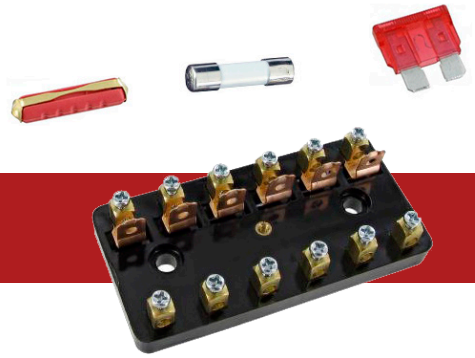
Paruzzi Magazine

Technical Publication for the classic Volkswagen

05

#13- Engine: setting valve clearance

page 02



#14- Electrical: fuses

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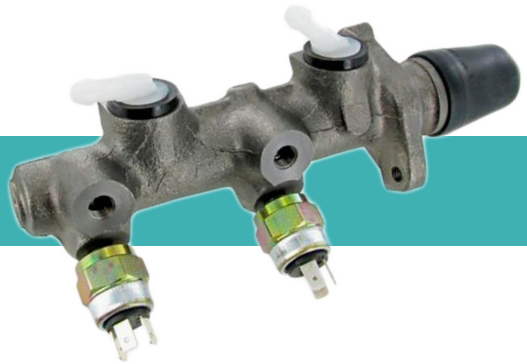

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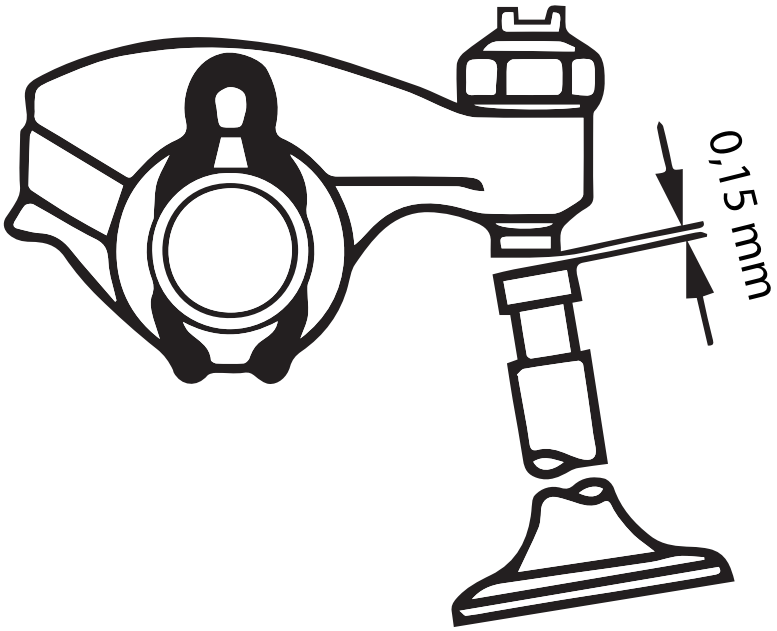
Cold engine

The very first technical action on my first VW Beetle I have ever attempted was the adjustment of the valve clearance. I was not very familiar yet with the technical aspects of the classic VW, but I took on the challenge. Adjusting the valve clearance is something any VW enthusiast should be able to do. You don't need too many tools to do this, and it is of the utmost importance for the engine. Adjusting the valve clearance is the first adjustment you need to make before even thinking of setting the ignition timing or tuning the carburetor(s).



We have already answered questions such as "*what are valves for?*" and "*where are they installed?*" in edition 04. Read edition 04 to learn about "*valve clearance*".

You need to work on a cold engine when adjusting the valve clearance. Some younger water-cooled engines show adjustment figures for operating temperature though. Measuring and adjusting valve clearance needs to be done on a cold engine for all air-cooled boxers, if not, serious damage can occur!

Put your VW to sleep, before you start with the adjustment job, I work better just after my first coffee in the morning anyway.

Valve clearance for adjustment at operating temperature is mentioned in the original Volkswagen workshop books for the T25/T3 Vanagon Diesel engines and the VW Golf family water-cooled engines.

setting valve clearance

Hydraulic lifters

Some classic VW engines have hydraulic lifters installed. You don't need to adjust the valve clearance when your engine has hydraulic lifters. The valve clearance is automatically adjusted via an hydraulic system. We show below an hydraulic lifter from a Mecixo Beetle with type 1 engine.

Below a list of VW engines equipped with an hydraulic system:

- T2 type 4 engine 1978-1979, engine code GE 2000 cc
- T25 type 4 engine from 1979, engine code CU, CV 2000 cc
- T25 1600 cc CT, CZ engine 1979-1982
- WBX engines
- Type 1 engines from 1992 on, engine code ACD from the late Mexico Beetles, these Mexico Beetles are using special lifters, don't use the type 4 engine lifters.

Above: this is an hydraulic lifter from a 1992 on Mexico VW Beetle.

Do you want to know more about the different Volkswagen types, check out edition 02 starting on page 2.

Tools

What tools do you need to set the valve clearance? Adjusting the valve clearance is a great project to start during a quite Sunday morning, you don't need to invest in expensive tools to realize this job.

The first tool you need is a set of feeler gauges. You need them in the following sizes: 0,10 mm / 0,15 mm / 0,20 mm / 0,30 mm. We have a complete set available in our webstore as product number 01120.

Below another great tool to help you to set the valve clearance. Once you have this tool in your workshop, you won't be able to go back to the basic screw driver/socket wrench system!

setting valve clearance

Use the correct valve cover gasket that matches the cylinder head installed on your classic Volkswagen.

If your valve cover bails are crooked or if they don't offer the necessary strength to keep your valve cover in place, replace them with new ones.

Use this liquid gasket to seal the valve cover gaskets, only apply liquid gasket to the valve cover side, never apply on the cylinder head.

You will need 2 new valve cover gaskets and optional a liquid gasket tube, we use the liquid gasket shown below, you can order this product in our webstore. Watch out to order the correct valve cover gaskets for your type of engine (read: type of cylinder heads). Make sure the valve cover bails are still in good shape to avoid oil leakage.

Jacking up the car will give you more working space, necessary especially if it is the first time you do this on your Volkswagen. We discussed all about how to use the original Volkswagen jack in edition 03 starting page 2.

Preparations

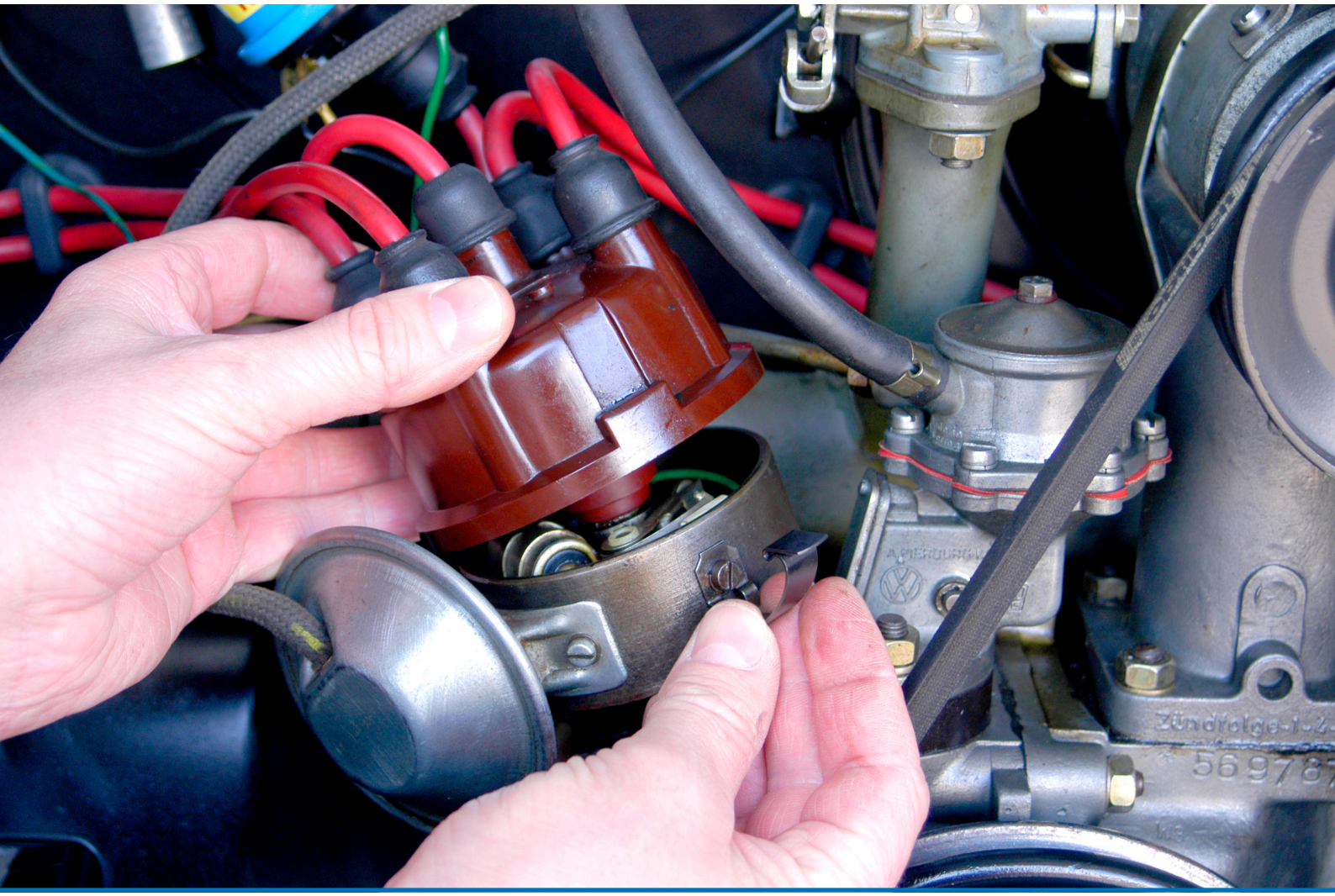
It will be much easier to set the valve clearance once you have removed the rear wheels. It is not a must, but it will make the job more pleasant. If this is the first time you do this type of maintenance, we advise you to follow this procedure.

Jack up your VW following the guidelines described in our edition 03. It can take a few hours to set the valve clearance, if this is the first time you do this. Take your time, this is not a competition, make sure you do the job correctly. Once you gain some experience, it'll take only 30 minutes.

setting valve clearance

You need to get a good view on the cylinder head to be able to work properly. Use a working lamp to generate enough light to work under the car. Have an oil receptacle ready to catch the leaking oil from the cylinder head once you have removed the valve cover.

Remove the distributor cap as shown below. Store the cap in a save place in the engine bay, the cap is quite fragile. Don't remove the ignition wires, so you don't have to figure out which wire fits where later on.

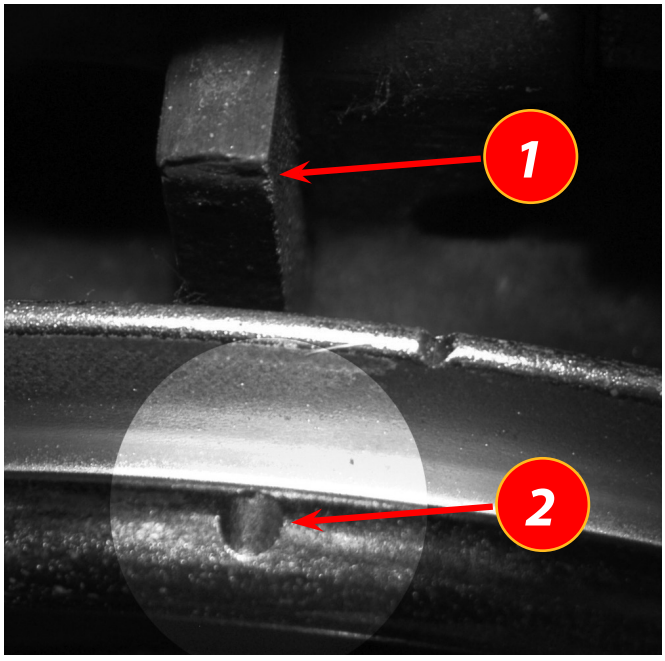


Top dead point (TDC)

