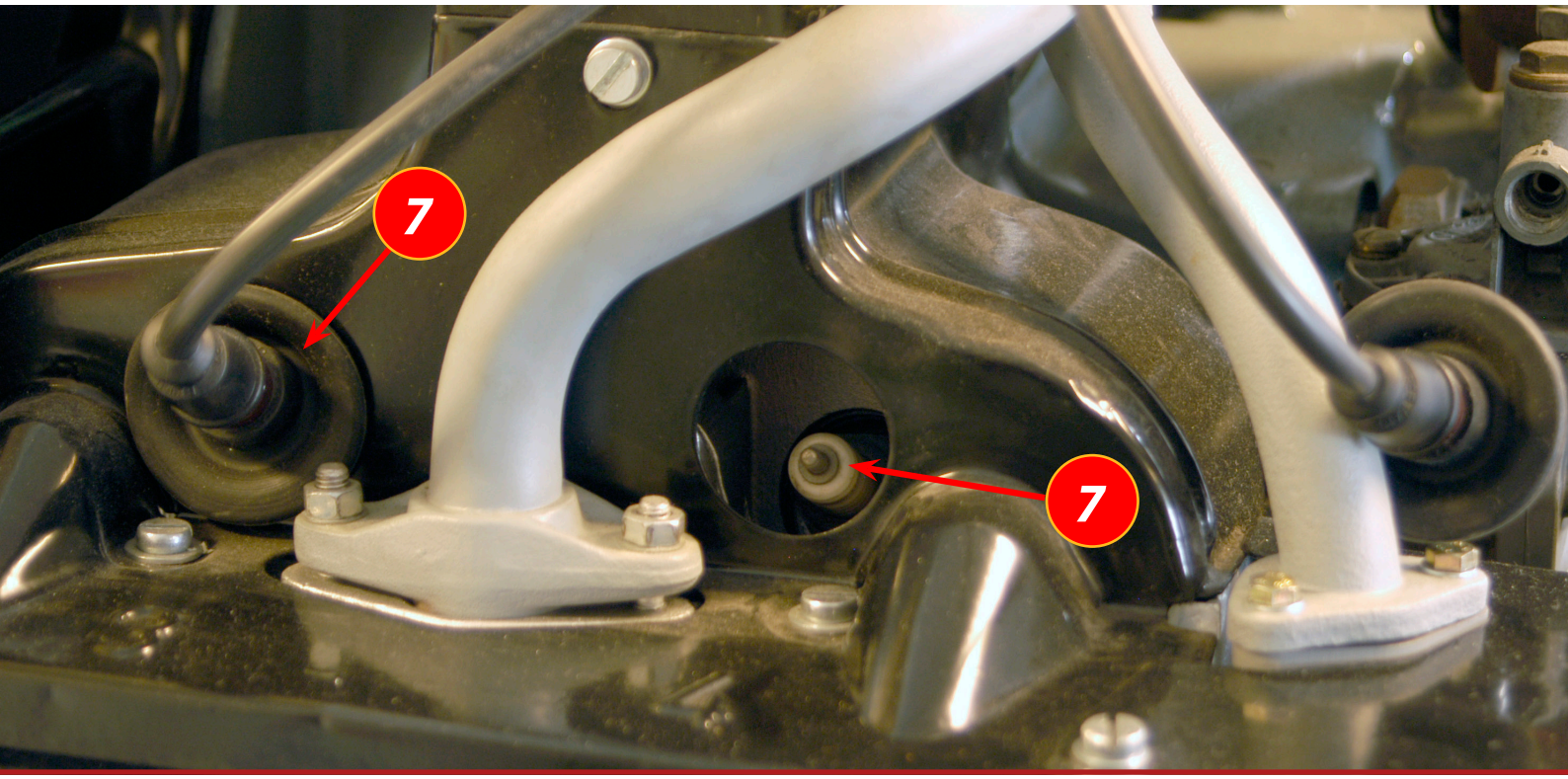



A small nut is installed on the top of a new spark plug (6). This small nut has to be removed first in most cases, it really depends on the type of cylinder head installed and the type of ignition wire boots installed. Check if the ignition wires fit properly onto the spark plug head, and also check if you installed the correct ignition wire corresponding to the correct cylinder number.

# spark plug installation

We insist to not tighten the spark plugs too hard. First tighten the spark plug by hand or using the fuel hose as described earlier. Once installed by hand, rotate an extra 1/8 to 1/4 turn using the special spark plug wrench. If you install a spark plug that has already been used, the shim (5) has already been compressed, rotating an extra 1/8 turn is plenty, 1/4 would be too much. The engine gets very hot, so the spark plug will expand and tighten even more.

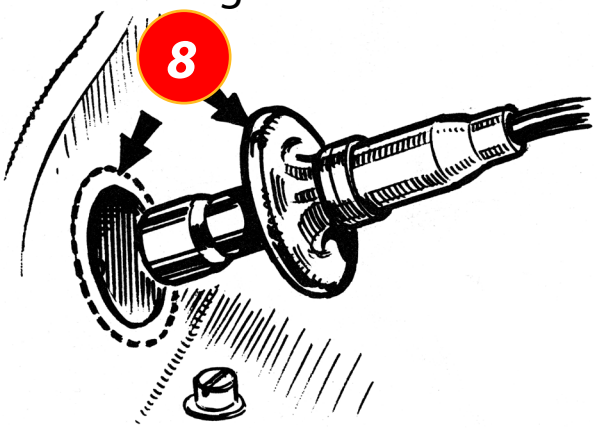
When installing the spark plug using the fuel hose trick, make sure the spark plug faces the cylinder head opening in a right angle. Rotate slowly clockwise until the spark plug thread grabs the cylinder head thread. Never force it! The fuel hose trick will help you with that, if there is too much resistance, the fuel hose will slip. We show in the picture below (7) the small space you have to work in to install the spark plugs, be patient, it's worth it.



If you feel too much resistance, just rotate the spark plug counterclockwise and then back clock wise until you feel the resistance getting smaller. If the resistance persists, remove the spark plugs and check if dirt has accumulate on the spark plug thread, in worst case try to clean the cylinder head thread by blowing some pressured air into the spark plug hole. Also make sure the spark plug thread is not damaged. You don't want to damage the cylinder threads believe me.


The spark plug should not be forced too hard! A "soft" last rotation at the end of the installation is more than enough as explained earlier. When installing the ignition wires, make sure the ignition wire boots are secured properly. Double check if the matching wire is connected to the matching connection on the distributor, and you are almost ready to go.

Check if the rubber seals (8) are in good shape so to seal the ignition wire onto the engine metal sheet. Don't hesitate to replace the seal if it is cracked or harden as shown on picture 9. Replacing the complet ignition wire set is the best thing to do then.

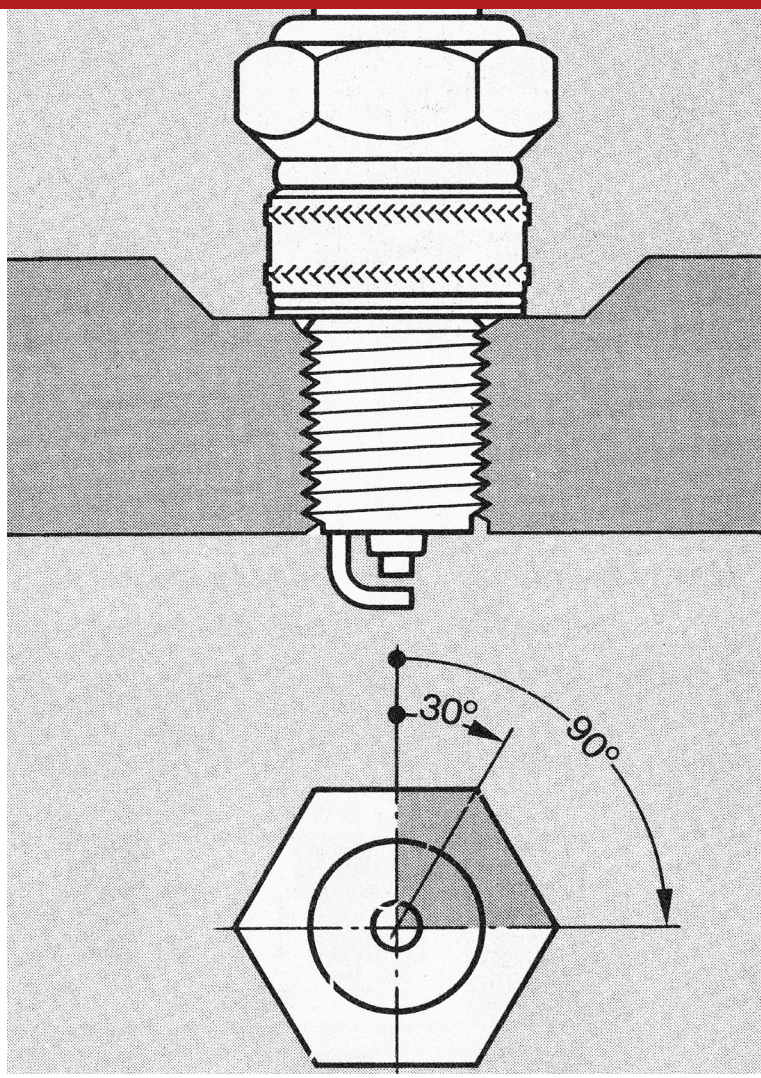


# spark plug installation

## How tight?

*A new spark plug should be installed using 30 Nm to 35 Nm torque, as advised by VW and Bosch manuals. It is very difficult though to impossible to use a torque wrench in the small space between the car body and cylinder head in our air-cooled VW..*

*This drawing we received from Bosch should help us to install new or already installed spark plugs correctly. A used spark plug needs to be rotated an extra 30° after being tighten by hand. A new spark plug needs an extra 90° turn. This is equivalent to the 1/4 and 1/8 extra turn we explained earlier. So, make sure you understand that used or new spark plugs need to be handled differently to allow the seal or shim to work properly!!!*





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## VW engine types

The cylinder head is for sure one of the air-cooled Volkswagen engine parts that gets the most stress. The valves, valve guides and valve seats get very hot, the temperature changes and the mechanical stress is very high. The air-cooled boxer engine design causes these issues, but this should be no problem if the engine is healthy.

If you experience power loss, blue exhaust, an irregular running engine or unfamiliar engine sounds, then your cylinder heads could be faulty, best case replacing the heads will solve the problem, worst case you will need to overhaul the engine. These problems can occur because of the mileage of the engine, because of wrong tuning of the ignition or the carburetors or because of bad maintenance in general.

We have some information that relates to this article about cylinder heads. We explain all about the cylinder head valves in edition 04, edition 05 explains how to set the valve clearance and edition 06 explains how to measure the compression.

