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## #58- Engine: Type 1 sump plate

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## Introduction



Replacing the crankcase oil of a Type 1 engine is a job every VW enthusiast has done once in a while. It involves loosening a few nuts, replacing gaskets and tightening everything again, right?

It seems a simple operation, but nothing could be further from the truth. Wasn't it that many air-cooled engines leak oil at the bottom of the crankcase, more specifically at the level of the sump plate. Your garage full of oil, oil on the road, more oil consumption than desired.

Not to mention the possible rejection during the technical inspection. An air-cooled VW must not leak any oil at all if it is to be called a real classic car. Is the underside of your VW like on the picture above?

What goes wrong?

To understand that we will show you how the sump plate is attached to the crankcase and which parts require attention, as well as where it can go wrong.





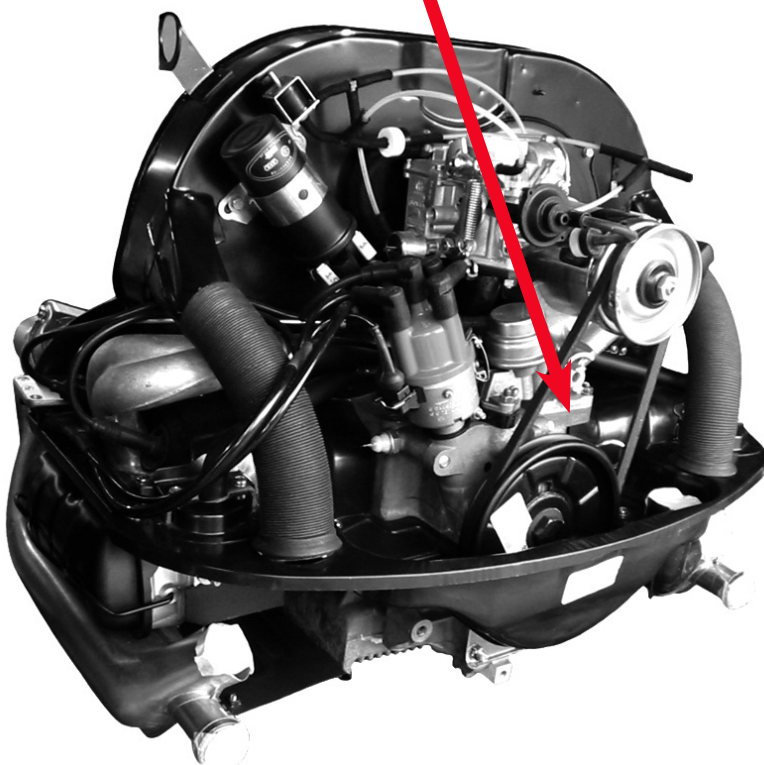
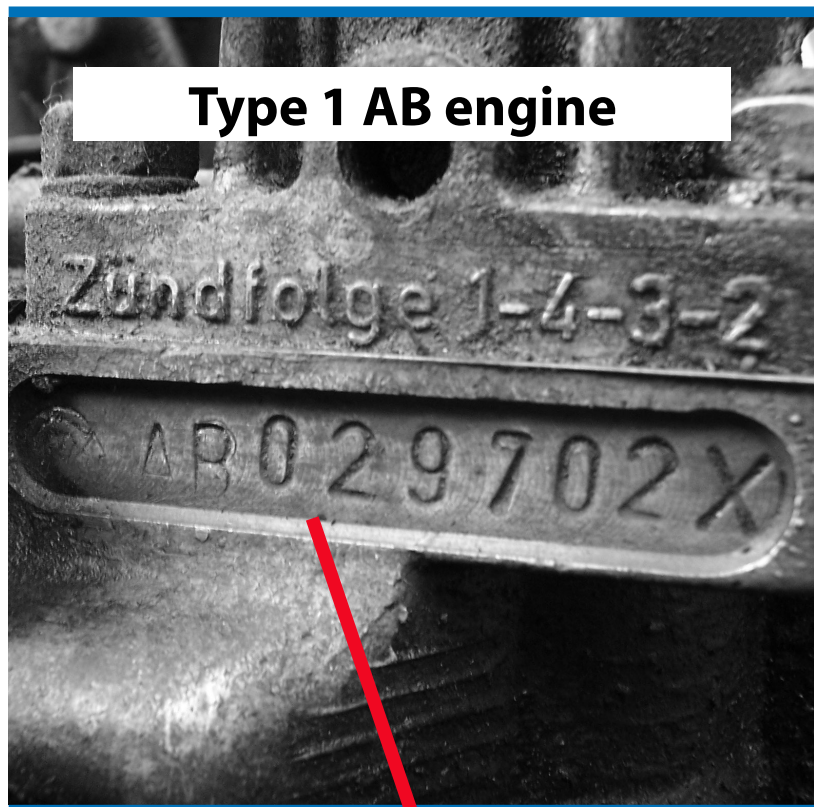
# Type 1 sump plate

## Engine type recognition

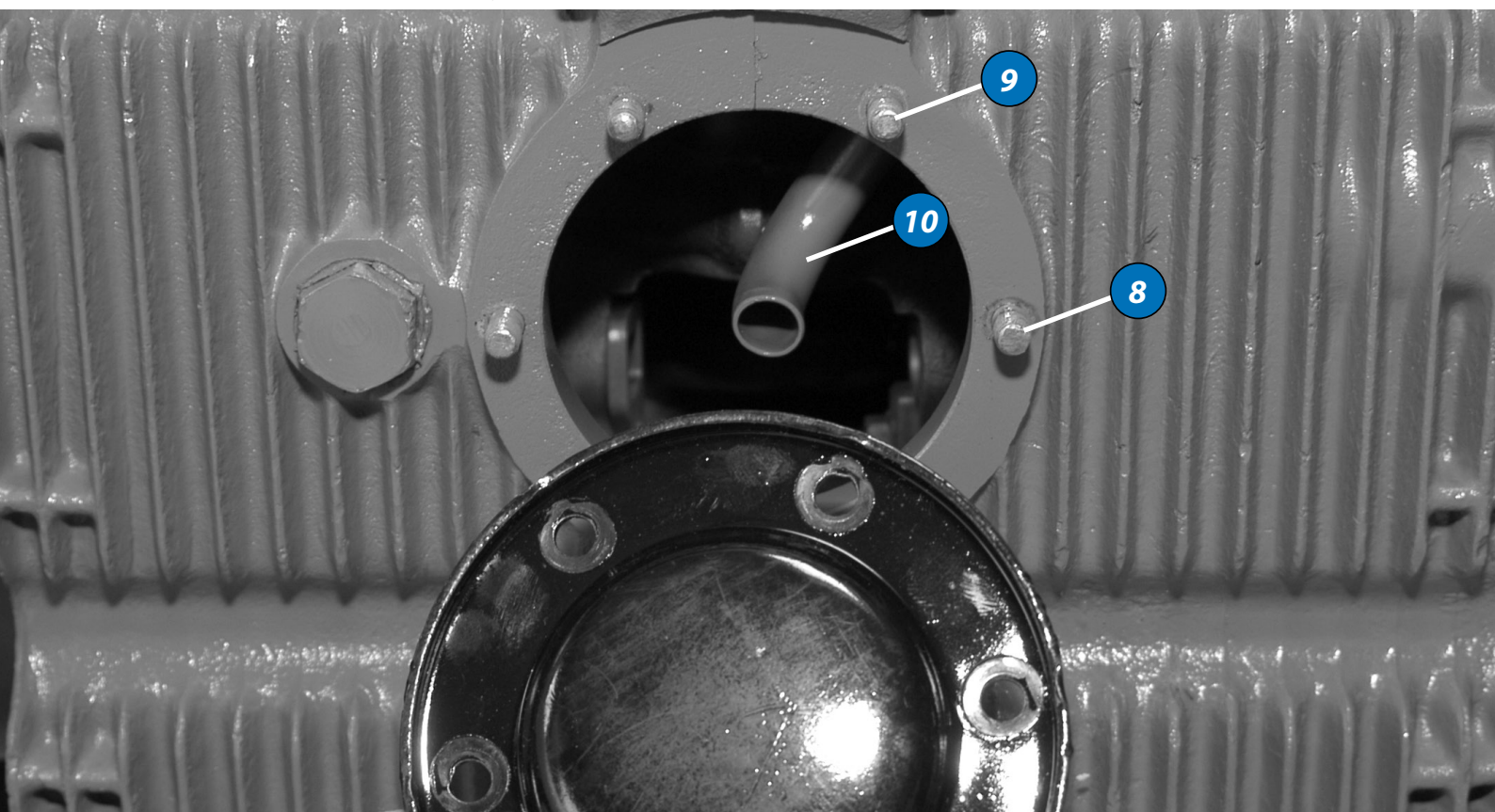
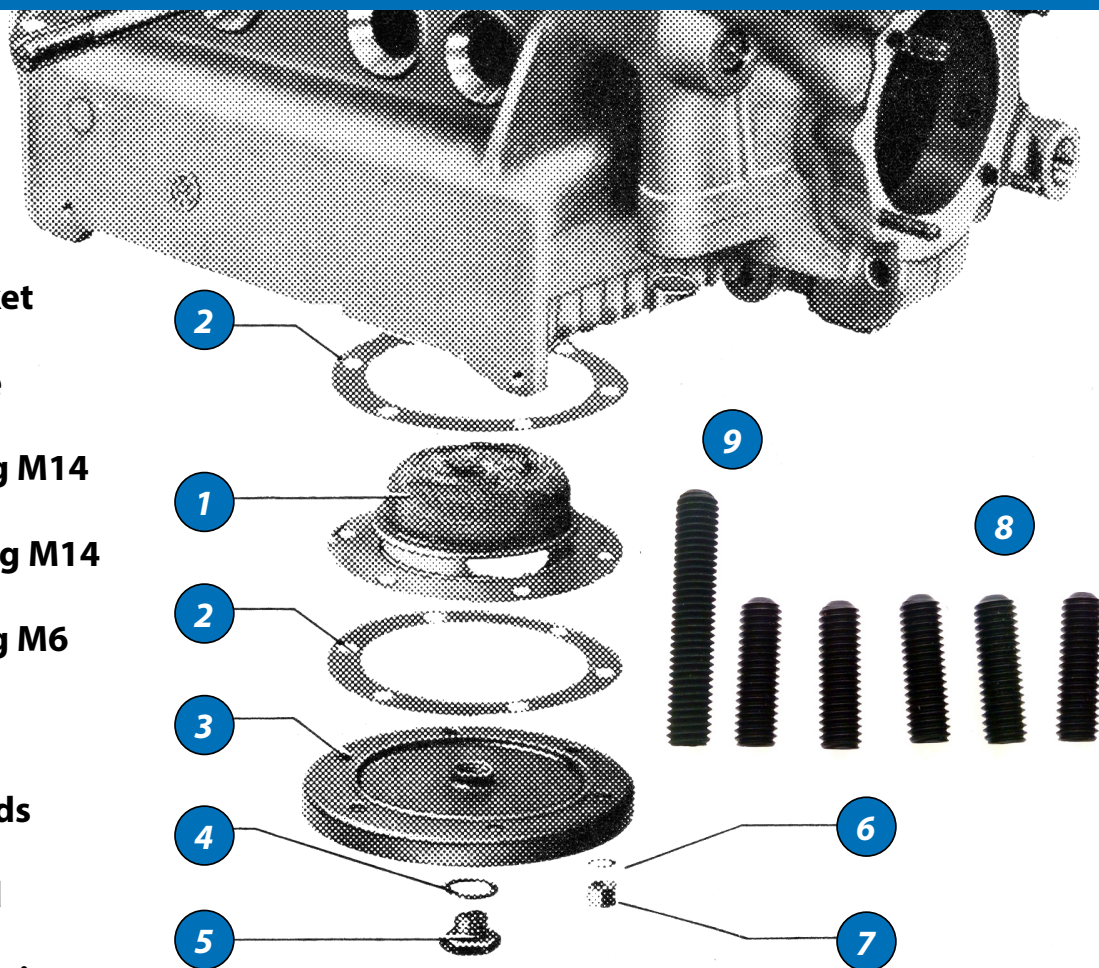
Many of our classics have already had some owners. The maintenance has not always been done according to the workshop manual, and in many cases the damage has been present for a long time.

To prevent oil leaks, first of all you have to make sure that all parts are present, but also that you use the correct parts for your engine.

It is very easy to order the correct parts. Do not make assumptions based on the chassis number of your VW, the engine may have been replaced by another type of engine over the years. The sump plate parts are different for the different types of engines. In [edition 02](#) we explained where you can find the serial number of each type of engine, and which year of construction belongs to which type of engine. Refer back to that article if you find this necessary.