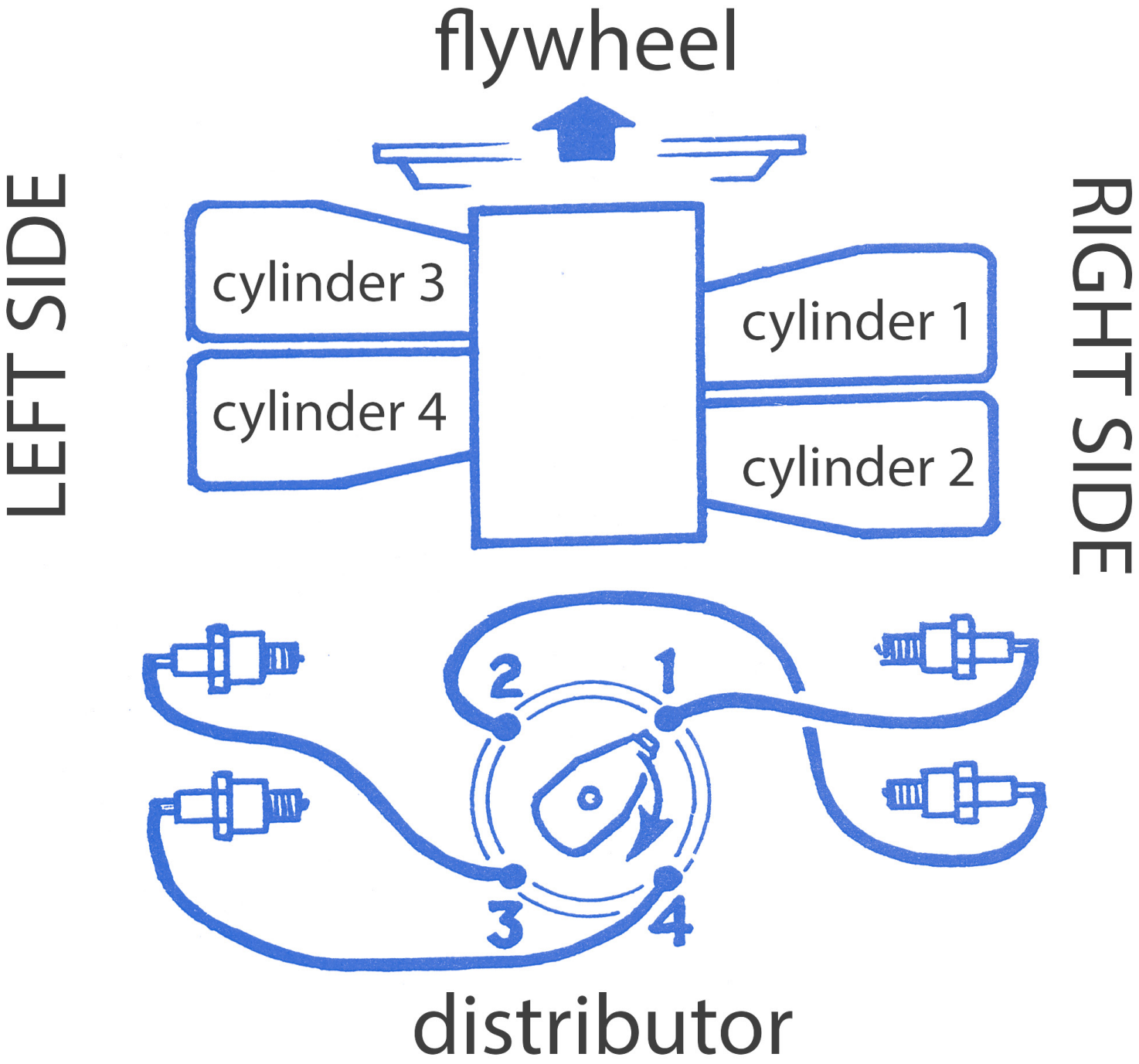
Let's start with cylinder 1. You need to position the intake valve and the exhaust valve from cylinder 1 at its top dead center (TDC). The valve clearance should be at its maximum at the TDC. The piston in the cylinder is positioned at the end of its compression stroke, which is the same as the beginning of its power stroke, the valve clearance will be at its maximum at that point.

We will begin to adjust the intake valve and the exhaust valve of cylinder 1. We show in the drawing on the right page how the cylinders are numbered in an air-cooled Volkswagen boxer engine. Watch out, the ignition sequence is as following: starting with cylinder 1, then cylinder 4, 3 and 2. We also show this on the drawing, follow the ignition wire that connects the ignition (distributor) cap and the spark plugs.

Position cylinder 1 to its top dead center (TDC) by rotating the pulley with a 21 mm wrench (can be a different size on early air-cooled engines). The notch in the crankshaft pulley (2) should be perfectly aligned with the middle of the engine carter (1). We show the crankshaft pulley in the picture below, the bright circle shows the notch in the crankshaft pulley (2) that indicates the TDC of cylinder 1. You also see a small notch in the pulley just above, this notch is used to set the ignition timing.



setting valve clearance

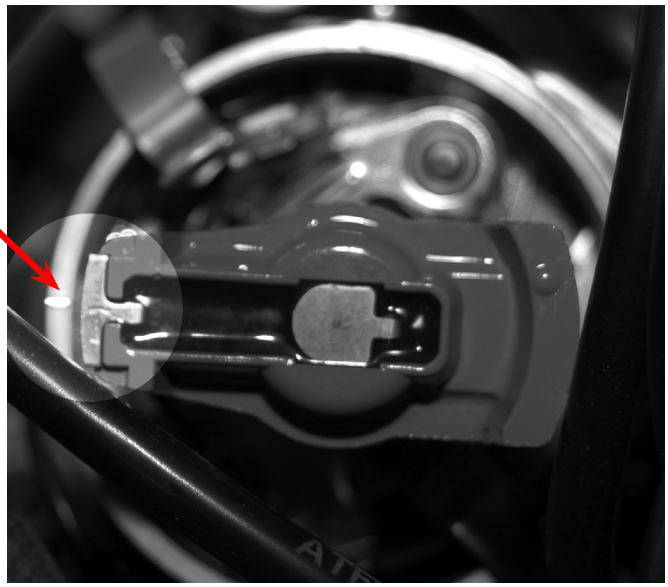


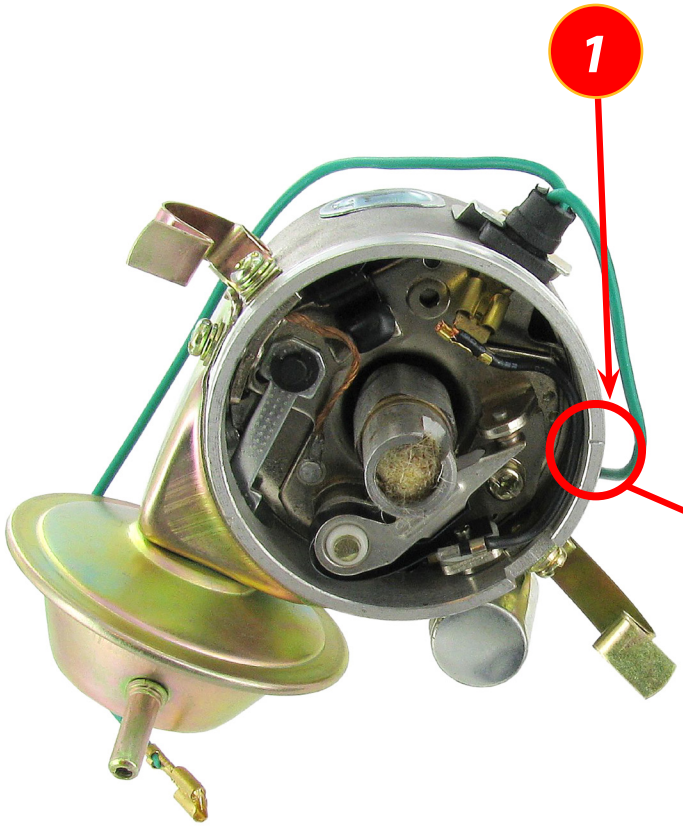
Cylinder 1 is on the right side of the car as you can see in the drawing above (view from behind the car), behind cylinder 2. You will have to rotate the pulley to position cylinder 1 in its top dead center.

We also show the ignition sequence here above, the VW Boxer engine ignition fires cylinder 1, then cylinder 4, then cylinder 3 and finally cylinder 2.

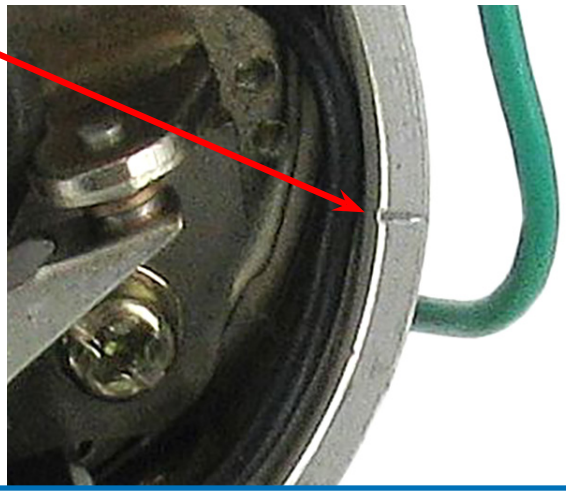
Setting valve clearance

The notch on the distributor (1) should be aligned with the ignition rotor. In which direction the rotor is facing at that moment is different for each engine, as long as it points towards the notch you are fine, so don't use a picture in a book but only trust the notch.



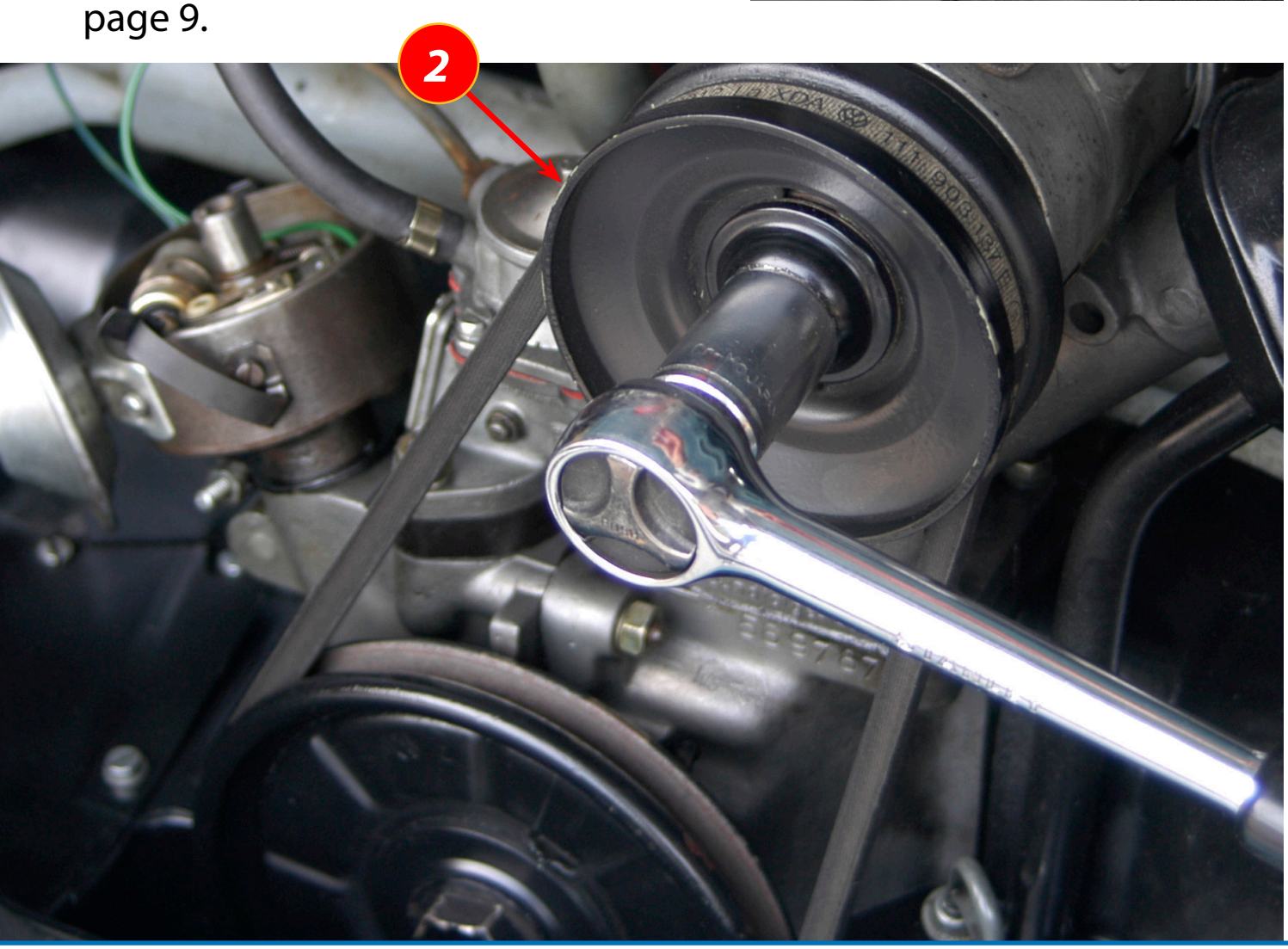


If the rotor points to the opposite side of the notch, cylinder 3 is in TDC, rotate (360°= 1 full rotation) the pulley (2) until the rotor points to the notch as shown in the picture (1). The notch on the pulley should be aligned again with the carter center. Cylinder 1 is now in TDC.

