Paruzzi Magazine

Technical Publication for the classic Volkswagen

18

#52- Front axle: wheel play adjustment

page 02

#53- Electrical: the condenser explained

page 16

#54- Engine: installing the engine

page 40

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#52 Front axle

Introduction

The front and rear axles of your Volkswagen are mechanical parts that have to withstand a lot of forces. They are designed to withstand the full weight of the car, on average 1500 kg for our VW passenger cars, but they are also designed to absorb the forces that occur during acceleration and braking, which can be several times greater than the car's own weight.

The learning is therefore, make sure that the front and rear axle components are properly adjusted, that they are adjusted to the engine power and weight of the car and that they are regularly lubricated according to the manufacturer's specs. In this article we will start by adjusting the wheel play of the front axle. This needs to be reset when the brake drum or disc is removed, and of course also when the wheel bearings are replaced.

wheel play adjustment

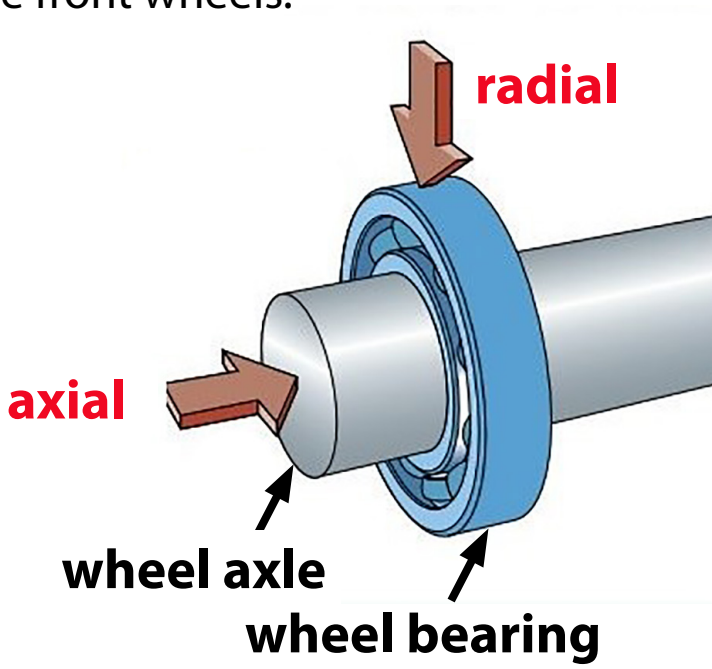
Wheel bearings

Where two mechanical parts must be able to move independently of each other, a form of bearing must be provided between the contact surfaces of the two mechanical parts.

The most basic form of bearing arrangement is, for example, a wheel axle which rotates in a metal or plastic cylinder. This system can be found for instance in inexpensive rolling carts, chairs and low-priced fitness equipment. This type of bearing is good for low loads and limited use, so it is very cheap to make.

Wheel bearings must be able to withstand tons of forces, several times the full weight of the car. We will keep the theory of bearings for a next edition, we want to get to work quickly and adjust the front wheel play in this edition of this technical series.

The front and rear axles have one big difference, the way they are mounted. There is a simple reason for this. The rear wheels cannot turn to the left or to the right, so the forces that arise are different from those that arise at the front wheels.



On the rear wheel mainly axial forces have to be absorbed, the front wheels on the other hand have to deal with both axial and radial forces.

#52 Front axle

Rear wheel bearings

The rear axle uses ball bearings like the one on the picture below.

Ball bearings have the ability to withstand high axial forces. The rear axle nut is tightened with a torque of 300 Nm or 350 Nm depending on whether the vehicle is equipped with swing axles or IRS, there is no wheel play to be set on the rear wheels.

The procedure to tighten the rear wheel nuts will be discussed in a next edition.

Front wheel bearings

The front wheels should be able to rotate to the left and right, and ideally the forces on the wheel bearings should always be evenly distributed during rotation to reduce wear and tear. This is not possible with ball bearings as used on the rear wheels. You need bearings that can absorb both axial and radial forces.

Tapered or conical roller bearings (picture below) are the solution for the front wheels. They have the characteristic that the forces on the bearing are always evenly distributed regardless of the position of the wheel axle, or of the wheel. And that's just what is needed on the front of our Volkswagen.

wheel play adjustment

Why do you need wheel play?

A tapered wheel bearing that has not been properly adjusted can shorten the life of the bearings and can affect more than just the bearing. It affects the operation and life of the shaft, the wheel seal and the brake components. It is important to adjust the wheel bearing to the correct specifications, it is part of the annual inspection of your VW. If the bearings are adjusted too loosely or too tightly, this can lead to premature failure.

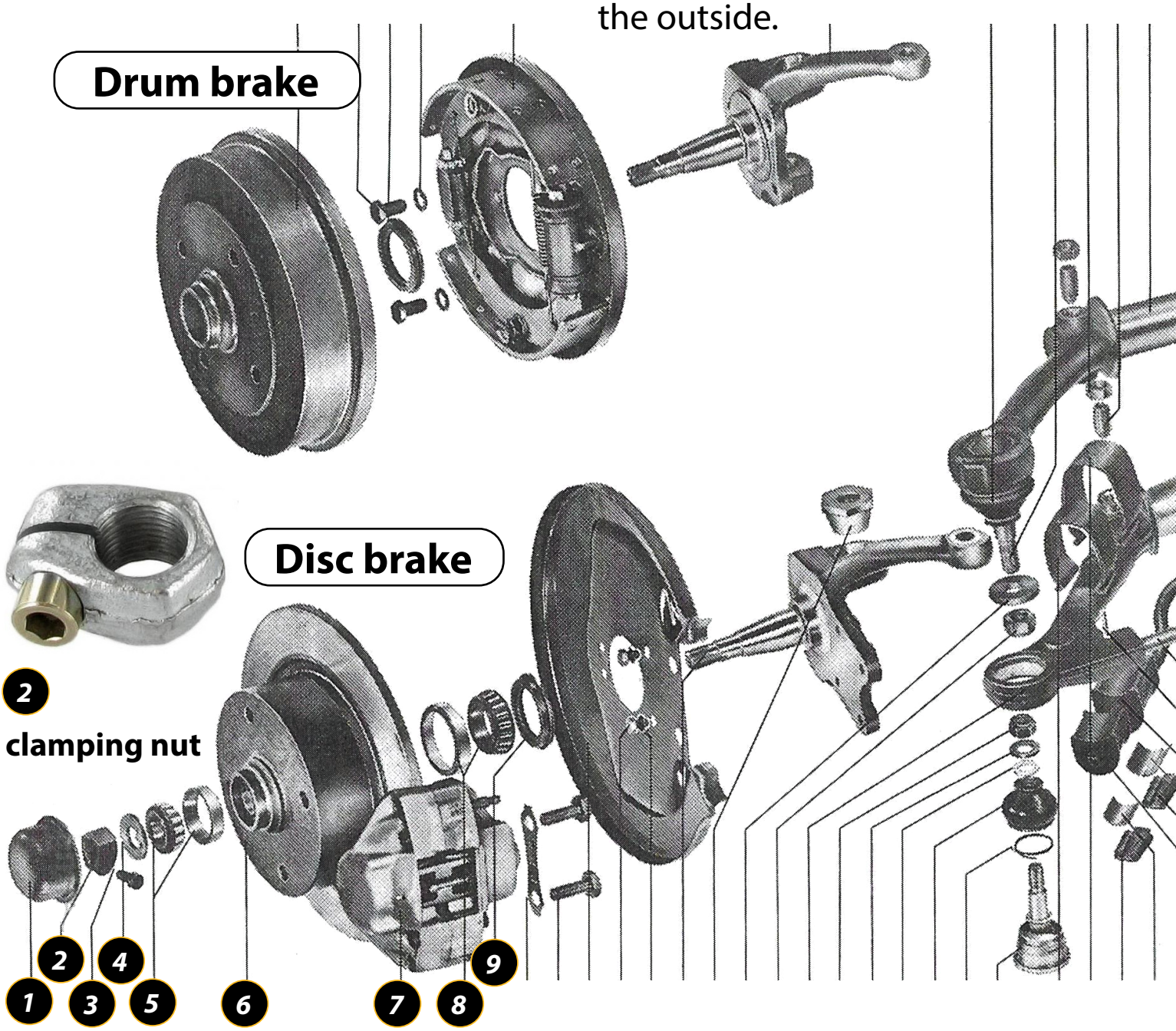
The adjustment of the bearings only became crucial for braking performance after the introduction of the disc brakes. The caliper is mounted directly on the stub axle. If there was too much play, this would result in the brake piston being pushed back into the caliper, resulting in an excessive brake pedal play. The wheel bearings of the front wheels have to be pre loaded, and you can adjust that with the wheel play.

#52 Front axle

Construction

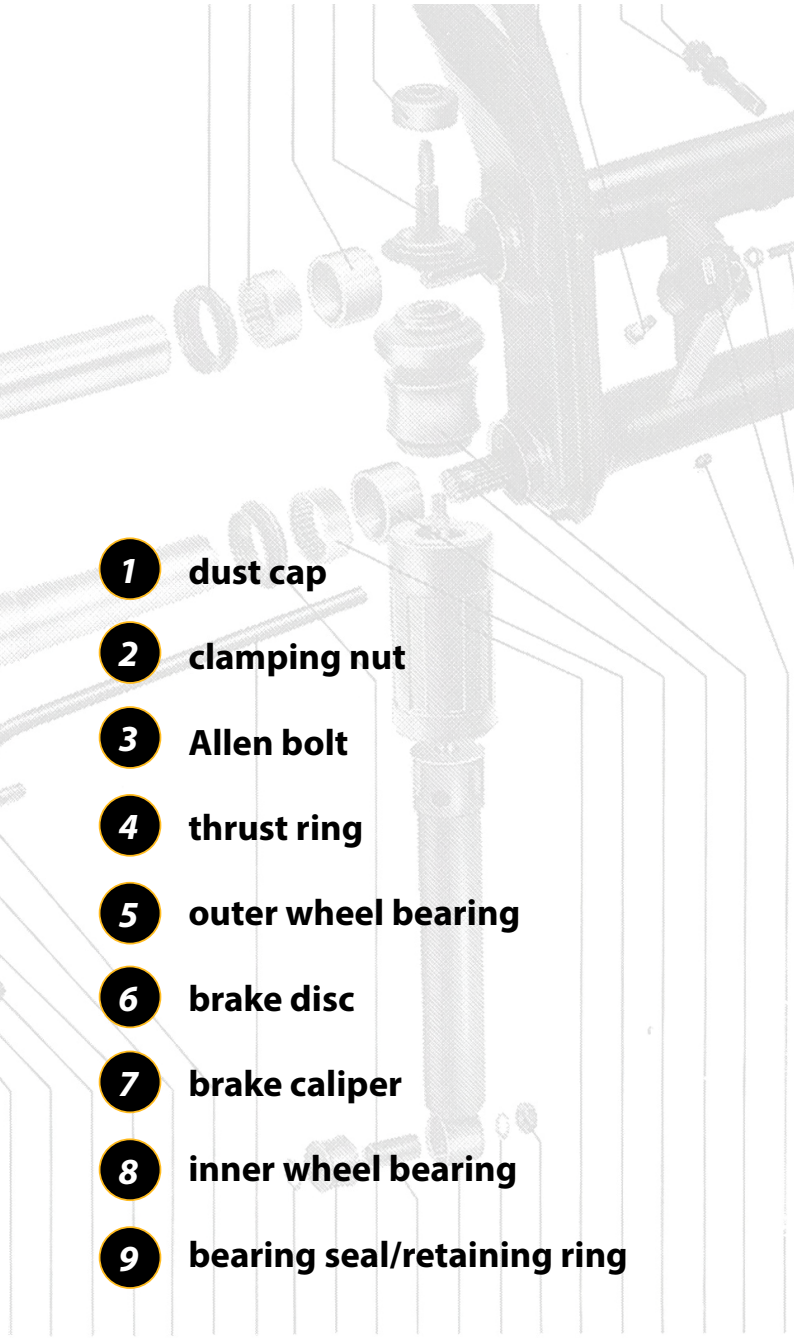
Before we adjust the wheel play, we will look at how the bearings are mounted, the drawing below will clarify some of the details.

At the bottom you can see the wheel bearings of a VW with disc brakes. There is a tapered roller bearing on the inside of the disc, and a tapered roller bearing on the outside.



wheel play adjustment

At the top left of page 6 you see a brake drum, the wheel bearings are not visible, but we show this for the sake of completeness.



1. dust cap
2. clamping nut
3. Allen bolt
4. thrust ring
5. outer wheel bearing
6. brake disc
7. brake caliper
8. inner wheel bearing
9. bearing seal/retaining ring

The construction of the front wheel bearing of a VW with disc brakes and front drum brakes is very similar.

You can see on the drawing that the largest diameter of the tapered roller bearings, both inner (8)and outer (5), is facing the outside.

On the inside there is a retaining ring (9) to stop the dust. On the outside you see a thrust ring (4), a clamping nut (2) and an Allen bolt (3), these are the three parts that serve to adjust the wheel play.

In one of the next editions we will explain more about the construction before we replace the wheel bearings of the front axle.

Adjusting the wheel play only makes sense if the bearings are not worn or damaged!