- 1** oil screen
- 2** paper gasket
- 3** sump plate
- 4** copper ring M14
- 5** sealing plug M14
- 6** copper ring M6
- 7** nut M6
- 8** 5 short studs
- 9** 1 long stud
- 10** oil suction pipe



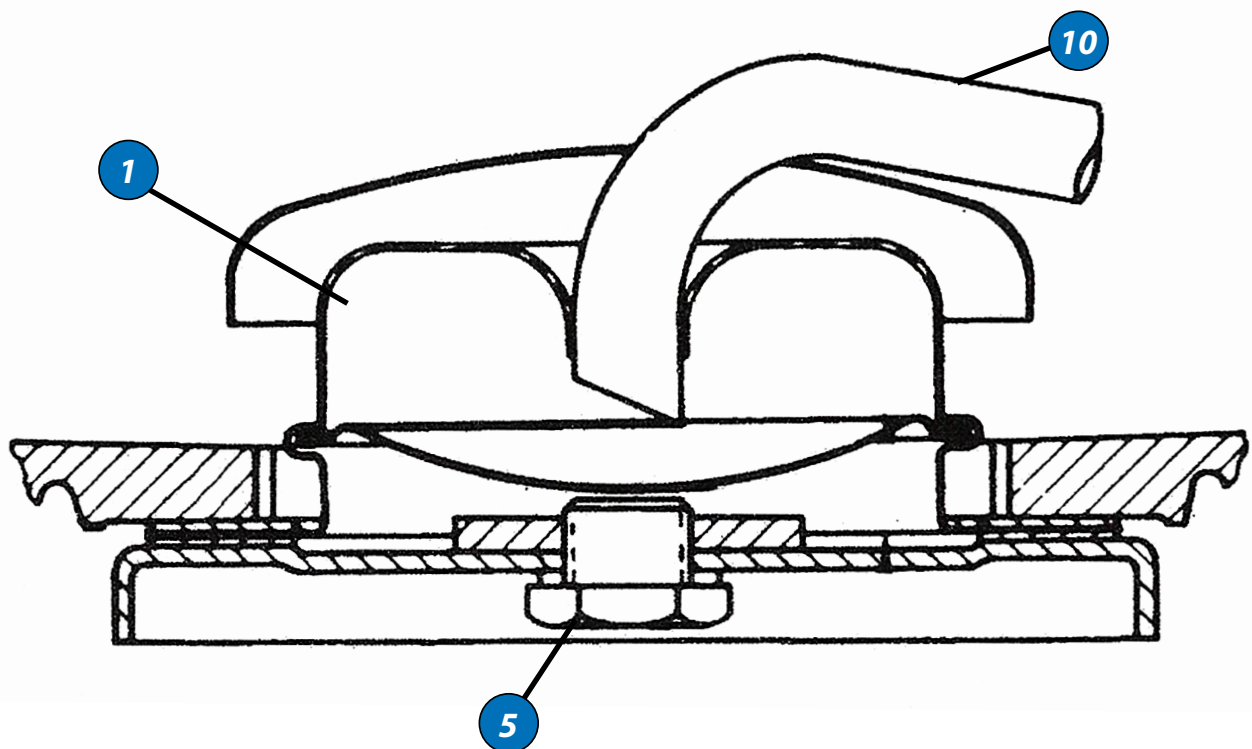


# Type 1 sump plate

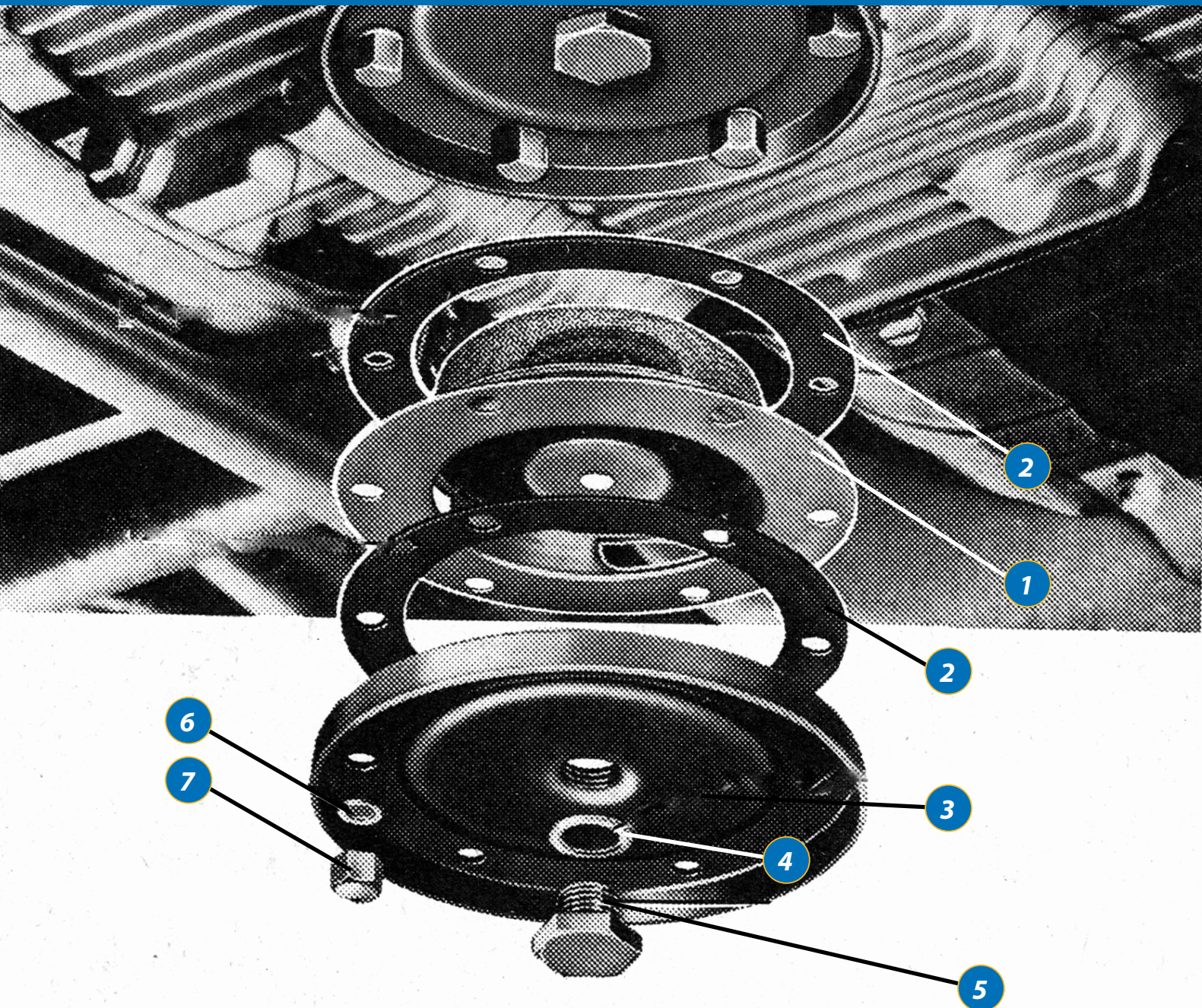
## Sump plate parts

The different parts and the order of assembly are shown in the drawing on page 4. The six studs are screwed into the crankcase. One of them is longer to attach the oil suction pipe. Make sure they protrude just enough to accommodate the gaskets and oil screen (see page 15).

The difference between the different years of construction lies in the diameter of the metal tube (number 10, oil suction pipe) through which the engine oil is sucked through the oil screen. The greater the power of the engine, the wider the tube became to cope with the greater oil flow rate. The metal tube must be tightly enclosed in the oil screen (number 1). Therefore, use the correct oil screen (see page 7).

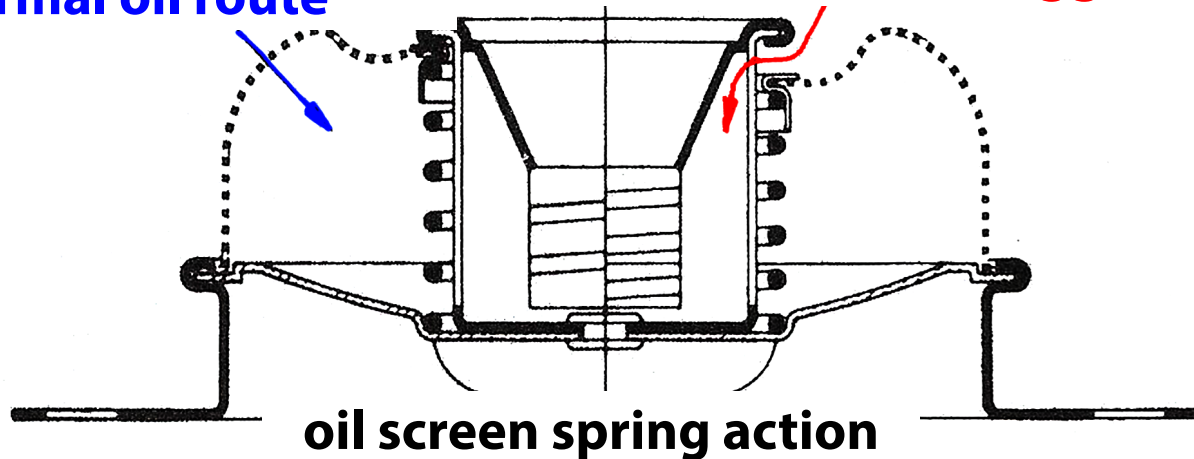






normal oil route

oil route in case of clogged screen





# Type 1 sump plate

## Oil screen

Pay close attention to the diameter around the opening for the oil suction pipe. This one on the picture on the right is 14.5 mm, this one underneath is 18.5 mm (we measure at the bottom of the opening, at the narrowest part). Under normal use, the oil screen is immersed in the engine oil in the crankcase. When the engine is running, the oil pump will suck the oil through the oil suction tube, the oil will flow through the mesh of the oil screen (blue route page 6). When the oil screen is clogged, the engine will no longer get any cooled oil, the spring of the oil screen will be pushed down by the pressure (picture below), the oil can then flow past the screen (red route page 6 bottom).

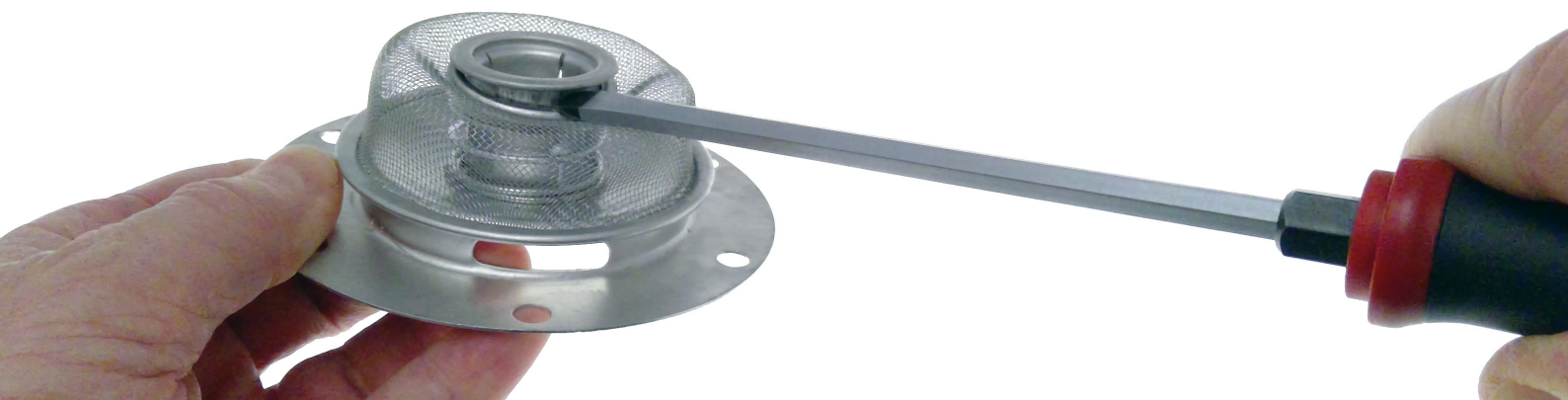
### Type 1 until 7.1969



### Type 1 8.1969 and later



With the older types (25 hp and 30 hp) there is just a hole in the screen to suck in the engine oil.



### *Oil drain plug (M14)*

The first engines had an oil drain plug as standard, this was later removed because nobody bothered to remove the sump plate. After tens of thousands of kilometers and years without changing the oil screen, the oil supply was blocked by accumulation of dirt. This can be fatal for your engine, the oil pressure drops, the engine is no longer optimally cooled and becomes too hot and eventually brakes.

It is therefore recommended to use the drain plug at each engine oil change only to drain the engine oil without spilling and to remove the sump plate to check and clean the oil screen.

The diameter of the drain plug is different for different years of manufacture, as is the corresponding copper gasket ring.

Consult the workshop manual of your type of Volkswagen engine for the correct tightening torque of the oil drain plug.



**35 Nm**

Volkswagen also offered a drain plug with a permanent magnet (picture below). The magnet will retain all metal particles from the engine oil. In this way you can quickly see if your engine has a lot of wear and tear, which is characterized by abrasion of metal parts and therefore metal residues in the oil.



**35 Nm**

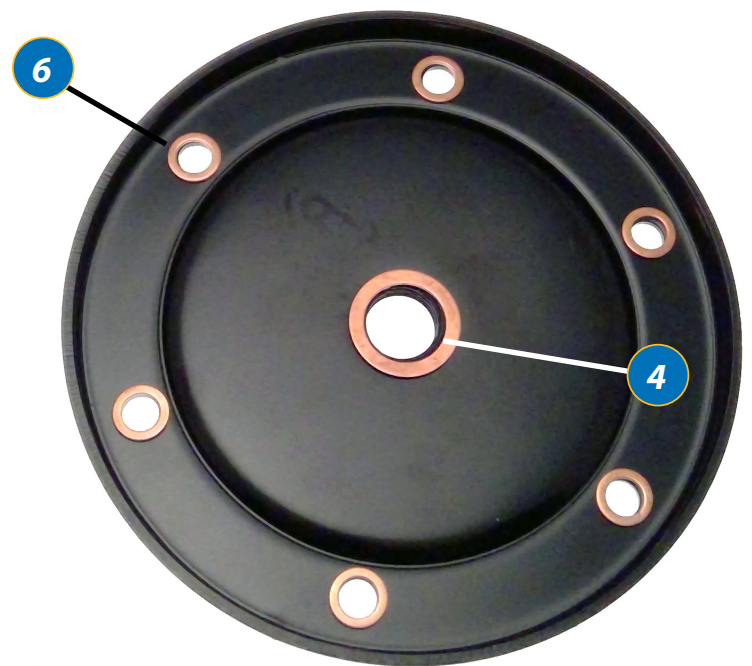
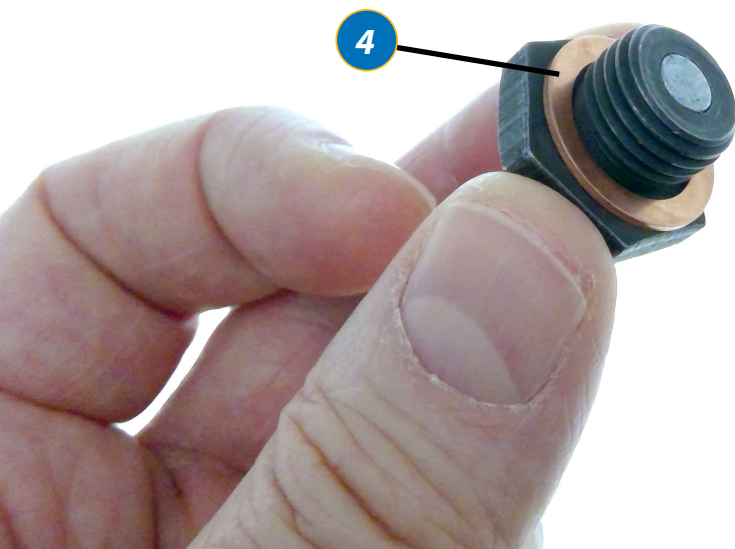


# Type 1 sump plate

## *Copper gasket rings*

The sump plate and drain plug (if present, photo below) are sealed against oil leaks by means of gasket rings. These are made of copper, for good reason. Copper, like aluminium, is a very soft metal. The intention is that these copper rings are pressed together while tightening the nuts to form a good seal against oil leaks. So never replace these rings with standard metal rings, you can't compress them, resulting in oil leaks, but even worse, you risk bending the crankcase cover.