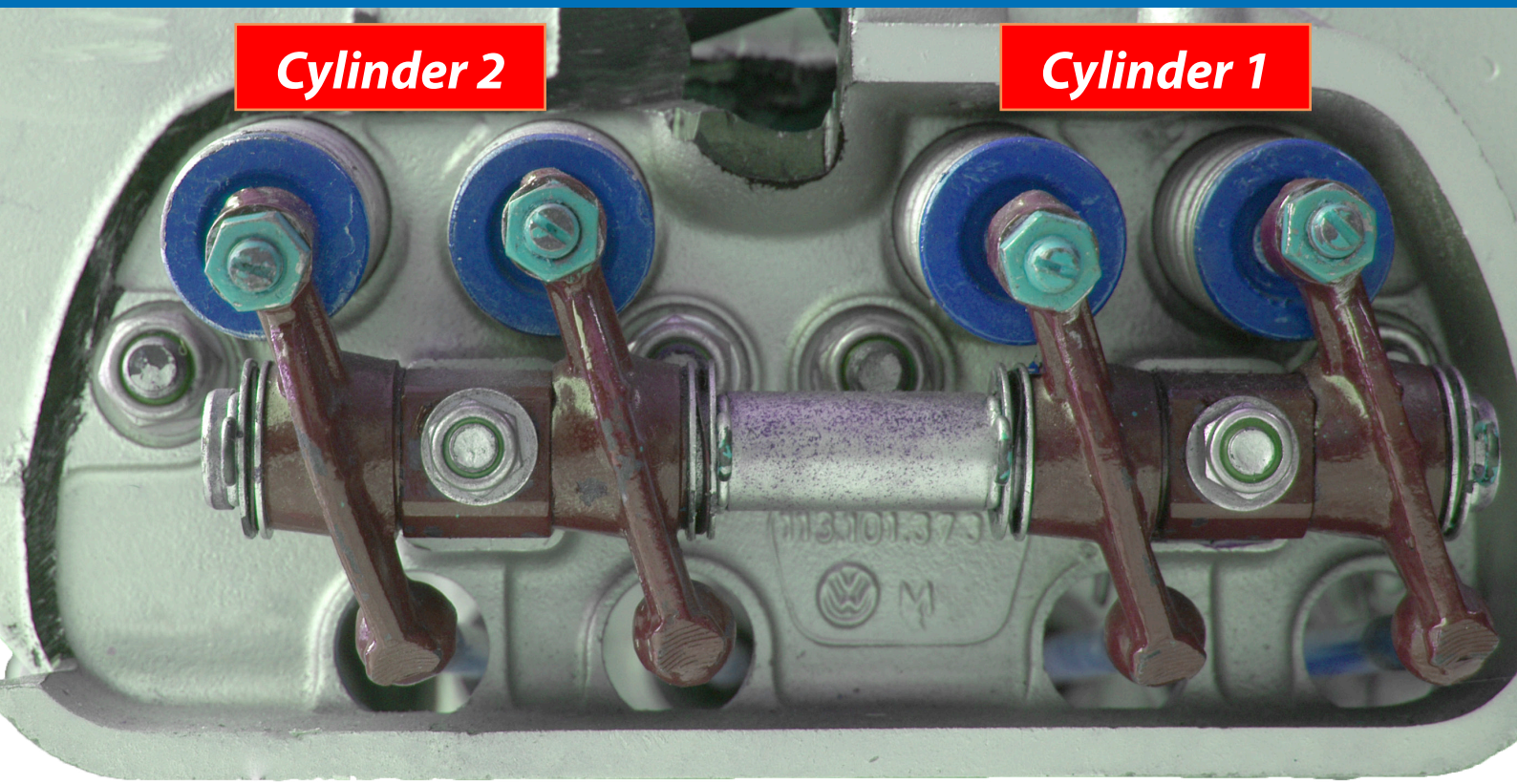


setting valve clearance

Now go to the right side of your VW and find the valve cover (3), it is located behind the right rear wheel. Remove the valve cover, don't forget to place an oil receptacle under the valve cylinder head to catch the dripping engine oil. Once removed, you will see the intake valve and the exhaust valve of cylinder 1 and 2, as we described in the drawing on page 9.



#13 Engine

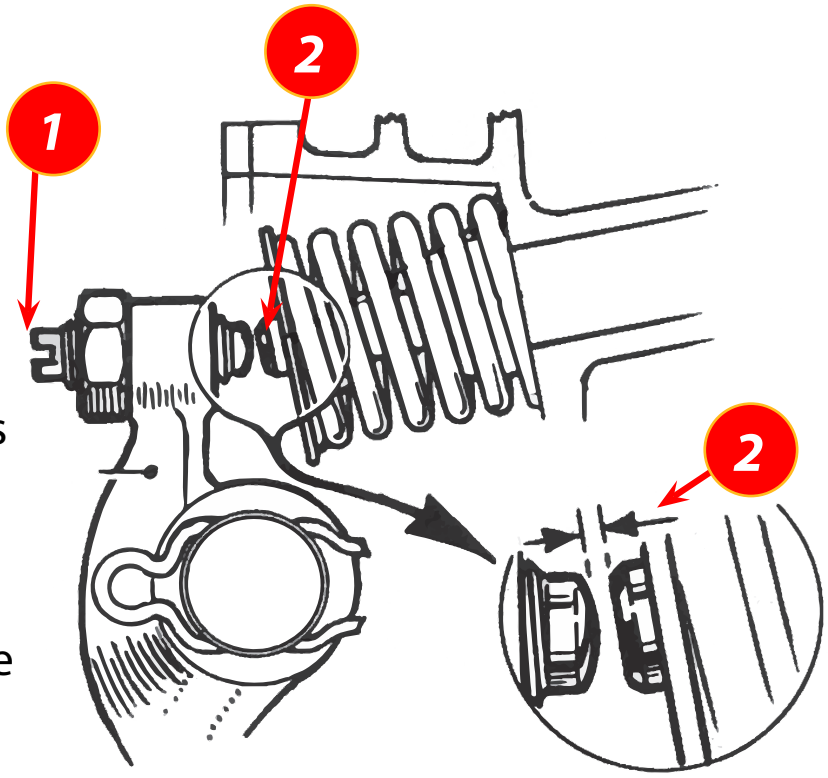


It is possible that the valve cover sticks to the cylinder head, use a soft hammer to loosen the valve cover if needed. Put the valve cover in a safe place, I have this habit to store my valve covers together with my car keys somewhere safe. I have once done that mistake to crank the engine while the valve covers were removed, you don't want to experience this believe me. The complete oil volume of your engine is sprayed all over your workshop floor. If you don't stop the engine timely you could end up with a broken engine.

If all went well, you removed the valve cover from the right side cylinder head, you should see both intakes and exhaust valves of cylinder 1 and 2 (picture above). How much valve clearance do you need depends on the engine type. Most air-cooled engines need 0,15 mm valve clearance, for both the intake and the exhaust valve. There are some exceptions, that is why we have added this table on page 13 as a quick recap. You need to check which type of cylinder heads you have installed on your engine and the manufacturer

setting valve clearance

recommendations. You don't need to adjust the valve clearance if all valves are already set to the correct clearance. So, first check the valve clearance using your 0,10 mm, 0,15 mm and 0,20 mm feeler gauges (depends on the type of engine you have of course, refer to the table below). Try which size feeler gauge you can insert between the valve stem and the adjustment screw (2) of both the intake and exhaust valve of cylinder 1.



Most type 1 engines need a valve clearance of 0,15 mm, some old VW workshop manuals will mention 0,10 mm. Volkswagen has advised to change it to 0,15 mm back in the sixties because of many break-downs.

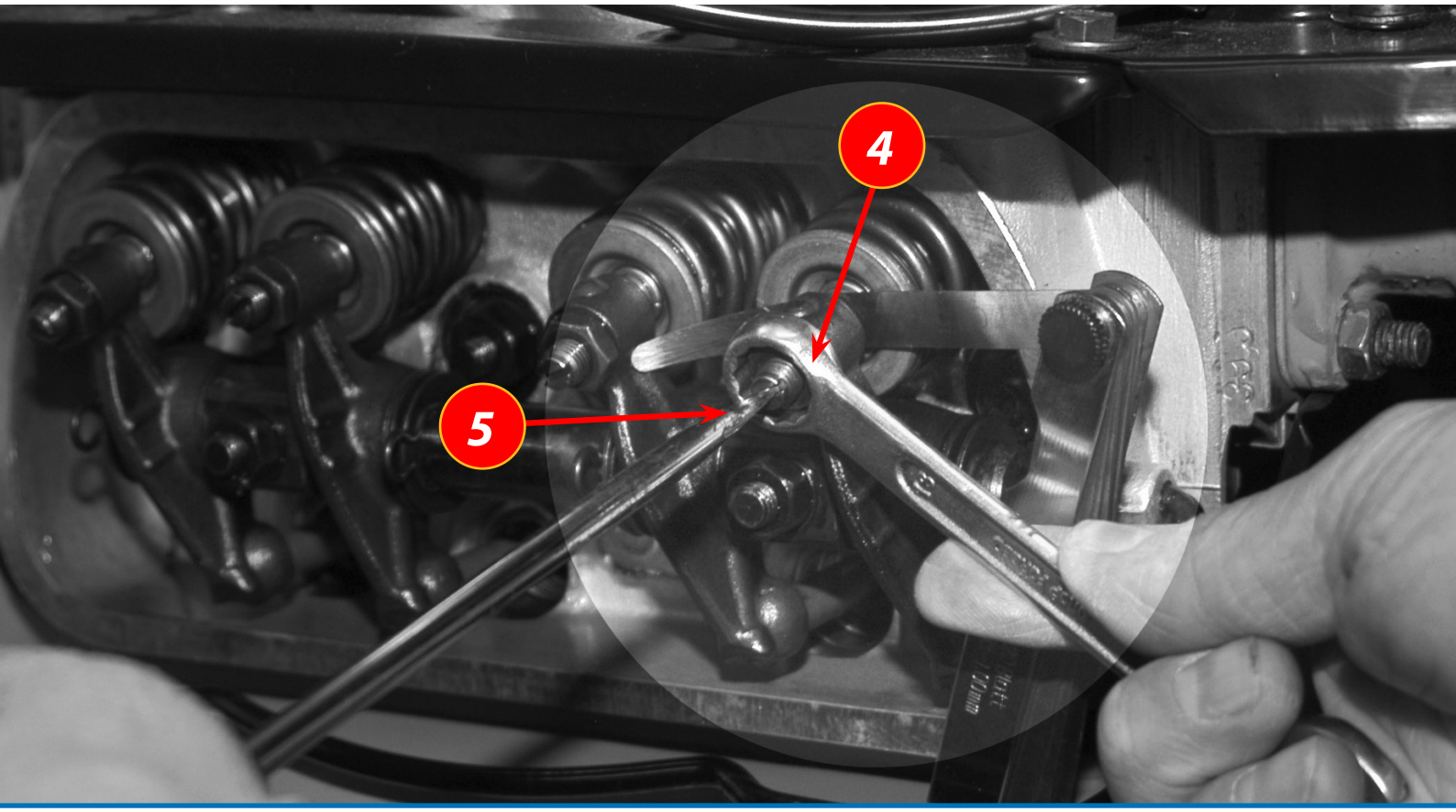
engine type	inlet valve	exhaust valve
type 1 30 hp	0,10 mm	0,10 mm
type 1 34, 42, 45 hp	0,20 mm	0,30 mm
type 1 engine from 11/1964 (engine number 9205700)	0,15 mm	0,15 mm
type 2 62 hp, 66 hp, 68 hp	0,15 mm	0,20 mm

We advise you to check your manufacturer data if you don't have original Volkswagen cylinder heads installed. The valve clearance mentioned in the table is to be measured on a cold engine.