Adjusting the front wheel play

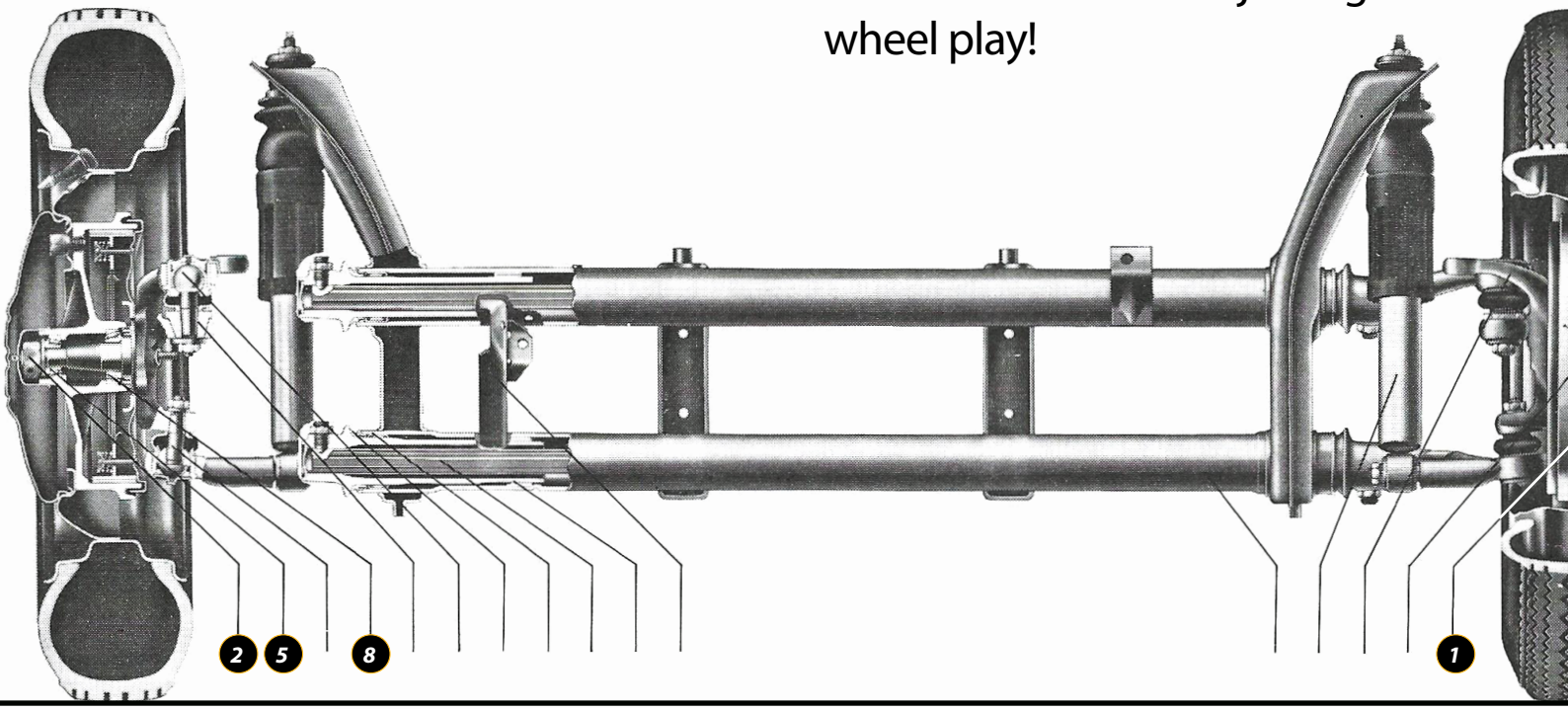
Beetle 1970-1979

We will adjust the wheel play without using a dial gauge. In a following edition we will show you how to make a more precise adjustment with a dial gauge.

If the wheel bearings have been in there for some time, it is best to first check if they are still in good condition. Jack up the car (**never adjust the wheel play with the wheels on the ground!**), and rotate the wheel.

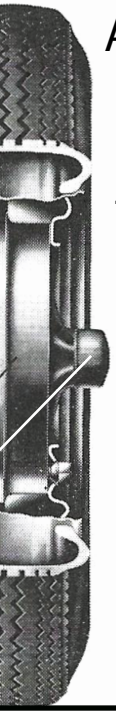
No sounds should be heard while the wheel is rotating, except for the sound of the brake pads on disc brakes or the brake shoes on drum brakes. We will not replace the wheel bearings in this article, we will do that in a later article. But if you do remove them, you can check them for wear and give them fresh grease.

The right hand side wheel uses a classic right-turning clamping nut, i.e. you tighten the clamping nut by turning it clockwise. The left wheel uses a left-handed nut. So be careful when adjusting the wheel play!



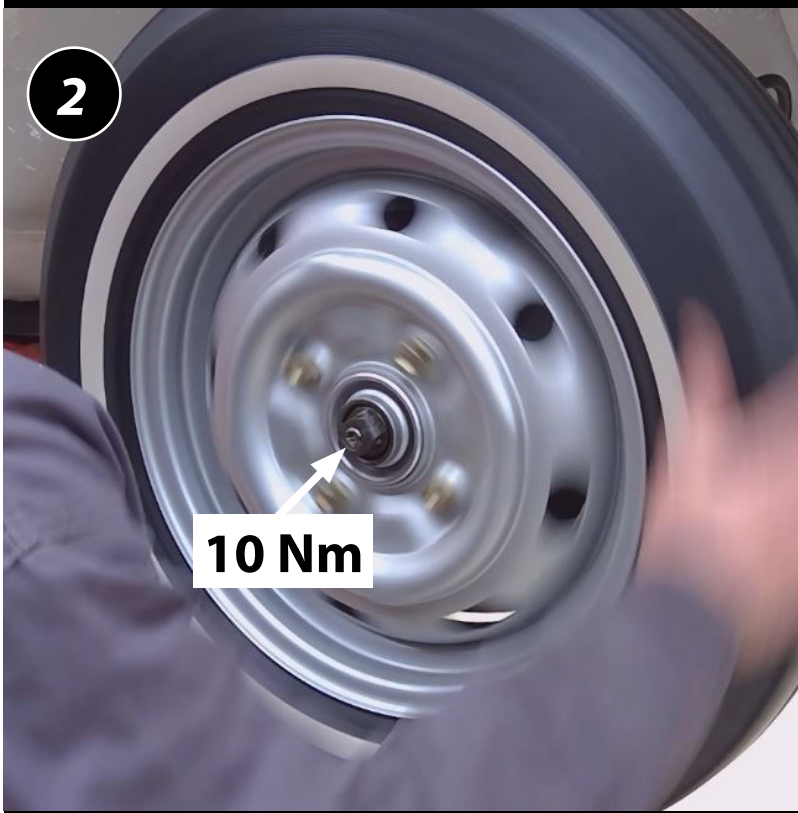
wheel play adjustment

We'll start with the right wheel. Remove the dust cap (photo 1) with, for example, a heavy screwdriver. The inside of the dust cap can sometimes be full of grease, clean it and prepare it for mounting later.
Loosen the Allen bolt from the clamping nut. Loosen the clamping nut, and then tighten it again until you can no longer feel any play. You can use a torque wrench set at 1 mkg (9.8Nm), while turning the wheel (photo 2) to prevent the bearings from seizing.



Attention, the clamping nut must never be tightened over 1.3 mkg in order not to damage the wheel bearings.

1. dust cap
2. clamping nut
5. outer bearing
8. inner bearing



#52 Front axle

Now hold the wheel on both sides (photo 3) and feel whether there is any play.

You should feel the play when pulling and pushing the wheel, a slight clicking sound should be heard, very suttle.

If you feel a lot of play, tighten the clamping nut a little (remember that the clamping nut must not be tightened more than 1.3 mkg). If no play can be felt, loosen the clamping nut a little (photo 4).

Ideally, you should do this the first time together with an experienced mechanic.

wheel play adjustment

When the wheel play is set correctly, tighten the Allen screw (photo 5) of the clamping nut to 1.0 to 1.3 mkg (or equivalent in Nm: 10 Nm to a maximum of 13 Nm).

Apply a little universal grease on the inside of the dust cap and on the clamping bolt to prevent corrosion. Use a hammer to secure the dust cap (photo 6).

The same procedure can be used for the left wheel. What out, he clamping nut of the left wheel has a left-hand thread! So, turn anti-clockwise to secure the nut and clockwise to remove the nut! The odometer cable is connected to the left spindle, through the dust cap, so, first remove the cable and place it somewhere safe.

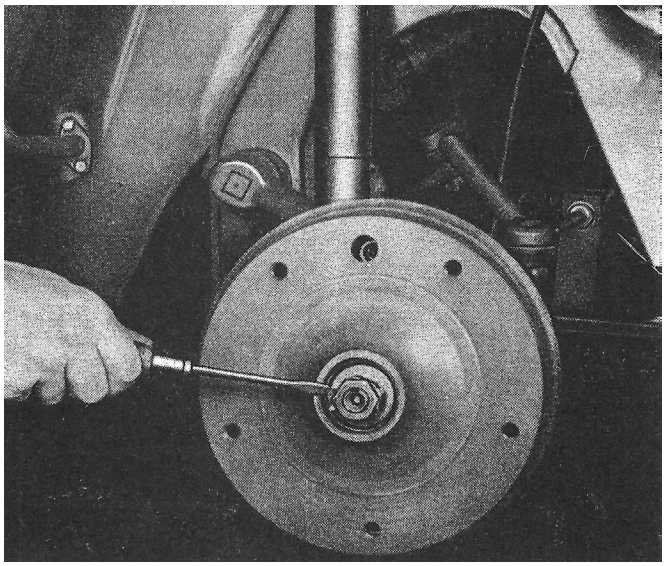
Other VW models

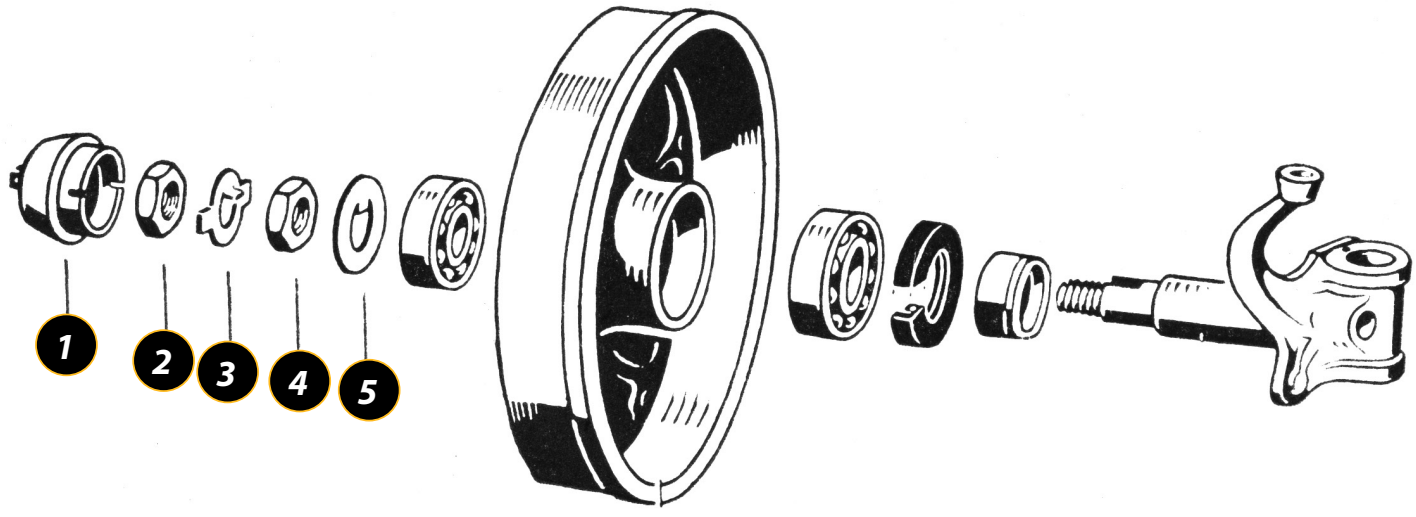
For the sake of completeness, we went to study all VW workshop manuals to see if there are differences for other VW models than our VW 1303 with disc brakes.

1. **dust cap**
2. **outer nut**
3. **locking plate**
4. **inner nut**
5. **thrust ring**

Beetle/Ghia 1952-1957

The drawing below is valid for the models until July 1965 with spindles. Remove the dust cap (1). You can first check the play by trying to move the thrust ring (5) back and forth as shown in the picture on the right. If you can, the wheel bearings are not too tight. The thrust ring should also not be too loose.

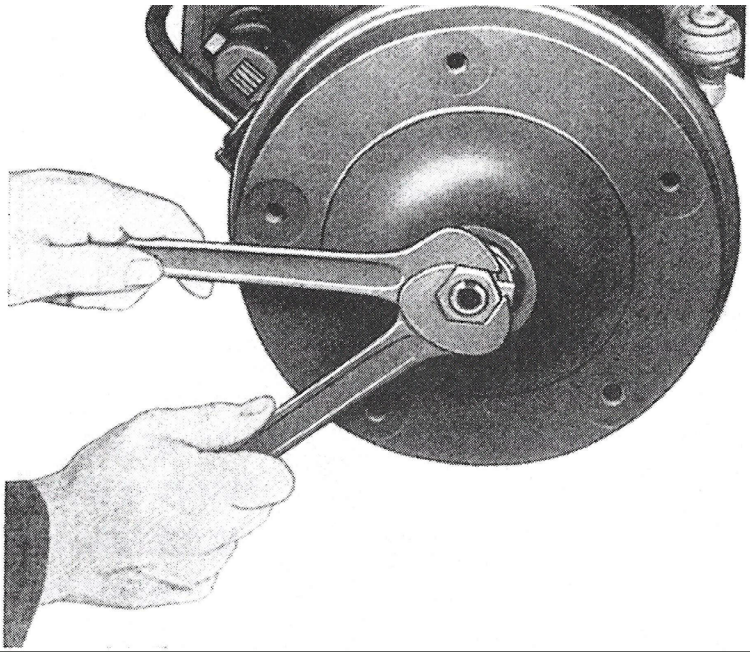




wheel play adjustment

After removing the dust cap (1), you must first unlock the locking plate (3) with a screwdriver by bending the two lips.

Then loosen the two nuts (2 and 4) with a 27 mm wrench. If necessary, mount a new locking plate first.



Now tighten the nut (4) closest to the drum until the thrust ring (5) can just be moved with a screwdriver and no play can be felt when pulling and pushing the drum. You have to do this after the outer nut (2) has been tightened, the tightening can affect the setting.

Repeat this until the thrust ring can only just be moved with a screwdriver.

Secure the locking plate by pushing out one lip and pulling in the other lip. It is recommended to replace the locking plate.

#52 Front axle

Beetle/Ghia 1958-1965

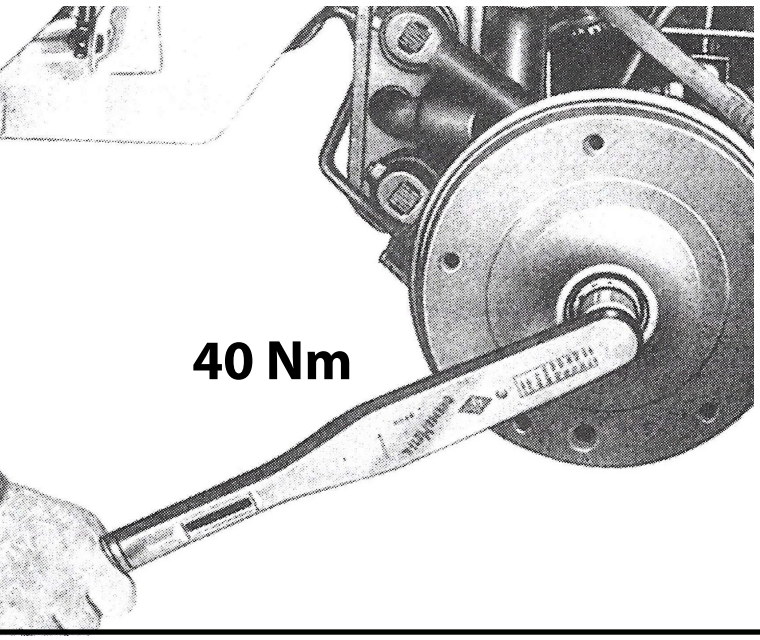
The drawing on page 12 is still valid for the years of construction of 1958-1965.

