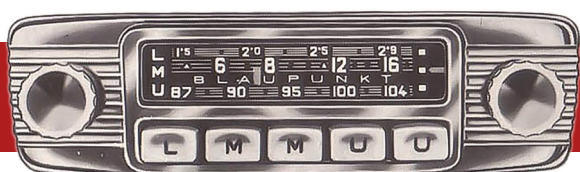




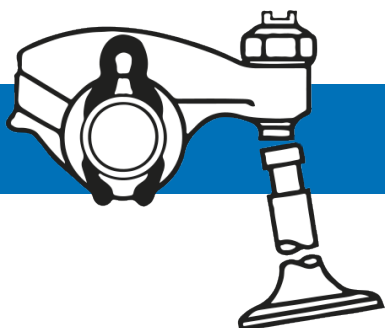
#10- Carburetor: HPMX carburetors

page 02



#11- Electrical: radio interference

page 24



#12- Engine: what is valve clearance?

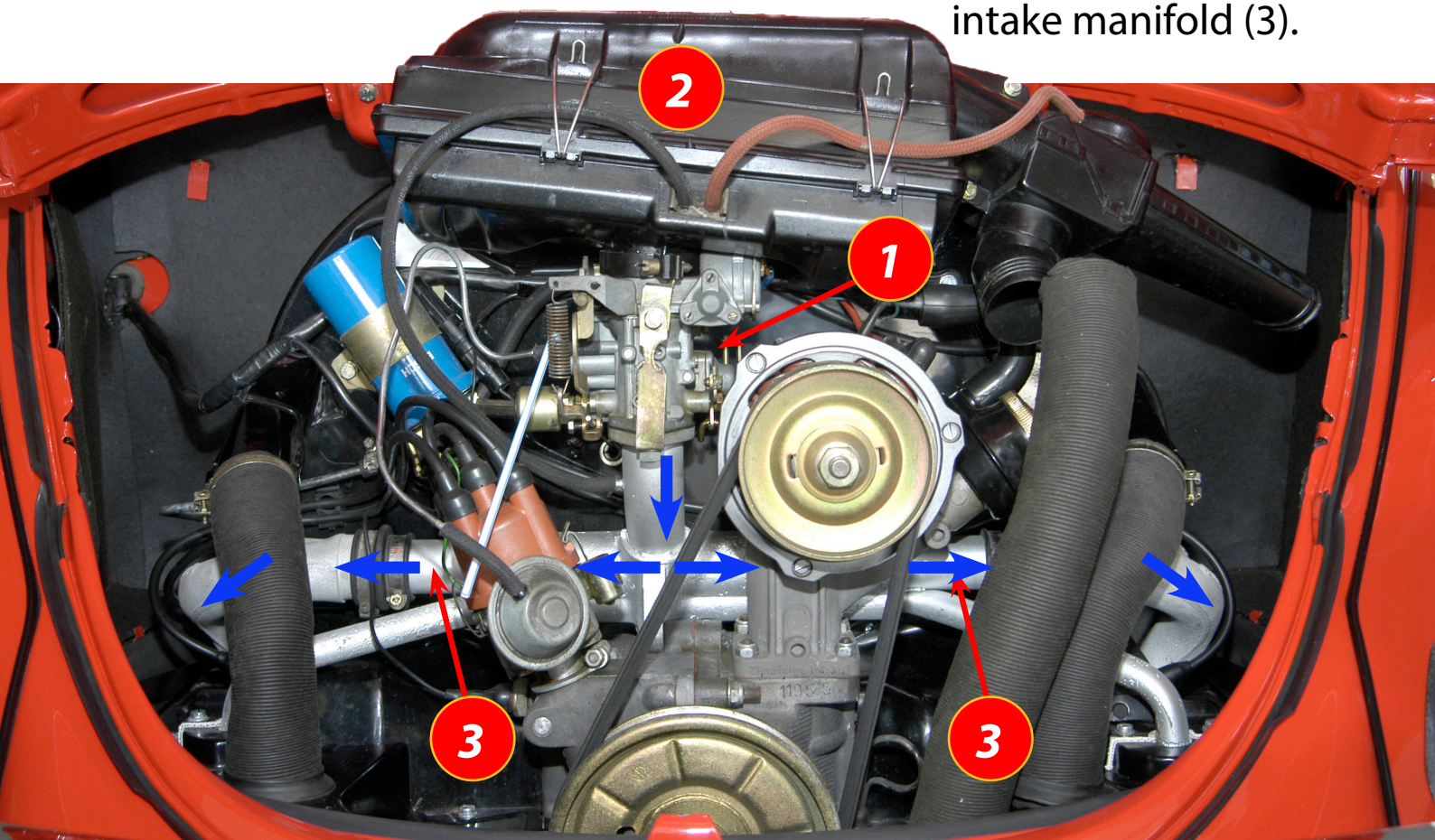
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Single carburetor