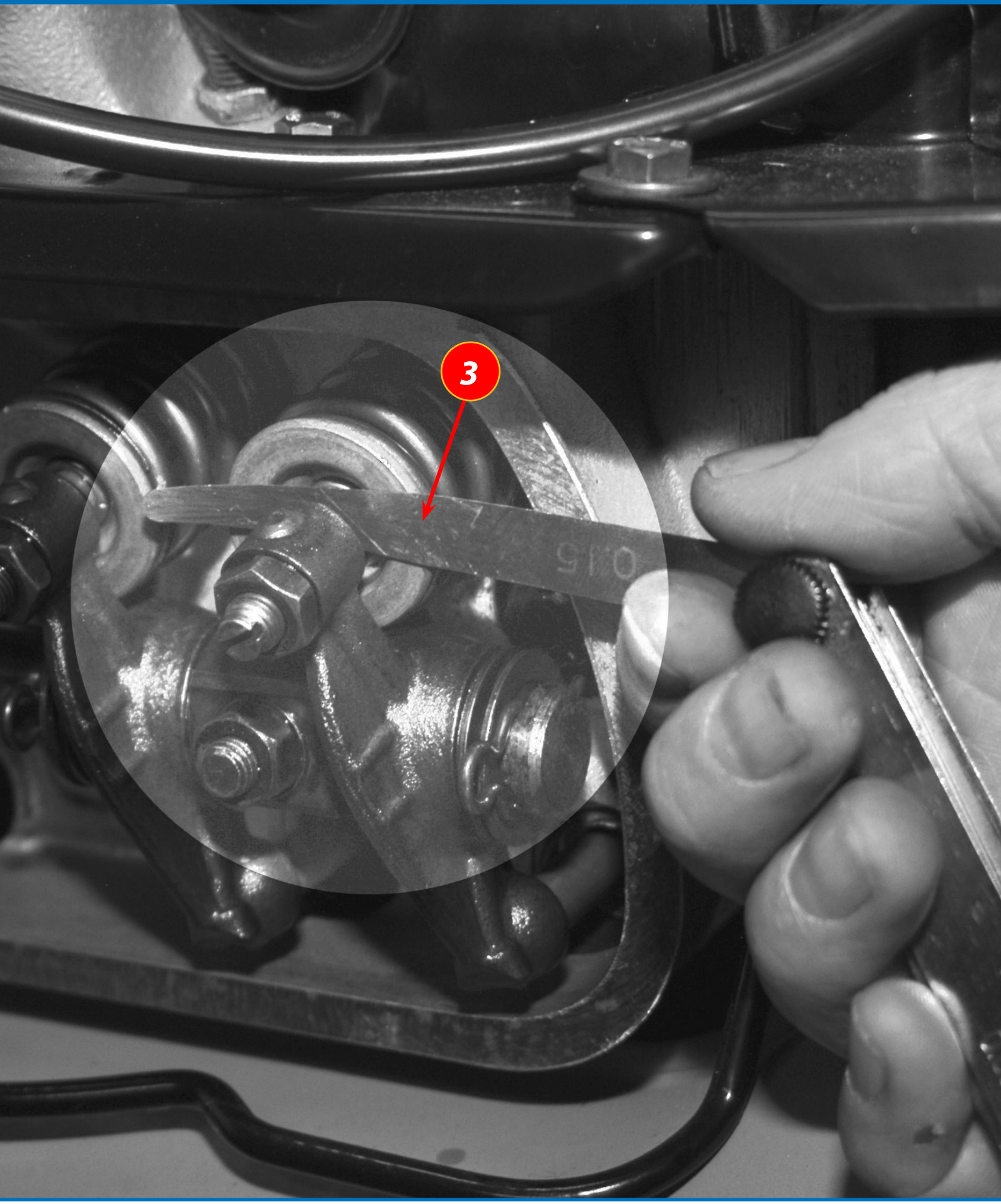
Sometimes the valve clearance is also mentioned at operating temperature. As an example, the VW Golf 1100 cc workshop manual from Volkswagen advises a valve clearance of 0,20/0,30 mm at operating temperature and 0,15/0,25 mm cold.

#13 Engine

We will work on a VW 1303 with a 1600 cc engine. Both the intake valve and the exhaust vale need a clearance of 0,15 mm. The 0,10 mm feeler gauge should move (3) back and forth very easily without any friction. If you can't insert the 0,10 mm feeler gauge, the valve clearance is too low. It should not be possible to insert the 0,20 mm feeler gauge, if you can do so, the valve clearance is too high. The 0,15 mm feeler gauge needs to move back and forth easily with minor friction. If it does so, the valve clearance is just fine. Measure the intake valve and exhaust valve on cylinder 1. If the valve is far away from the prescribed 0,15 mm, then you need to adjust the valve clearance. To adjust the valves, use a 13 mm wrench (4) or the tool we showed on page 4. Take a screw driver (5) to loosen the adjustment screw. Insert a 0,15 mm feeler gauge between the valve stem and the rocker as shown in the picture on the right (3).



setting valve clearance

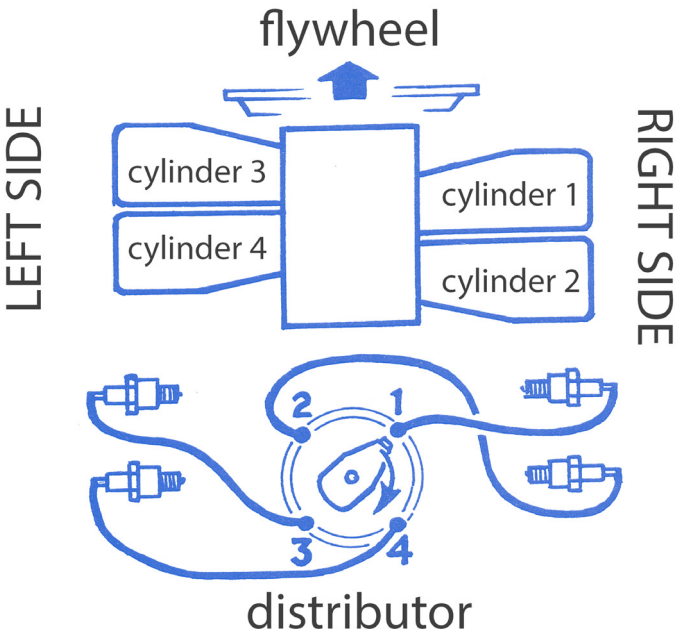


Tighten the adjustment screw by rotating it clockwise carefully with a screw driver (5), the adjustment screw should gently touch the feeler gauge. Secure the adjustment screw by tightening the nut (13 mm nut, see picture 4 on page 14) while you keep the adjustment screw in position. Not an easy exercise if you do this for the first time. Don't hesitate to start over if you feel like you don't have it right.

Once the 13 mm nut is secured, I always check if the valve clearance is fine, if a 0,20 mm doesn't fit, you are fine. You should be able to insert the 0,15 mm feeler gauge without too much friction. There is a possibility that the valve clearance shifts when you try to tighten the 13 mm nut.

If you have some troubles to find the TDC of your cylinders, if your distributor doesn't have that notch or if your pulley doesn't have this TDC notch mark? Don't worry, we will explain in the next edition how to find the TDC the hard way.

You are done with cylinder 1, now it is time to set the valve clearance of cylinder 2. Rotate the pulley counter clockwise until cylinder 2 is positioned in its TDC. The rotor rotates 90° counter clockwise while you rotate the pulley. At exactly 90° rotation of the rotor, you should be at cylinder 2 TDC.
Adjust the valve clearance of cylinder 2 using the same procedure as we explained for cylinder 1. You need to rotate the rotor further 90° to reach cylinder 3 TDC, and further 90° to reach cylinder 4 TDC. Cylinder 3 and 4 are located on the left side of the car as shown below.



Valve covers

Install the distributor cap, check if there are no cracks in the cap before installing, just to be sure.

Clean the valve covers. Use new valve cover gaskets and install the gasket using the liquid gasket tube we showed on page 5. Never apply liquid gasket on the cylinder head side of the valve cover. If you have new valve covers with new cylinder heads, you don't really need liquid gasket, the valve cover gasket should do the job just fine.

For some older Volkswagens with high mileage, it doesn't hurt to use the liquid gasket, it will avoid oil leakage due to distorted valve covers. Not too much though, you don't want a piece of gasket to come off and enter the oil channels, this could damage your engine. Install both valve covers now, you should have found your car keys in the same box as your valve covers. Crank the engine and check for valve cover leakage. Also check if your valves don't produce strange noises. Take your VW for a ride and check again for oil leakage. Write down the mileage of the car and make an appointment with yourself for a valve clearance adjustment within 5.000 to 10.000 kilometers.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#14 Electrical

Why fuses

Modern cars have many accessories installed nowadays. All these accessories need to be protected. You will find a lot of fuses installed in new cars, sometimes located in different places in the car, in the front next to the engine, in the back and under the seats.

Our oldest classic Volkswagen has one fuse box with 4 fuses, an additional 4 fuses were added later on, the more advanced the Volkswagen became, the more fuses it received. The youngest VW Vanagon T25/T3 has more than 20 fuses installed.

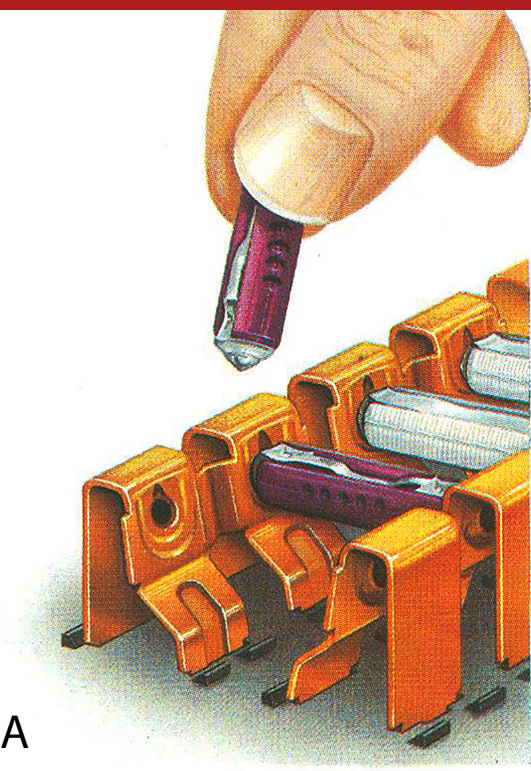
But why do we need these fuses? A fuse will protect an electrical circuit in case too much current is running through the wires. The fuse melts first when too much electrical current flows through it, so that the electrical wires don't melt.

The picture above shows a fuse box for an October 1952 to July 1960 VW Beetle. This type of fuse box was also used in a Karmann Ghia until July 1960. The early VW fuse box was installed under the front hood. On the right, the fuse box in my almost completely restored VW 1303, 12 fuses under the dashboard. In the picture below a fuses box with 8 fuses including a plastic cover.

fuses

Fuse types

There are many different types of fuses used in automobiles, we discuss the fuses installed in classic Volkswagens.



Ceramic fuses

Well known by all classic car enthusiasts are the ceramic fuses. The ceramic fuse consists of a metal wire or strip installed on a ceramic support. The strip melts when too much current flows through it. The thickness/width of the metal strip defines at which (continuous) current level the strip will melt.

The 8 A and the 16 A ceramic fuses are commonly installed in our classic Volkswagen. You recognize the Amp level by their color, and of course the printed Amp value on the ceramic support.

fuses

Blade fuses

You will not find this type of fuse in the Vintage Volkswagens, if they are completely original of course. These blade fuses are installed in the T25/T3 Vanagon. Blade fuses (also called spade or plug-in fuses), with a plastic body and two prongs that fit into sockets, are mostly used in automobiles. Each fuse is printed with the rated current in amperes on the top. It is not that easy to see if a fuse has melt down, in most cases you only see the top side of the fuse when installed. The main advantage of this type of fuse is that they take less space and they create less "bad contact" issues. Use the special tool shown to remove the blade fuse.

Glass fuses

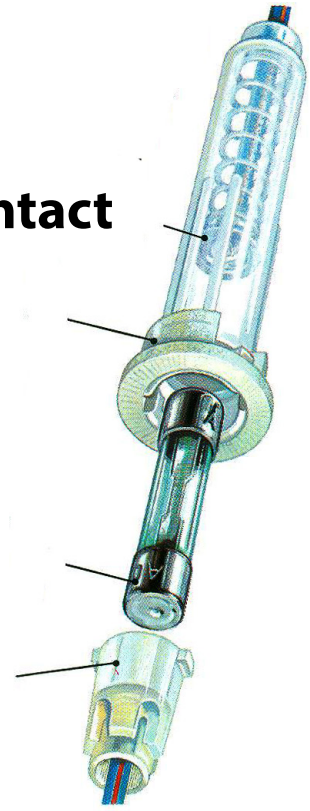
You won't find this type of fuses in your classic Volkswagen. We want to add this information anyway because this glass fuse is installed in some accessories such as a radio or most electronic equipment.

Glass fuses show the current level (amperes) but also how fast they will melt after experiencing an overcharge. Fast glass fuses are used to protect electronic equipment, slow glass fuses are used for power supplies for instance. Don't mix them up!

Sometimes you will read two values on a fuse, first the continuous current level the fuse will support (during a long period of time), for instance 20 A, and the short (peak) value it can support (e.g. 10 A). Peak currents can be generated by a power supply.

Line fuse

Sometimes you need to protect one electrical accessory, even though it is already protected by a fuse in the fuse box. You can achieve this using a line fuse connected to the power cable of the accessory. A ceramic fuse or glass fuse is placed in a line fuse holder as shown in the drawing on the right and in the picture below. One side has an electrical contact installed on a spring, the other side has a fixed electrical contact.