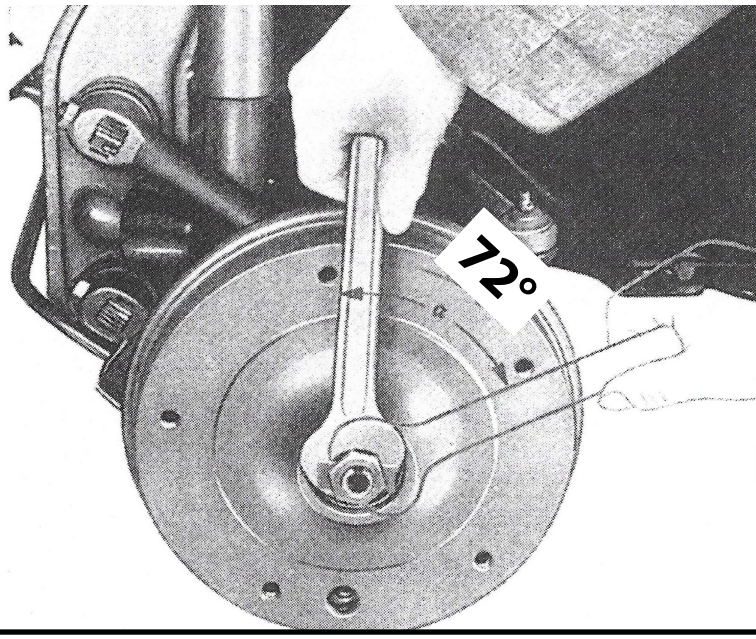
Starting 1958 an additional technique is explained in the Volkswagen workshop manuals to adjust the wheel play a little more accurately.

Tighten the inner nut (closest to the drum, number 4 in the drawing on page 12) with a torque wrench set at 4.0 mkg (40Nm) while keeping the wheel running to prevent the wheel bearings from getting stuck.

Install a new locking plate (3). Tighten the outer nut (2) by hand.

Then loosen the inner nut 72° as shown in the drawing below. For five-hole drums, this corresponds to the distance between two wheel bolt holes. Now tighten the outer nut.





wheel play adjustment

Beetle/Ghia 1966-1969

From 1966 onwards, the clamping nut with Allen head bolt was introduced together with the ball joints that replaced the spindles. It replaces the system with locking plate and two nuts.

For these years of construction, the workshop manuals only use a dial gauge (dial indicator). We will show how this works in a next edition. However, most enthusiasts do not have a dial indicator unfortunately. The technique without special tools for the Beetle from 1970 to 1979 explained in the beginning of this article also applies to these years of construction.

VW Bus 1950-1962

For these VW Buses the same system is recommended as for the Beetles from 1952 to 1965.

VW Bus 1963-1967

The dial indicator is introduced in this period for the VW Buses. According to Volkswagen the play check of the thrust ring is no longer sufficient.

VW Bus 1968-1979

The setting is the same as for the 1966-1969 Beetles.

VW Bus 1980-1991

Strangely enough, the setting of the Vanagon is very similar to that of the first Beetles. With these models a thrust ring with a special locking nut is used.

Next editions we will replace the wheel bearings and adjust the wheel play with an dial gauge.

Introduction

The condenser or capacitor is probably the most misunderstood part of the engine. What's inside that metal cylindrical part? What does this part actually do? Is it really necessary for the proper functioning of the engine? In this article we will limit ourselves to explaining what a condenser is and what it does, and to measuring and testing the capacitor. In the next editions we will study the role of the capacitor in the ignition circuit more closely and make practical measurements.

Most VW enthusiasts think that the condenser only protects the contact points from burning in, which is not entirely correct. The condenser actually has two functions, it will:

1. keep high voltage sparks between the contacts of the circuit breaker of the distributor to a minimum
2. increase the voltage in the primary winding of the coil in order to generate the necessary high voltage

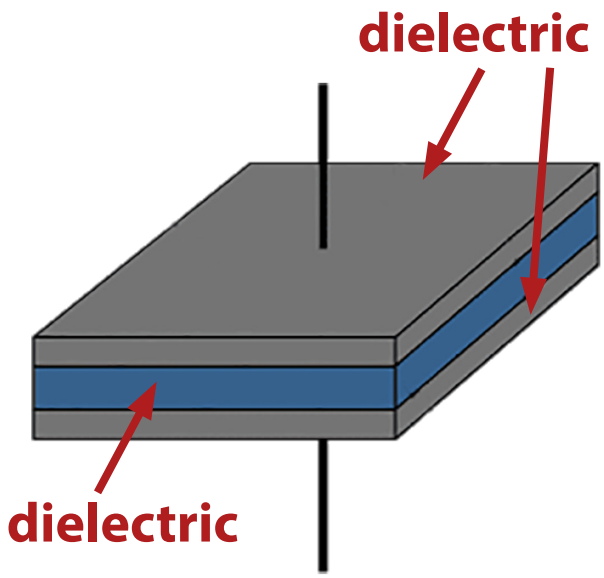
The condenser as we all know it, attached to the distributor of our air-cooled motor.

If you want to know more about the operation of the ignition coil and the ignition circuit, and about the secondary and primary circuit, read edition 08 and edition 10 of this series.

the condenser explained

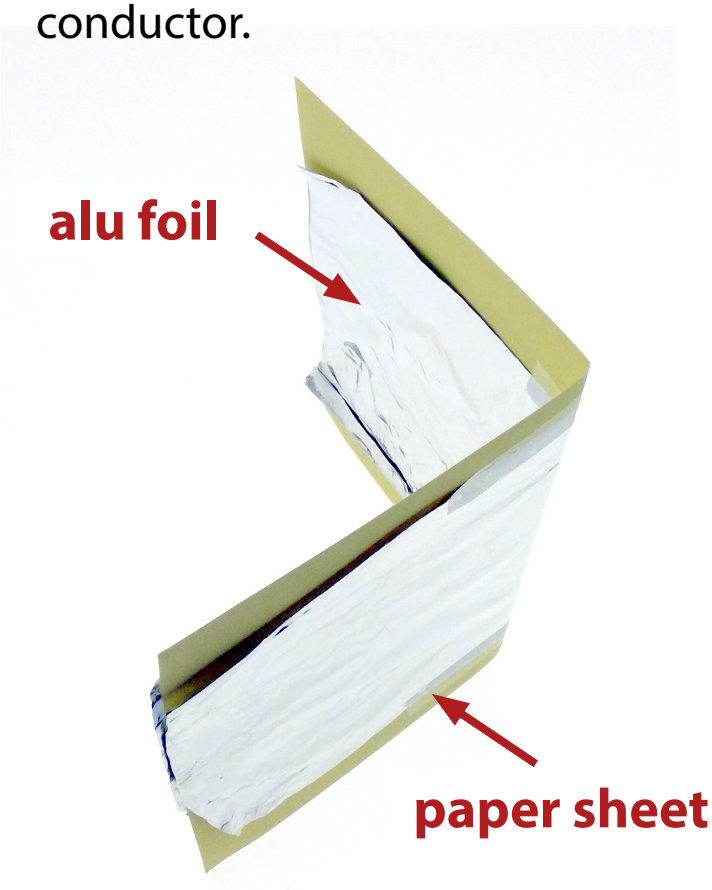
Construction

Before we continue, we have to remove the mythical veil that hangs around the condenser for good. We will now explain what a condenser is and what it actually does when you connect it to an electrical circuit.



A condenser consists of a dielectric, this is a kind of electrical insulation material, with an electrical conductor on both sides. We show the concept of a condenser in a very simplified drawing above.

The myth is directly disproved by making your own condenser, it is very simple and not dangerous, you can try this yourself. You take a sheet of paper, no matter what thickness or quality you have available. You also need a roll of aluminum foil and adhesive tape. You stick a piece of aluminium foil on both sides of the sheet. The sheet of paper serves as an insulating material, the aluminium foil as a conductor.



Our homemade condenser is ready. We now use a capacitance meter to measure the value of our homemade condenser, this is a measuring function that is usually not present on the standard multimeter. We will explain later how you can measure a condenser without a capacitance meter.
The value we measure now is 1.106 nF. Not bad for a home-made condenser!

A4 format: 1,106nF

The theory says that the value of a condenser is proportional to the surface of the insulator and the conductors on both sides. We can easily test this. We cut the sheet of paper in two and do a new measurement, we read half of the value, namely 0.509 nF. The theory seems to be correct.

Did we make a big capacitor or a small capacitor? What is an nF (nano farad) anyway? Is that big? We explain this on page 21.

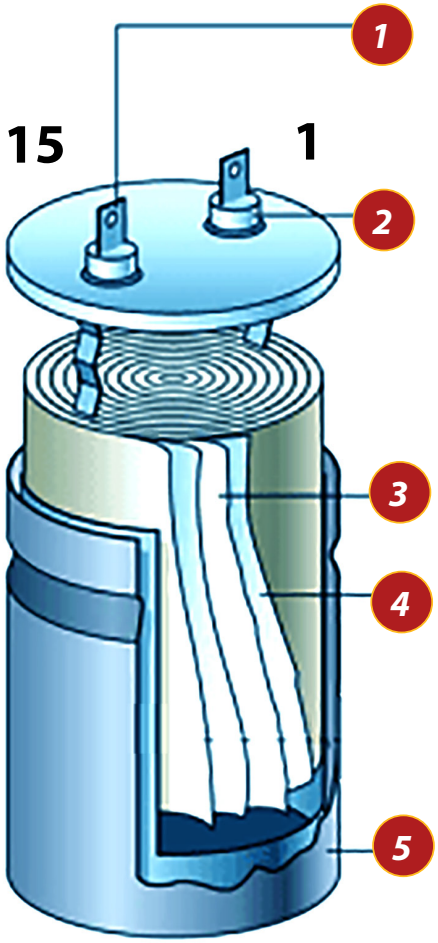
A5 format: 0,509nF

the condenser explained

The condenser used in the ignition circuit of a classic Volkswagen has a value of about 0.2 micro F. So we should use a sheet of paper with two aluminium foils that is 2500 times larger than our A5 sheet on page 18. How do the manufacturers get that in such a small metal cylinder?

Well, the insulation material is of better quality than the paper we used, it's a dielectric that has better polarisation properties than paper. And, the insulation material and the electrical conductors are rolled up in such a way that a lot of electrical charge can be stored in a small space, as you can see in the drawing on the right.

The amount of electrical charge a condenser can accumulate is expressed in farad (F). The maximum voltage in volts (V) that it can withstand without the insulation layer breaking through is also very important. These two values will be mentioned in the technical data sheets for condensers.



1. **to chassis ground clamp**
2. **to plus clamp battery**
3. **electrical insulator**
4. **dielectricum**
5. **metal protection chassis**

The role of the condenser?

To explain how a condenser works and what it does, most textbooks compare it to a water reservoir.

A stream of water is pumped to the water tower, at a certain moment the water tower is completely filled and the flow of water stops. When residents of a village or city need water, it is extracted from this reservoir. By accumulating water in a water tower, you can provide a continuous water flow without having to take into account changes in water consumption.

In an electrical circuit, the water flow can be compared to an electric current. An electric current is therefore nothing more than electric charges that flow through an electric conductor.

The water tower is similar to a condenser, it will stack or accumulate electrical charge. A small detail, this only applies to direct current (DC), for an alternating current (AC) a condenser behaves like a short circuit. However, our air-cooled Volkswagen only enjoys direct current, so the condenser will behave like a reservoir for electric charge. If you want to know more about direct current and alternating current, read edition 17.

How big is a condenser?

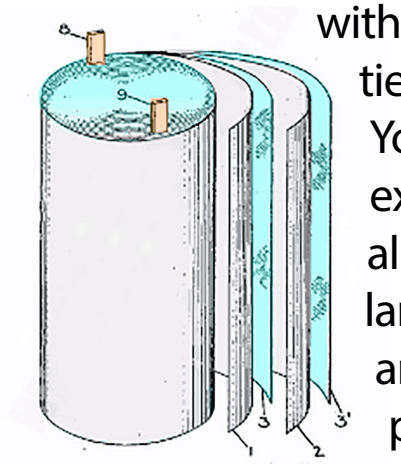
The size (in farad) of the condenser is thus proportional to the area of the conductors on both sides of the insulator and also of the insulator (dielectric) between those plates.

This value determines how much electrical charge a condenser can stack or accumulate per volt of voltage. So the higher the value, the more charge it can handle.

$$Q = C \times V$$

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

As you can see in the formula, the electrical charge that a condenser will accumulate is all the greater when the voltage is greater and when the condenser is greater.



The value of a condenser can also be written in function of the materials used, as follows:

$$C = \frac{\varepsilon \times A}{d}$$

ε= determined by type of dielectric
A= surface area of electrical conductors
d= distance between electrical conductors

The value of the condenser increases as the total surface area of the rolled up foil increases and the distance between the foils decreases. A larger ε will also result in a larger condenser, this can be achieved by using better insulation materials with higher dielectric properties.

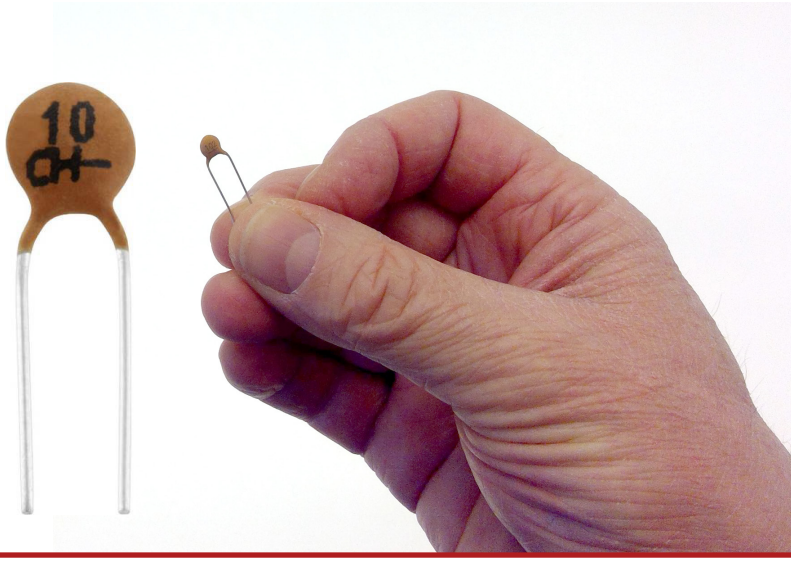
You can now see that our experiment with paper and aluminium foil cannot lead to large capacitor values, there are better dielectrics than paper of course.