We want to start now with a brief overview of the cylinder head types that are used in the Volkswagen air-cooled engines. These are the three most important types (as shown on the picture on the right page):

1. *25/30 hp (until 1964)*
2. *Type 1 (1200, 1300, 1500, 1600)*
3. *Type 4 (1700, 1800, 2000)*

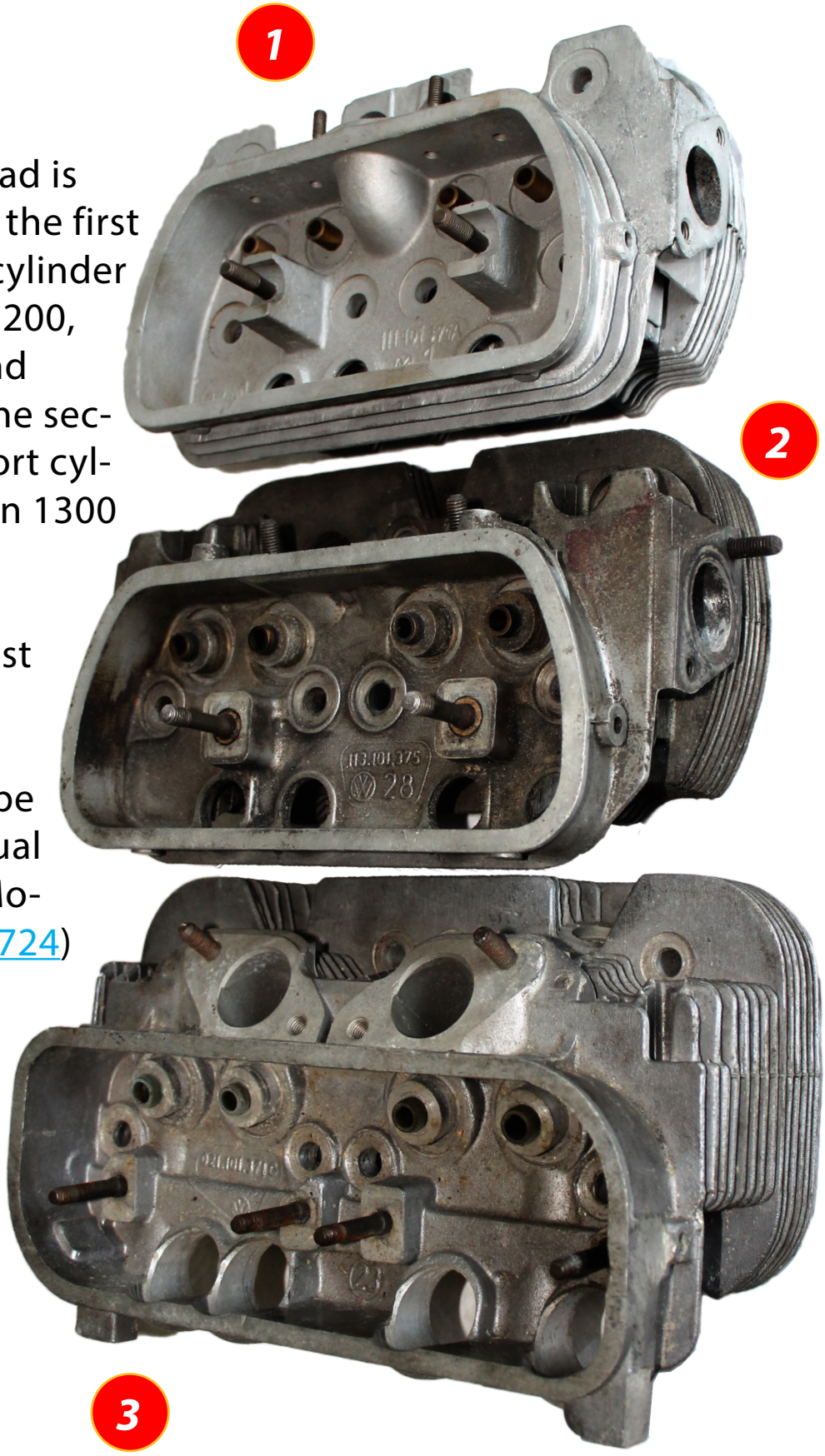
We explain all about the Volkswagen engine types and the engine codes in edition 02, take the time to read all about this.



# cylinder head specs

The Type 1 cylinder head is available in two types, the first one is the single port cylinder head (installed on all 1200, some 1300, all 1500 and some 1600 engines), the second type is the dual port cylinder head (installed on 1300 and 1600 engines).

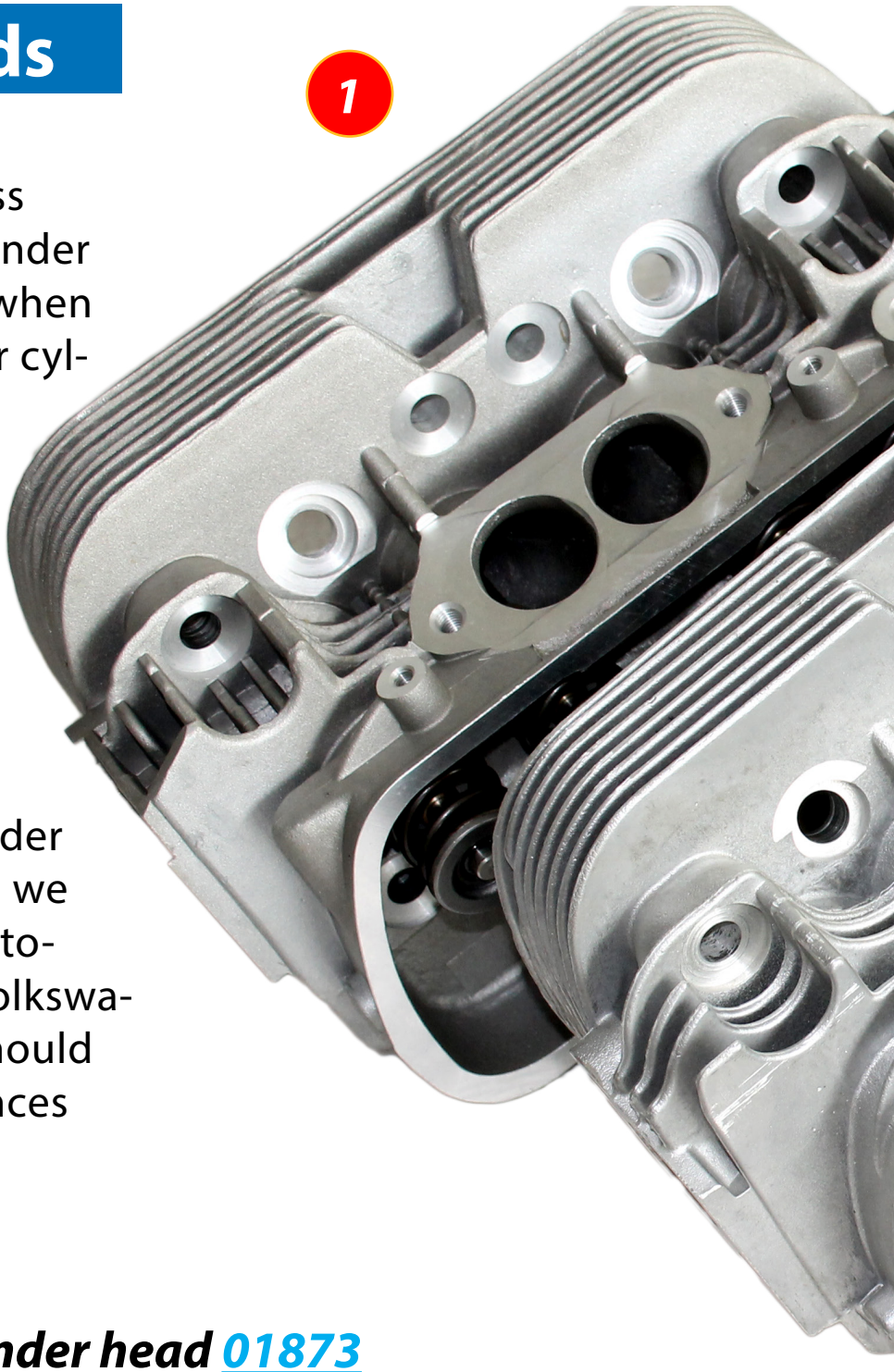
We will discuss the most popular cylinder head in this article: the air-cooled Volkswagen Type 1 boxer engine with dual port. We will use the Mofoco cylinder head (01724) and the EMPI cylinder head (01873) to compare specifications.



## Our demo heads

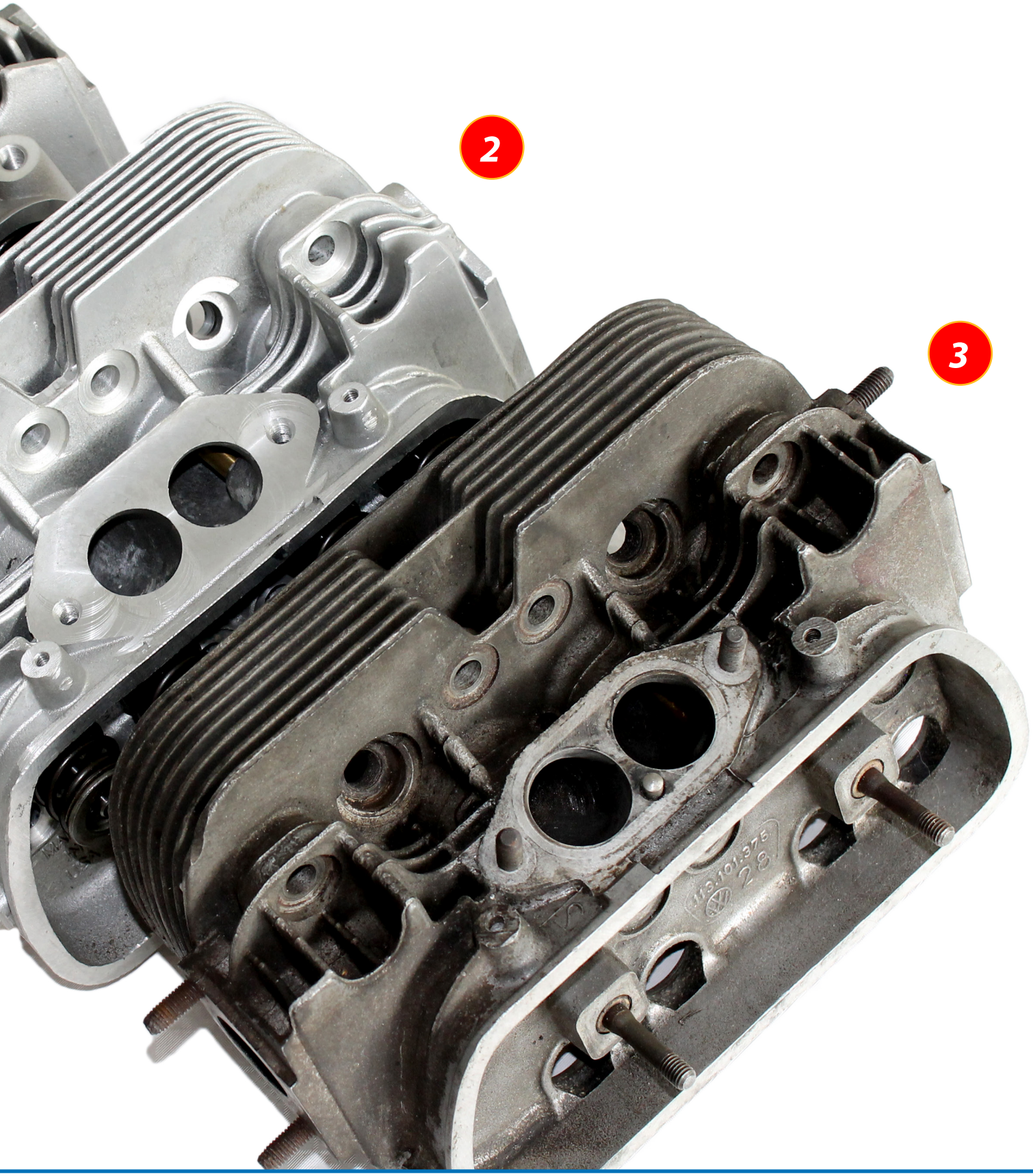
We have chosen to discuss the Mofoco and EMPI cylinder heads, it is possible that when you read this article other cylinder heads from Mofoco or EMPI are available in our webstore with different specifications. Just keep watching our Newsletter for updates.