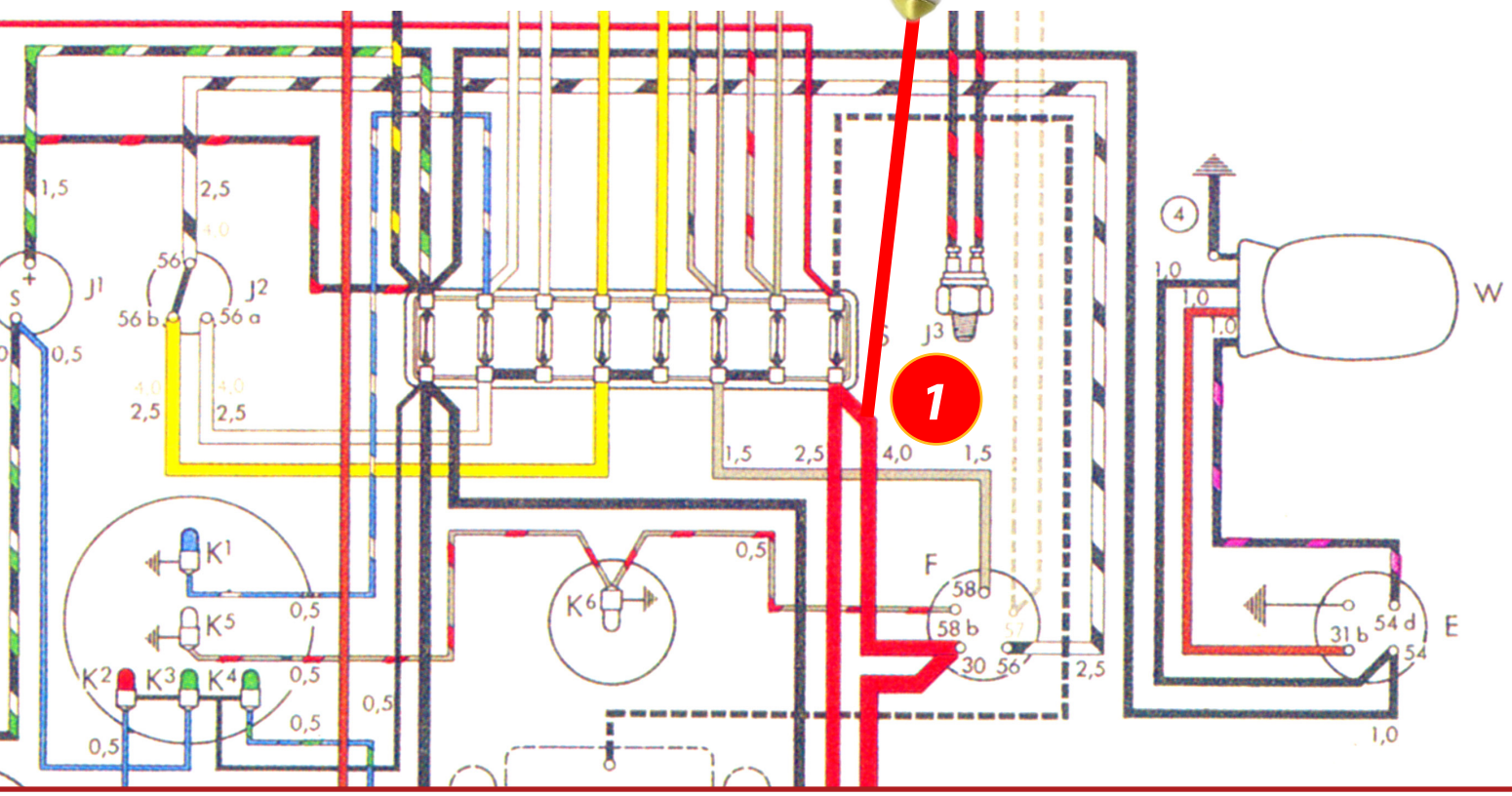


Both glass fuses and ceramic fuses are used in a line fuse holder, it depends of the application.

This type of fuse is ideal when you want to add an accessory such as a modern radio, but you don't want to modify the original fuse box in your Volkswagen. We show this type of application on the next page.

fuses

Below is an electrical circuit as already discussed in edition 02 of this technical series. If you want to add an accessory, in this case it is a fog light, you can't just add it to an existing circuit without risking overloading that circuit. The easiest way to add this type of high current accessory is to insert a line fuse. Connect the line fuse to the plus side of the battery, as long as you connect before any existing fuse in the fuse box you are fine (1 on the electrical circuit below). Connect the plus side of the fog light to the line fuse (2) and the mass of the fog light to the car mass. Now, what is the value of this extra fuse?



Value in amperes

The maximum continuous electrical current a fuse will have before it melts is written on the fuse holder as explained earlier. When you replace a fuse you need to replace it with exact the same type and the same value. I have experienced that many old cars don't have the correct fuses installed, for many reasons. The previous owner did an emergency repair, or didn't bother too much. Always check the original specifications for your type of car and replace the fuse with a correct type and value.

If the complete wiring has been replaced, you don't really know if the original fuses are still fine. You need to check the diameter of each circuit and match that with the correct fuse value. We discussed the relation between the electrical wire diameter and the maximum electrical current it can carry in edition 3 of this series.

The fuse value installed (measured in amperes) should always be **lower** than the maximum current the electrical circuit can bear. The diameter of the electrical wire defines how much current can flow through before it starts to heat up.

diameter (mm^2)	*maximum current (A)*
0,5	8
0,75	9
1	11
1,5	14
2,5	20
4	25
6	31
25	100

We already covered some of the basic topics concerning the electrical circuit of the classic Volkswagen, below is an overview of these articles:

edition 01: battery diagnose
edition 02: basic circuit
edition 03: 6 volts or 12 volts

Fuse melt down

When will a fuse melt down?

1. Old fuses

The fuse can be so old and so corroded that it no longer can take the maximum current mentioned on the fuse holder. This can be the case for many ceramic fuses, just replace all fuses if you doubt about the quality of the installed fuses, also replace the fuse box if needed.

2. Short-circuit

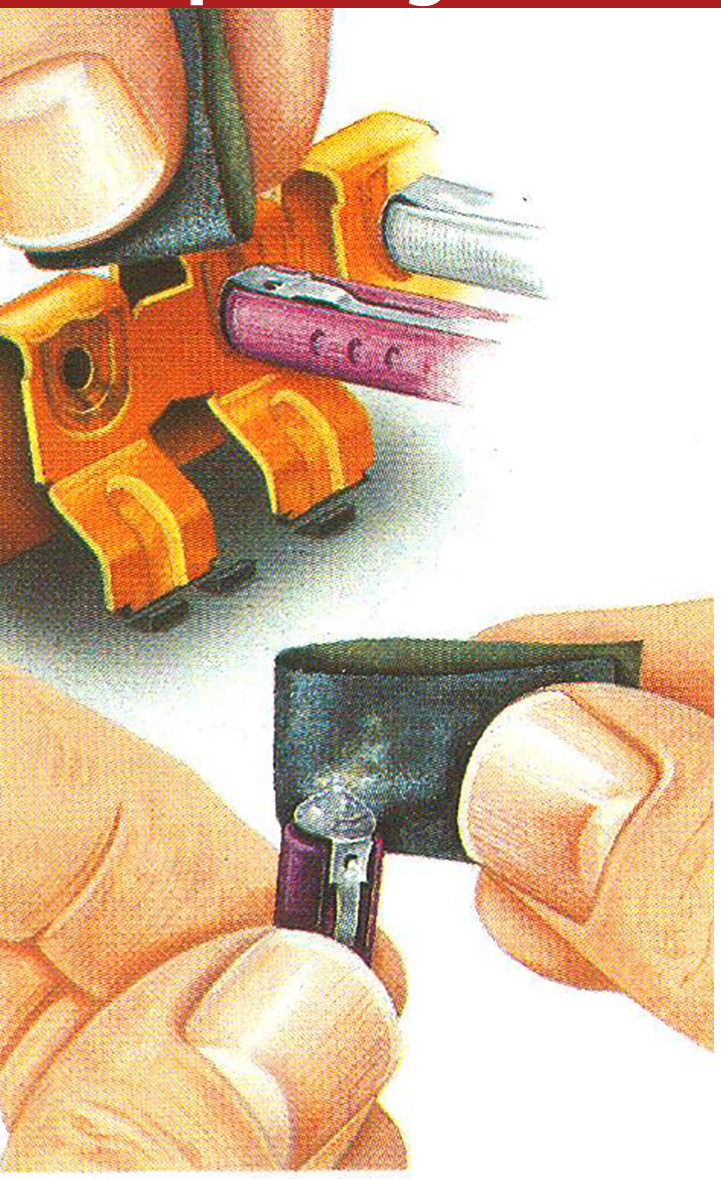
If a peak current has occurred, even just for a short period of time, a fuse can melt without anything being faulty in the electrical circuit. This can happen when a light bulb breaks, a short-circuit happens for a very short time, this can cause a fuse to react. Replacing the faulty light bulb and the fuse is the only action to take.

3. Fault

A problem may occur in one of the electrical accessories, a short-circuit or a faulty electrical component. The best way to solve this problem is to remove all components in the faulty circuit, and add them back one by one. When the fuse is melting, you know exactly which component generated that problem.

Never replace a fuse with an electrical wire, it seems obvious but believe me I've seen that so many times. The consequences can be disastrous. Best case scenario, all electrical circuits work fine and you never need a fuse in your car, worst case you have a faulty wire that causes a short-circuit and the complete wiring of your car acts as a fuse, and your car disappears in flames.

Replacing a fuse



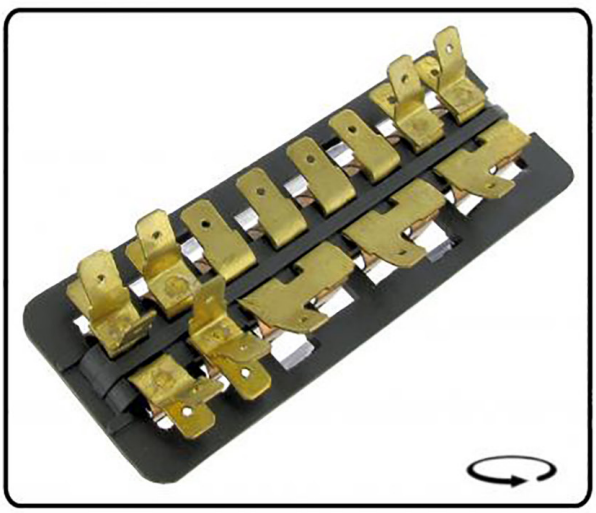
If after replacing a faulty fuse the electrical components attached to that circuit still don't work, make sure the contacts of the fuse box and the contacts of the fuses are clean from corrosion. Also make sure the clips of the fuse box are secured and clean and that they still have enough resilience.

If the replaced fuse still melts you need to check the wiring of that circuit and all electrical components attached to that circuit. Maybe you have too many accessories attached to that circuit, you have added a radio amplifier or additional fog lights in the front. You need to review your fuse box to match the new setting when adding extra electrical consumers.

Fuse box

The fuses are installed in a fuse box protected by a fuse box cover. This fuse box is installed in a different place depending on the type and model of your Volkswagen. The fuse box on the VW 1302 and earlier models are installed under the front hood, close to the back of the dashboard. It is possible that you need to remove the cardboard protection to be able to see the fuse box. The fuse box is located under the dashboard in most other models, close to the steering column. Check the original documentation of your Volkswagen to find out where your fuse box is installed.

The fuse box always has a fuse box cover in our classic Volkswagens. This cover protects the fuses against moisture and short-circuits. You will find numbers or symbols on this fuse box cover that explains which circuit each fuse is protecting. Your original Volkswagen owner manuals explains what these numbers or symbols mean. Don't hesitate to replace your fuse box including all fuses if you think corrosion has affected the fuse box or fuses. Replace with new parts, we have them all available in our webstore.



Measuring

You can measure with an ohmmeter (resistance meter) if a fuse is still usable or not, if it has already melt or not. Make sure you read the manual of your ohmmeter or multimeter before you start measuring.

Remove the fuse!

Never measure the fuse while it is inserted in the fuse box. First, this will result in a faulty measurement because you are measuring the electrical resistance of the complete circuit, but worse, you could damage your ohmmeter.

The ohmmeter needs to be connected in parallel to the fuse, as shown on the picture on the left. Connect the ohmmeter plus clamp and minus clamp to the fuse, it doesn't matter which one goes where. Don't touch the meter clamps nor the fuse metal strip with your hands, this could influence the result.

The ohmmeter should be set to a low ohm value.

Fuse is fine

If the fuse is fine, the ohm value should read close to zero, some multimeters have a special features that beeps when a zero ohm value is measured. If the value is zero, the electrical conduction is perfect, this means the metal strip didn't melt and your fuse is ready to go.

Fuse is bad

If you read ERROR, or some kind of symbol to show that there is no electrical conduction, the resistance is close to endless, the fuse is not usable anymore. Our ohmmeter shows the value "1", which means no conduction. Make sure that the meter is connected correctly, and try again just to make sure.

#14 Electrical

Not fused

Some electrical consumers in our classic Volkswagens are not protected by a fuse. There is no protection against electrical short-cuts or failure of electrical components. You need to be very careful when you work on these components! You'll find a list below of some of the electrical consumers in our VW that has no fuse.

The headlight switch (1 on the drawing on page 33) is the most critical one. You could get into big troubles when the dimmer switch (installed on deluxe models) fails. The circuit that connects the generator (2) (dynamo or alternator) to the battery including the battery load bulb in the dashboard (3), the starter engine (4), the ignition (5), the automatic choke, the electromagnetic idle jet and the oil pressure warning bulb (6), the turn signals, the bulbs for the odometer and fuel gauge.