The original type 1 air-cooled engine with single carburetor is a very simple construction, it was a deliberate choice from Volkswagen to make it as simple as possible. The engine on the VW Beetle needed to be reliable, affordable, inexpensive to manufacture and easy to maintain. The biggest bottleneck on the type 1 engine is probably the centrally mounted single

carburetor, it limits the amount of power and torque the boxer engine can produce. This setup was ideal to create a reliable engine (less maintenance and easy to tune), but at the same time it created some technical issues that needed to be solved by the VW engineers. We show below the typical setup of a type 1 engine with central mounted carburetor (1), air cleaner (2) and intake manifold (3).



HPMX carburetors

Many alternative solutions to the central mounted single carburetor are available to improve the performance of the type 1 engine, such as:

- ***bigger single carburetors***
- ***progressive carburetors***
- ***two single carburetors***
- ***one central double carburetor***

But the most popular solution and the most efficient is the installation of two double carburetors installed on each side of the engine such as the dual EMPI HPMX series. This solution offers four carburetors, one carburetor per cylinder. The main advantage of this dual carburetor set is that every cylinder receives the same amount of fuel mixture at the same time. Another advantage is that the fuel mixture flow doesn't have to change direction to often compare with the original Volkswagen central

single carburetor, resulting in a much better combustion. As you see in the picture on the left page, the fuel mixture on the original carburetor has to follow the T-shaped inlet manifold to transport the mixture from the carburetor to the cylinders

(refer to the [blue arrows](#) on the picture on the left page), and then another 90° turn to get to the cylinder 3 and 4 on the left of the engine and cylinder 1 and 2 on the right of the engine. These many turns will influence the fuel mixture flow in and deteriorate the performance of the engine. The original setup also need an additional preheating system (refer to [article 08 in edition 03](#)). Dual carburetors are ideal for tuned engines. A disadvantage of dual carburetors is the fine-tuning that can be time consuming.

Dual carburetors

The most popular dual carburetors are the Weber IDF and the Dellorto DRLA series. A new player came onto the VW scene a few years ago with a brand new HPMX carburetor set. This HPMX dual carburetor is manufactured by EMPI and sold as a complete set including inlet manifolds, air cleaners, cross bar linkage and mounting hardware. This HPMX set is a good

alternative to the original Weber IDF for the VW enthusiast that want a good quality dual carburetor but at a reasonable price. Another advantage is that the EMPI set is really complete, maybe you want to change the size of the jets to fine-tune your



HPMX carburetors

engine, but this is not a must. Below we show an [EMPI HPMX 40 mm](#) carburetor set designed for the double port type 1 engine. This HPMX set also exists for the type 3 engine and the type 4 engine.

We will share our experience now to add some practical information to the standard manual delivered with the EMPI HPMX carburetor set. We hope this additional information will help you to enjoy your new HPMX dual carburetor set even more.



Dual carburetors

We have unpacked the HPMX carburetor set, we take some time to read to original manual from EMPI and start the installation..

1. It is much easier to install the carburetors when the engine is removed from your Volkswagen. The tuning is much easier when the engine is right in front of you on an engine stand or a workshop table. The carburetor set including the inlet manifolds will have to be removed to install the engine on a VW Beetle.

2. The HPMX set doesn't fit in combination with the original Volkswagen fan shroud because the carburetor will get stuck against the fan shroud due to the shape of the inlet manifolds.