We show on this picture both 1600 cc Type 1 cylinder heads (EMPI and Mofoco) we will discuss in this article together with an original Volkswagen cylinder head. You should already see some differences between them.



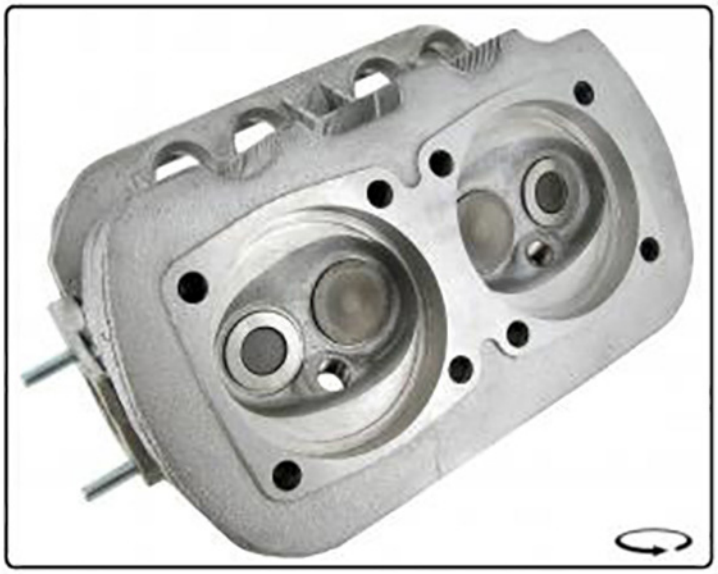

1. ***EMPI cylinder head 01873***
2. ***Mofoco cylinder head 01724***
3. ***Genuine VW cylinder head***

# cylinder head specs



## The differences

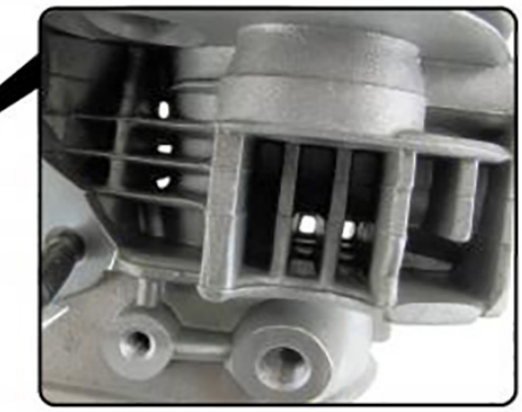
Not all "visual" or "visible" differences between cylinder heads will result in better or worse performance in a standard (read not high-performance) air-cooled Volkswagen engine. We will discuss these differences though, because these differences will result in higher or lower retail prices.



These are the pictures of the demo heads we are comparing in this article, as shown in our webstore. Below is the EMPI cylinder head, the Mofoco cylinder head is shown on the top of the page.

1 ***EMPI cylinder head 01873***

## 2 Mofoco cylinder head 01724

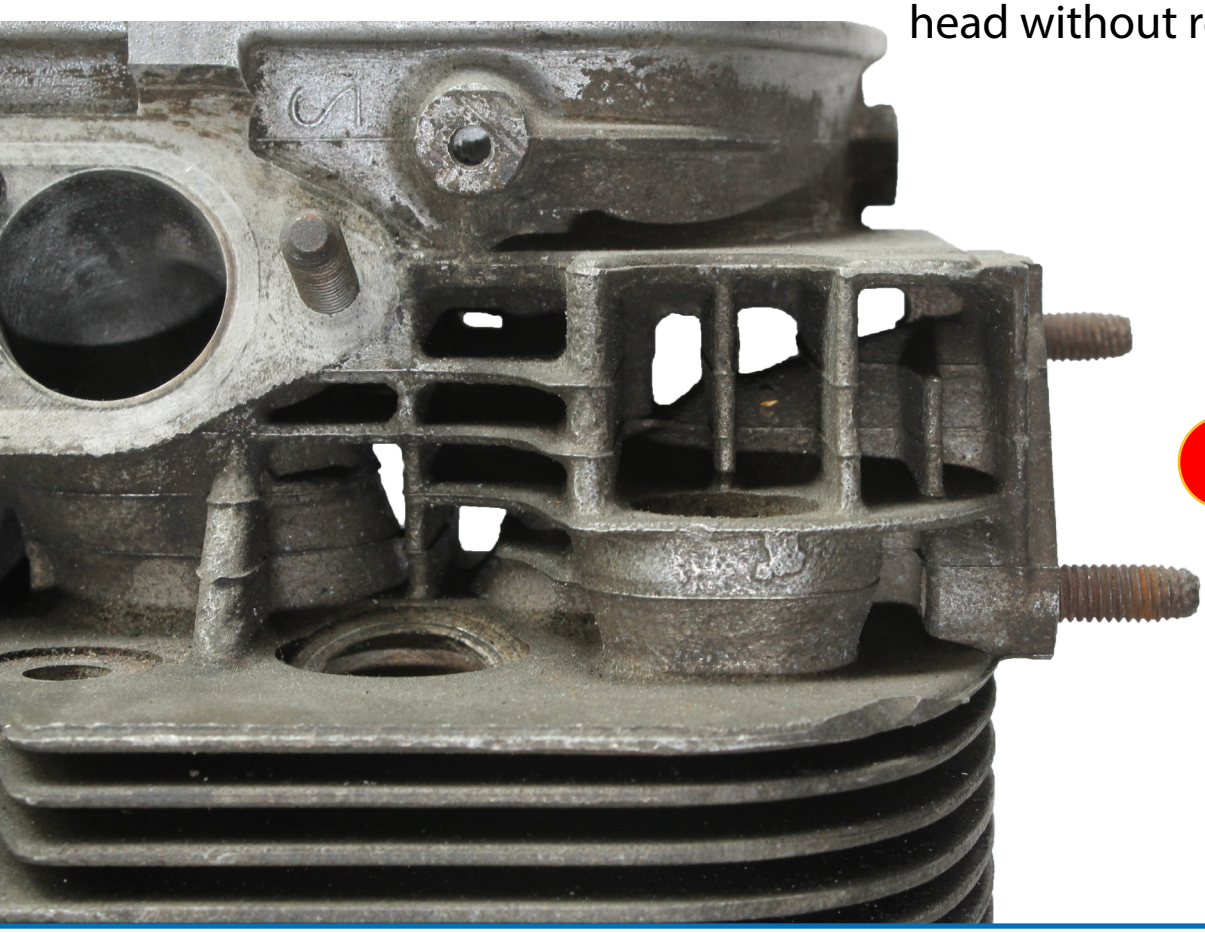
Mofoco and/or EMPI have made some changes to their cylinder heads compared the original Volkswagen head to improve the strength, to improve the fuel-air mixture flow and filling of the cylinders or to make sure the cylinder heads get more cooling than was originally offered. These changes in the cylinder heads are necessary to be able to tune (read more performance) an air-cooled boxer engine.

We will discuss the cylinder head casting, the importance of the cooling fins and the intake and exhaust ports, and finally we will discuss the valves.

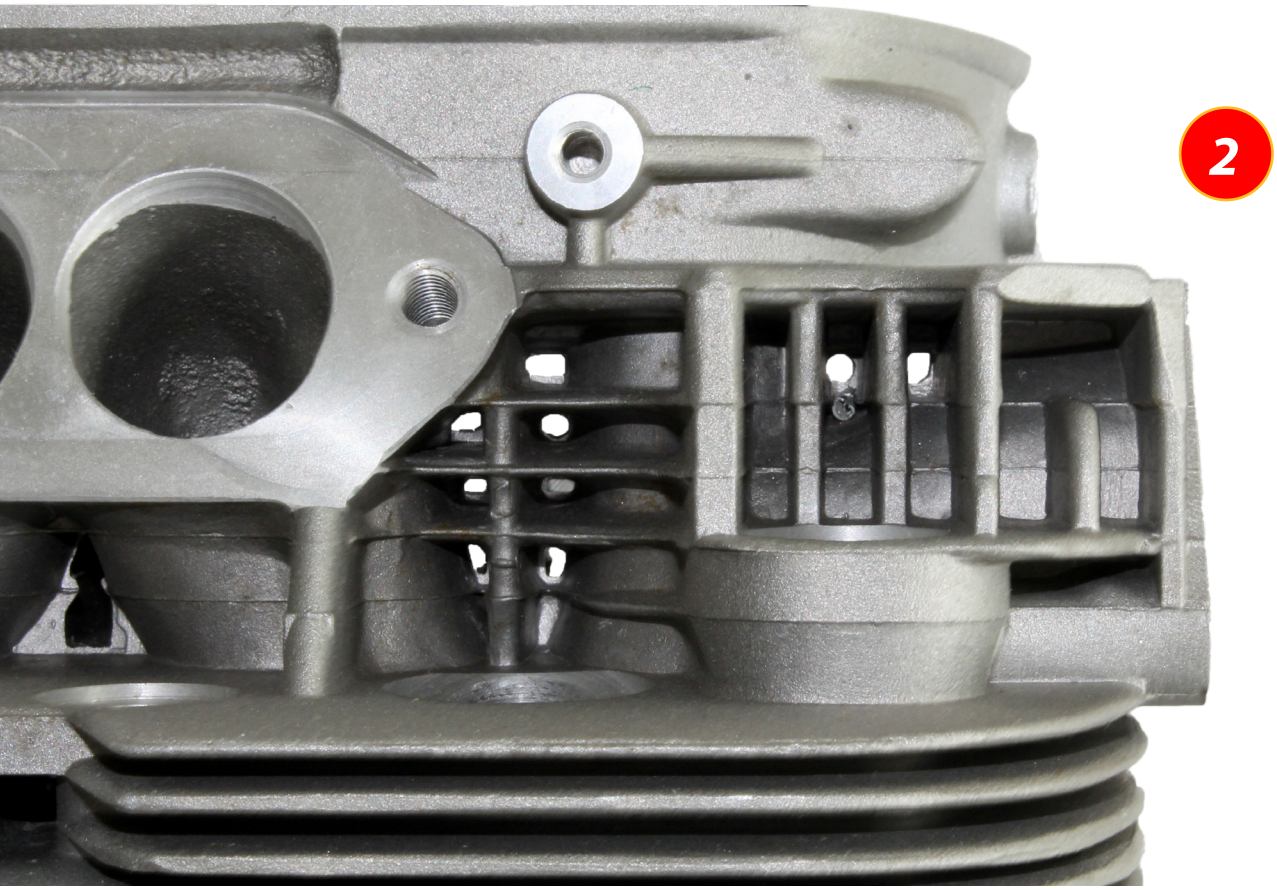
## 1. Casting

The first cylinder head feature we discuss is the "casting", what we will compare is the shape and the casting of the demo cylinders heads from Mofoco and EMPI with the original Volkswagen head. Are they different, if they are, is this an improvement or the opposite? A quick peek to these pictures already unveil major differences between the original VW (1), EMPI (2) and the Mofoco head (3).

The original VW cylinder head has bigger air flow openings between the cooling fans, the EMPI openings are narrower and the Mofoco openings are almost non existant. The reason for these difference is the way the cylinder heads are cast, and how much residual metal is left after the casting process. Most of the residual metal can be removed before installation of course, but I guess you want a new cylinder head without residuals.