How many amperes

How do you calculate the fuse value? The value depends on the voltage your car is using, 6 V or 12 V, and the total power of all consumers in the circuit you are calculating. We have explained the formula to calculate the electrical power in edition 03, the formula sounds like:

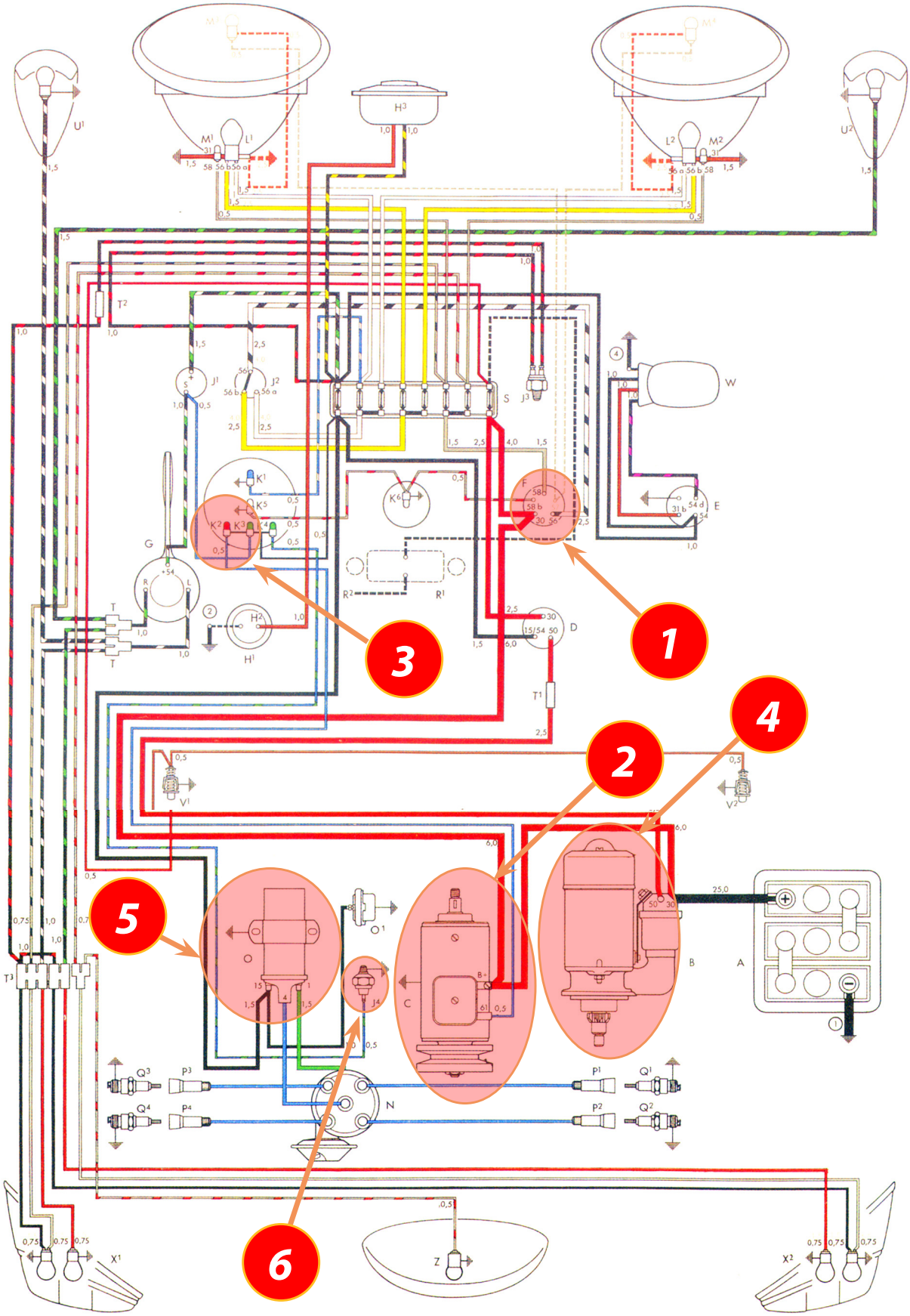
Power: P = U x I

P is the electrical power in watt (W), U is the electrical tension in volt (V) (e.g. 6 volts or 12 volts) and I is the electrical current in ampere (A). If you connect for example a light bulb of 12 watt to a 12 volts or 6 volts battery, you will need a fuse that melts at a higher value than:

P / U = I or
12 W / 12 V = **1 A**
12 W / 6 V = **2 A**

You need to make sure that the wires can support this current.

fuses



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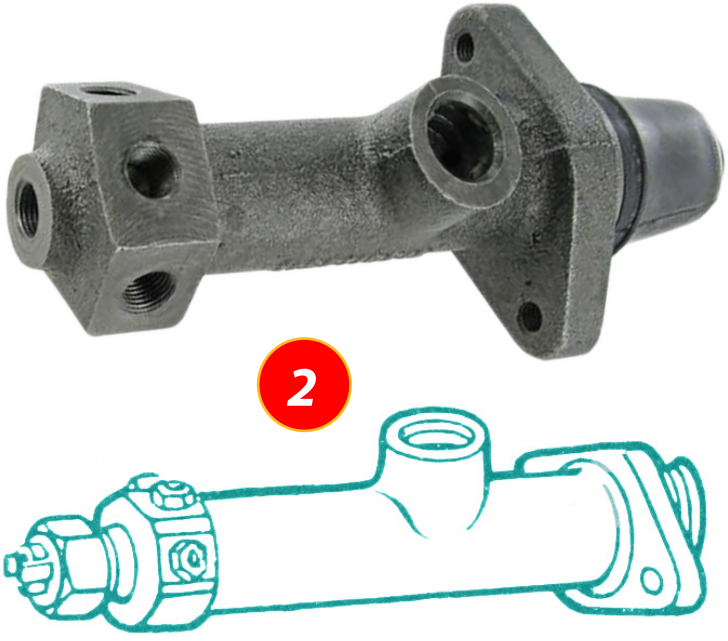
Hydraulic basics

The first Volkswagen that was introduced in the late 1940's had brake drums installed on the front wheels and the rear wheels. The first VW Beetle had a 25 hp air-cooled engine and weighted about 700 kg. It ran on small diagonal tires and had cable operated brakes. The VW developed and gained power, the VW Beetle was able to drive faster than 100 km/h, people requested more comfort and security.

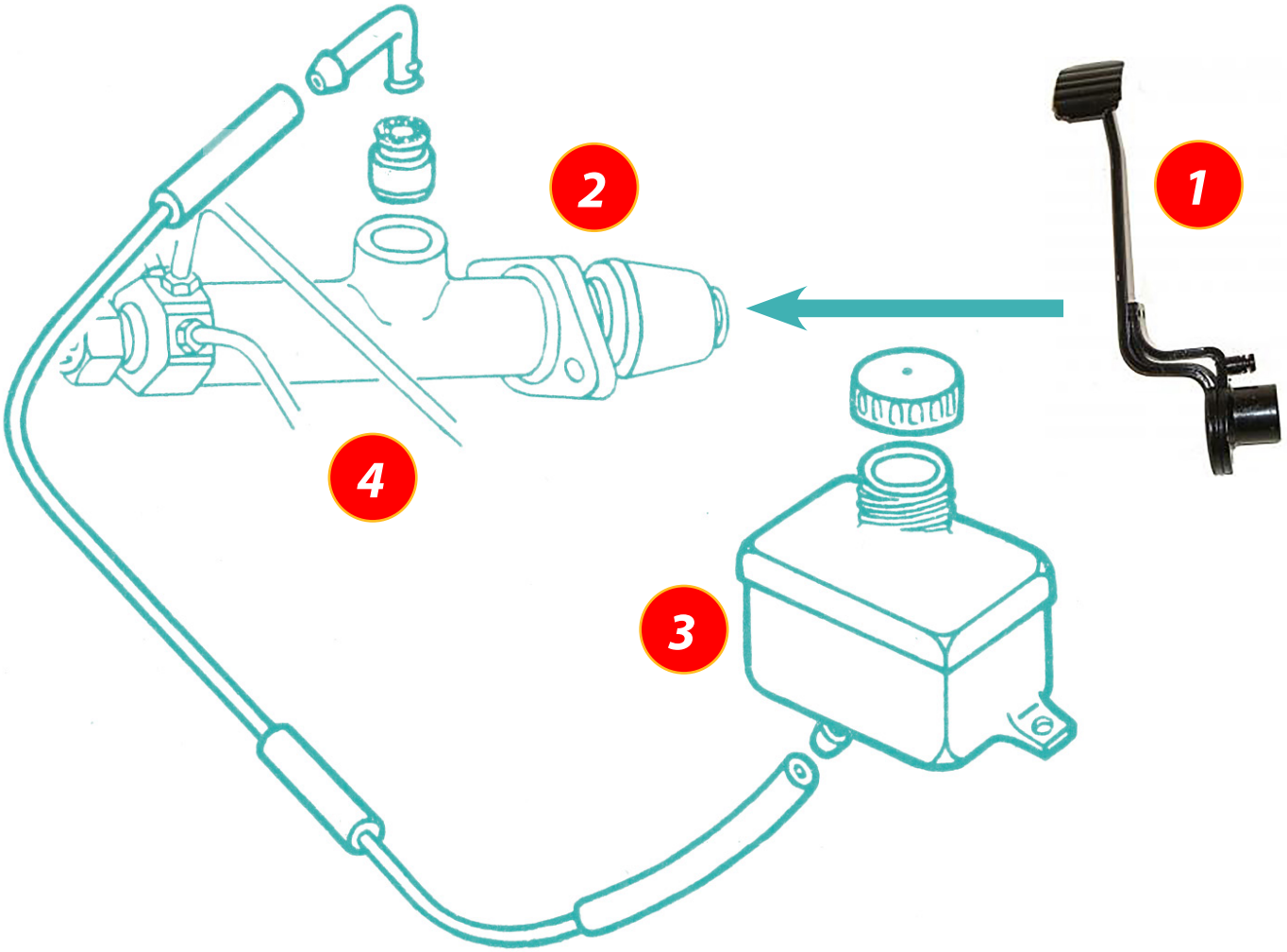
An hydraulic brake system was the next thing to add to the air-cooled Volkswagen, most family cars from the fifties had hydraulic brakes installed. The brakes were still brake drums on all 4 wheels. Disc brakes were introduced on the type 3 Fastback in 1965, on the front wheels only, a first for Volkswagen, other models such as the VW 1302 and the VW 411 followed in the late sixties early seventies.

The most basic set-up for an hydraulic brake system is the one we show on the drawing in the next page, this is a single-line hydraulic brake system. Look out, every VW will have a different set-up of course, we show a standard 1970 Volkswagen Beetle here.

The brake pedal (1) operates the master brake cylinder (2) via a stud. The master brake cylinder is an hydraulic component, filled with brake fluid. The brake fluid reservoir (3) adds brake fluid to the brake circuit when needed.

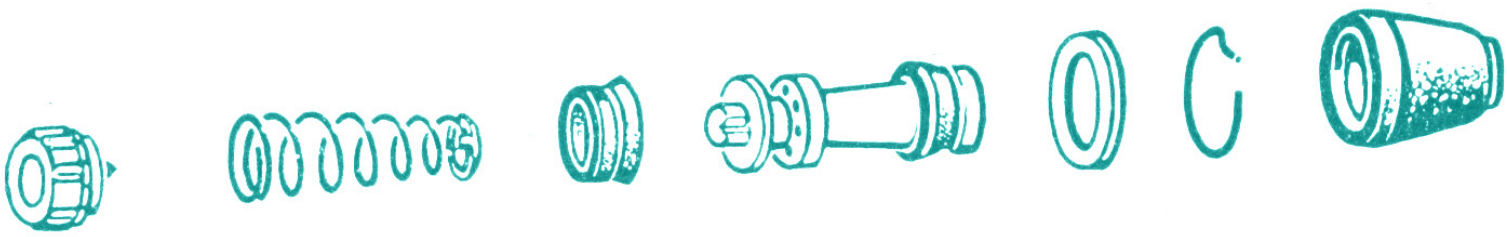


hydraulic brakes



1.brake pedal
2.master brake cylinder
3.brake fluid reservoir
4.brake lines

We show the parts of a master cylinder in the drawing below. Master brake cylinders could be repaired in the good old days, today, it is not possible to purchase an overhaul kit, the good news is that all master cylinders for all classic Volkswagens are still available in our webstore



Single- and double-line brake system

Hydraulic braking systems exist in both single-line and double-line. Below you see an hydraulic double-line braking system. The master brake cylinder (1) serves two separated brake lines, both brake lines get their brake fluid from a separate chamber in the master brake cylinder.
Both master brake cylinder chambers are fed by one brake fluid reservoir (2).