You had already understood that these copper washers have to be replaced every time the nuts and plug are removed. Compressing the washers can only be done once. If you don't replace them, the sump plate may leak, or worse, you will bend the crankcase cover.



Six M6 copper packing rings (number 6) and one M14 (number 4) copper packing ring are used to make the sump plate of the Type 1 engine leak free.

### *Paper gaskets*

Two paper gaskets are used, one against each connecting surface of the oil screen. The paper gaskets will absorb the small unevenness of the plane of the crankcase and the sump plate. The word small is important here. At every oil change you absolutely have to clean the crankcase surface on which the paper gasket is lying and free it of all the old gasket residue, oil and dirt. The same goes for the inside of the sump plate.



If you don't change the oil screen, you also have to clean it thoroughly and check if the contact surfaces with the paper gaskets are nice and smooth. Any irregularity will lead to oil leaks.



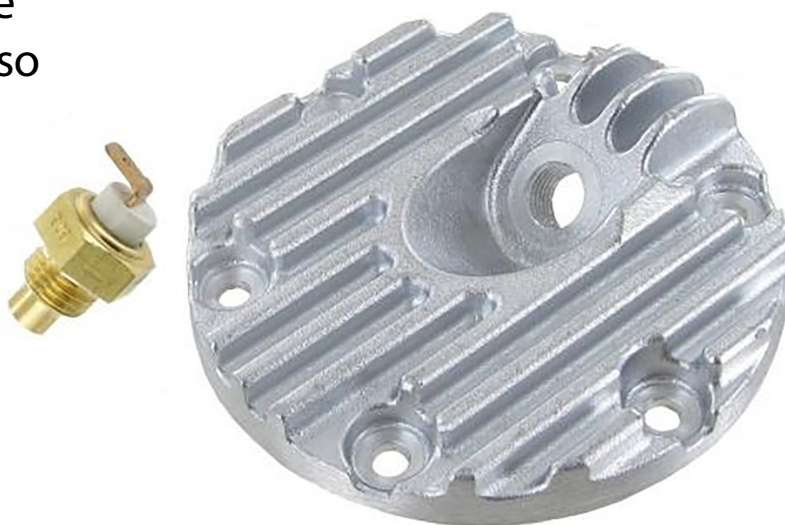


# Type 1 sump plate

## *Sump plate*

There are sump plates with and without the provision for a drain plug. With a drain plug (picture at the top right) it is obviously more convenient to drain the oil quickly. The danger is that the mechanic will not bother to loosen the sump plate to clean or replace the oil screen. When the screen is too dirty, the spring (if any) will bypass the oil screen. The advantage is that the engine is cooled, but the oil is no longer filtered. Sump plates exist in black lacquered or galvanized.

A special version is this one with provision for an oil temperature probe (photo on the right). The probe is mounted at an angle so as not to touch the ground.



### *Sump plate nuts (M6) and studs*

**7 Nm**

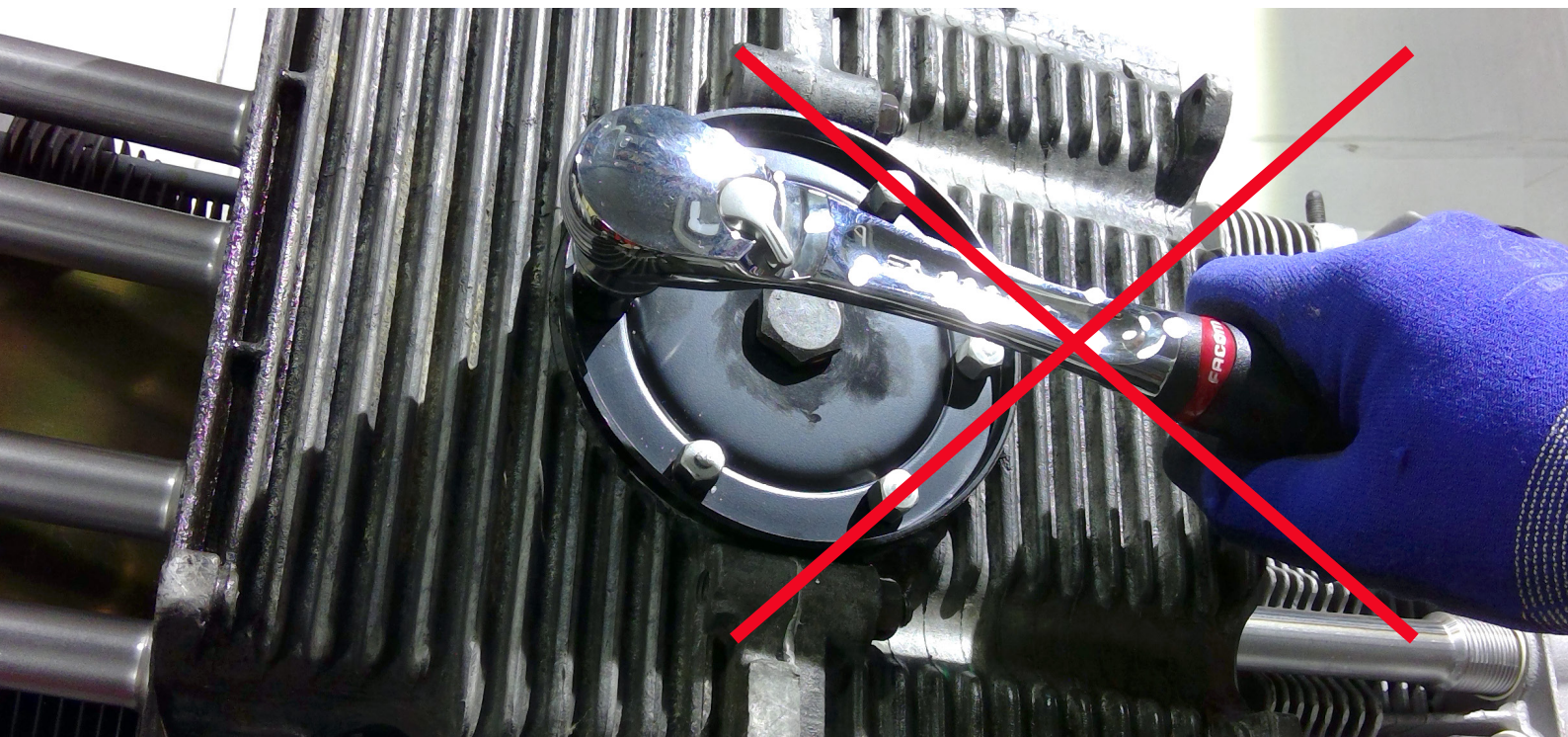
#### **Tighten too tightly**

The sump plate is a critical part of the whole. We see a lot of warped sump plates, and that has nothing to do with the quality of the sump plate, but it has to do with how they were treated by the previous owners.

The plate is made of metal and is strong. But if you exert too much force, with a too big lever as shown in the picture below, on one side of the plate it will warp, resulting in oil leaks. You don't need that much force for it.



The correct way to tighten these M6 nuts is with a small torque wrench. The cap nuts of the Volkswagen Type 1 engine are tightened with 7 Nm (0.7 kgm), that's not much at all. You can also tighten the cap nuts on the feel, but beware, 7 Nm you have reached very quickly with a ratchet arm of 20 cm.



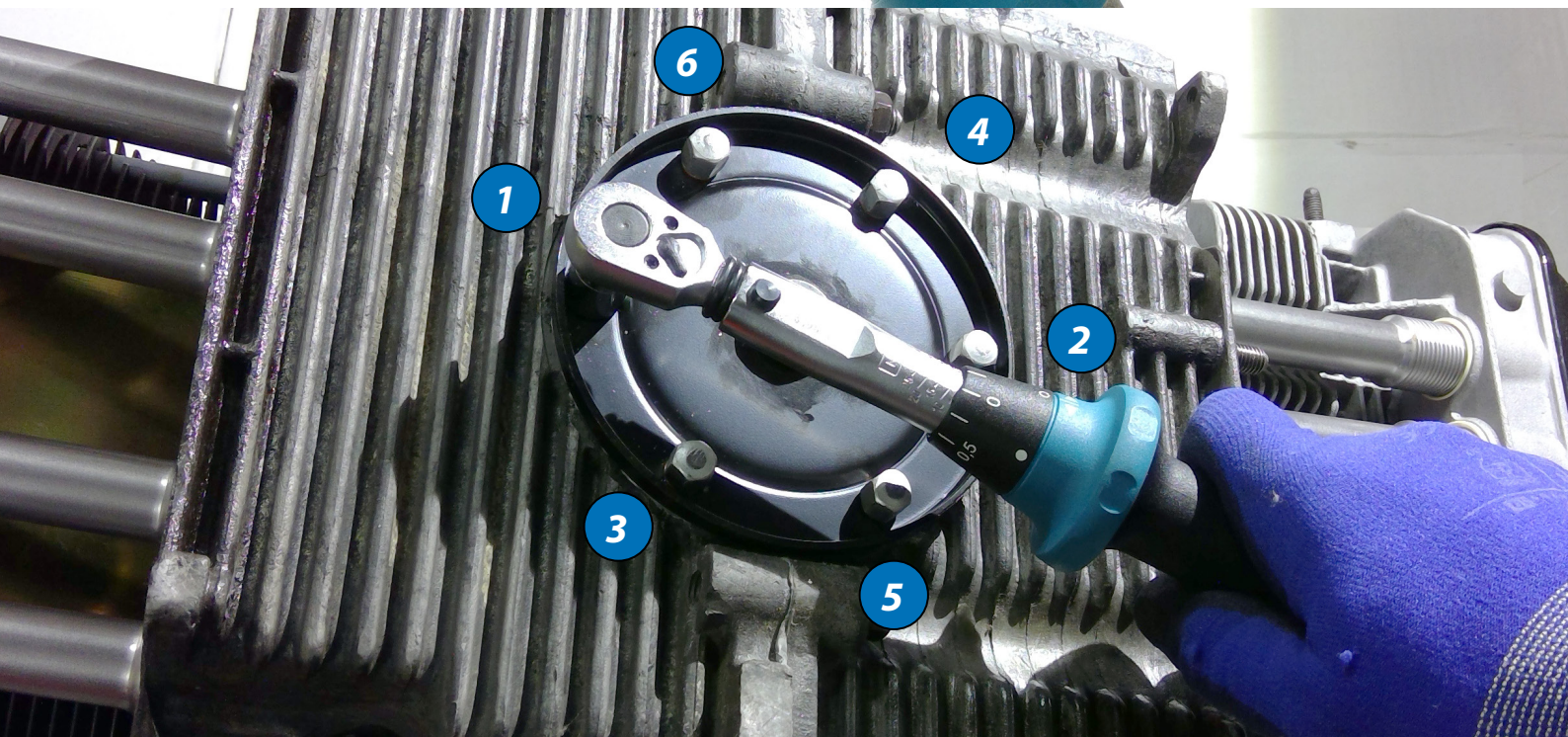


# Type 1 sump plate

0,7 kgm corresponds to a weight of 700 gr exerted on a lever of 1 meter. If the lever is only 20 cm, you have to push 3,5 kg to reach 0,7 kgm, that's really not much.

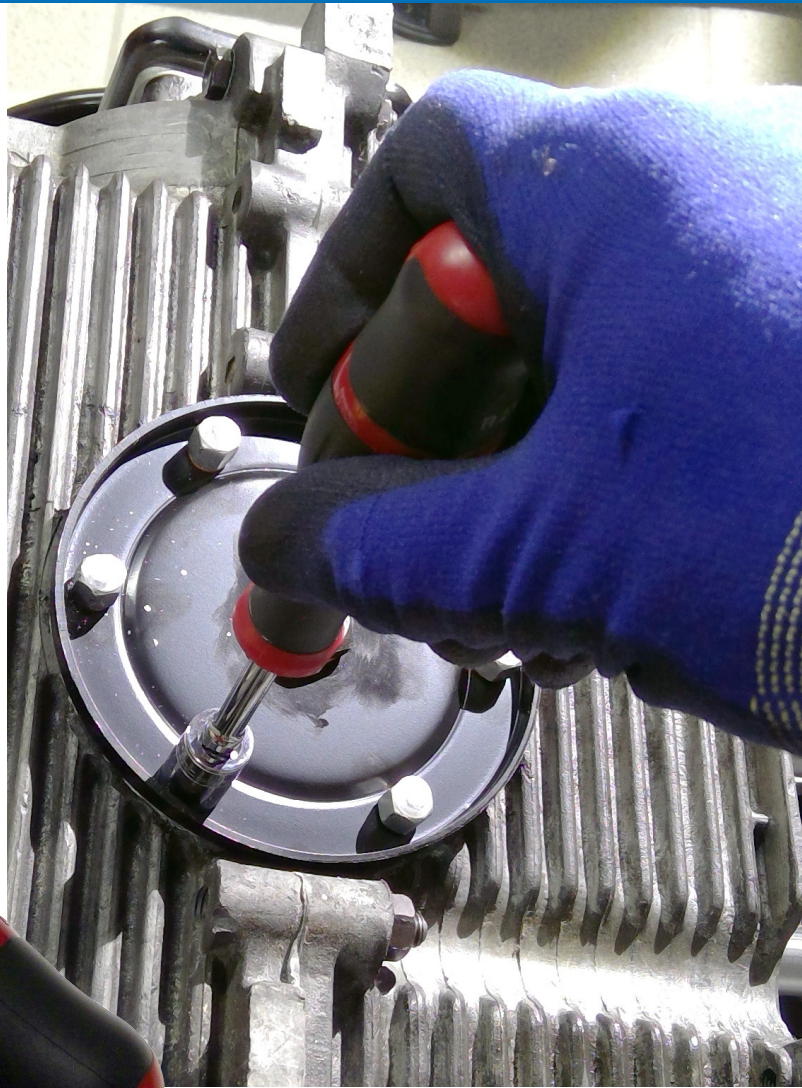
Tighten the cap nuts crosswise in small steps, in the order shown in the picture below, to avoid bending the sump plate.