# cylinder head specs



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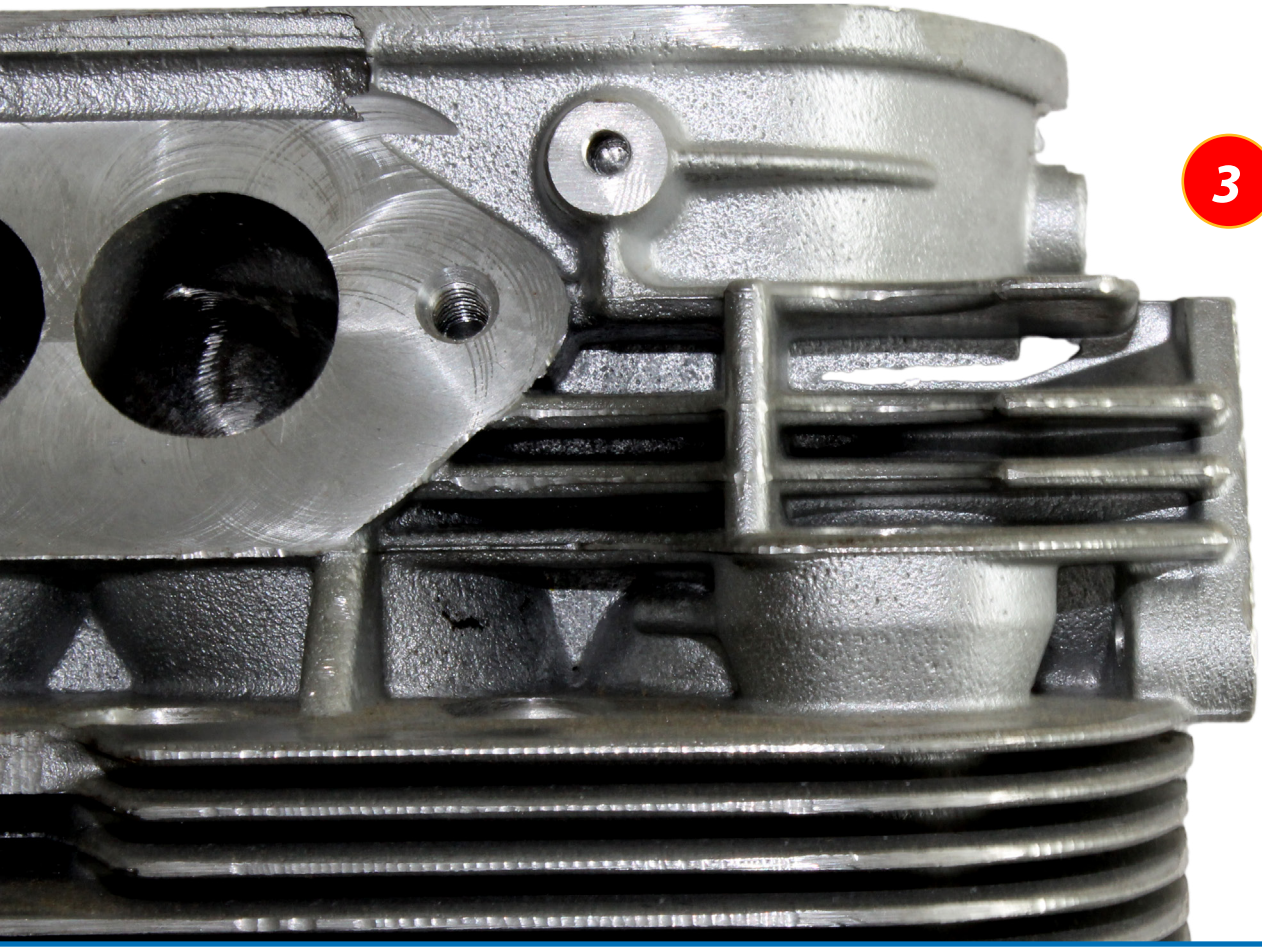
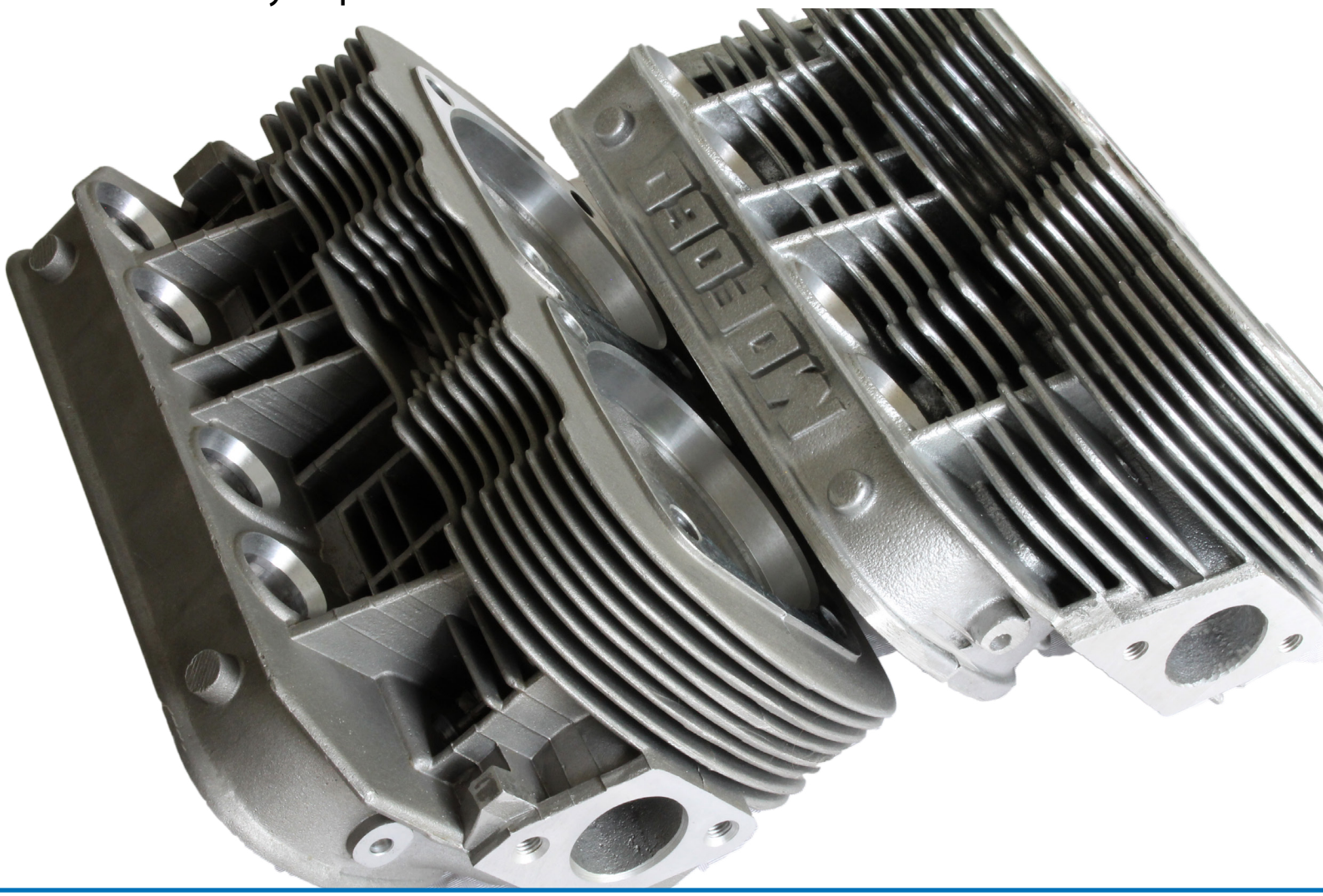


3

## 2. Cooling fins

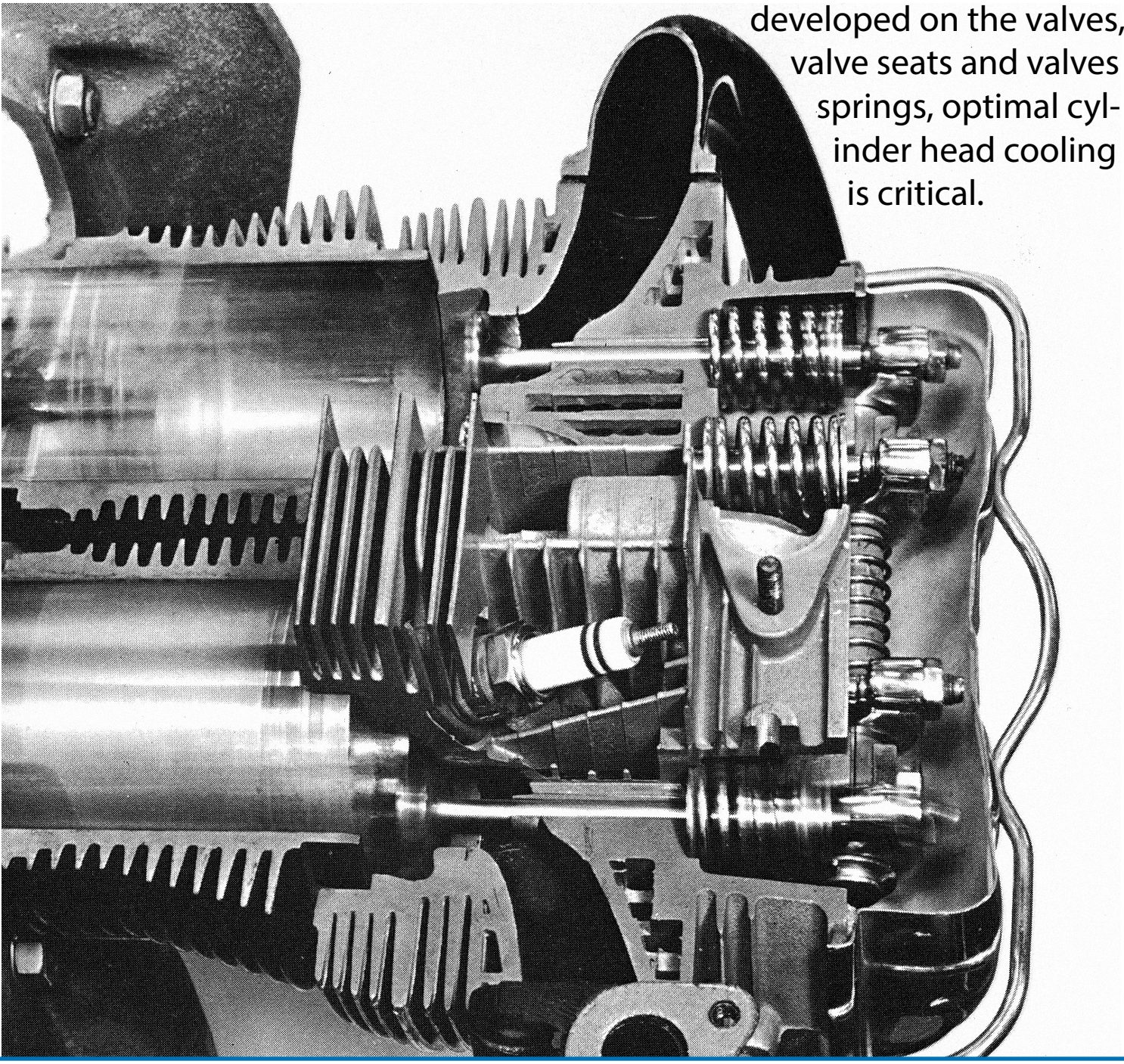
The theory says that the bigger the surface air flows by, the more cooling capacity you create. If you translate this theory into cylinder heads this would mean that the bigger the cooling fins the more cooling, but of course the heavier your engine will be. The shape of the cooling fins and the location of the fins are also very important.