Condenser types

Now you know that the value of a condenser depends on the surface area of the foil, the distance between the stacked foils and the quality of the insulator or dielectric. There are various types of condenser on the market, each of which tries in its own way to make a condenser as large as possible in as small a package as possible. It would take us too far to discuss them all, we show here some types for completeness.

Ceramic condenser

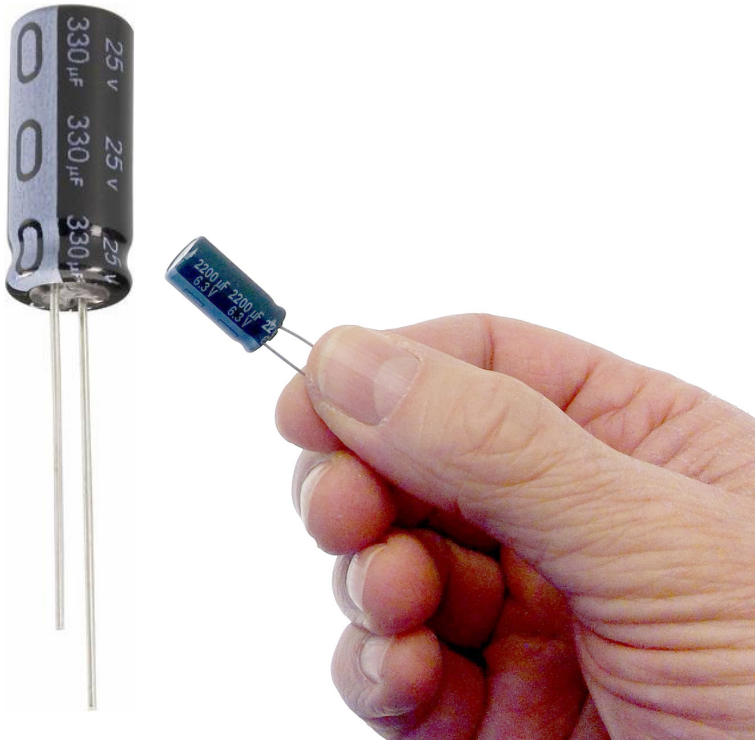
This brown circular condenser is a ceramic condenser, we are holding a 1nF condenser on the picture to give you an idea of its size. 1nF is the same value as our homemade condenser with paper and foil.



the condenser explained

Electrolytic condenser

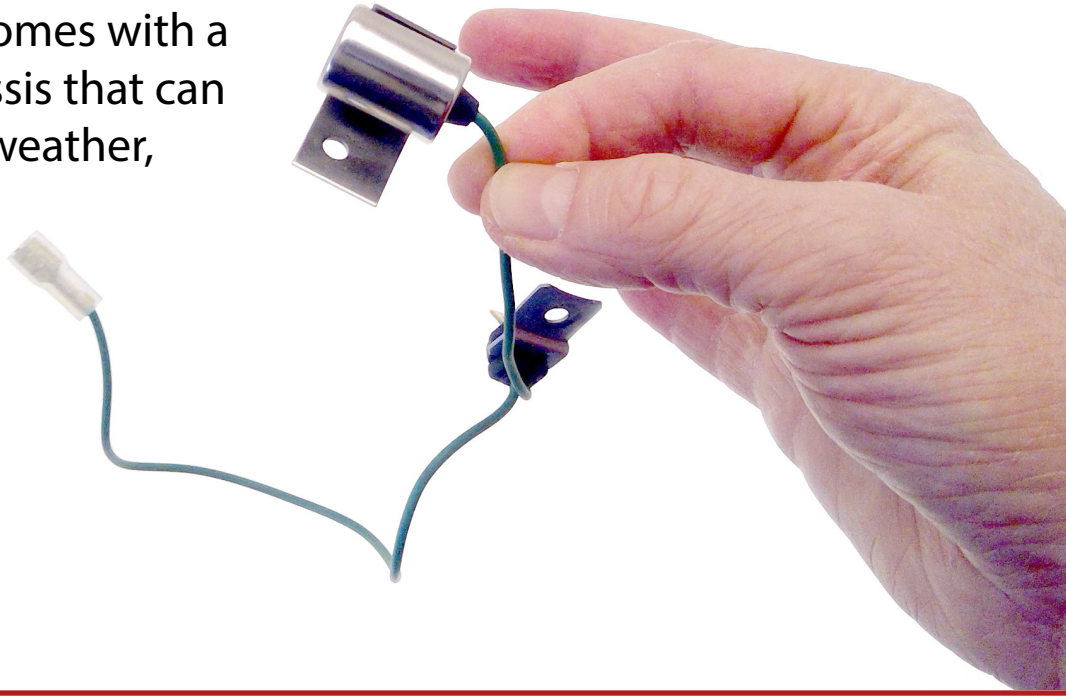
This black cylindrical condenser is of the electrolytic type. The dielectric has been replaced by a chemical electrolytic material to further enhance polarisation. This makes it possible to obtain larger condenser values in a smaller format.



VW engine condenser

The condenser we all know has a metal housing or chassis. The condenser can be found near the distributor, under the engine lid. This is of course not a very nice environment for an electrical (read electronic) component. That's why the condenser comes with a protective metal chassis that can withstand wind and weather, moisture and grease.

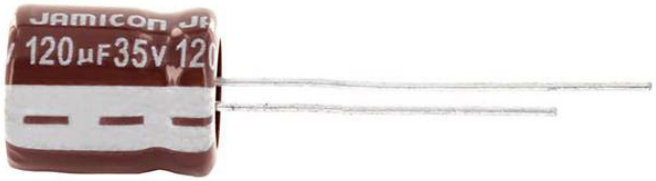
The green cable connected to the coil is hermetically attached to the condenser.



Polarisation

Some condensers are polarized, i.e. they have a plus and a minus connection. The electrolytic condensers are of that type. If you change the connections, the electrolytic material will melt down and start to smoke.

In the picture below we show such an electrolytic capacitor, the white band with minus signs and the shorter connection indicates that this is the minus connection.



Watch out, it is not always clearly indicated, so look carefully at the specifications of the condenser you are going to use before you connect it.

The condenser used for the ignition circuit of our VW is not polarized, so it doesn't matter how you connect it. You can't really connect them wrong, the ground (minus pole or connection to the chassis) is always the metal housing, and the plus is the green wire in most condensers for our VW (the older models dare to deviate from these agreements).

Value in farad

The value of a condenser is expressed in farad (after the scientist Michael Faraday), the letter F is used as a symbol. A 1 farad condenser is very large, most of the condensers we encounter in electronics or the automobile have values like shown below:

pico farad (pF), this is 10^{-12} F
or 0,000000000001 F

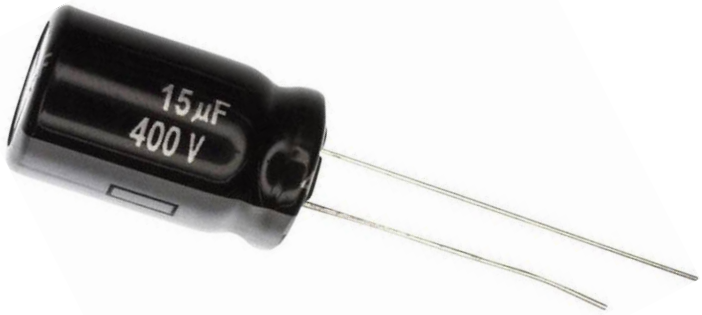
nano farad (nF), this is 10^{-9} F
or 0,000000001 F

micro farad (µF), this is 10^{-6} F
or 0,000001 F

the condenser explained

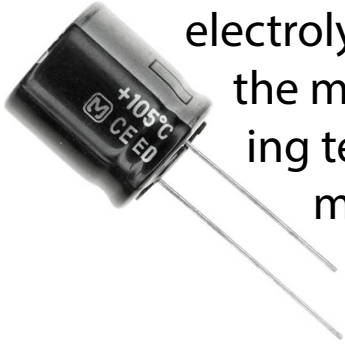
Maximum voltage

The insulator between the conductive plates ensures that there is no short circuit when you connect a voltage to the condenser. Each capacitor has a maximum working voltage, it is not always mentioned on the condenser's housing. On this condenser the value in µF is indicated as well as the maximum voltage.



Maximum temperature

Each condenser has a maximum working temperature, a condenser also gets very hot when it is under tension. On this electrolytic condenser the maximum working temperature is mentioned.



Specifications

The information printed on the capacitor can sometimes be very cryptic, as you can see with this ceramic capacitor. So it's a matter of sorting this type of component well into separate trays with a clear indication of what it's for.

Age

No matter how attractive it is to look for an N.O.S. condenser, in other words a condenser with an average age of 50 years, it is not a good idea to actually use it. Indeed it looks nice, it is original, but a condenser will not work 100% properly after a few decades. Due to moisture infiltration or other influences, the Vintage N.O.S. condenser will no longer have the correct specifications. Compare it with car tires of 50 years old, very special, but no longer usable.

Measuring the condenser

As mentioned before, the common multimeters can't measure a condenser value, unfortunately. A multimeter with capacity measurement as we use in this article costs around 100€, if you only need it once, it is of course a purchase that will pay off very little.

To avoid having to buy extra expensive tools that you probably won't use later on, we'll show in a next edition how to test the condenser of your VW engine and determine the value using a smart and cost effective set up.

In the workshop of my colleague I came across this Vintage capacity meter from Philips (picture on the left), a real nostalgia item, it works with lamps.

Our capacitance meter on page 27 is a bit more modern, it has the advantage that you don't have to set the scale, it will automatically choose the right scale. All you have to do is connect one clamp to the metal chassis of the condenser and the other clamp to the green cable (or yellow cable depending on the type of condenser).

The VW condenser

We have connected all available condensers, which were available at the time of writing this article, to our capacity meter in our workshop.

At the bottom you can see our measuring setup. For each condenser we mention the value. We expressed all values in micro farad because this is more common in the automotive industry, although our multimeter indicates the value in nF. The Paruzzi code is shown in blue.

02029

0,257 µF

02027

0,233 µF

02080

0,233 µF

02081

0,203 µF

02028

0,207 µF

02075

0,283 µF

the condenser explained

02074

0,271 µF

02082

0,199 µF

If you want more information about one of these condensers, such as the model or year for which the condenser was used, go to our webstore and search for the part number or use the key-word "condenser".

To facilitate your search for the correct condenser for your engine and distributor, we have created a special online search tool.

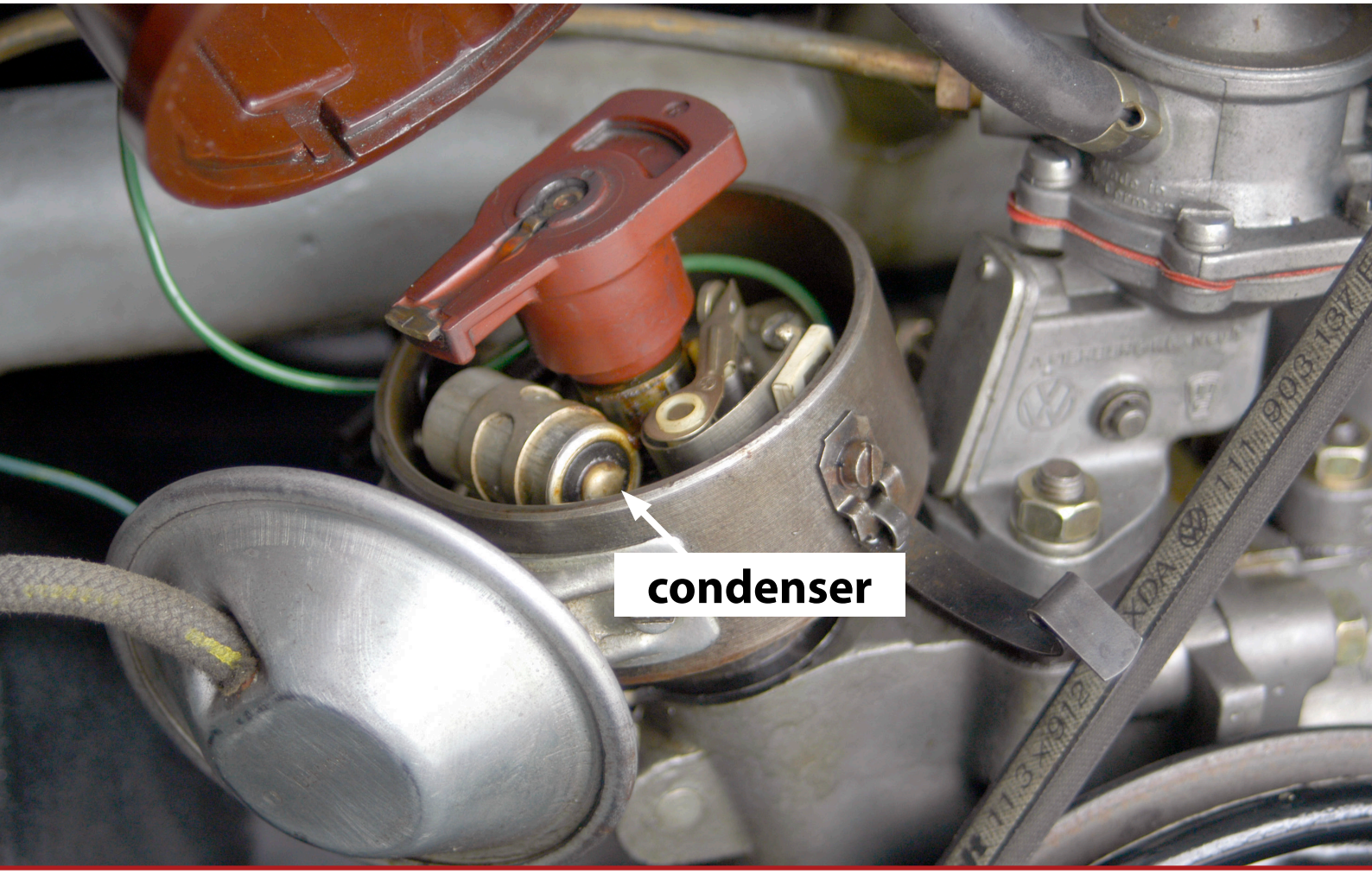
Not all condensers have identical values. The capacity value of the condenser is not documented in the Volkswagen workshop manuals. The value 0.2 µF is sometimes mentioned when talking about the Vintage VW engine.

The smallest value we have measured is 0.199 µF, the largest is 0.283 µF. A condenser is not a precision component, deviations of 10% and more are very common.