A small torque wrench that can handle a range of 7 Nm, as shown on the picture on the left and below, is not available in every workshop. That is why we recommend using a socket wrench with a handle instead of a ratchet (see page 14), because then you really can't tighten the nuts too much. But of course the use of a torque wrench is always the best solution to achieve the best result.





With a socket spanner with handle you can't exert much force, and that's a good thing. The maximum prescribed torque of 7 Nm is really not much.



### Not tight enough

Another common problem, but less well known, is that you can't tighten the sump plate hard enough. Whatever you try, the oil leaks from between the sump plate. Does this sound familiar to you?

The M6 cap nuts have a closed head to prevent engine oil from leaking along the stud located in the crankcase. So you have to make sure the stud doesn't protrude too much.





# Type 1 sump plate

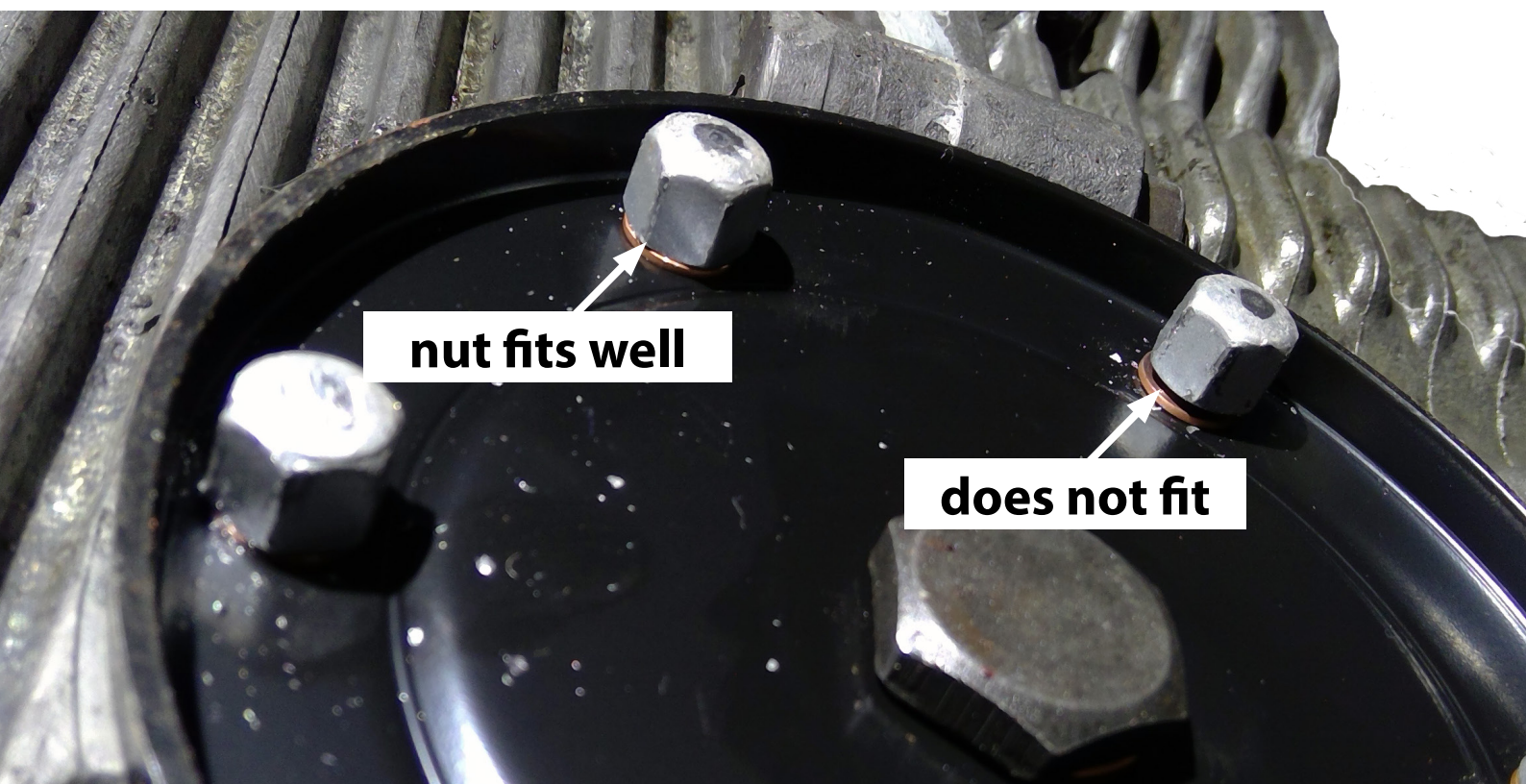
If this is the case, the M6 nut will not be able to be fastened, because the studs will get stuck against the head of the M6 nut (picture below).

If you have just bought a classic VW and you plan to do its first maintenance, check if the studs are inserted at the right depth. If they are too deep, you may not have enough thread to tighten the M6 cap nuts properly. If they are not deep enough, the head of the studs will get stuck against the M6 cap nut.

The result is, as mentioned before, that the closure is not optimal with oil leaks as a result.

If you mount a new sump plate, with new gaskets, measuring the studs is a good idea. There is quite a difference in thickness of materials (sump plate, paper gaskets, copper rings) between different manufacturers.

In the next edition we will show you how to mount the studs correctly to avoid warping of the sump plate.

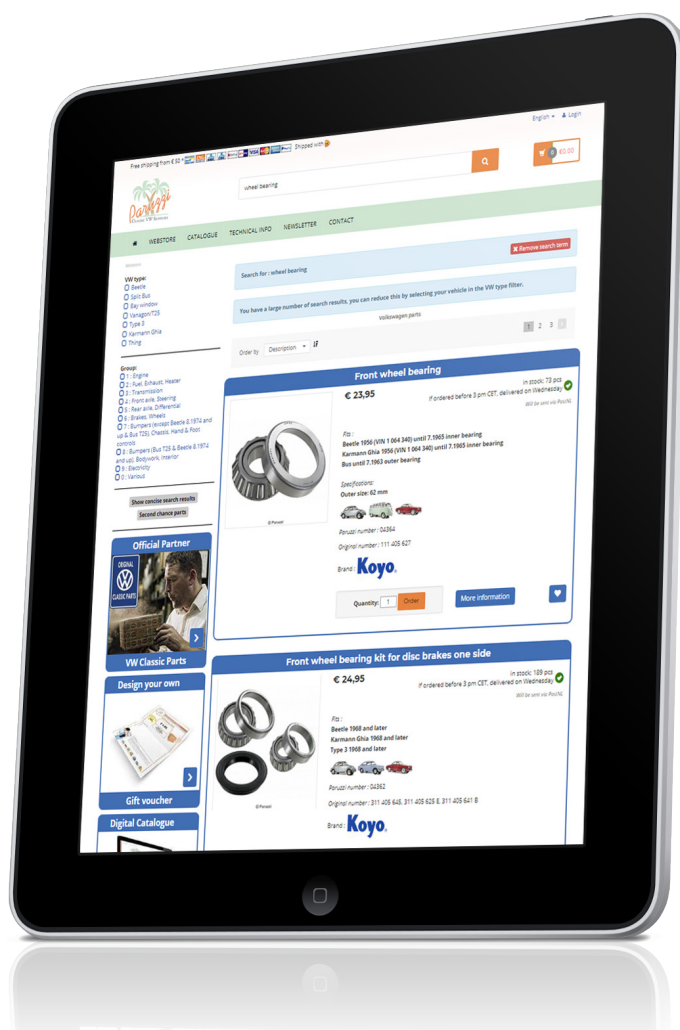


## Introduction

When you like to repair and replace everything on your classic Volkswagen yourself, there will come a time when you will have to replace damaged bearings? Bearings are used in the steering unit, suspension, wheel axles, dynamo or alternator, among other things.

There are various types of bearings, each with its own application. Which bearing should be used where and how strong it should be, we leave to specialized engineers. The SKF website, for example, is full of drawings, dimensions, tolerances, for all possible bearings used in the automotive industry. The information is very complex and for specialists, I wouldn't spend too much time on that if I were you.

When you need to replace a bearing, all you have to do is search our web shop for your VW type, year of manufacture and application, we have done the search for you to make sure you always have the right bearing for your application.





# bearings replacement

In [edition 18](#) we showed a rear wheel bearing and a front wheel bearing and explained why different types of bearings are used front and rear. For the rear wheels, ball bearings are used (photo bottom left) and for the front wheels, tapered needle roller bearings are used (photo bottom right).

In the next editions of this technical series, we will replace the wheel bearings at both the front and rear.

It will then be useful to know which are the best techniques and which are the most suitable tools to perform this task, which is exactly what we will do in this article. We will start with the assembly techniques of tapered roller bearings used on, among other things, the spindles of the front axles.

Incorrect handling is not allowed with bearings, premature wear is the result or, in the worst case, major damage and breakage can occur.

**rear wheel bearing**



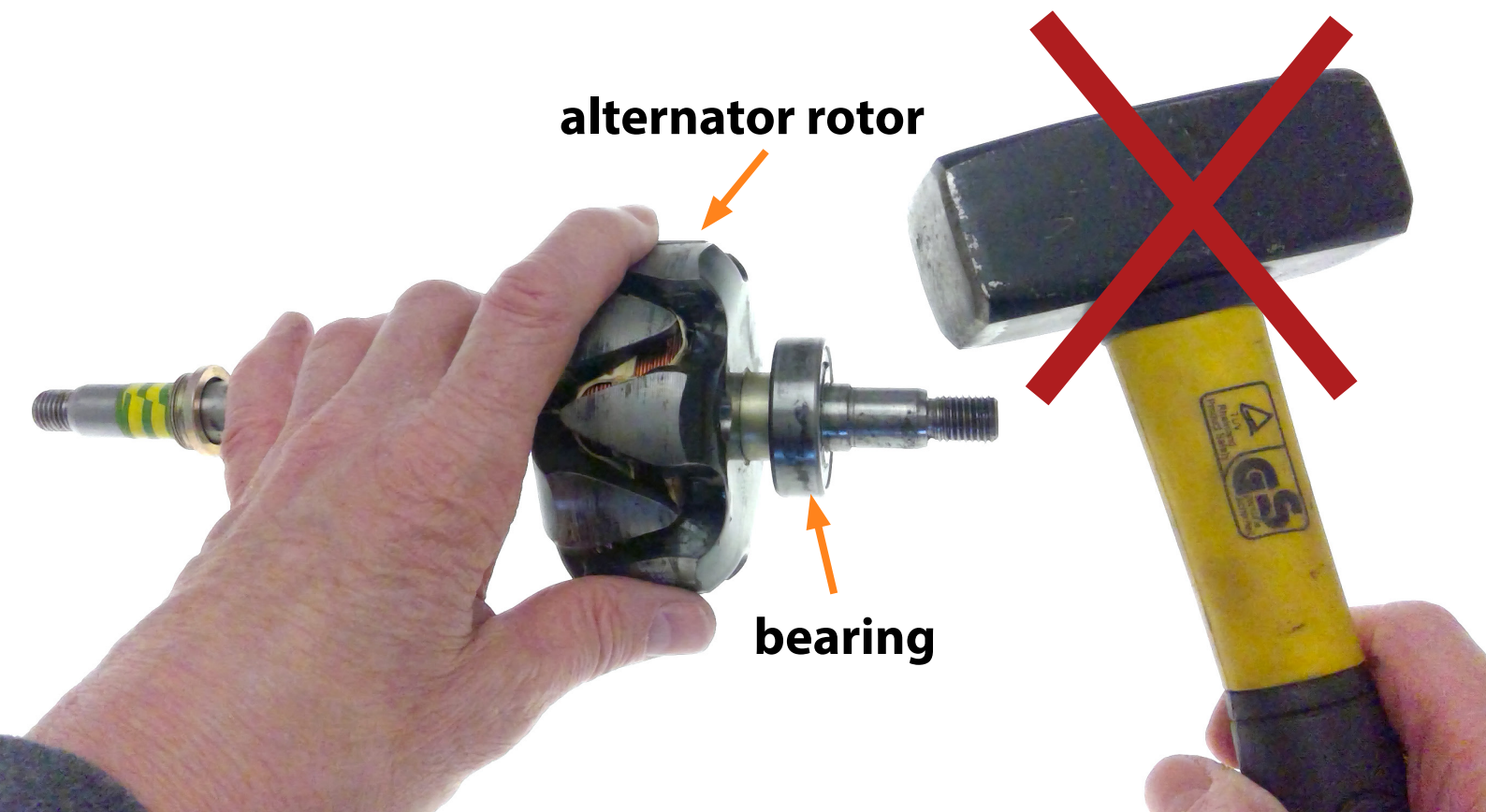
**front wheel bearing**



## Bearings and their construction

In order to know how to assemble a bearing without damaging it, you must first understand how they fit together. What are the weak points, what are you allowed and what are you not allowed to do with a bearing. It is very easy to knock a bearing in place with heavy artillery as shown in the picture below, but premature wear or breakage will be the result. Damage will not always be immediately visible, but will become noticeable after a while.

Do not damage the bearing itself. You also do not want to damage the sliding surfaces of the part in which the bearing is mounted. So never use a heavy hammer as the only tool to mount bearings, or a drift puncher tool, this technique poses a high risk of permanent and irreversible damage, damage that is not always visible to the naked eye.