Looking at the original Volkswagen cylinder head you would conclude that this original head has the best air-cooling capacity. But when we look at the bottom part of the Mofoco head (picture below), we see that there is a series of additional cooling fins installed. EMPI and VW do not have these additional fins!



# cylinder head specs

Cooling fins are necessary to cool the cylinder heads, more cooling fins surface equal to more air-cooling. The air flow along the cooling fins should be as efficient as possible of course. We show on the picture below (a picture we already used when explaining the concept of the valves in edition 04) the forces developed on the valves, valve seats and valves springs, optimal cylinder head cooling is critical.

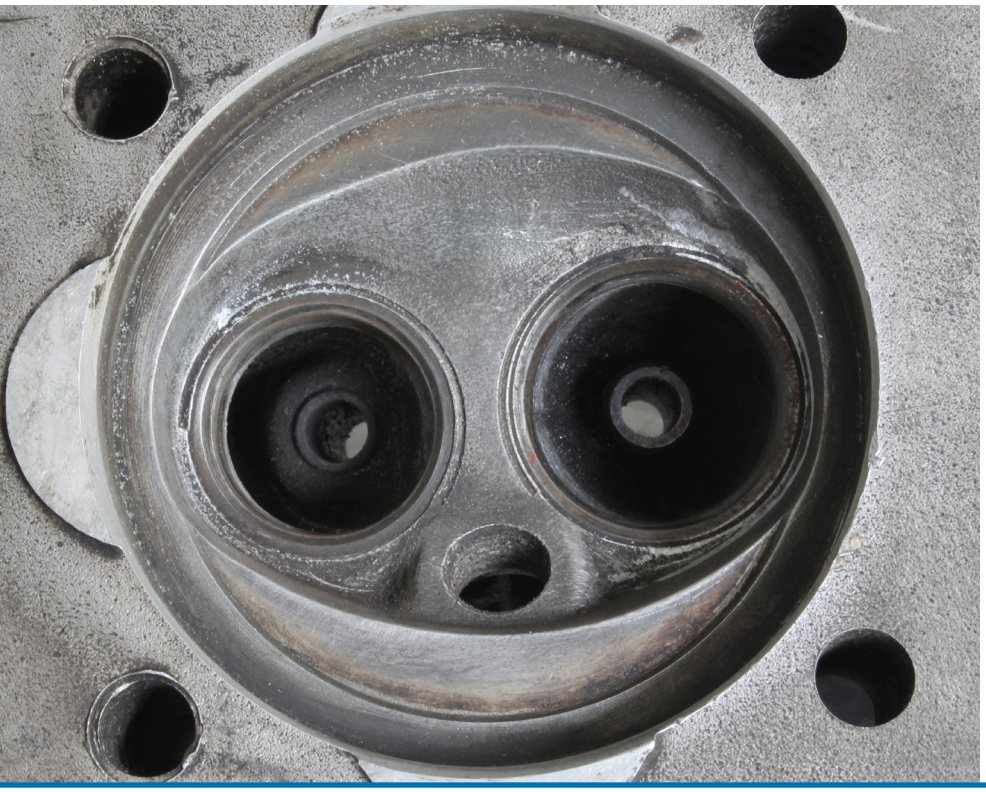


## 3. Combustion chamber

We show the combustion chamber of the three cylinder heads we are comparing. Major differences are visible: the original VW cylinder head (3) and the Mofoco head (2) look very alike, the EMPI cylinder head shows a 8-shaped combustion chamber which is quite different from VW and Mofoco. We know that an 8-shaped combustion chamber is favorable when tuning your engine, it improves the fuel-mixture flow which improves the combustion of the fuel mixture in the cylinders. The Mofoco cylinder head (2) designers have filled the hollow spaces near the spark plug hole to improve the combustion. The spark plug on the Mofoco head is deeper than the EMPI and VW ones – just as on a Type 4 engine.

The spark plug hole is also further away from the valve seats. Both the longer spark plug hole and being further away will lower the chances for cracks in the cylinder head. Having the spark plug hole closer to the valve seats improves the ignition of the mixture though, every advantage has a disadvantage of course.

**3** ***Genuine VW cylinder head***

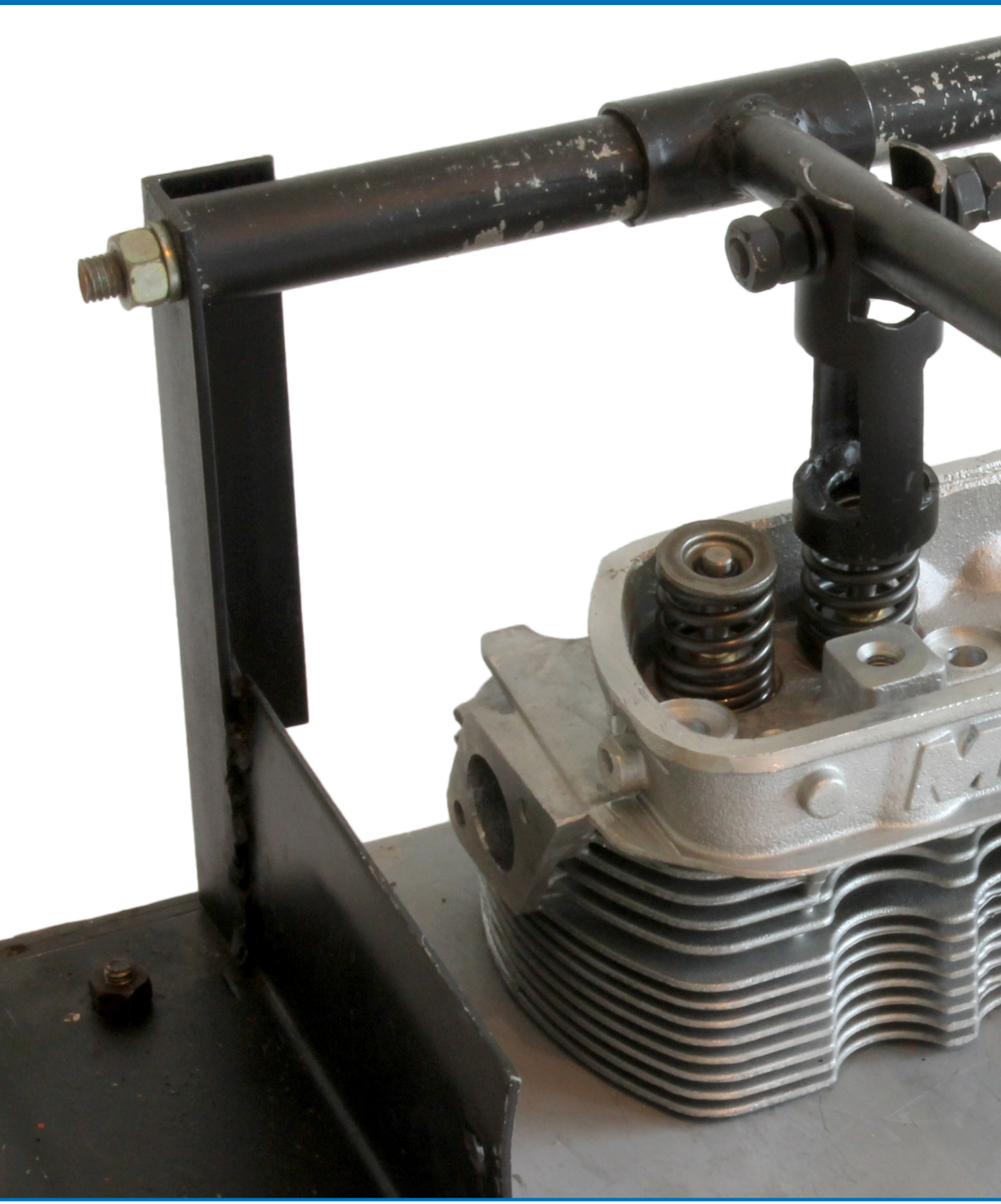


# cylinder head specs

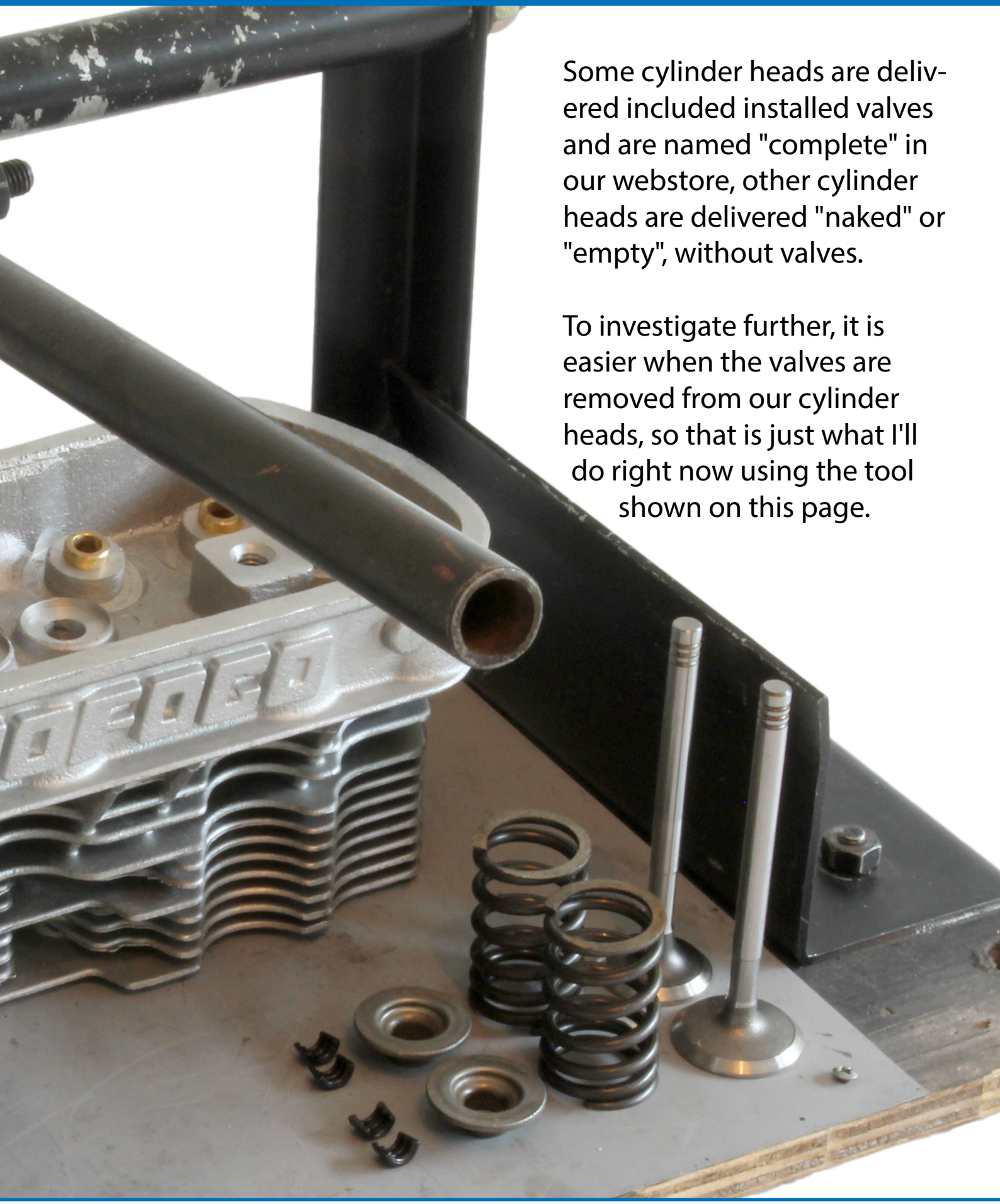
## 1 EMPI cylinder head 01873

## 2 Mofoco cylinder head 01724

# #21 Engine



# cylinder head specs



Some cylinder heads are delivered included installed valves and are named "complete" in our webstore, other cylinder heads are delivered "naked" or "empty", without valves.