1.master brake cylinder
2.brake system reservoir

hydraulic brakes

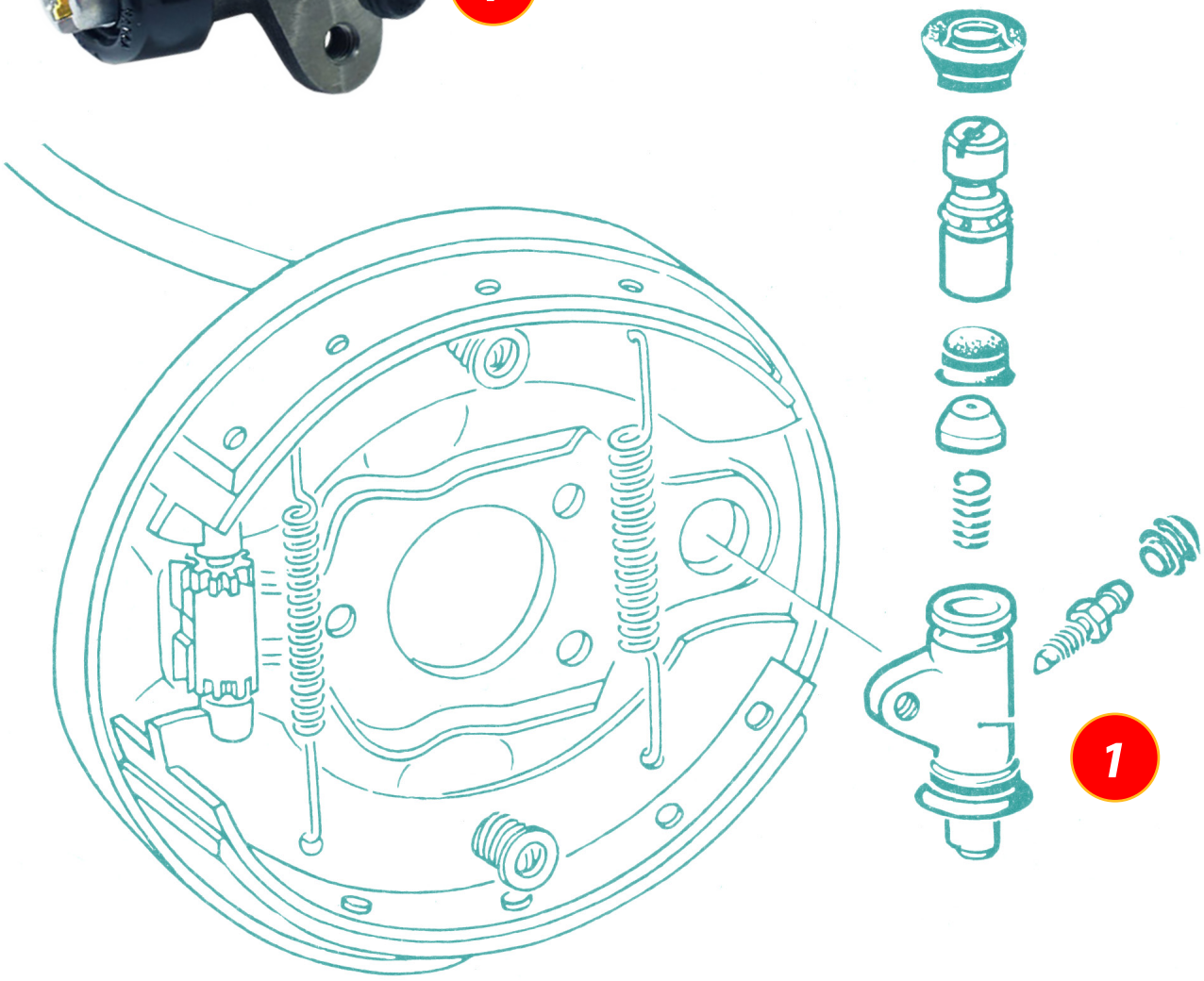
What is the advantage of a double-line braking system? Imagine there is a leak in one brake line or in one of the brake cylinders, in a single-line braking system. This could have disastrous consequences, your only backup is the handbrake system that uses a metal cable to operate the handbrake on the rear wheels. A double-line braking system operates the front brakes and rear brakes independently from one another. The master brake cylinder has two brake fluid chambers operating two separate brake line systems. If one fails you still have approximately half of your braking power available. The double-line braking system is much more reliable! The brake fluid reservoir also needs to have two lines, to feed both chambers of the master brake cylinder. Volkswagen installed different reservoirs during the many years of production of our classic cars. The early ones are made of metal, the younger reservoirs are plastic ones. On your right are some examples:

A. *Beetle and Ghia until 1960*
B. *Beetle, Ghia, Bus until 1966 and Kübel/Thing (master cylinder and reservoir combo)*
C. *Beetle from 8/1966 until 7/1967*

Wheel brake cylinders

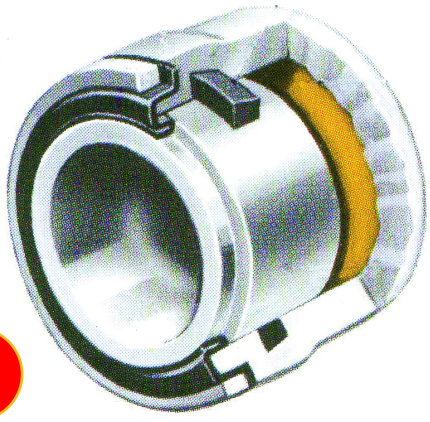
When you push the brake pedal, it will generate a pressure in the master brake cylinder, this pressure will continue through the brake lines to the wheel cylinders.

The wheel cylinders will open and operate the brakes on all wheels. Wheel brake cylinders for drum brakes (1) or disc brakes (2) are built differently. We show a brake drum with wheel brake cylinder below.



hydraulic brakes

On this page, a disc brake with brake caliper and a wheel brake cylinder. As you can see, the construction of the wheel cylinder is very different from the one on a brake drum. We have an article ready about brake drums and disc brakes for a later edition of this series.



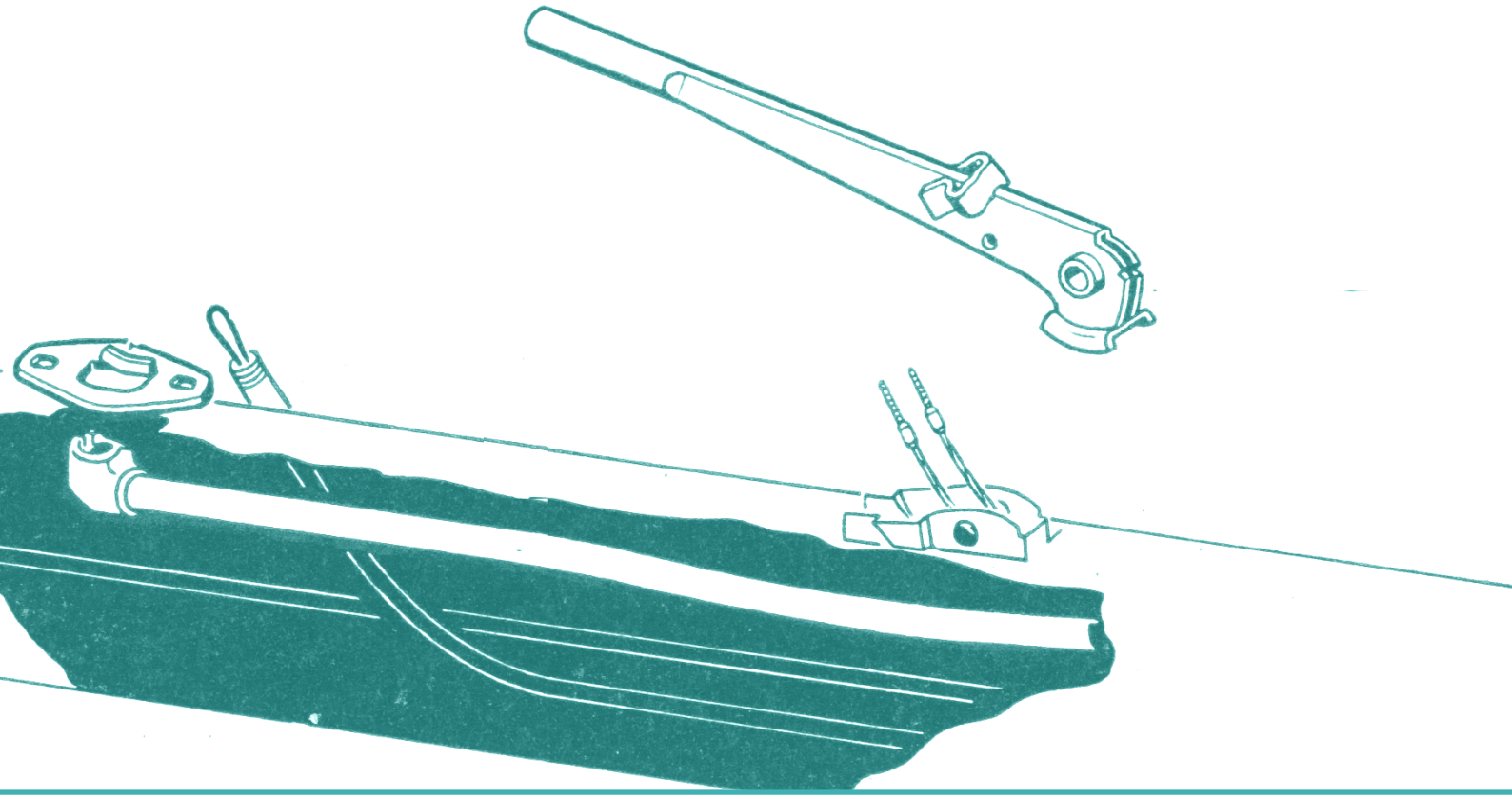
1.wheel cylinders - brake drums
2.wheel cylinders - disc brakes

The handbrake

Don't think brake cables are not in use anymore on modern cars. Cable operated brakes have been installed on all classic Volkswagens, the Vanagon T25/T3 Bus in1992 still has a mechanical operated handbrake.

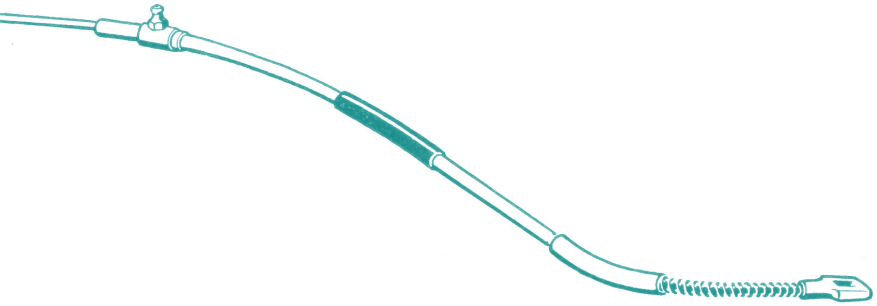
We show the components used to operate a handbrake system on a classic Volkswagen. In the top right of the next page, we show the handbrake cable of a Vanagon T25/T3.

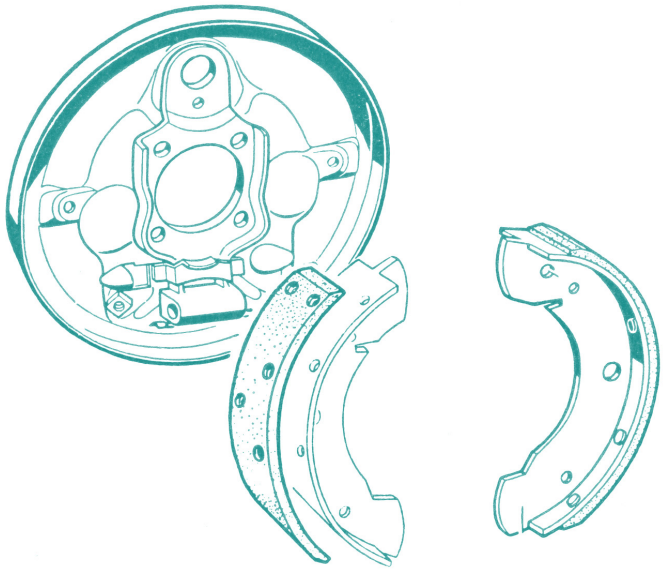
An hydraulic brake system has many advantage compared to a brake system operated with cables. An hydraulic brake system generates less noise, it is more flexible and self-lubricating, the braking power is also evenly divided between the wheels.



hydraulic brakes

The car shouldn't pull to one side as it usually does with a cable operated brake system. If it does pull to one side with an hydraulic system, there should be a clogged brake line, a brake fluid leakage, a broken wheel cylinder or a dirty brake pad.





Don't confuse the concept of an hydraulic brake system with a power brake system (servo-brakes). Servo-brakes are installed on the younger classic Volkswagen generation, they have a different purposes than an hydraulic brake system. A servo-brake makes it possible to generate more brake power with less force on the brake pedal.