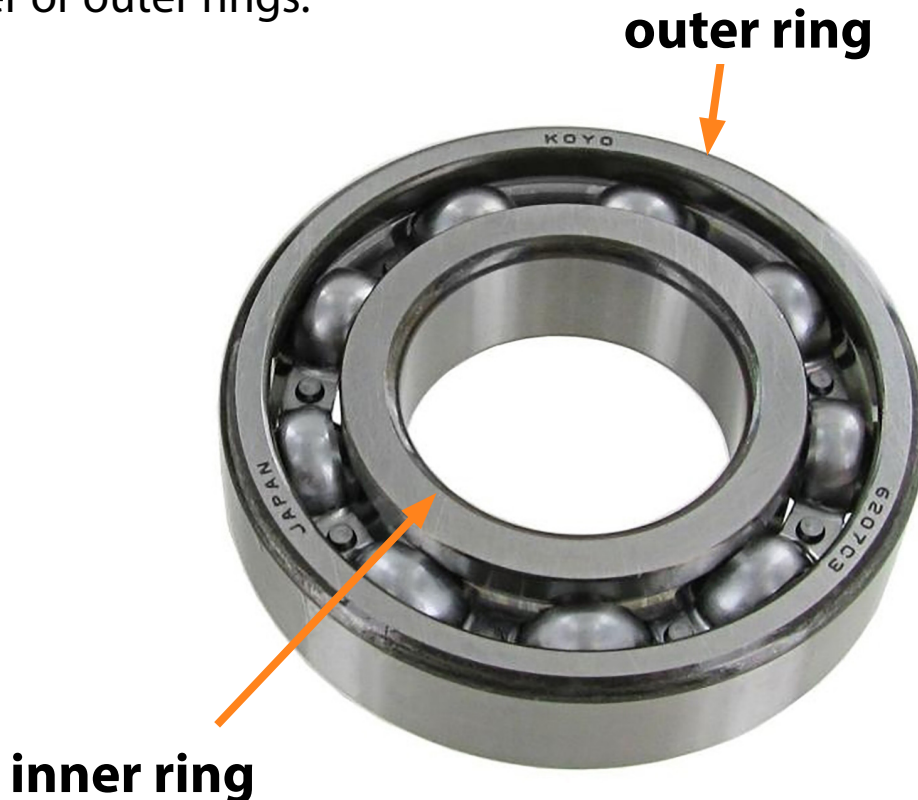


# bearings replacement

## *Inner and outer ring*

Bearings are designed to mount two parts that must be able to move freely from one another, with minimal friction. Friction is synonymous with heat and wear, and we just want to avoid that. To achieve this, roller bearings or needle roller bearings are fitted between the two parts. To protect the parts themselves against the rotating roller bearings or needle roller bearings, they are built into a metal shell, i.e. the inner and outer bearing or inner or outer rings.

The only thing that can wear are the bearing parts themselves, the part it is mounted in is theoretically free of wear. By replacing the (relatively cheap) bearing, all wear and tear disappears. At least that is the intention, and that's right on condition that the bearings are mounted correctly. Poor mounting or wrong type of bearing could cause the outer ring to rotate and the part to wear out.

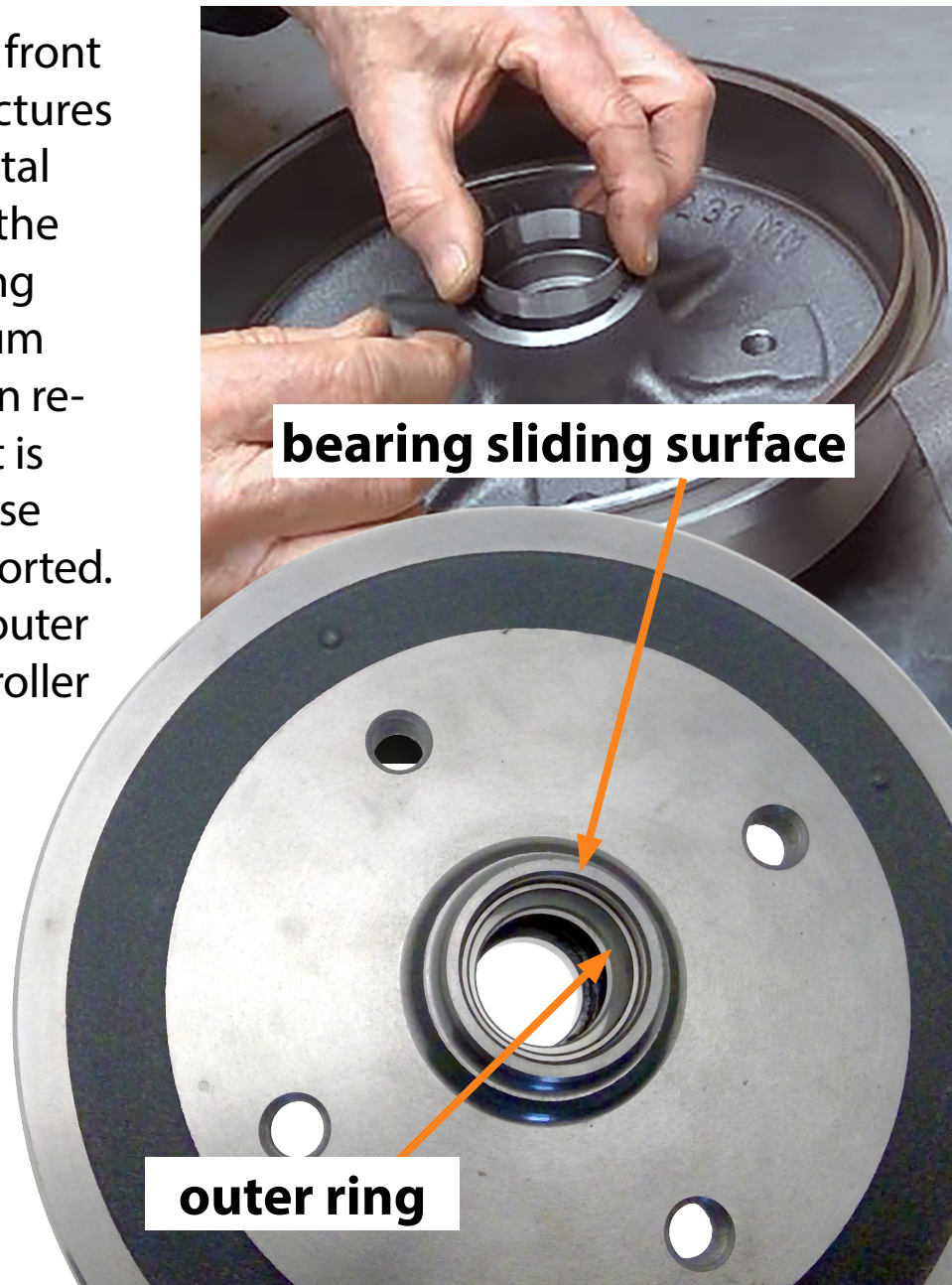


## Press fitting or slide fitting

Bearings will always fit somewhere in a metal opening in a part or over an axle of your car. Fitting may be the wrong word, because sometimes they just won't fit. What do we mean?

Let's take the example of a front wheel with drum brake (pictures on the right). The outer metal bearing or bearing race of the tapered needle roller bearing must be clamped in the drum to prevent it from rotating in relation to the part in which it is mounted, which would cause wear to the part to be supported. This is called **press fit**. The outer race of the tapered needle roller bearing will have a slightly larger diameter than the brake drum into which it is to slide. With a slightly larger diameter we speak of for example 0.1 mm (one tenth of a mm).

So during assembly we have to find a technique where we push the outer bearing race (outer ring) of the bearing into the drum without damaging the drum itself.





# bearings replacement

thrust ring

needle bearing

The inner ring of this tapered (conical) needle roller bearing slides in turn over the spindle with a little resistance, this is a **slide fit**. The thrust ring serves to absorb the axial forces on the bearing.

outer ring/  
outer bearing race

bearing sliding surface

inner ring

bearing race



## Useful tips

This magazine was written to help enthusiasts work on their classic VW. Most will have a limited set of tools at their disposal, others have built a semi-professional workshop over the years tinkering with old VWs.

We will explain all the techniques. One technique is not inferior to the other, the end result is identical for all techniques.

The big difference lies in the fact that a professional will assemble bearings on a daily basis, so it has to work fast and efficiently. A professional can invest in expensive tools, an enthusiast doesn't mind spending a morning assembling a bearing, that's part of the fun of the hobby; no time pressure, no stress. In the case of a professional (or an assembly line such as in the photo, VW Brussels 1960) working hours obviously count for more.

There are bearings that you have to press in or out of the part with a very high pressure. Only the technique with the hydraulic press is possible, an enthusiast won't get that quickly, although a basic press is reasonably affordable. Fortunately all bearings of our classic Volkswagen can be disassembled and assembled with tools that are easily accessible.





# bearings replacement

## *Heating and freezing*

For the enthusiast who will be working with a limited set of tools, the following technique is very interesting. With some parts it is even prescribed by the manufacturer to avoid unnecessary stress on the parts.

The use of heat is probably known by most enthusiasts. When parts are stuck, it is often recommended to first heat them well with a paint stripper or gas burner.

An additional technique, which I don't see so much in the VW scene, is freezing metal parts. Why on earth would you do that? To do that, we have to explain some theory, it becomes much clearer. Heating and freezing parts offers an ease of assembly for enthusiasts and avoids unnecessary knocking with a heavy hammer. The use of heavy hammer force with a screwdriver is a technique I strongly advise against.

First of all, it is not necessary at all, secondly, it can cause a lot of damage to the bearings or the part that the bearings are in. So, **don't do it!**

It is best to study the characteristics of metals before working on the heavy mechanical parts of your VW. This will help you to deal better with the parts that are subjected to greater mechanical forces. The theory of metal expansion due to temperature rise, and contraction due to temperature drop is often applied, sometimes unconsciously, while working on cars.

We recommend that you read the theory about metal and temperature changes on the following pages before continuing.

## Expansion and contraction of metals

All materials, and of course metals of which the bearings and mechanical parts of our VW are made, tend to expand or shrink with every temperature change. The extent to which this happens depends on the temperature difference, the size of the part and the coefficient of expansion of the material. The following formula is used to calculate the expansion:

$$\Delta l = \alpha \times l \times \Delta t$$

$\Delta l$  = the change in length

$\alpha$  = coefficient of expansion

$l$  = length of the part

$\Delta t$  = temperature difference

The coefficient of expansion  $\alpha$  is different for all materials. For example, aluminium ( $\alpha = 0.000023$ ) expands twice as much at the same temperature change than steel ( $\alpha = 0.000012$ ). A large part will therefore also expand or contract more than a small part according to the formula. Just think of the high voltage cables that will hang during a hot day (picture below). These are very interesting facts that we can apply to make it easier to disassemble or assemble bearings without using too much force.





# bearings replacement

## Heating

If we take an aluminium part with a bearing diameter of 60 mm and heat it from 20°C to 100°C, according to the formula the part will expand by 0.11 mm.

$$\Delta l = 23 \cdot 10^{-6} \times 60 \text{ mm} \times (100^{\circ}\text{C} - 20^{\circ}\text{C})$$

## Cooling down

A 60 mm diameter steel bearing cooled to -18°C in the freezer will shrink by 0.03 mm according to this formula.

$$\Delta l = 12 \cdot 10^{-6} \times 60 \text{ mm} \times (-18^{\circ}\text{C} - 20^{\circ}\text{C})$$

In total we gained 0.11 mm + 0.03 mm, or 0.14 mm. When you combine both, heating and cooling, the bearing sometimes slips on or in effortlessly. As mentioned before, a press fit is around 0.1 mm. And that just makes the difference between having to knock the bearing in hard with a hammer and lightly tapping the bearing, or in some cases, letting the bearing slide in. To be honest, I prefer the scenario with little violence.



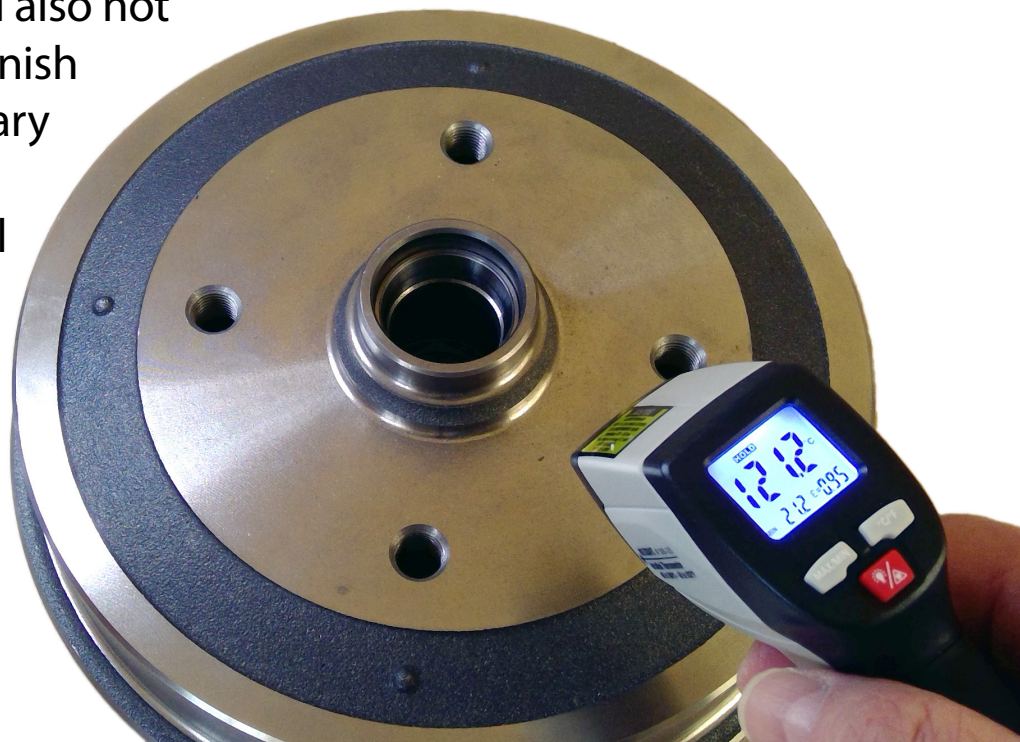
## Heating

Heat comes in handy both when disassembling and installing a bearing. In the case of a press fit, the bearing will be very hard to install. Heating the part in which the bearing is press fitted is always a good idea (see why in the theory on the previous pages). By heating the part it will expand and the bearing will be less difficult to install.

If the part is painted or coated with a varnish, the use of a paint stripper is recommended. A paint stripper will not overheat a solid metal part, and will also not damage the paint or varnish layer. Perhaps unnecessary to mention that the gas burner will burn away all paint or varnish!