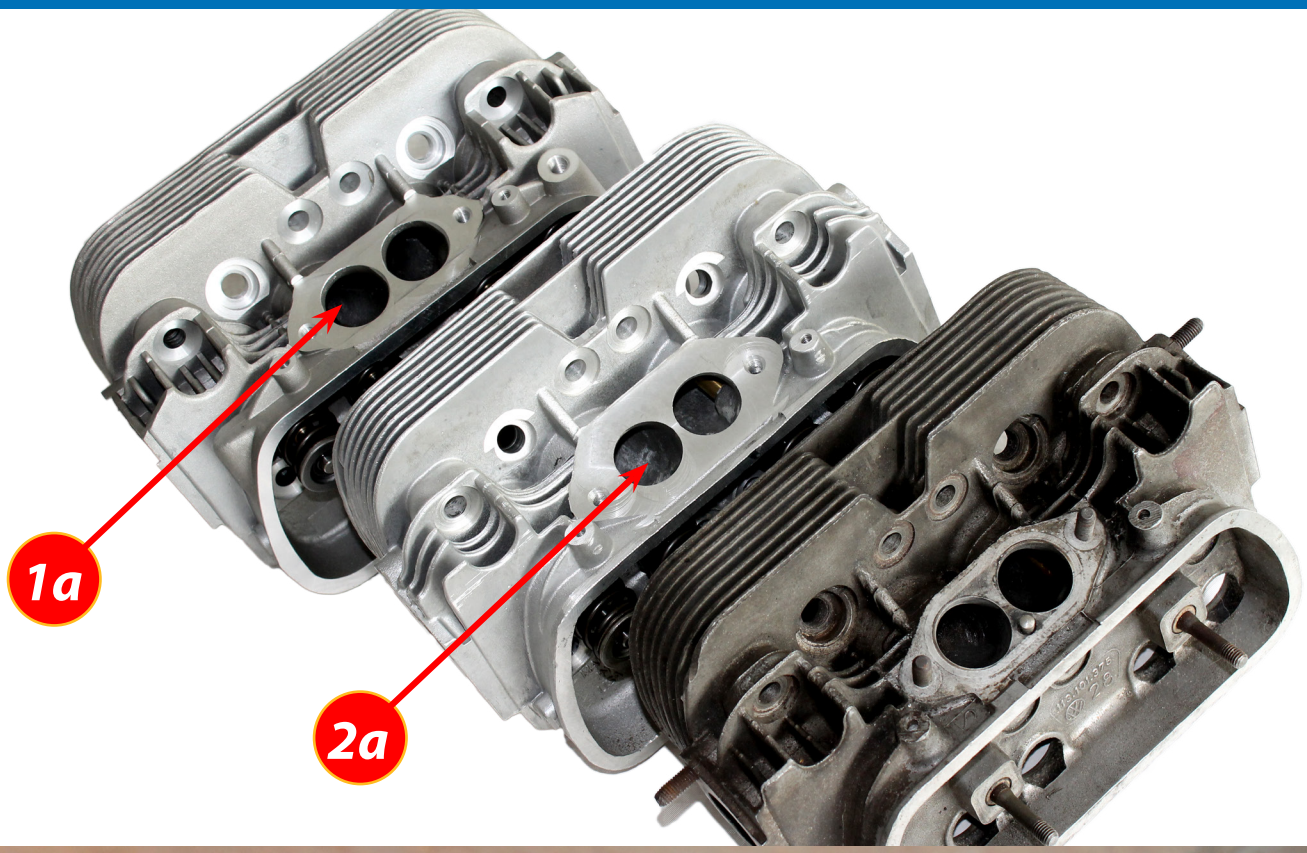
To investigate further, it is easier when the valves are removed from our cylinder heads, so that is just what I'll do right now using the tool shown on this page.

## 4. Intake

We show on picture (1a) that the casting of the intake port of the EMPI cylinder head is a little rugh. There is a little too much material left below the valve seat. We show on the top of the next page where both pictures below are taken, if you're not experienced to work with cylinder heads, you could have lost your way here.

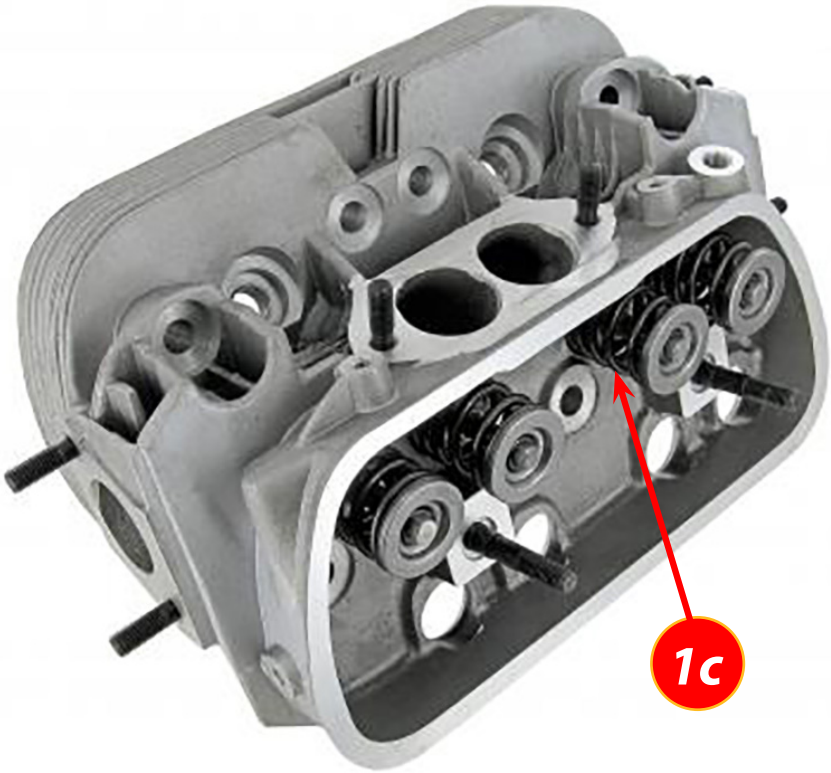
The intake port of the Mofoco head (2a) is very clean and well cast, there will be less resistance for the fuel-mixture to flow, improving the horse power potential. The intake port valve guide is a little shorter on the Mofoco head and shaped from wide to narrower at the end, which should improve the flow.

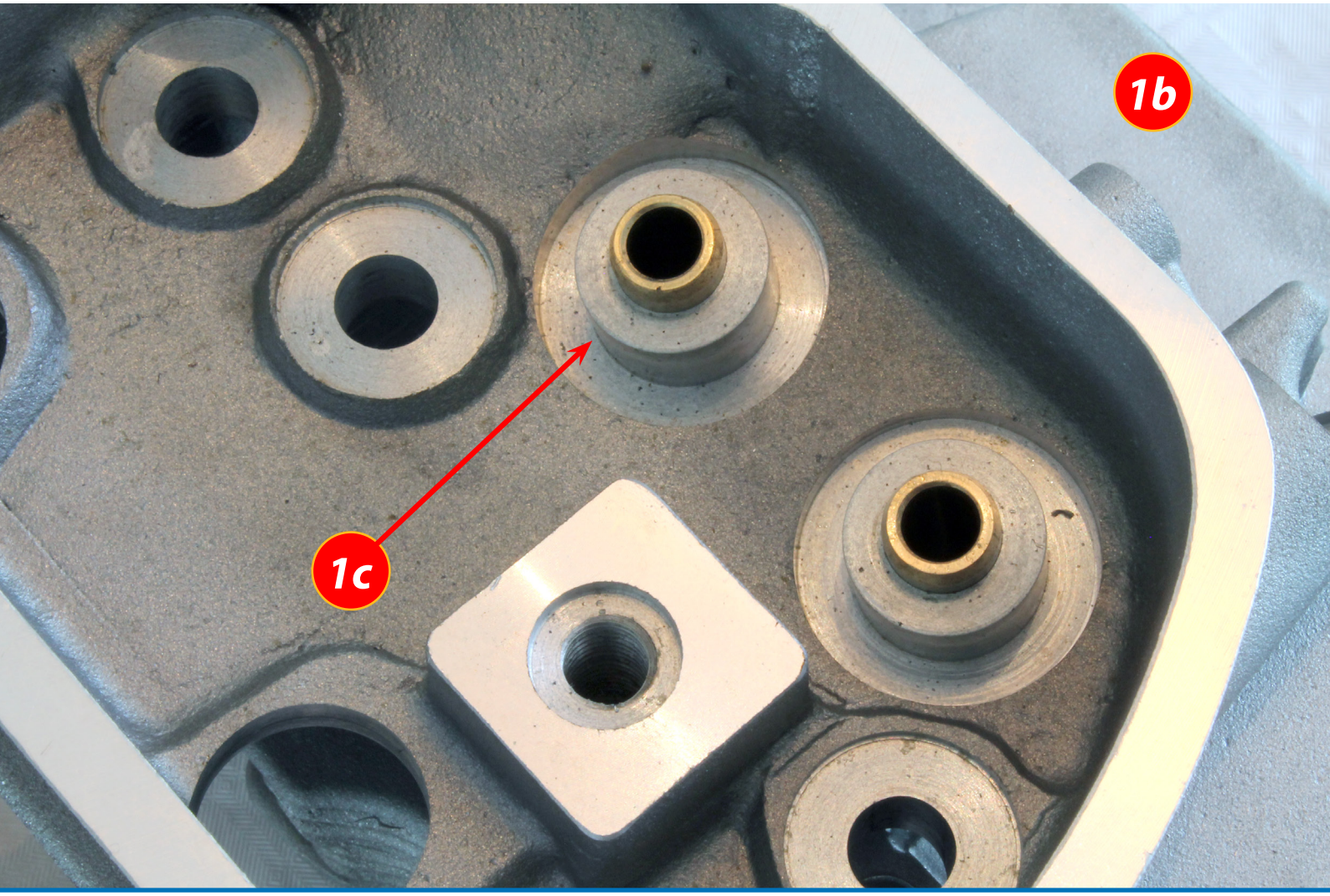
# cylinder head specs



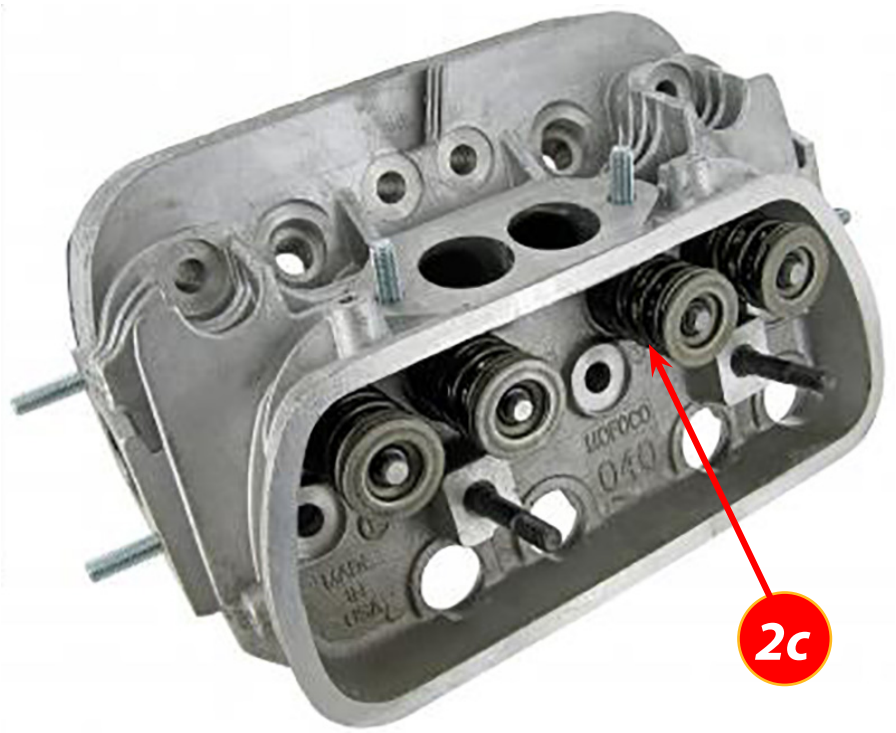

## 5. Rockers

The casting of the EMPI cylinder head (1b) is very good in general, the rocker area is extremely well finished, the surface where the valve springs are installed is very smooth (1c) compared to the Mofoco cylinder head (2b).