In principle you could replace the condenser in your VW with another condenser type with a value of about 0.2 µF.

The maximum working voltage is also not mentioned anywhere. But in old schoolbooks we could find an extensive explanation why the maximum working voltage is 500V, this value was also mentioned in documentation from Bosch for example.

In a next edition of this magazine we will show where the 500V comes from and how the 12V battery voltage suddenly rises to 300 to 400V in the primary winding of the coil due to the presence of the condenser. So why use these specific condenser types? Can't you mount another condenser with a value of 0,2 µF / 500V? Or a condenser of another brand or model?

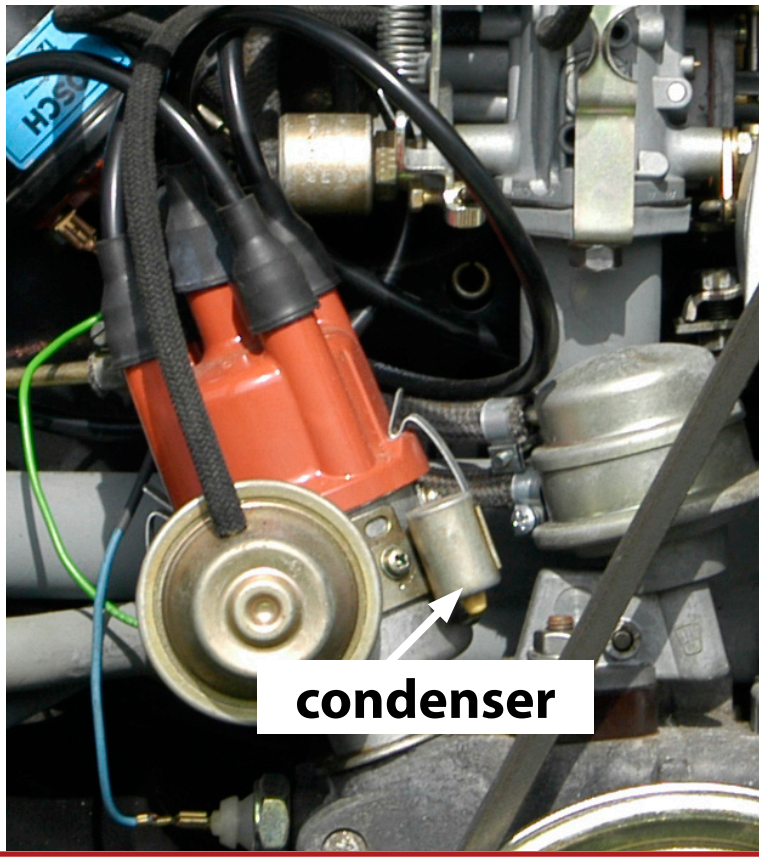


the condenser explained

Well, technically, there's no argument for not doing so. However, the available condensers in our shop have the exact dimensions of the original and therefore fit perfectly where they were originally mounted; on the outside of the distributor (picture below) or under the distributor cap (picture page 30). The dimensions have to be right and also the way of attaching it you want to be sure that the condenser won't come loose or hit the rotor for example.

Another important feature of the condensers intended for the automotive industry is that they are protected by a strong metal casing against moisture, dirt and grease that are present under the bonnet.

As a test we tested a condenser of a two-wheeler with a 750cc 2-cylinder engine (picture top right). The Bosch condenser of our two-wheeler is slightly smaller, so it might be able to withstand less than 500V, but the capacity value is identical to that of our VW's.

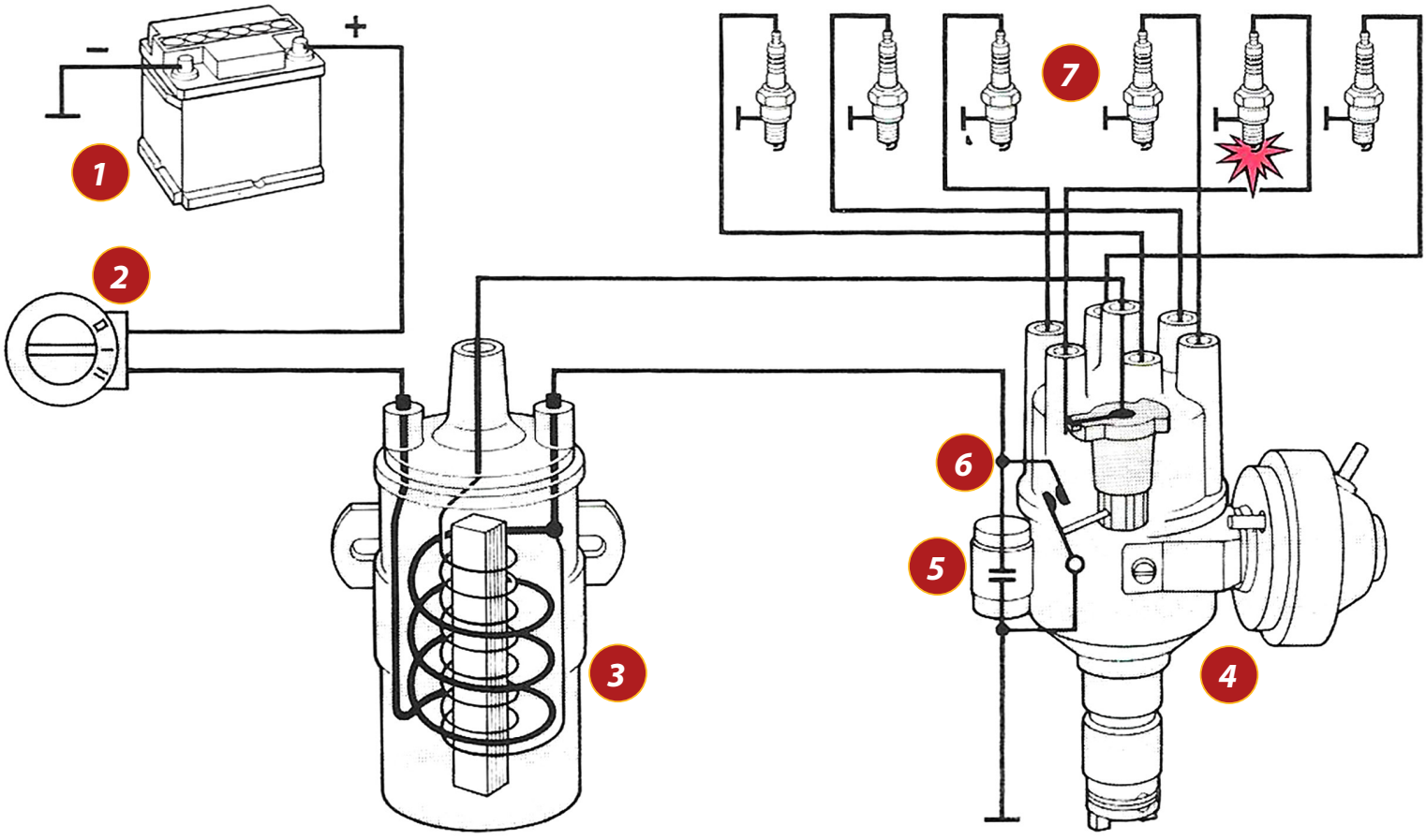


Is the condenser necessary?

Will the engine operate without a condenser, or with a defective condenser? The engine will run, but not well, the ignition will not perform as it should.

To answer this question in a more academic way, let's clarify what the condenser does and what happens if the condenser is defective or not present.

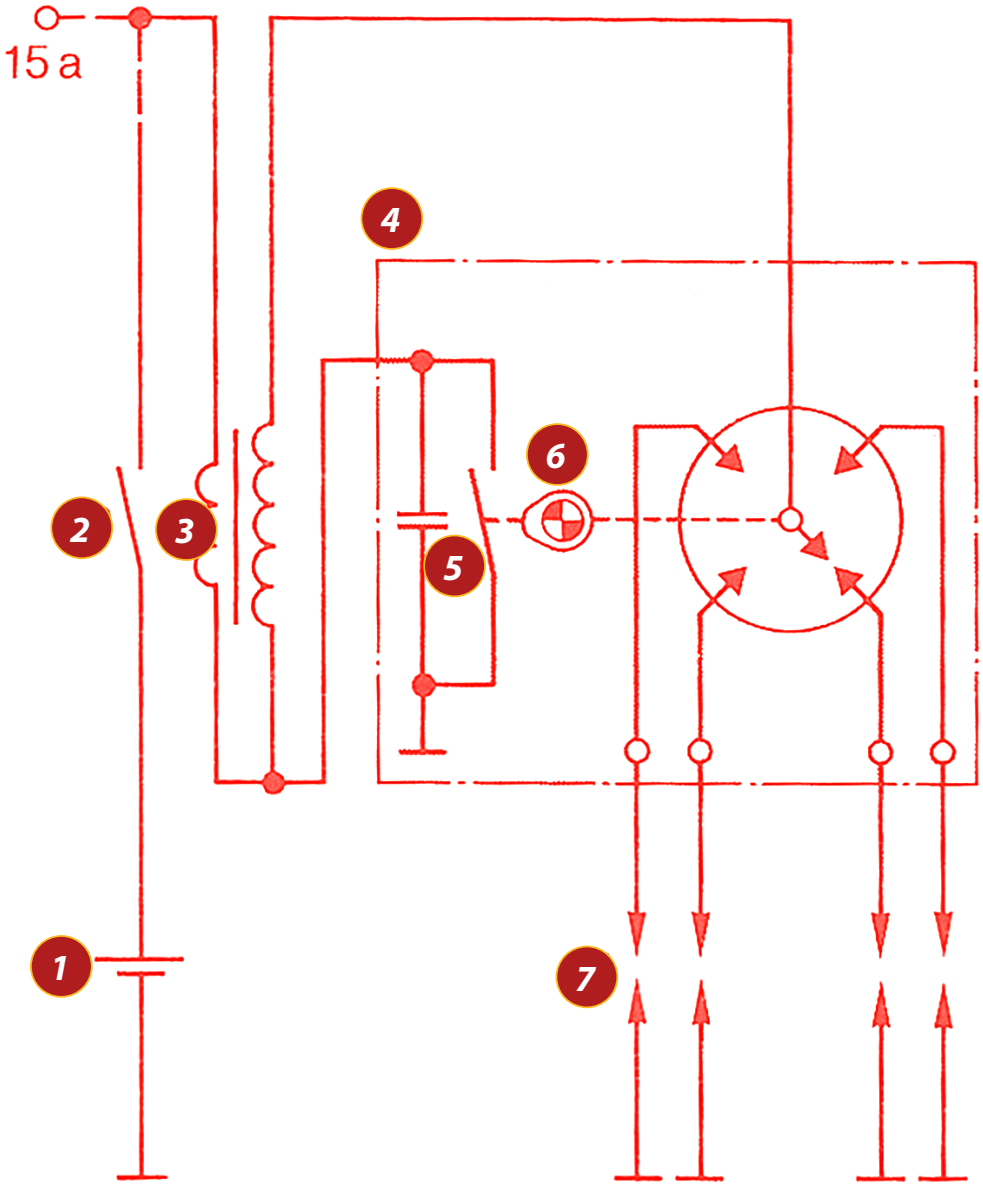
Below we show a schematic representation of an ignition circuit, as shown in the Bosch textbooks. This is a 6-cylinder setup as used for example in a Porsche 911, but the principle remains the same for a 4-cylinder or a 2-cylinder setup.



the condenser explained

Below on the right is the wiring diagram of the ignition circuit, this time for a 4-cylinder engine. When the circuit breaker is open or closed, the condenser will have no influence.

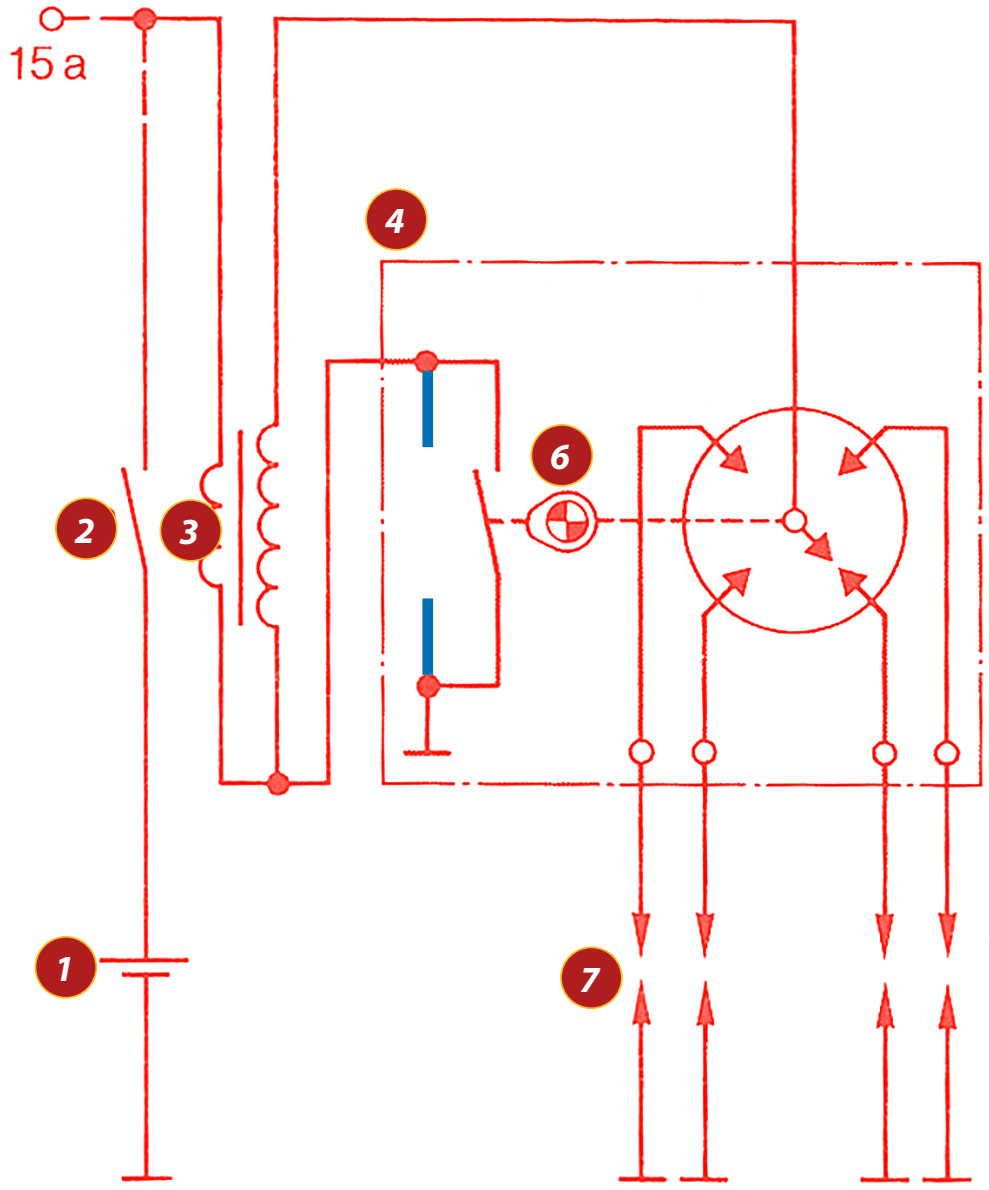
As mentioned before, our VW engine works with DC voltage. In a DC circuit, a condenser will not conduct, only accumulate voltage, so you can remove the condenser and the circuit will behave almost identically.