For some parts the manufacturer recommends higher temperatures to loosen a bearing, then you need a gas burner.

The use of an infrared thermometer is recommended to heat a part to the correct temperature. Below we show the use of such a thermometer when mounting a front wheel bearing.





# bearings replacement

## *Cooling down*

Mounting a tapered bearing helps to freeze the outer ring (picture below), in combination with heating the part. In the case of a front wheel bearing we would heat the drum with a paint stripper or gas burner and freeze the outer ring of the bearing to  $-18^{\circ}\text{C}$ . The inner ring of a brake drum bearing in turn slides gently (slide fit) over the spindle.

The heat causes the drum to expand by a few tenths of a millimetre and the cold causes the outer ring to shrink by a few tenths of a millimetre (see theory on pages 24 and 25). If you have little experience with mounting bearings, it happens that you insert the outer ring obliquely, with this technique the outer ring of a conical bearing will not seize that quickly.



**$-18^{\circ}\text{C}$**

### Hydraulic press

It always helps to heat the part with a paint stripper, it should not be extremely hot, heating up to  $60^{\circ}$  is sometimes sufficient to reduce the tension between the part and the bearing. We have calculated on pages 24 and 25 how much a metal part expands when heated or frozen.

Then you can choose between one of the following techniques to remove the old bearing and to mount the new bearing. Which is the best technique will depend on the situation, we will give you advice on this, but experience will of course also help you to estimate this better.

The hydraulic press (photo below) can be used to remove or mount a bearing.

VW enthusiasts do not have a hydraulic press in their workshop. But in some cases this is the only tool you will be able to use to remove the bearings. This has to do with the size of the bearing and the needed press force. Of course the part has to be disassembled to be placed on the hydraulic press.

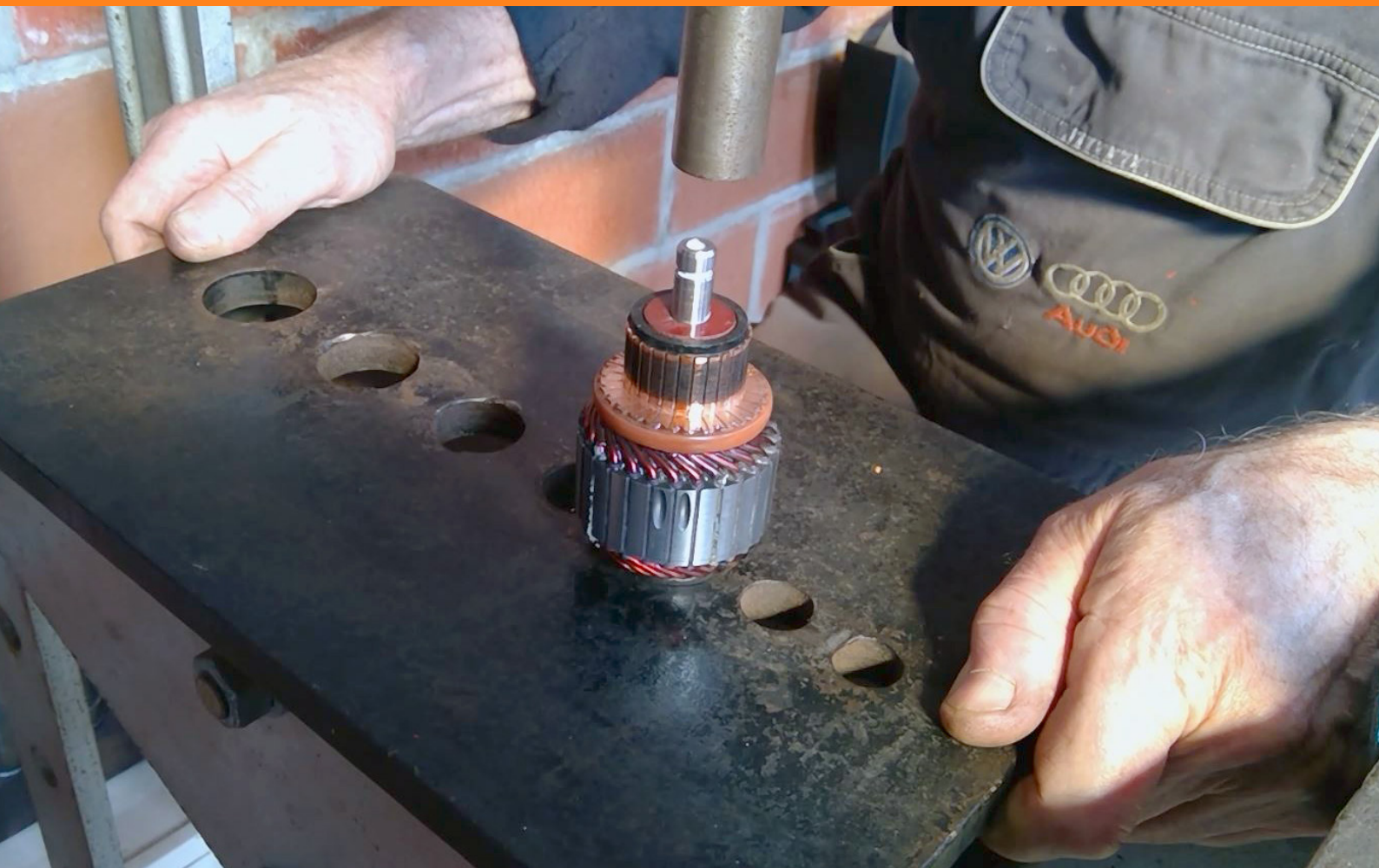


© www.hbm-machines.com





# bearings replacement



Fortunately, no hydraulic press is needed for the bearings of our VW, with a few handy tips from this article you will be able to do all the work.



## Disassembly

### 1 Bearing puller

As mentioned before, you want to avoid the heavy artillery (hammer and chisel) as much as possible. A tool that is within the budget of every enthusiast is the bearing puller. There are **internal** and **external bearing pullers**.

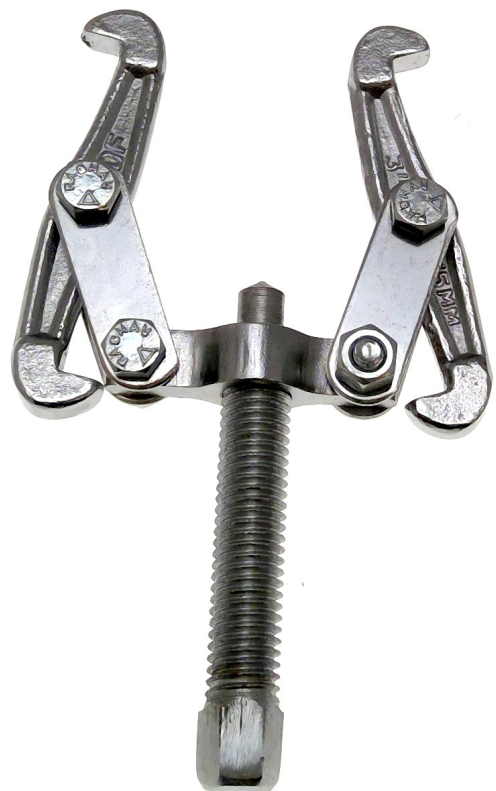
A bearing puller uses a solid part of the part in which the bearing is located to apply force. The puller itself can move on a stud to loosen the bearing.

An external puller (picture above) can also be used as an internal puller (picture below) with some models, simply by loosening and reversing the legs.

*Right: an external puller can sometimes be transformed into an internal puller, ideal for pulling off a pulley, for example.*



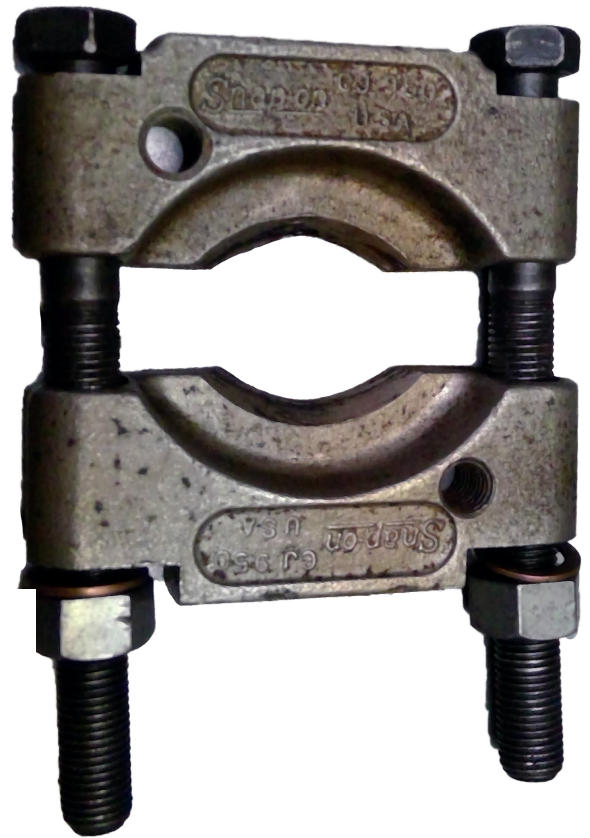
*Above: an external puller is very handy but you need to have the necessary space to grab behind the bearing. Usually come with grippers with different thicknesses.*





# bearings replacement

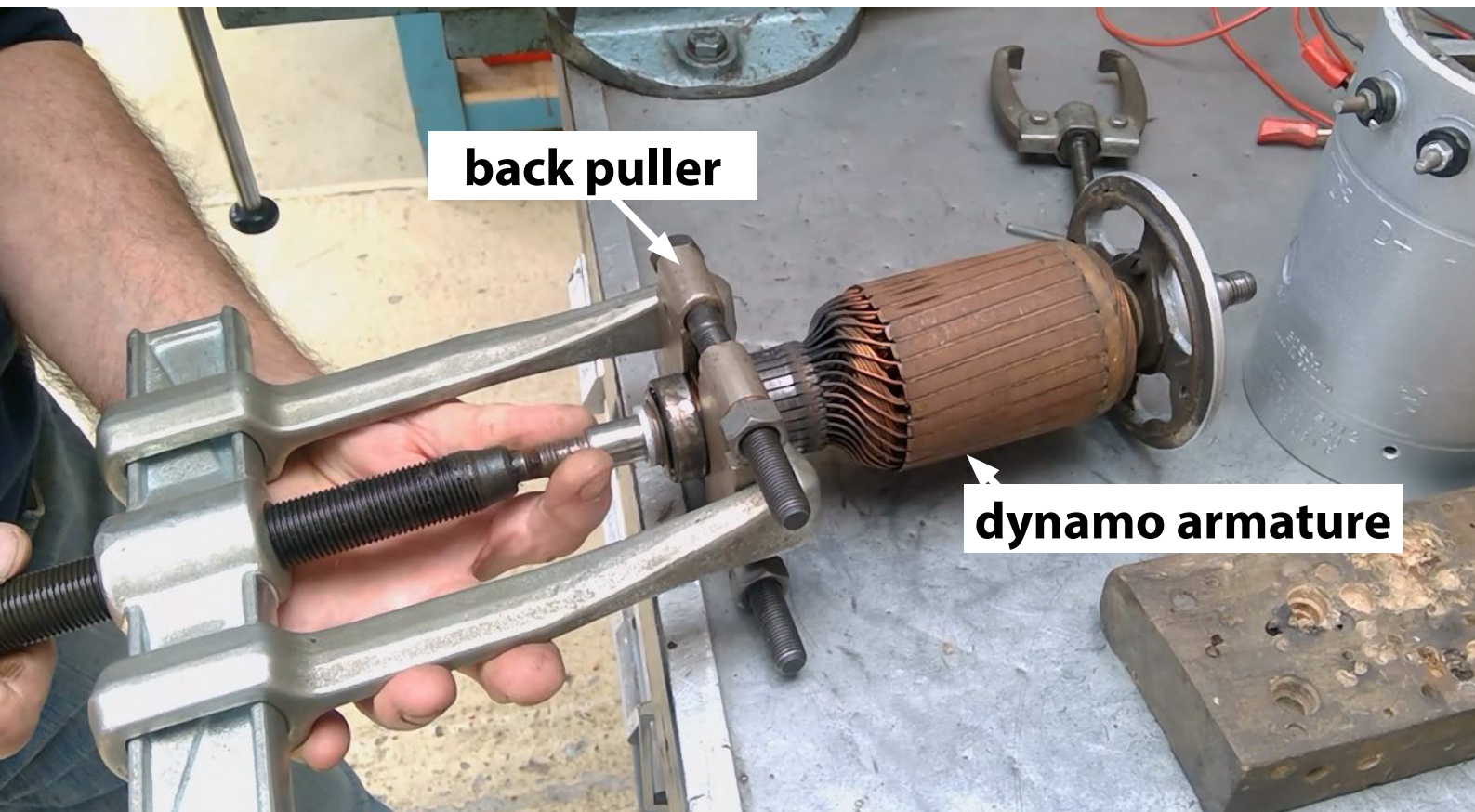
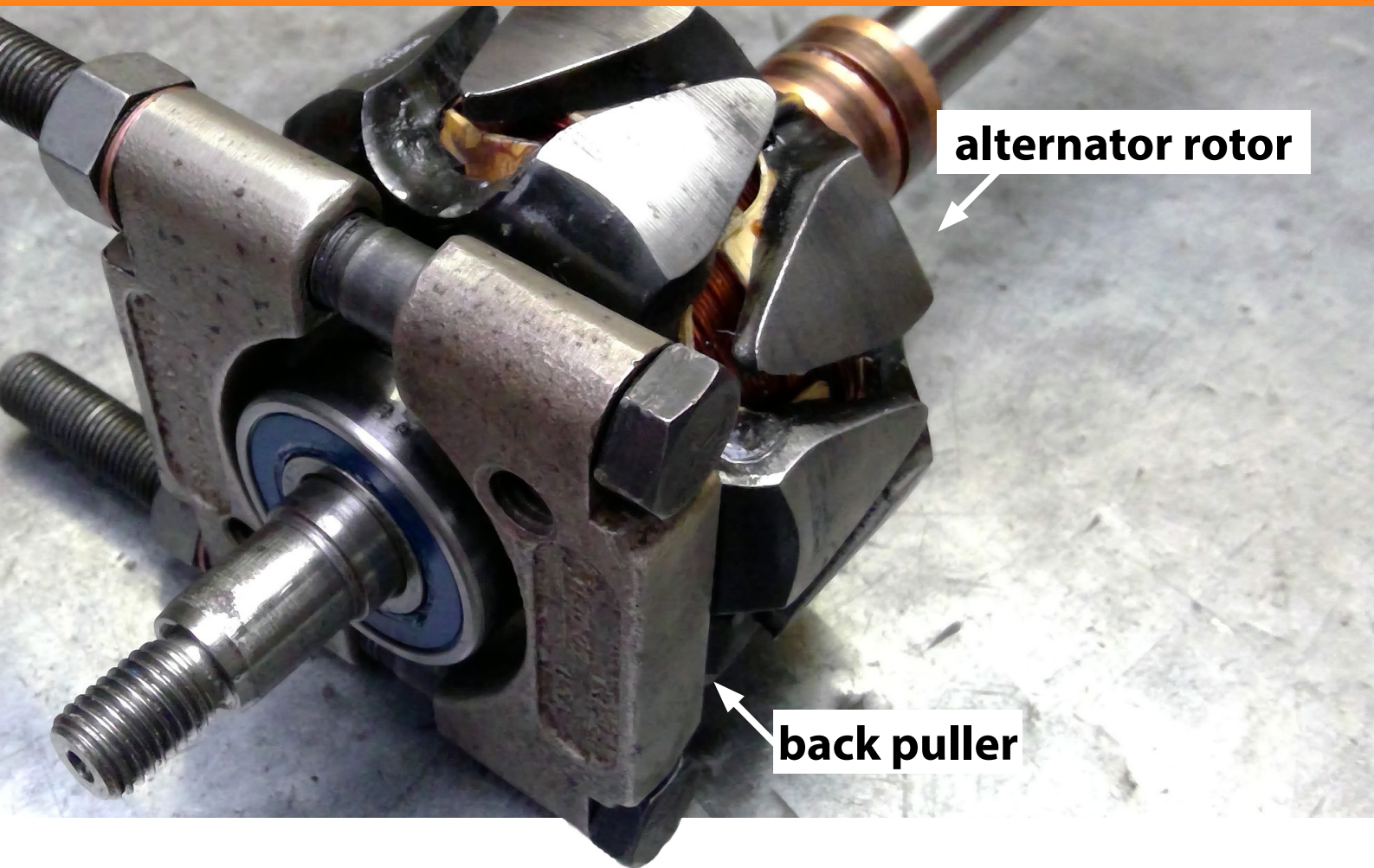
An internal bearing puller like the one below is useful to remove the outer ring of a tapered bearing, for example. You slide it through the bearing, by turning the shaft with a wrench the gripper will expand and lock itself behind the bearing. The thickness of the gripper determines whether it is usable for a certain application, depending on the space available behind the bearing.