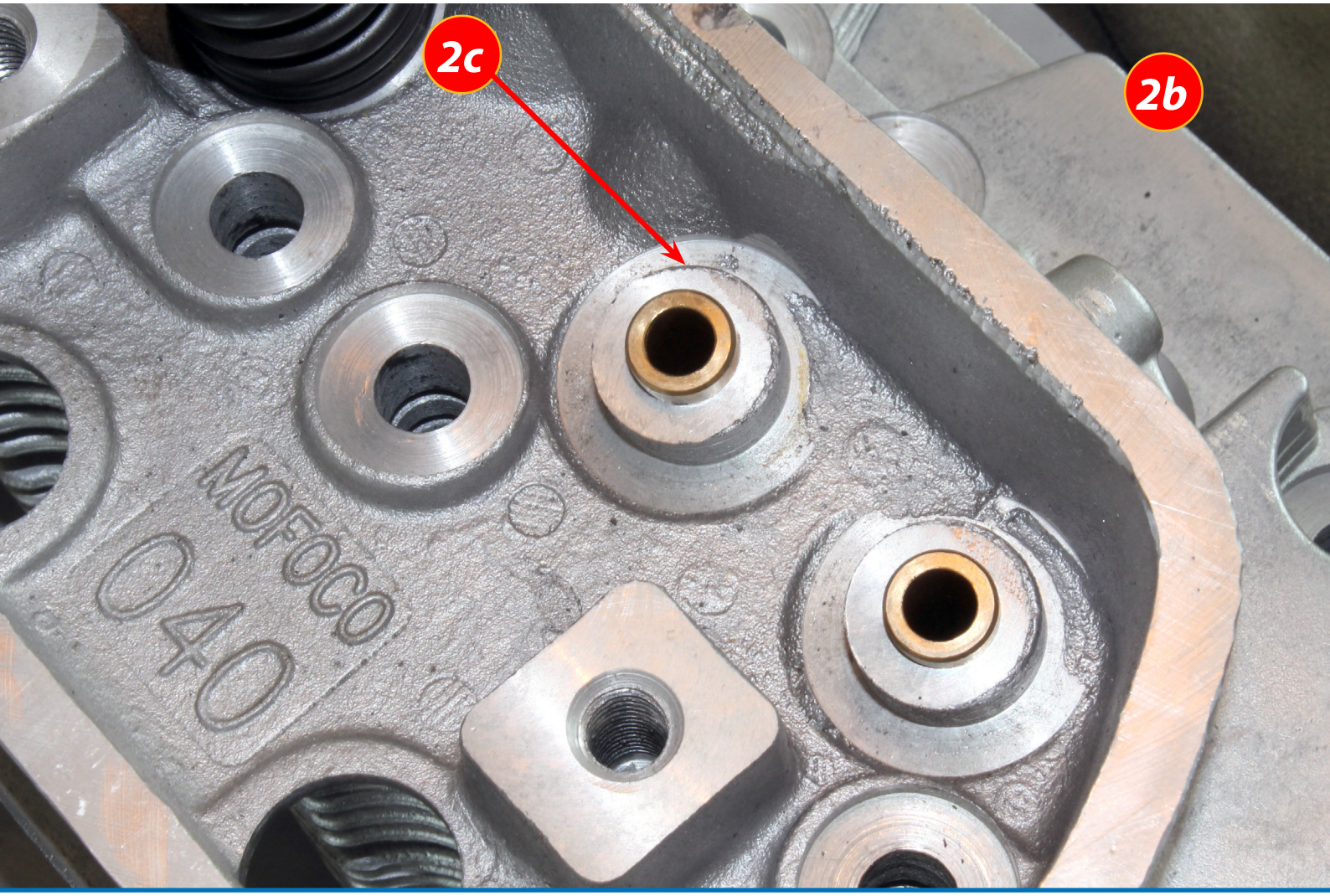


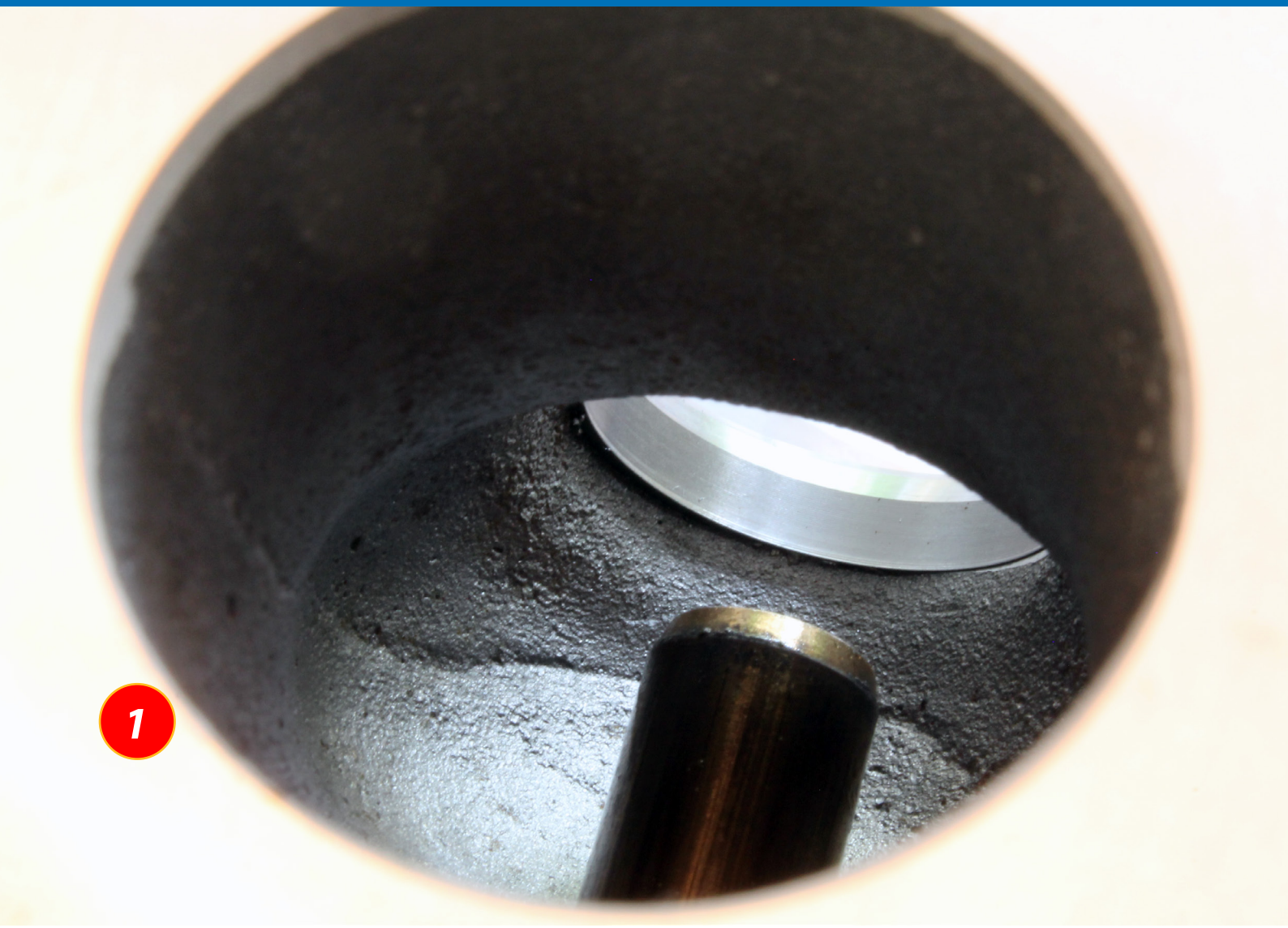



# cylinder head specs




The valve springs get enough space to settle in the EMPI cylinder head (1c), while the Mofoco cylinder head doesn't have enough real estate on the edge of the head to the position the valve springs (2c) nicely.






## 6. Exhaust

We can see the same issue with the exhaust port but now in favor of Mofoco: there is some metal missing below the valve seat on the EMPI cylinder head (1). The casting and the the shape looks better on the Mofoco head (2).