1. Battery
2. Ignition
3. Coil
4. Distributor
5. Condenser
6. Ignition points
7. Spark plugs

If the condenser does not work, or is not present, and does not form a short circuit, the engine should run normally.
In the diagram below we have removed the condenser, it doesn't change much.

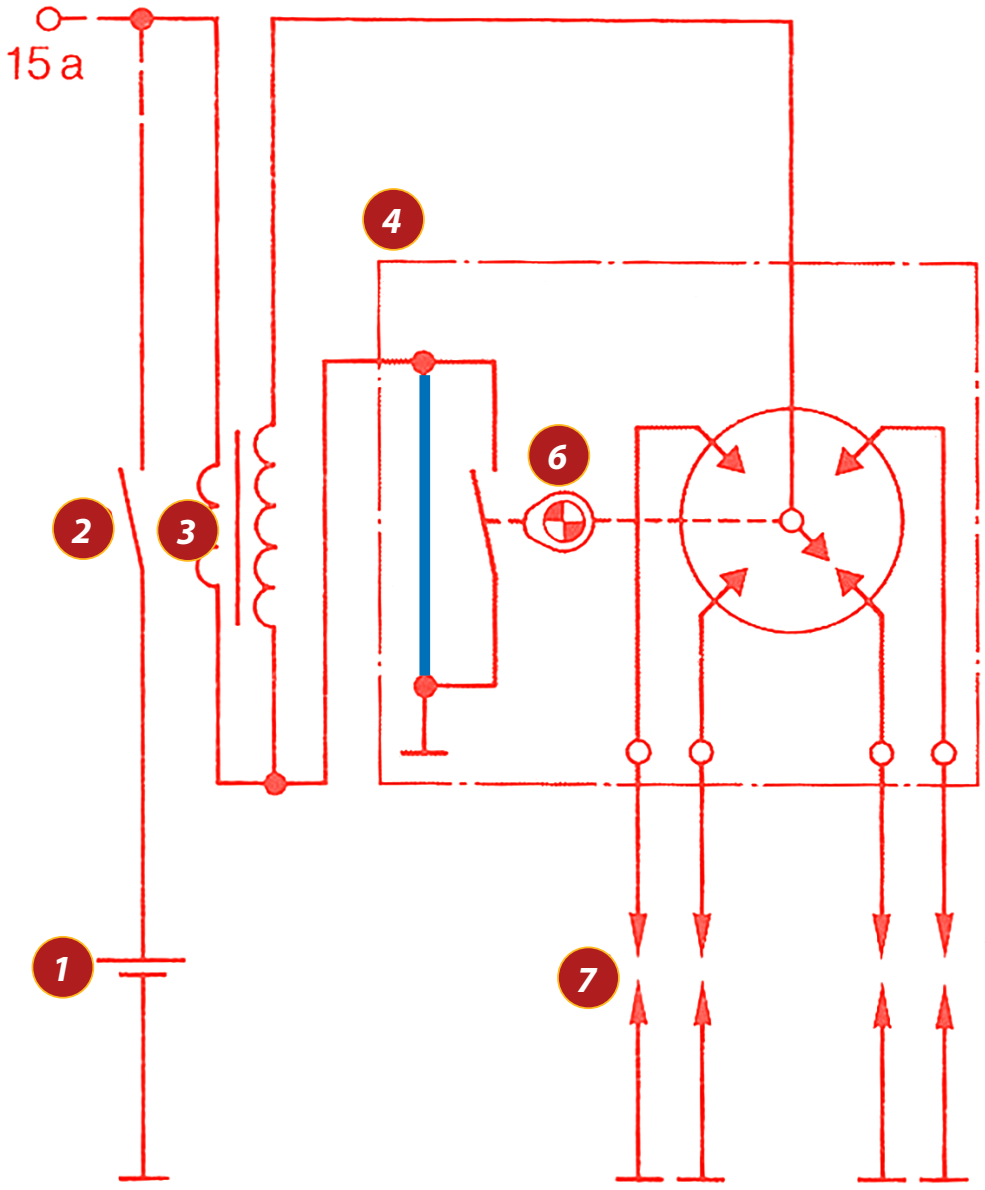
The circuit breaker continues to work, the primary winding of the coil is always interrupted, as it should be, by the opening and closing of the contact points.
Nothing wrong.



the condenser explained

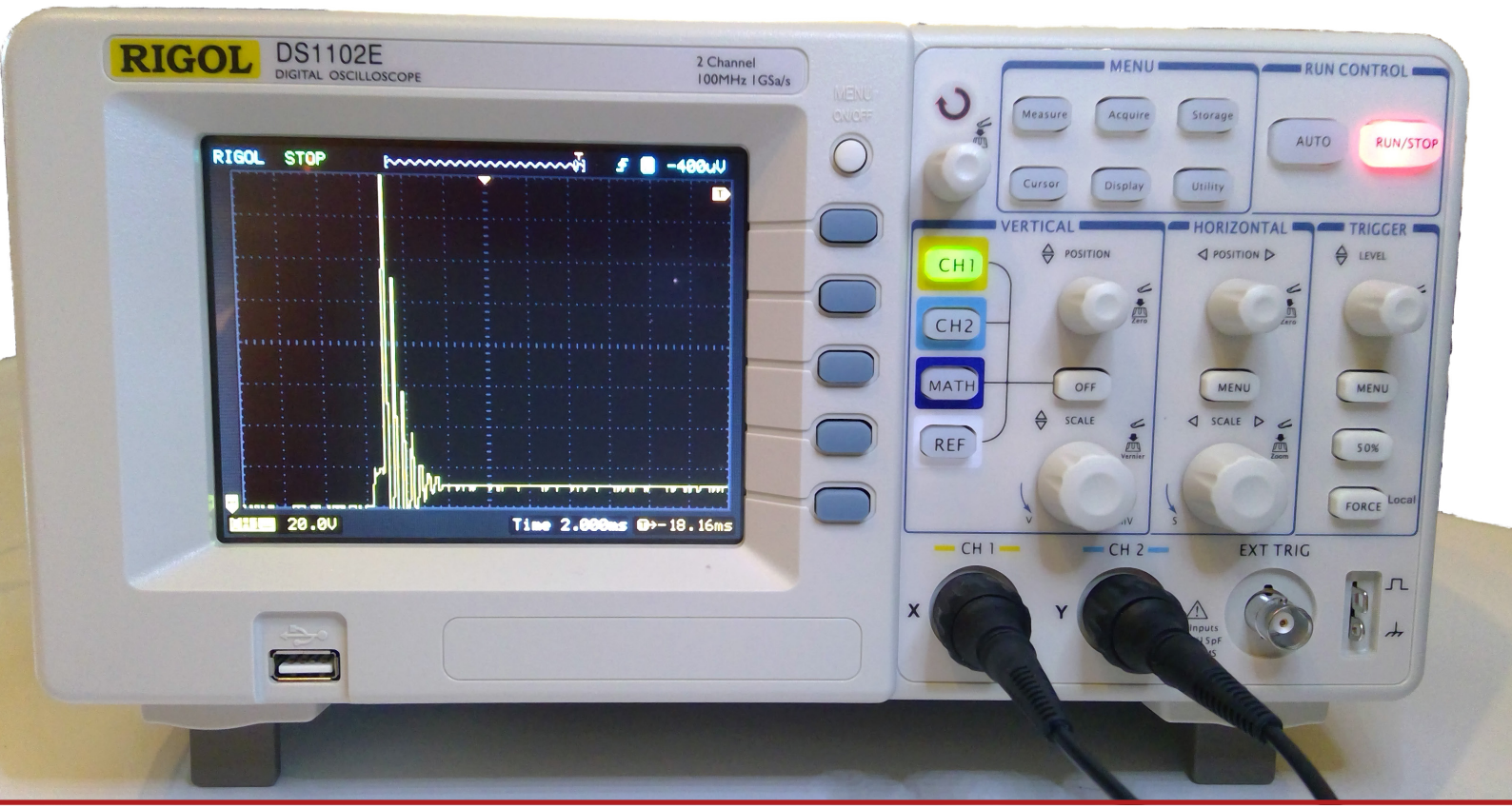
If the condenser forms a short circuit because of a defect due to for example moisture and/or age, then the ignition will not work because the circuit breaker is always short-circuited.

There must be something wrong with our reasoning, why does the VW motor have a condenser in parallel with the circuit breaker? And we know that if we remove the condenser, the fuel-air mixture explodes in the exhaust and the engine doesn't perform.



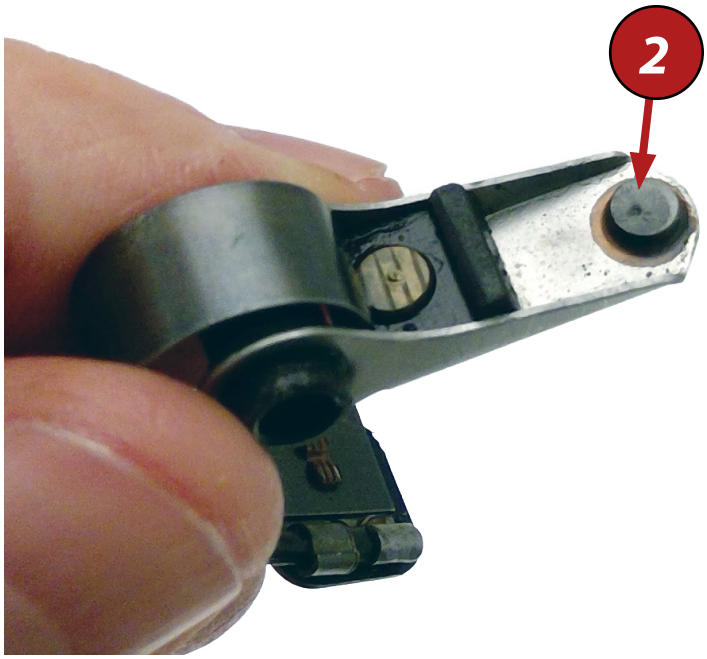
The reasoning error we make is that we forget that **the ignition circuit works on direct current but also on alternating current**. So where does the AC voltage come from? The battery still delivers pure DC voltage (for more information on what DC and AC voltage is, we refer to edition 17).

The opening and closing of the breaker points, which corresponds to the sudden loss of the battery voltage and the sudden rise of the battery voltage, is experienced by the condenser as an AC voltage. The voltage suddenly goes from 0V to 12V (or 6V) and from 12V (6V) to 0V. When opening the contacts of the circuit breaker, the current will disappear through the primary winding of the coil, causing **a high voltage of about 500V** (shown on the oscilloscope screen below). We will explain, calculate and measure this voltage in a next edition of this series.

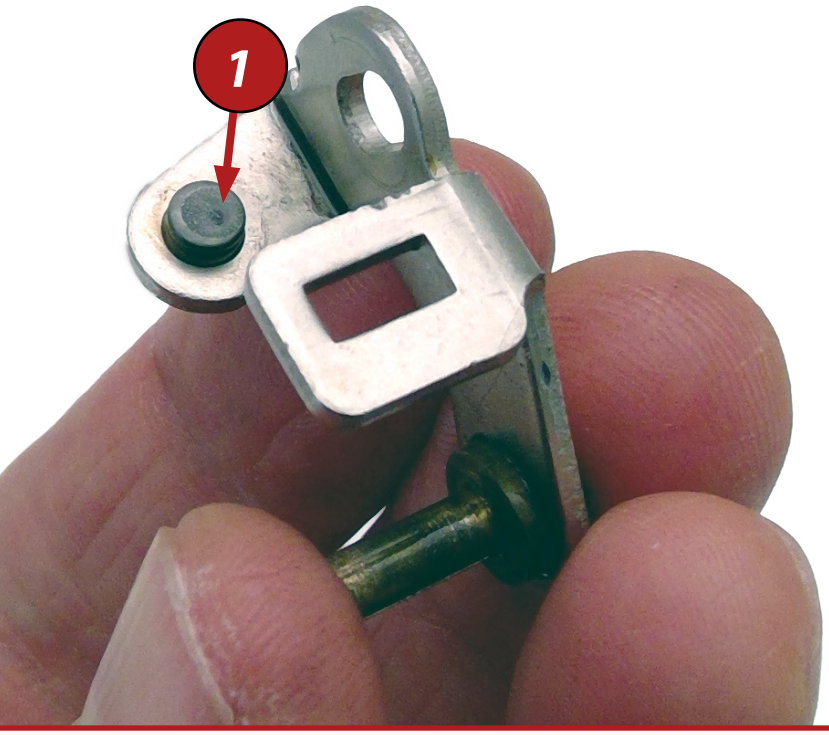


the condenser explained

This high voltage of about 300V to 500V will cause sparks between the contacts of the circuit breaker when they open. These sparks will damage the contact points, one contact area will have dimples (picture below 1) and the other contact area will have carbon deposits (picture right 2). We will explain why this is the case in a next edition.



Damage to the contact points will not be visible immediately, it will only be visible after a few hundred kilometers.

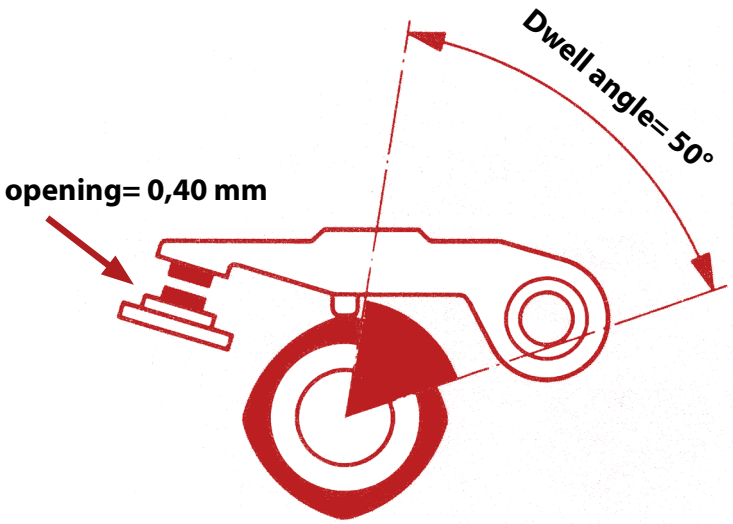


Due to damage to the contacts, they will no longer close properly, they will not make good contact. Another problem is that the opening or the contact angle (see edition 10) will change, the contact opening will change because of the damaged surfaces, so the ignition will not work properly.