When the parts are mounted very close together, as can be seen on the picture on the next page, this back puller come in handy (picture at the top). The photos show how to remove the bearing from an alternator rotor (photo at the top of page 32) without damaging the shaft. The photo at the bottom of page 32 shows the same tool used for the dynamo bearing.









# bearings replacement



## 2 *Drift punch*

In some cases, you'll just be able to push the bearing out from behind. This is the case with the front wheel bearings. As you can see in the picture, you can reach the rear of the outer ring of the wheel bearing with a punch. Don't use a screwdriver, you don't want to damage the sliding surface of the part, in this case the drum.

It is of course always recommended to warm up the drum to make it easier to remove the bearing. The tension will drop considerably by increasing the temperature.

On some bearings you have a notch on the outer ring to make it easier to push with a drift punch. If this is not present, you can add it yourself before assembly. In the case of this drum, the ring runs flush with the sliding surface of the drum, which makes it impossible to drive it out with a punch, and not even with an internal puller. A small notch would therefore have helped to easily remove the bearing.



## Assembly

The theory of heating and freezing of metal parts is also very useful during assembly. Placing the bearing in the freezer and heating the brake drum helps to make assembly easier. Place the wheel bearing, possibly already greased, in a lockable plastic bag in the freezer.

A paint stripper is usually sufficient to heat the part.

For larger metal parts you will need more energy and a gas burner is necessary (picture here below). Do not use a gas burner on parts that are painted, coated or already provided with grease (fire hazard). Some mechanics use an oven or a baking tray to heat the parts.

There are various techniques for assembling bearings, ranging from without special tools to the use of professional equipment.





# bearings replacement



## 1 *Using the old bearing*

With this technique you don't need any special tools. You use the old bearing as a driving tool. The old bearing has exactly the same dimensions as the new one and is therefore very suitable as improvised tool.

For example, in the case of a tapered needle roller bearing of a front wheel, this is only the outer ring that you use as a tool; in the case of the roller bearings of the rear wheels, you use the entire bearing as a driver.

This technique is often used when the bearing does not need to be driven too deep. When the bearing needs to be driven very deep, then the old bearing is no longer sufficient, and you have to use a suitable socket wrench to push the bearing further. This is not without danger of damaging the tread of the part, that's why I prefer to use a bearing driver.

2

### *With socket*

With this technique you use a socket wrench that fits the inner ring of a roller bearing, e.g. for a dynamo, or the outer ring of a tapered bearing, e.g. for a front wheel bearing. You can also use a metal tube as shown on page 29.

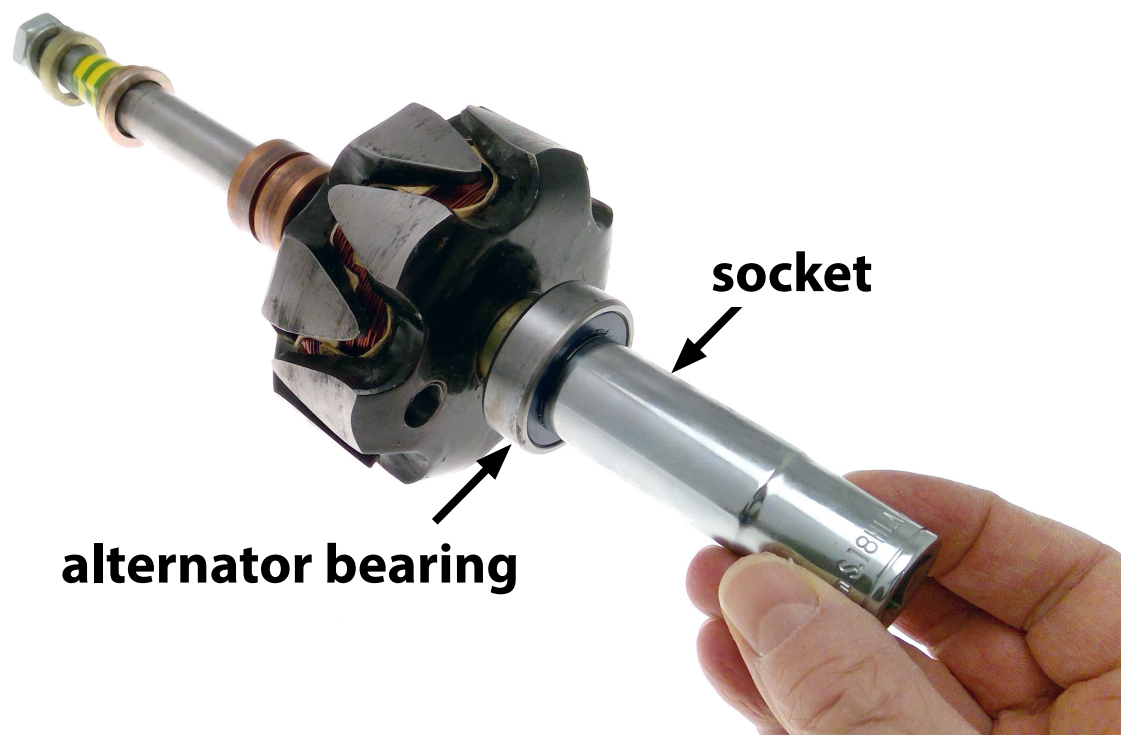
It is very important that you push on the part of the bearing that is in press fit to prevent damage. The two bearing rings are held together by a metal cage, roller bearings or needle roller bearings. The axial force that such a loose bearing can handle is not that great.

3

### *Bearing drive*

A bearing drive will usually be purchased as a set with several sizes. However, you will not have all the correct sizes for all applications, and you will soon buy a second or third set. They are not expensive at all, so that can't be the reason not to have them in your workshop.

The drives are made of aluminum, this is a very soft material, unlike a socket wrench or an old bearing.





# bearings replacement



area. The bearing drive must be placed vertically, axially, perpendicular to the bearing. If you position the bearing drive too obliquely, the bearing tends to go in at an angle, which can damage the part.

4

## *Hydraulic press*

If you hammer a bit too hard against, for example, a brake drum with a bearing drive, then mainly the bearing drive will be damaged. Do the same with a socket then the hard metal against hard metal will result in damage to the part.

You have to choose the correct drive for the bearing to be mounted for maximum contact

A professional will always tend to use his hydraulic press, it works fast, and that's what counts in a professional workshop or an assembly line. For the enthusiast this is less important. You don't need a hydraulic press for your VW bearings.

In the following editions we will discuss practical examples, such as replacing front and rear wheel bearings, dynamo or alternator bearings, starter motor, ...

## Introduction

In [edition 18](#) we explained which role the condenser has in the ignition circuit. Without the condenser, the ignition will really not work properly and the contacts will burn in quickly. So it is important to measure at regular intervals if the condenser in your VW motor is still working.

A malfunctioning motor that sputters or has no power, burned in contact points, these are all reasons to test the ignition parts in between maintenance.

How do you measure if a condenser is working or not? A condenser is not just an electrical resistor. You sometimes hear that a resistance meter (ohmmeter) is used to know if the condenser is still working. But a resistance meter will only tell you if the insulation (dielectric, see [edition 18 page 17](#)) inside the condenser is in a short circuit, in other words it is burnt out, nothing more.

We will now show different techniques to test a condenser, techniques that are within reach of every enthusiast. If you want to get straight to work, we recommend jumping to page 44, where we explain how to measure the condenser with a voltmeter.





# testing the condenser

## Measurement techniques

### 1 *with ohmmeter*

The condenser is sometimes measured with an ohmmeter. There is nothing wrong with that in itself. An ohmmeter (or resistance meter) is connected in parallel with the component to be measured, in this case the condenser. The component may not be connected to other electrical components, otherwise the measurement will be wrong. In other words, you have to disconnect the condenser to make the measurement.

*Use short measuring cables and do not touch the condenser during the measurement, this could affect the measurement. Use crocodile clips as shown in the picture.*

What an ohmmeter does, is to send a small constant current with fixed value through the resistor to be measured, will then measure the voltage across that resistor to finally come to the value of the resistor, as follows:

$$R = U / I$$

R= resistance in ohm

U= measured voltage in volts

I= current in amperes



If we are going to apply that to our condenser, the following scenarios may occur:

### resistance = 0 $\Omega$

The condenser forms a short circuit, the resistance of 0  $\Omega$  remains, or a value close to zero (depending on the multimeter and the length of the cables) The condenser is broken, the ignition circuit will not function properly.

### resistance = $\infty$ (infinite)

The ohmmeter indicates infinite (1 or OL of Open Line depending on the multimeter), the condenser does not conduct. This can mean that the condenser is broken or that it is perfectly fine. So the result "infinite resistance" has no useful meaning.



Measuring a condenser with a resistor meter only gives a usable result in one case, namely when the resistor is zero, the condenser needs to be replaced. In the second case, you don't know what to do with the condenser.





# testing the condenser

2

## *with capacitance meter*

A capacitance meter will tell you if the condenser works, but it will also tell you what value the condenser has. Few enthusiasts will have such a capacitance meter in their workshop, they are on the pricey side and can only be used to measure that one component of the ignition. Usually these are used as capacitance meter plus coil meter, you can use this type of meter to measure the ignition coil, the dynamo, the alternator or anything with a coil in it.

We do the measurement as you can see on the picture below, the value of the condenser is exactly  $0.2522\mu\text{F}$ . It is very easy to know if the condenser is still working, it should give a value around  $0.2\mu\text{F}$ . With such a meter you can also see if the condenser has the right value.



**0,2522  $\mu\text{F}$**

## The charge curve

If you have read the previous editions, you know by now that a condenser can store electrical voltage. So, for example, when you connect a 12 volt battery to a condenser, it will try to store and hold the 12 volt voltage. We compared this to a water tower.

To be more precise, for the electricity specialists among the readers, a condenser will store an electrical charge equal to the value of the condenser times the voltage:

$$Q = C \times V$$

Q= electric charge in coulomb  
V= the electrical voltage in volts  
C= value of the condenser in farad

Storing that energy is not instantaneous, the condenser needs a certain amount of time to charge. And it's just that time we can use to test if a condenser works or not.

How long it takes depends on the value of the condenser and the resistance in series with the condenser, as follows:

$$t = 5 \times R \times C$$

R= resistor in series with condenser  
C= value of the condenser in farad

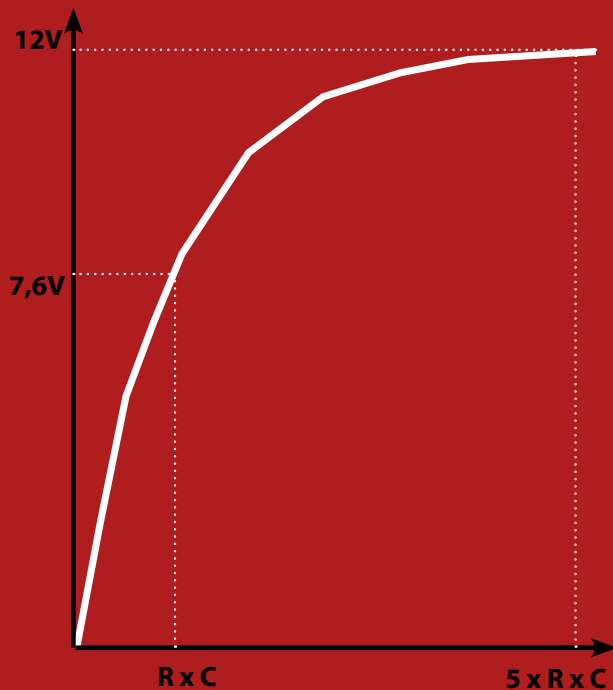
The theory says that after the value 5 times the resistor times the condenser, the condenser is almost fully charged, and thus stored the battery voltage. After 1 time R x C, the voltage will be 63% of the battery voltage.