# cylinder head specs

2

2a

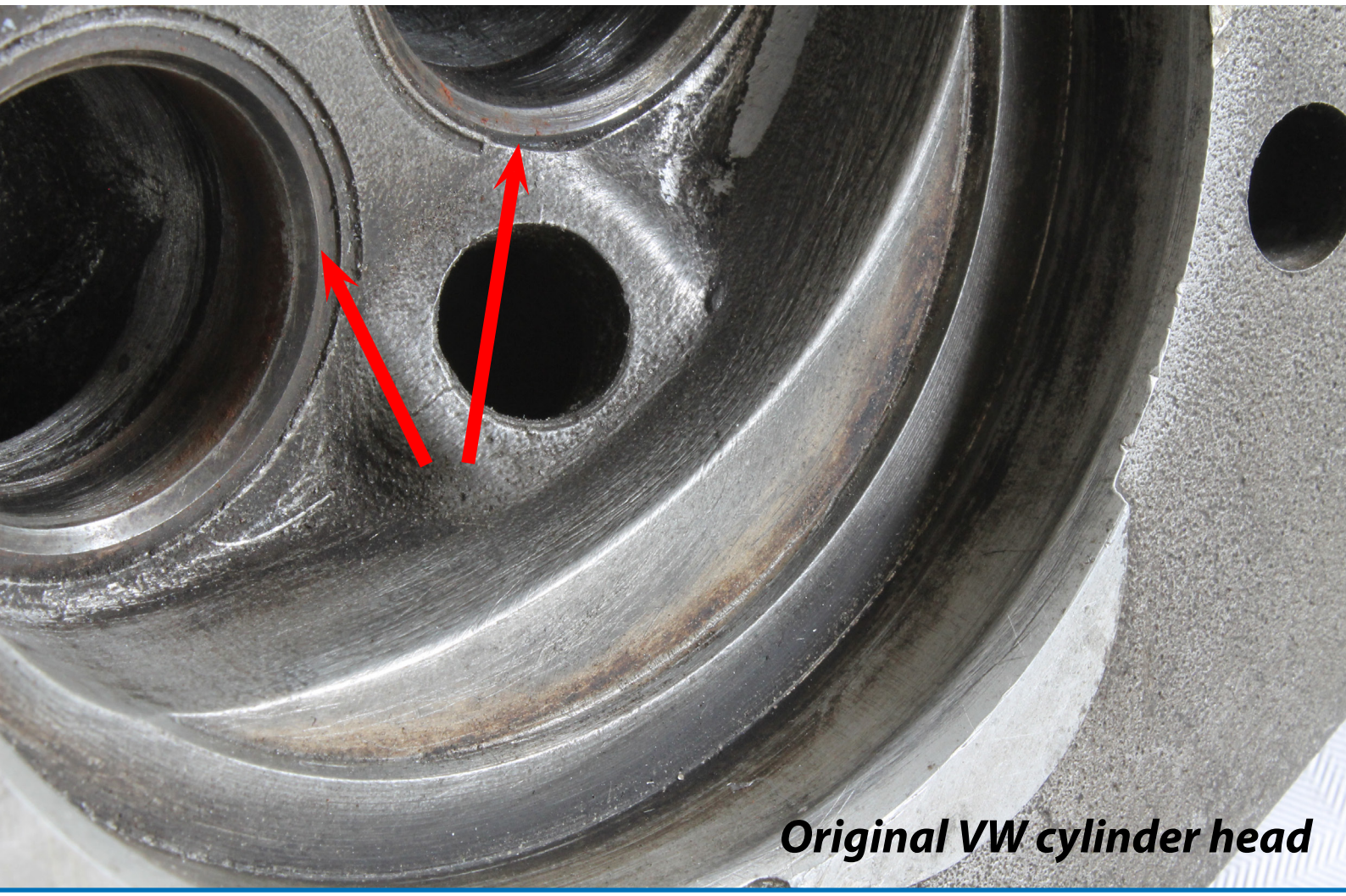
The difference in casting around the valve guides between the Mofoco head and the EMPI head is important. The valve guide shape on the Mofoco head has a better shape to allow the heat to escape faster.


## *7. Valves and valve seats*

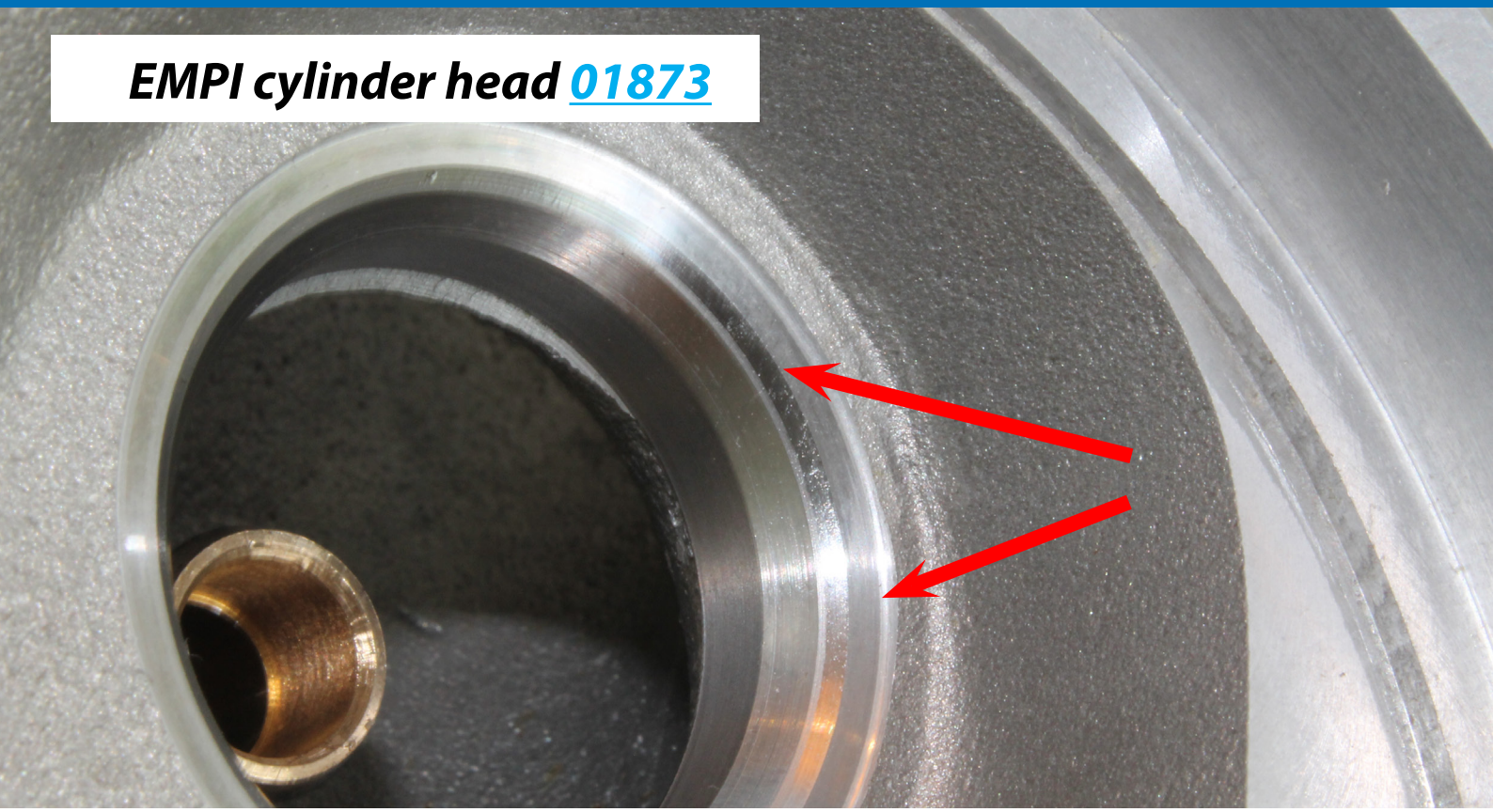
We start to analyze the valves: the Mofoco heads use Italian valves (1), we couldn't find a manufacturer stamp on the EMPI heads (2). My experience is that it is a good sign when the valve manufacturer is mentioned on the valves. But when comparing both valves from EMPI (1) and Mofoco (2) we see that the EMPI valves have a smoother shape. The wider valve shaft of the Mofoco looks better, but the valve seat isn't designed to support this feature, so this is unnecessary extra weight to carry, it will probably lead to a loss of performance.

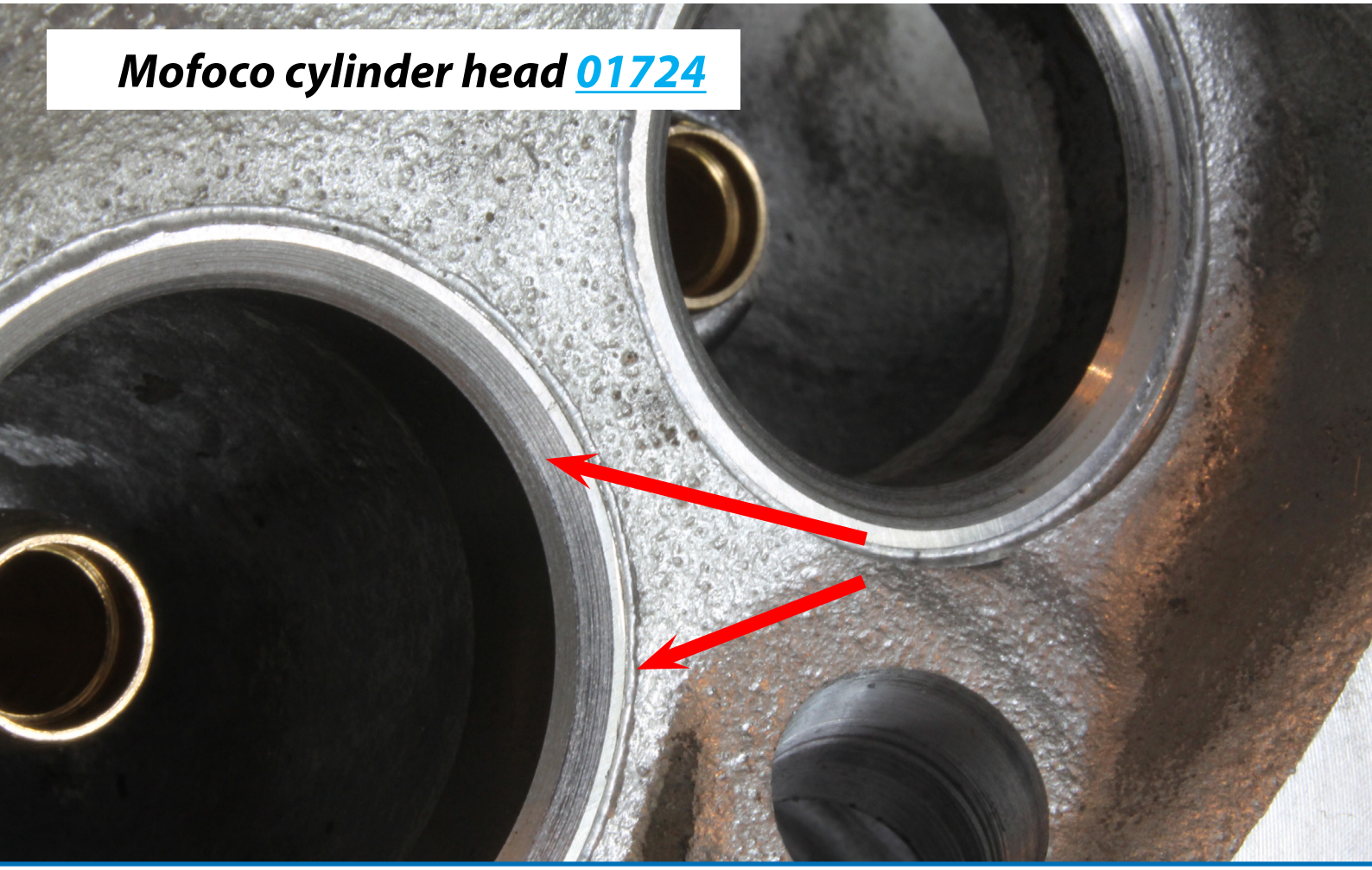
# cylinder head specs

The latter will not have an important influence on the performance of a standard engine (read not high performance engine). What will have an influence is the way the valve seats were grinding. The original VW cylinder head (picture below) was grinding at one single angle (commonly 45 degrees angle). Grinding using more than one angle is better, it improves the fuel mixture flow in the intake and exhaust channels. I was surprised to see that the EMPI head is grinding in three angles and the Mofoco head 'only' two angles (we show this on the following pages).Both cylinder head valve seats of our tested cylinder heads score better than the original Volkswagen head in this department.



*Original VW cylinder head*


EMPI cylinder head 01873


Mofoco cylinder head 01724

## Conclusion

We hope this information will help you to evaluate your cylinder head purchase for your classic Volkswagen. Both new cylinder heads we discuss in this article are different, the EMPI and the Mofoco have advantages and disadvantages, it all depends what the application will be.

You could conclude that the Mofoco is better suited for entry-level tuning, the EMPI cylinder would fit better in a standard engine. Now, it's up to you to decide what you want to do with your classic car, we offer you all the options in our Paruzzi webstore.

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