Changing the contact angle will affect the quality of the spark between the electrodes of the spark plugs and thus affect the combustion of the fuel-air mixture.

1 Protection

Below we show the drawing of edition 14 again, you understand that when the contact surfaces are no longer clean, the contacts will close sooner or later and affect the ignition.



We can finally summarize what the condenser does for our VW engine. The condenser has **two tasks**, as mentioned in our introduction.

One of the important tasks of the condenser is to protect the ignition contacts against the high voltage (300V to 500V) in the primary circuit, which occurs when the contact points open.

When opening the contact points, the condenser will short-circuit the contact points to ground (or chassis). A condenser behaves like a short circuit for an AC voltage. If the condenser is meant to let the AC voltage through, it does have a function in our VW motor.

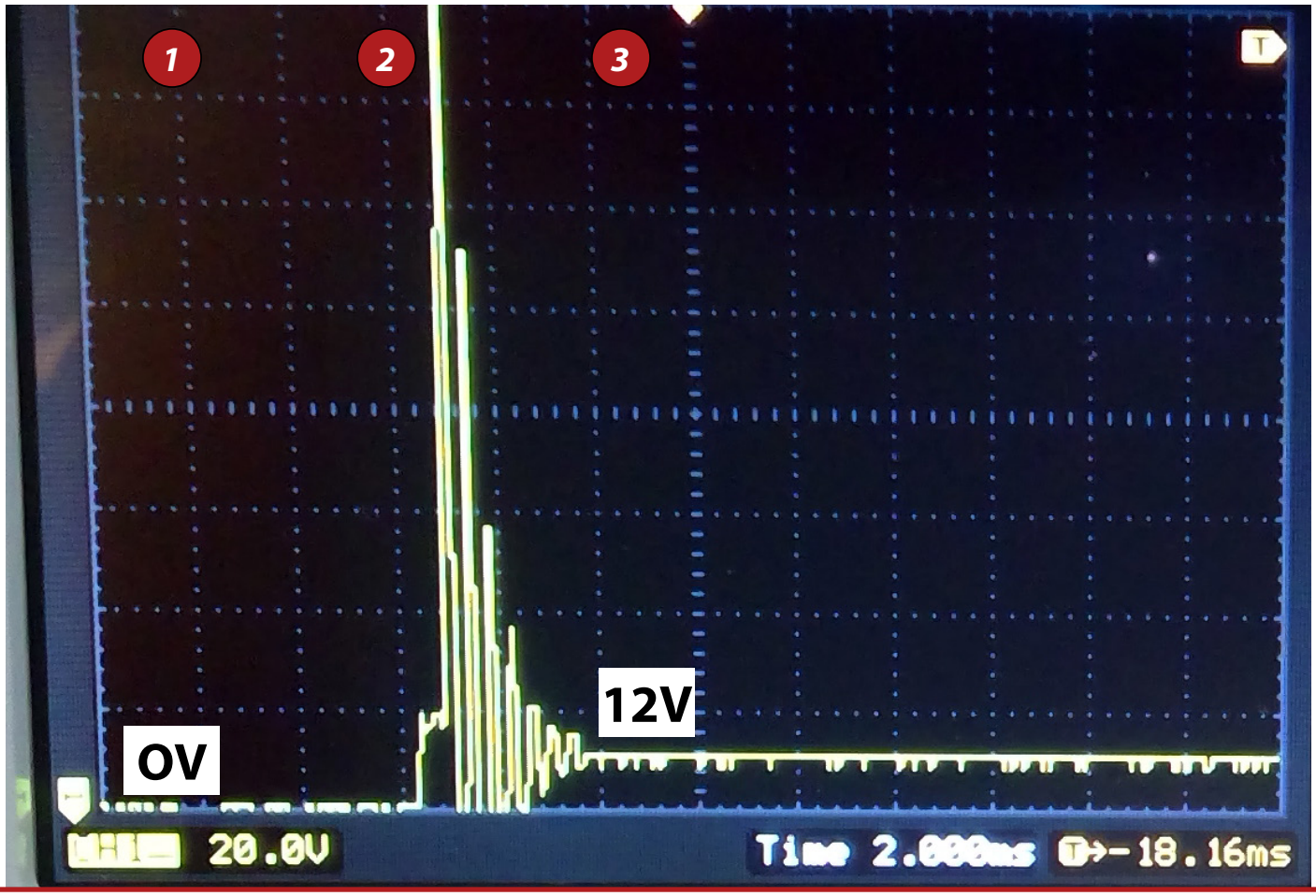
So don't drive without a condenser, because then the contact surfaces of the circuit breaker will be damaged and the ignition will be disrupted, a malfunctioning ignition can damage the engine irreversibly.

2 Higher voltage

You must have asked yourself the question: "*Where does the 300V to 500V come from in the primary circuit?*" The primary circuit is powered by a 12V (or 6V) battery. The condenser helps to increase the voltage in the primary circuit. Below we show a preview of the measurements we did in our lab for a next edition of this technical series.

At moment 1 you see the voltage between contact points when they are closed, at moment 2 with open points, there is a voltage of 300V, then the voltage stabilizes back to 12V. Do you want to know why your engine can't do without this 300V? Then read the following editions of this series.

300V



Introduction

In edition 16 we explained how to remove the engine of a VW Beetle, two techniques were discussed. Read that article in edition 16 before you read on, it will help you to install in the engine. We will not repeat everything in this article, the installation is almost the same as the removal but in the reverse order. The most important points of attention for the installation of the engine are indicated in this article.

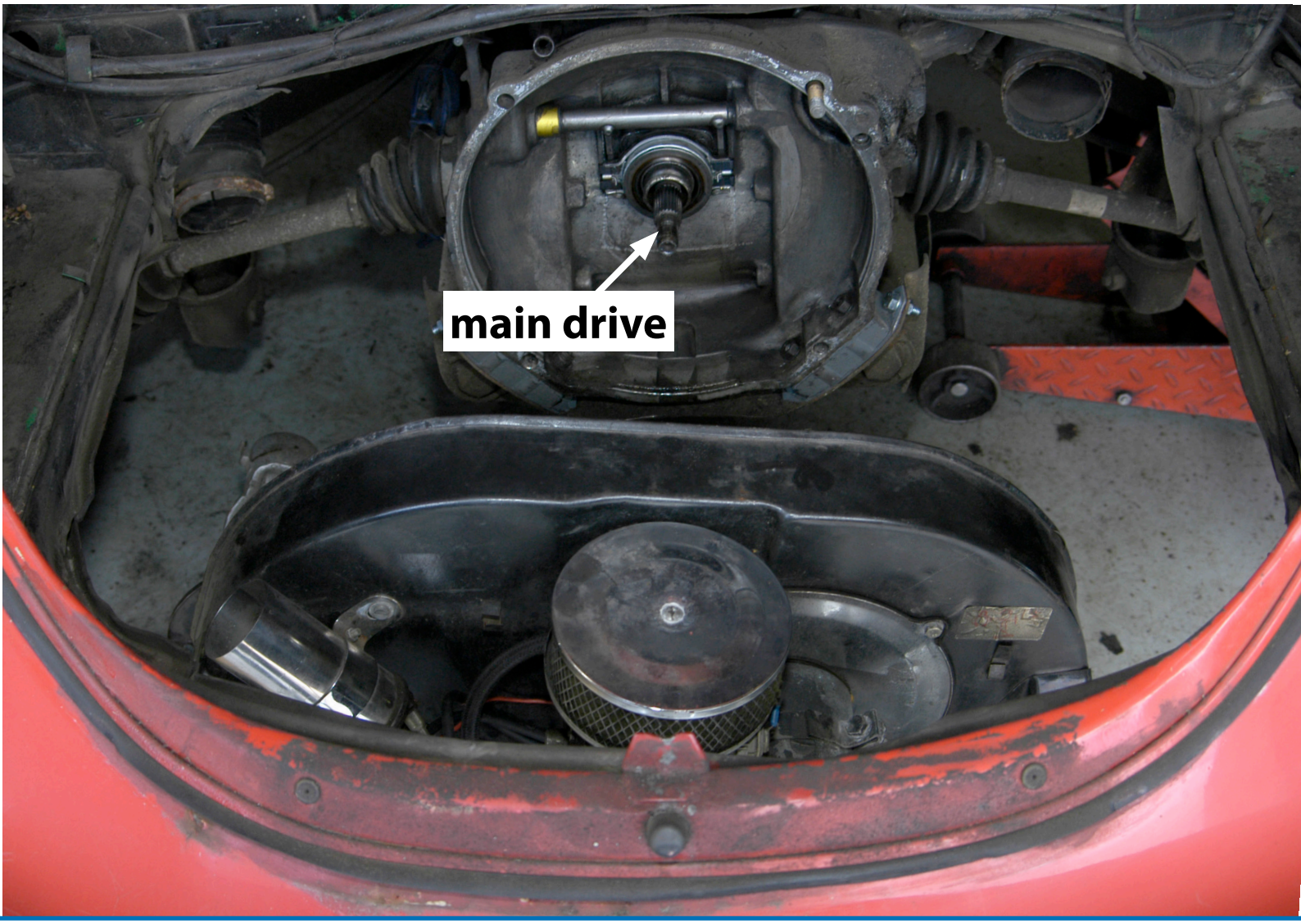
Just the two of us

You will have noticed that when removing the engine, we call on a fellow mechanic. Find some assistance to get this job done, it is more pleasant and above all safer. During the removal or installation of the engine, you can get into problems where the car or engine unexpectedly tilts, it is very difficult to control such a situation alone. During the installation of the engine you will have to position the main drive of the gearbox perfectly centered the clutch.

installing the engine

This is the most critical moment during the installation of the air-cooled engine. An experienced mechanic does this blindly on his own. If you are a less experienced enthusiast, then a colleague is no superfluous luxury at the time of installation.

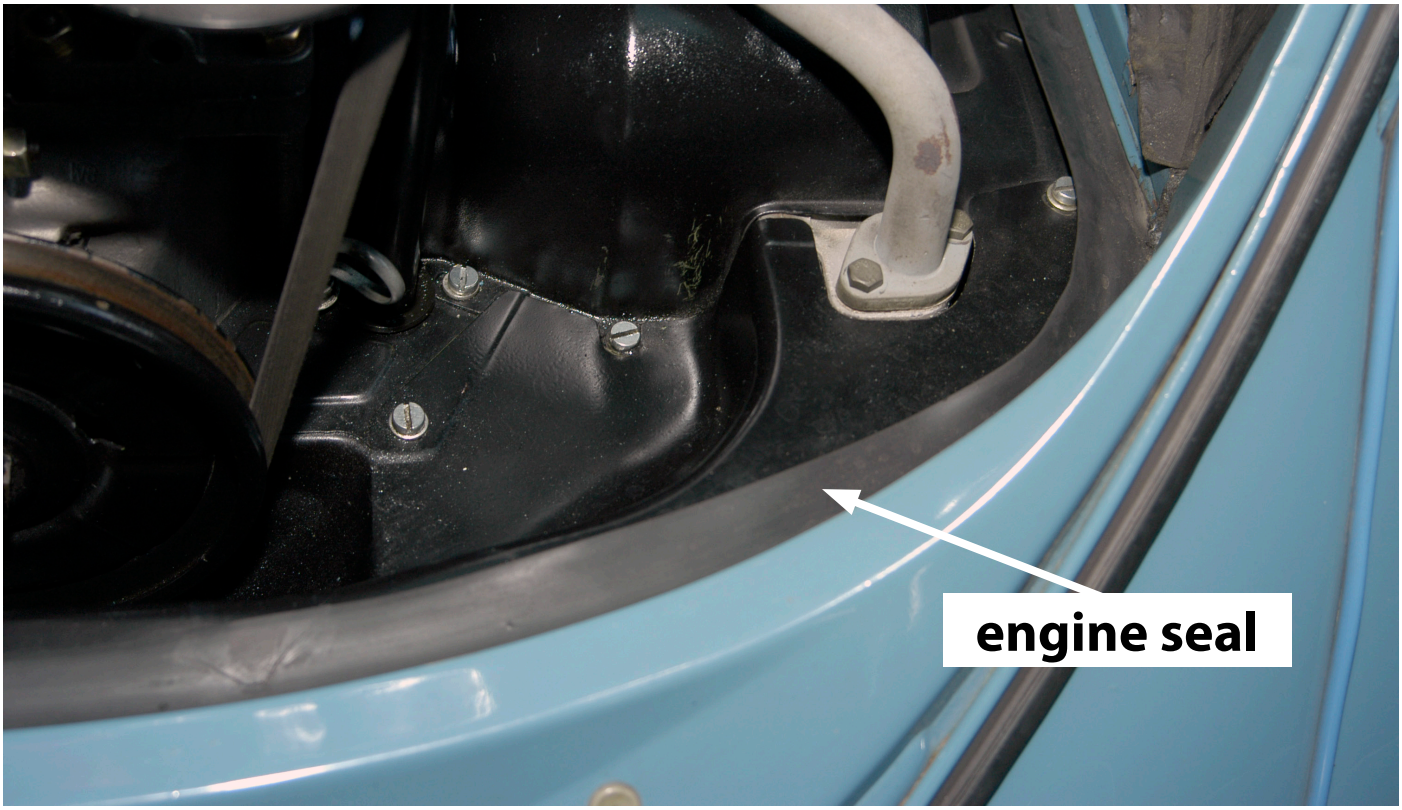
He or she can help to guide the engine by lying under the car (photo page 40), while you push the engine forward into place at the back. Below we show the main drive of the gearbox, you don't want to damage it during the installation of the engine.



Preparations

After you have carried out the planned work on the removed engine, it is time install it. Of course you took the opportunity to place the engine on the workbench to replace all faulty parts, to check all oil leaks, to replace hardened fuel hoses and maybe you also replaced the clutch and the crankshaft seal.

While the motor has been removed, we recommend replacing the engine seal around the engine tin plates, which is usually cracked or hardened. Place it with some silicone spray to make it easier for the seal to glide over the body. Placing the rubber seal after the engine has been installed is not easy, do this while the engine is removed.