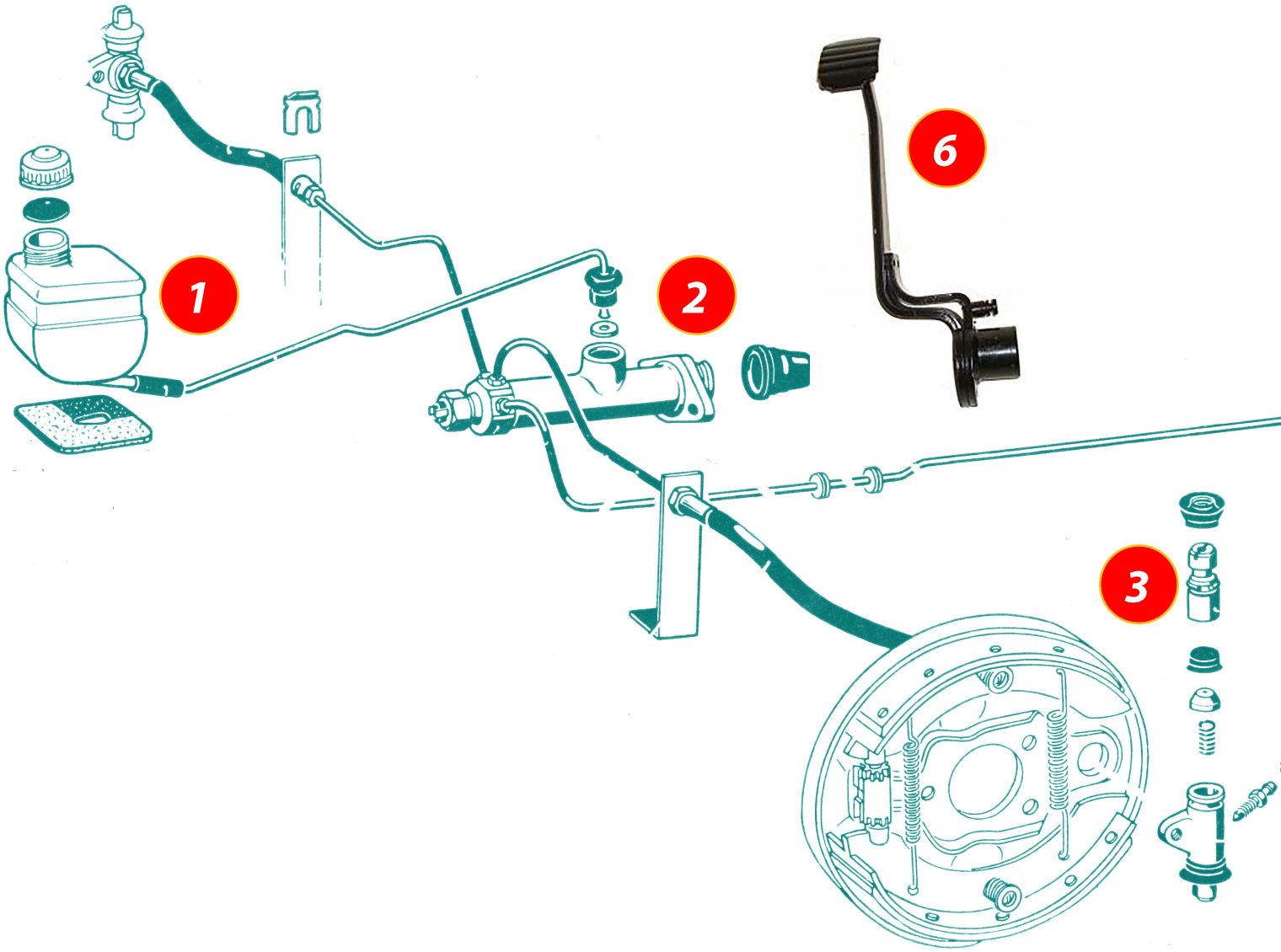
The most basic servo-brake system uses the vacuum from the intake manifold. Some other systems have a separate vacuum pump.

VW Beetle 1963

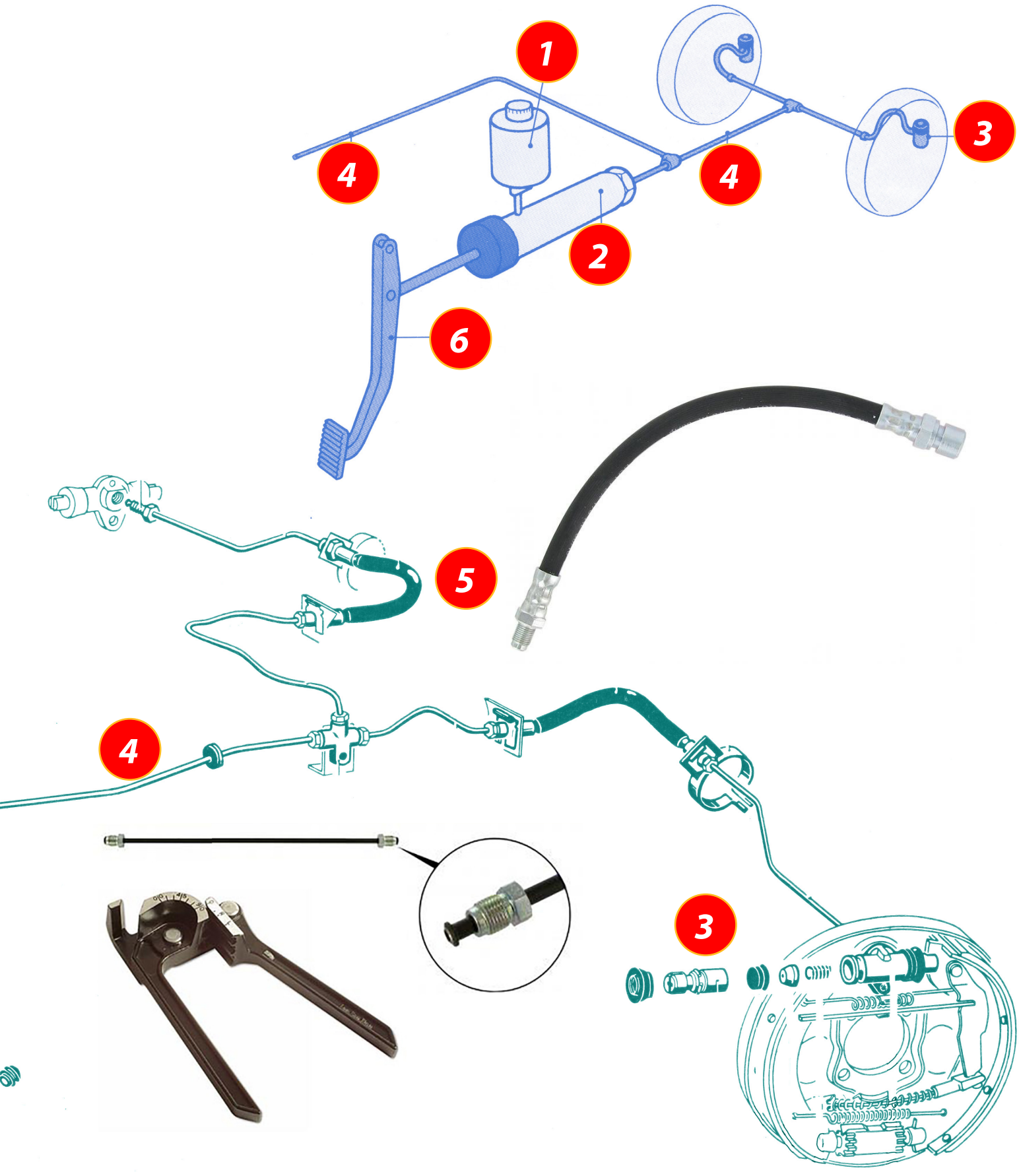
Below an example of a 1963 Volkswagen Beetle with a single hydraulic brake system.

On the next page in the top right a conceptual drawing we found in an old school manual.

1.brake fluid reservoir
2.master brake cylinder
3.wheel brake cylinder
4.brake lines
5.brake hoses
6.brake pedal



hydraulic brakes



Brake fluid reservoir

The master brake cylinder is connected with the brake fluid reservoir when the brake pedal is in rest position. Brake fluid can then flow to the master brake cylinder from the reservoir. This is how small amounts of brake fluid are added to the brake system to compensate for the changes in brake fluid volume due to temperature changes.

To avoid a vacuum in that brake fluid reservoir, a small opening is built into the reservoir cap. So, make sure that opening is free so that the brake system works fine.

You will find many different types of brake fluid reservoirs in our webstore. Check out which one will fit your classic Volkswagen on.

hydraulic brakes

You need to check the level of the brake fluid on a regular basis. There are 4 different types of brake fluids available, called DOT numbers (Department of Transport). The higher this number the higher the boiling temperature of this brake fluid.

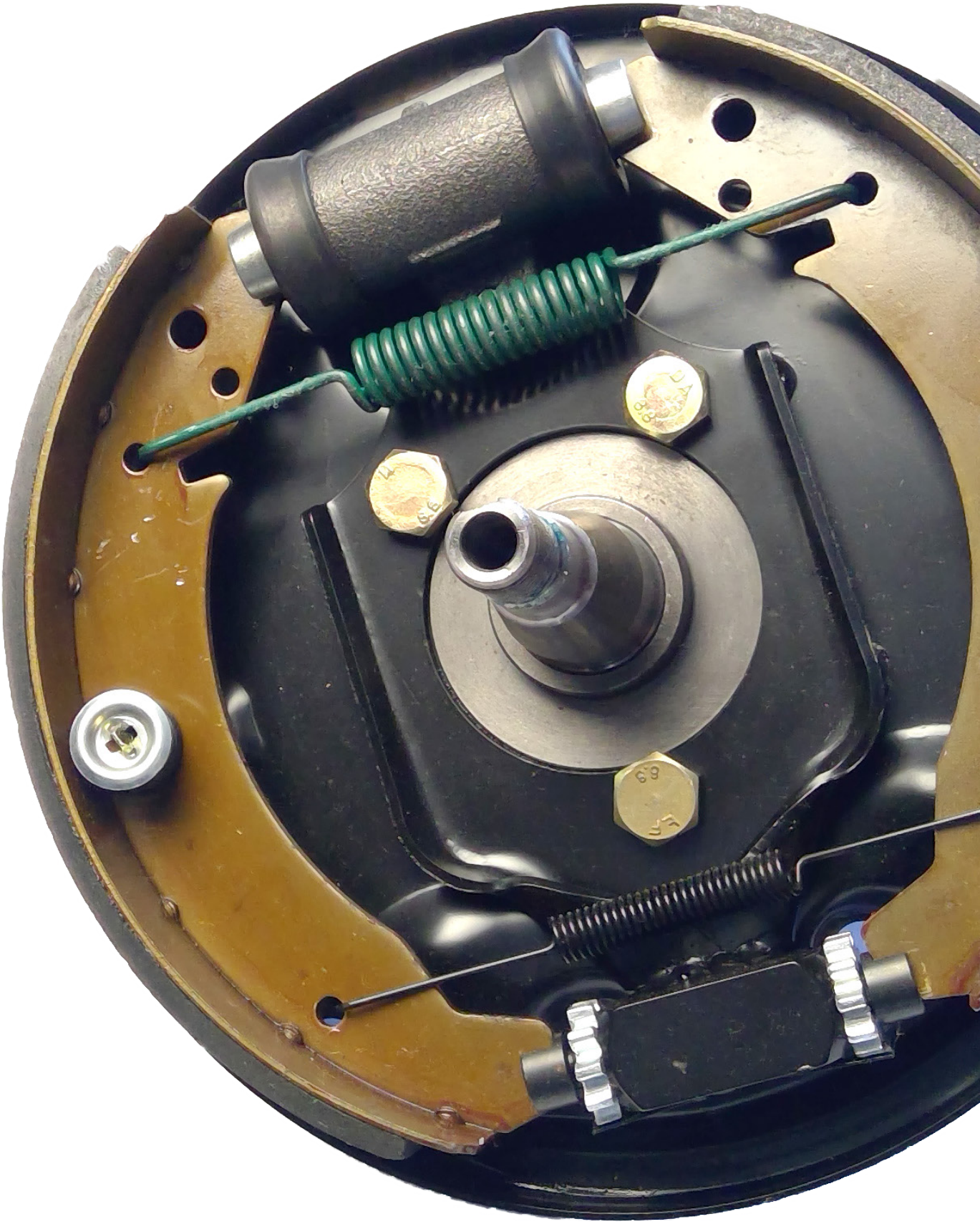
The more you will charge your hydraulic brake system, the higher the boiling point of your brake fluid should be. Heavy cars such as the T25/T3 and high-performance cars preferably have DOT 4 in the brake fluid reservoir. A standard Volkswagen Beetle with a 1600 cc engine is quite happy with DOT 3.

We don't advise to mix DOT 3 and DOT 4, but it is possible to add some higher number brake fluid to a lower number brake fluid, in case of emergency.

The hydraulic fluid used for the brake system is a synthetic liquid that keeps its properties even at high temperatures, it is harmless for rubber components such as brake hoses. Brake fluid will absorb moisture after some time. When the brake fluid contains about 2 to 3 % of water, its boiling temperature will drop to 140°C (for DOT 3). The water molecules will boil at this temperature, water changes into gas, which creates the spongy feeling when you push the brake pedal. This is the main reason why you need to change your brake fluid on a regular basis. Change the brake fluid at least every 2 years.

Warning! brake fluid is very aggressive for painted metal parts, if you spoil some clean it away as fast as possible wit lots of water.

#15 Brakes



Do you want to get to work practically? In edition 22 we will replace the drum brakes. In edition 12 we will explain how drum brakes work. These magazines are also available in digital format at www.paruzzi.com/magazine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