# testing the condenser

We show this in a graph:



If we apply this theory, we arrive at the following calculation. In [edition 18](#), we saw that a condenser in our VW has a value of about  $0.200\mu F$  (or  $0.0000002F$ ). If we now switch on a very large resistor of  $10M\Omega$  (or  $10,000,000\Omega$ ) and put a battery voltage of 12 volts on it, then the condenser will be fully charged to 12 volts after  $t = 10s$ , as follows ( $5 \times R \times C$ ):

$$10s = 5 \times 10.000.000\Omega \times 0,0000002F$$

With a battery voltage of 12 V it means that after 1 times the value  $R$  times  $C$  the voltage across the condenser is 7.6 V. After 5 times  $R$  times  $C$  it is almost 12 V.

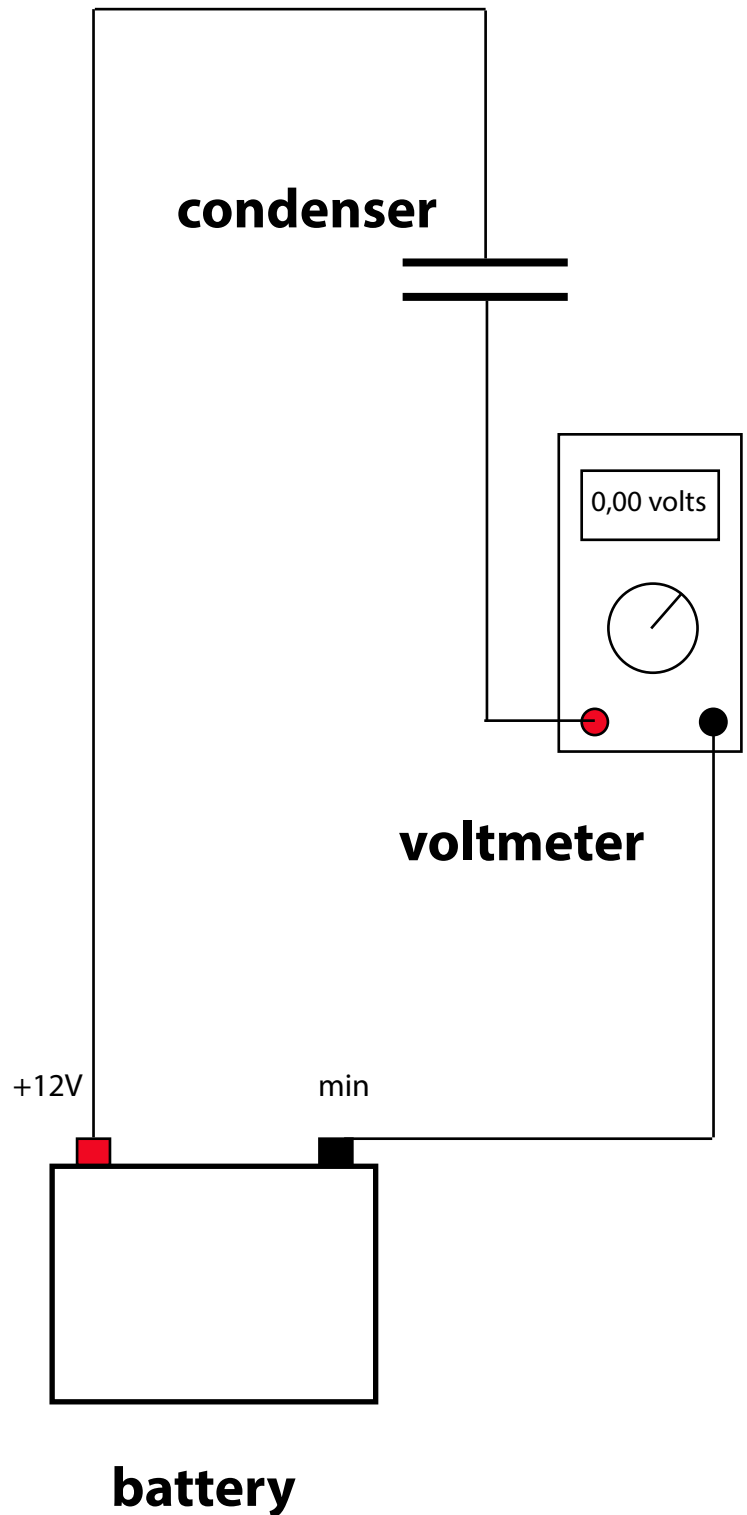
This behaviour of the condenser is interesting, it tells us that it will take 10 seconds to store the full battery voltage, and that's exactly what we can easily measure with a voltmeter.

### 3 *with voltmeter*

You can test if a condenser works with a voltmeter, we all have this type of device in our workshop. You can also use it to determine the value of the condenser, not exactly, but approximately, which is usually sufficient.

To understand the measurement, you need background theory about the condenser charge curve. We explain that theory on the previous pages, it is not a mandatory reading, you can perform the measurement perfectly without understanding the theory.

On the right we show the principle and the practical setup. It boils down to connecting a battery to a resistor and a condenser that are connected in series (see drawing). As a resistor we use our voltmeter.





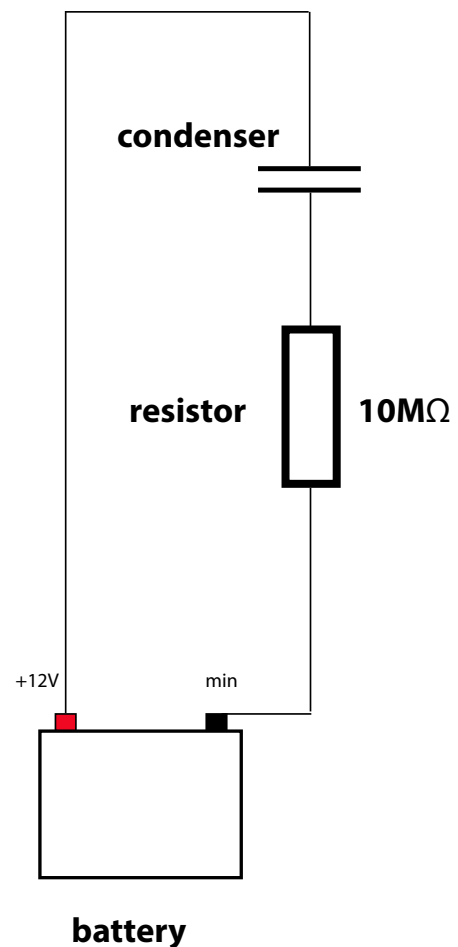
# testing the condenser

When the battery voltage is connected, the condenser will charge to the battery voltage, and this in a time equal to  $5 \times R \times C$ . The condenser will charge to the battery voltage. This formula is explained on the previous pages. So, after  $5 \times R \times C$ , the condenser is fully charged.

If we can now measure the progress of that charge, how long it takes to fully charge the condenser, then we can measure if the condenser actually works, and even determine its value.

In practice, we use a trick to perform this measurement, in such a way that you don't have to buy a resistor or other special devices, a voltmeter serves as a series resistor and also as a measuring device.

It seems a strange setup I know, who switches a voltmeter in series with an electrical consumer, I should know better I hear you think? Actually, in this setup, we use the voltmeter as a resistor. Below we show a circuit where the voltmeter is replaced by its internal resistor of  $10M\Omega$ .



A voltmeter must have as high a resistance as possible between its measuring terminals in order not to influence the measurement. A professional voltmeter will have a typical value of  $10\text{ M}\Omega$  between the terminals, this will be mentioned in the manual of your voltmeter. Very old, say Vintage, voltmeters, or very cheap voltmeters that you sometimes get for free, have a much lower resistance between the terminals.

That makes the difference between a correct measurement and a bad one. The lower the resistance of the voltmeter, the more it will influence the measurement, and you don't want that.

Below we show a series of voltmeters with left a free one, this one has a resistor of  $1\text{ M}\Omega$  which is usually too low for an accurate measurement. On the right is an affordable multimeter with  $10\text{ M}\Omega$  internal resistance.





# testing the condenser

To test the condenser, an ordinary voltmeter is sufficient, no matter which one. If you also want to estimate the value of the condenser, you need a professional voltmeter with a higher resistance (minimum 10 MΩ). Why is this necessary?

Well, the condenser in our VW has a small value, typically 0.2 μF. If you switch it with a resistor of barely 1 MΩ (typical for a cheap voltmeter) it will charge in a time of  $5 \times R \times C$ , that's 1 second, barely noticeable.

$$t = 5 \times 1.000.000\Omega \times 0,0000002F = 1s$$

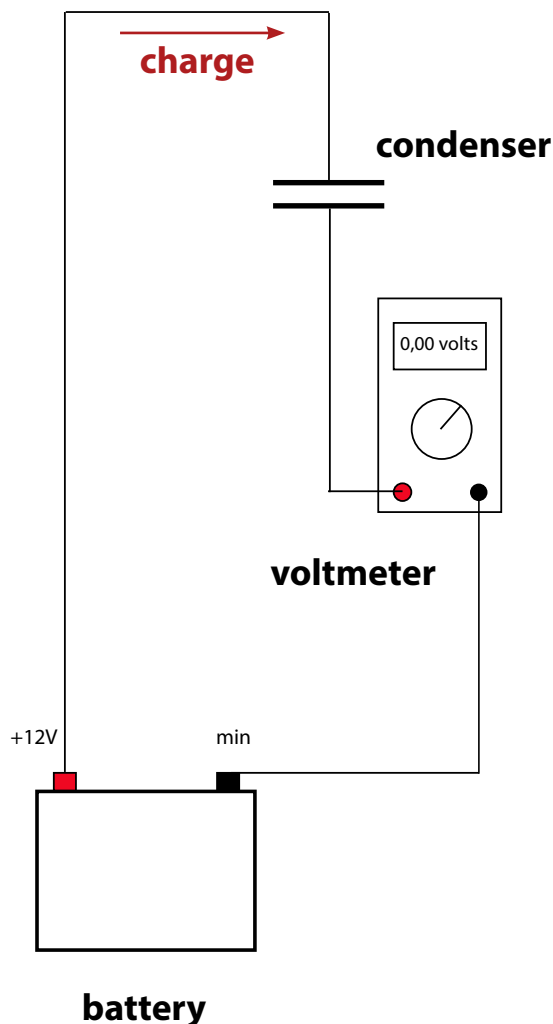
If your voltmeter is a 10 MΩ version, the charging time will be 10 seconds, and you can clearly see that.

$$t = 5 \times 10.000.000\Omega \times 0,0000002F = 10s$$

To measure the condenser you can use a 12 volts or 6 volts battery. If you are not so familiar with electrical measurements, use for example a 9 volts battery. The advantage of a 9 volts battery is that when something goes wrong, the battery cannot handle large currents, so no dangerous sparks. With a 12 volts car battery, a short circuit can be very dangerous.



Disconnect the condenser terminals from the ignition of your motor. Switch the plus terminal of the battery with one side of the condenser of your VW, no matter on which side (see [edition 18, polarization](#)). At the other terminal of the condenser, switch the plus terminal of the voltmeter as shown in the drawing below. The voltmeter will indicate 12 volts and then slowly go to 0 volts.



According to the calculation we did earlier, this should take 10 seconds if we use a professional voltmeter (with 10 MΩ internal resistance). If you use a hobby voltmeter that will be 1 second. With a voltmeter with digital reading it is not always clear, but compare the reading by suddenly disconnecting the voltmeter, you will see that it goes much faster to 0 volts than when the condenser is connected.

The condenser was charged through the voltmeter. When you disconnect the battery, the voltage on the condenser should stay for a long time.

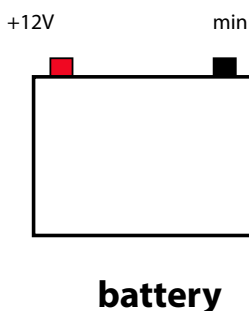
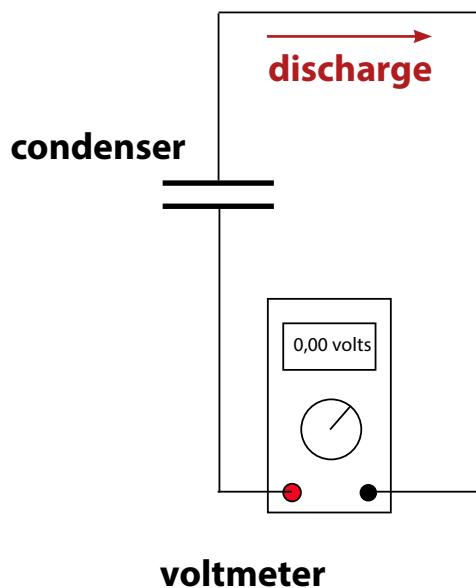
We can now also test if the condenser discharges properly by connecting the voltmeter in parallel to the condenser, as we show on the drawing on the next page.





# testing the condenser

The charge of the condenser will have to flow away through the 10 MΩ internal resistance of the voltmeter in a time of 10 seconds. (1 second with a hobby voltmeter). This way we can measure with an ordinary voltmeter whether the condenser is charging and discharging. This gives a correct indication if the condenser is still usable or not, in contrast to the measurement with the ohm meter.



If you want to know the value of the condenser, you measure the discharge time. For example, if you measured 12 seconds, and the internal resistance of the voltmeter is 10 MΩ, then the capacitor has a value of 0.24 μF.

The formula below is derived from this one on page 42.

$$C = t / (5 \times R)$$

$$C = 12s / (5 \times 10.000.000\Omega)$$

R= resistor in series with condenser  
C= value of the condenser in farad

To double the discharge time, you can switch a 10 MΩ resistor between the capacitor and the voltmeter (see next edition).

We're hoping this will help you. Replacing the condenser blindly without testing is now a thing of the past. To measure is to know, to measure is to save money.













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