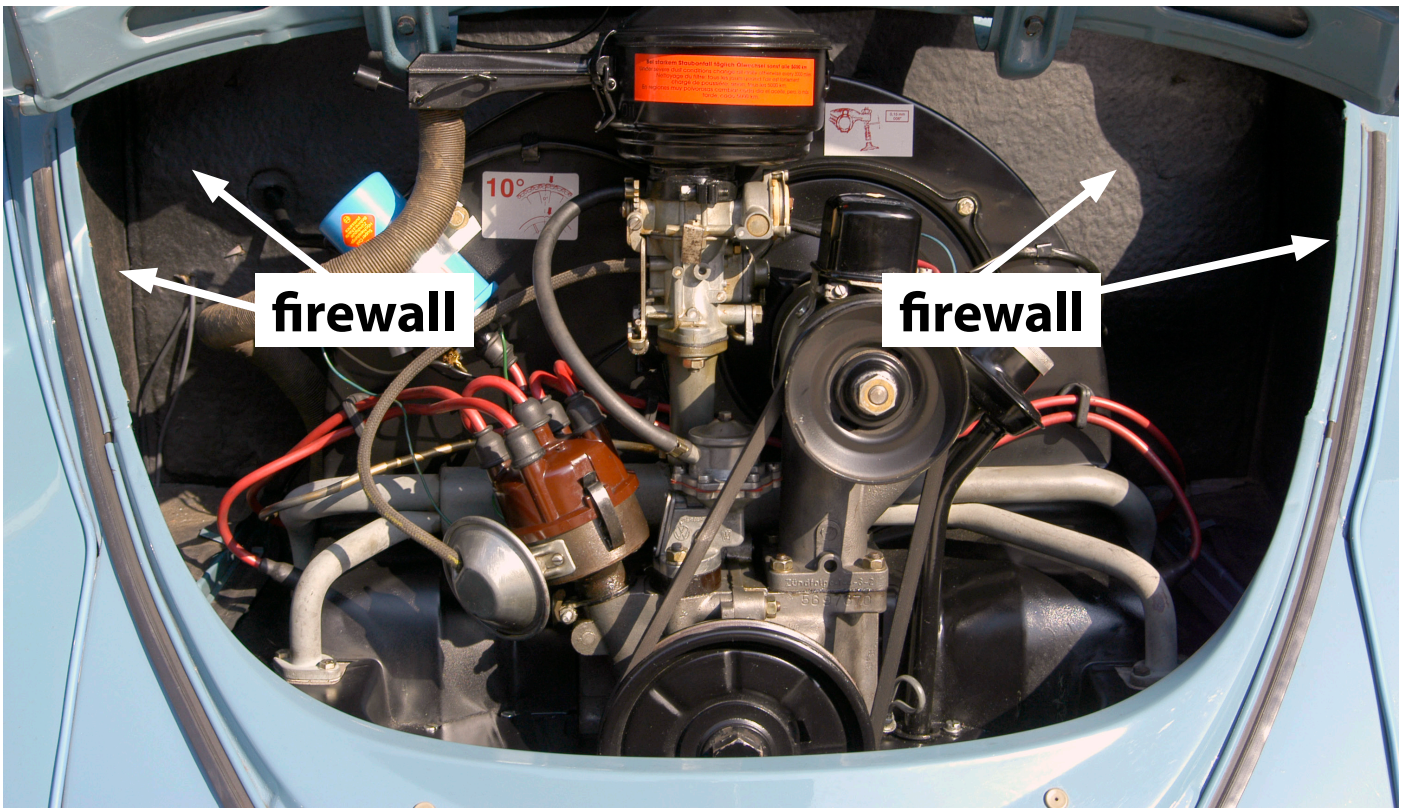


installing the engine

Check the quality of the firewall and that it is properly attached. The firewall is the insulation material that can be seen behind the fan shroud and on both sides under the engine lid. If the firewall has come loose, it can be sucked in by the fan and block the cooling of the motor. A firewall is not always present by default, like on older VW models.

We have already addressed some of these topics in previous editions. Replacing the clutch was discussed in edition 09, detecting oil leaks in edition 07 and replacing the crankshaft seal was explained in detail in edition 13 of this series.

We will now explain how to install the engine.



Installing

Do not add engine oil yet, this is only done after the engine has been installed. It is quite possible that the engine will tip over, the engine oil would leak if the crankcase is already filled. The battery is still not connected as shown in edition16.

Note: The convertible Beetle that we were allowed to use in the workshop lacks a firewall.

Use one of the two techniques shown in edition 16, on page 16 and beyond, to lift the car. The second technique is more convenient because the car is horizontal, so it's easy to position the engine properly. Once the car is high enough, you can roll the engine under the car with the lifting jack.

,

installing the engine

Don't forget to put the car in gear, otherwise when turning the pulley, the main drive of the gearbox will rotate, which is not desirable. The jack supports the crankcase on the sump plate, the engine can be a bit unstable. One person can now lift the engine until the main drive of the gearbox (see page 41) is on the same axial line as the opening in the middle of the clutch plate. Now it's more convenient to be with two, someone who keeps the engine in balance, and someone who pushes the engine in towards the gearbox.

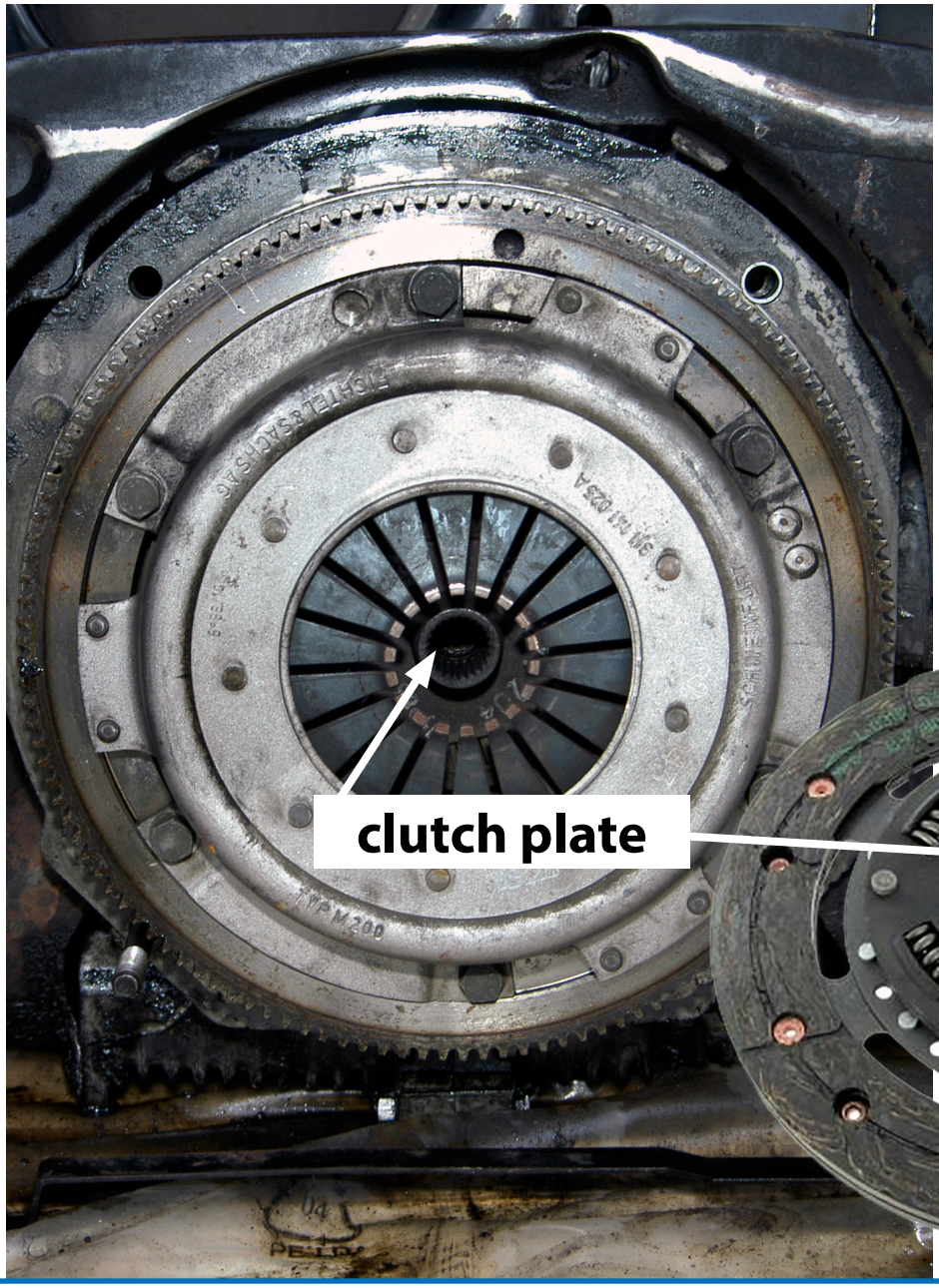
#54 Engine

Lifting or lowering the engine a little with the jack will prove necessary (1). Do not force it. If the engine cannot be moved forward, this can be due to two reasons:

1 the engine must be slightly higher or lower in order to align with the main drive, your colleague can see that or feel it under the car (2)

2 the teeth of the clutch plate are not in line with the teeth of the main drive, which you solve simply by turning the pulley (3) and pushing the engine forward.

installing the engine



On the left we show pictures of the gear-box and the clutch side of the engine. It quickly becomes clear that the main drive and the clutch plate must be perfectly centered, but the teeth must also be even.

Once the engine is pushed all the way against the gearbox, you can fasten the bottom two nuts, this is described in edition 16 on page 21.

Then fasten both upper nuts located behind thee fan shroud, this is described in edition 16 on page 15. The nut on the right is the one that holds the starter motor, your colleague can hold while under the car, and you can tighten the nut behind the fan shroud. The left nut behind the fan shroud holds the long bolt that slides through the top of the crankcase and through the gearbox.

Now that you've secured the engine with its four attachment points, you can lower the car. Re-attach all the parts that you have loosened before removing the engine. See edition 16.
In summary, but the list may be different for younger VW models:

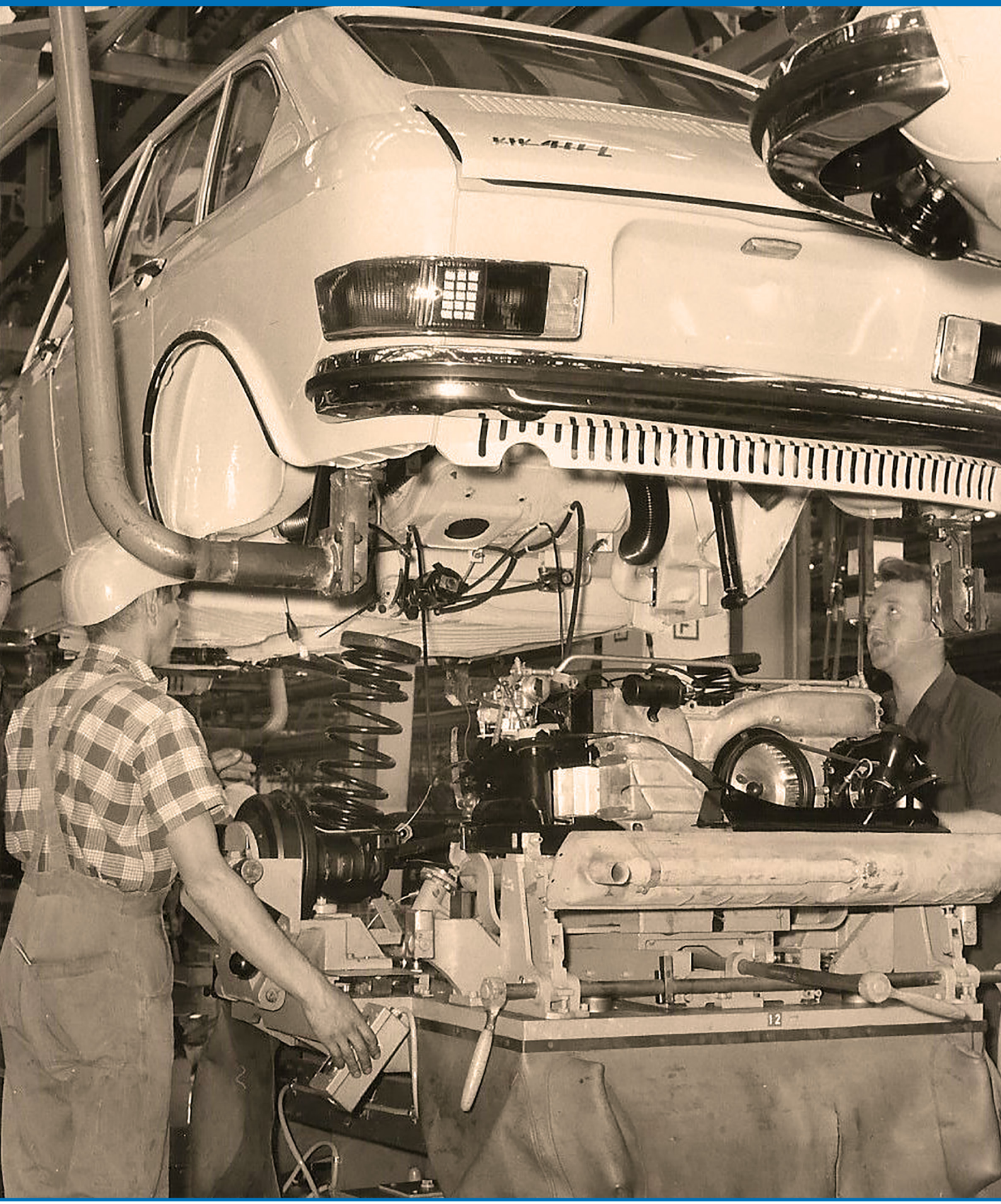
On page 49 we show a picture of the Volkswagen factory in Brussels, the engine of this VW 411 is mounted together with the gearbox, as a whole. Very similar to a Porsche 911.

1. Install the throttle cable guide tube, connect the throttle cable to the carburetor and adjust it correctly.
2. Connect all electrical connections of the alternator or dynamo, ignition coil, oil pressure contact and carburetor.
3. Reconnect the fuel hose at the bottom of the vehicle.
4. Attach both control cables to the heat exhanges. Fit the hoses of the heat exhanges. to the interior, if applicable.
5. Reset the free travel of the clutch.
6. If the air filter of your VW has an oil bath, top up the oil
7. Fill the engine oil with the car in the horizontal position.
8. Attach the battery ground terminal.
9. Mount the engine tin plates if necessary.

Start the engine and check for oil leaks. Carry out a test drive, bring the engine up to operating temperature, and check everything again. Have a save trip!

**Warning!
don't start the engine without oil!!!**

installing the engine

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