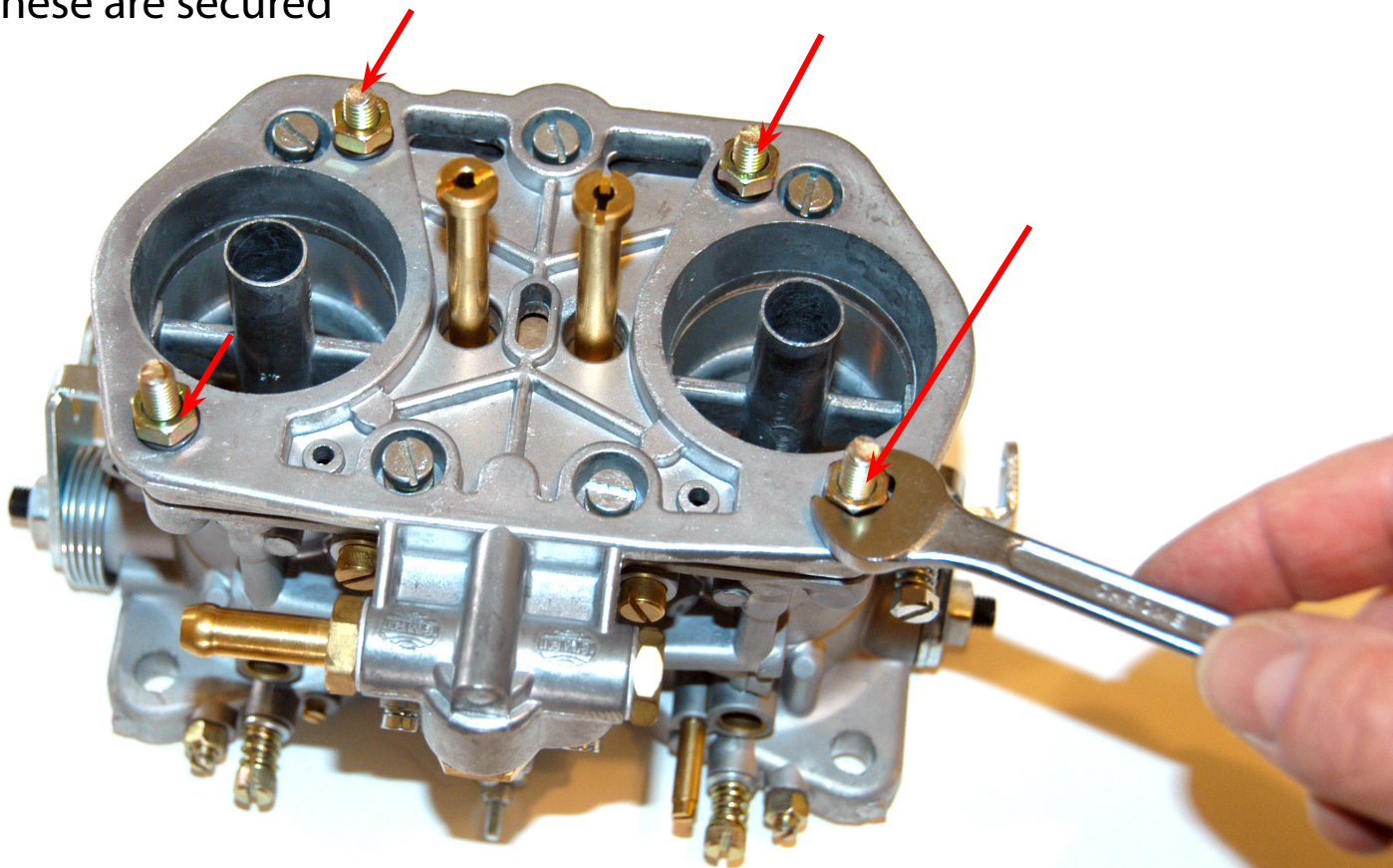
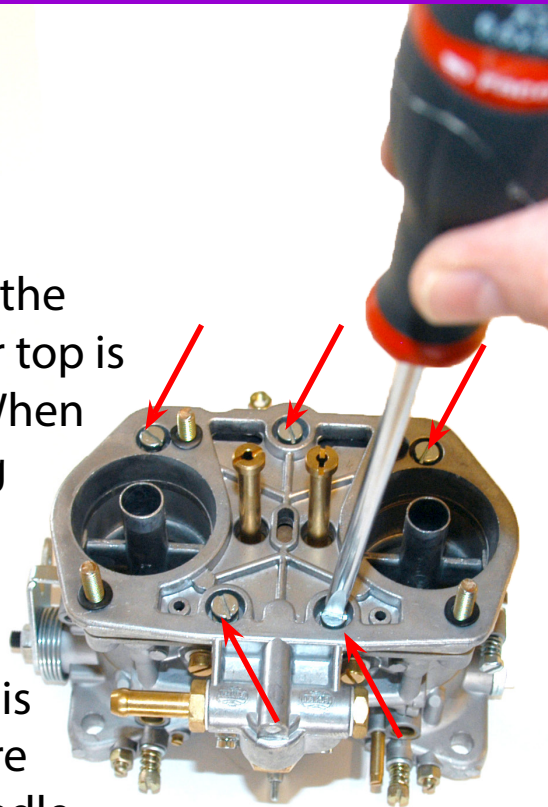
You could adapt the original fan shroud but it is much easier to install a new one that fits in combination with the HPMX set, the 30 hp type 1 fan shroud is the perfect candidate. This type of fan shroud frees up some space around the inlet manifold, just the space you needed to install your dual carburetor set. The 30 hp type 1 engine fan shroud is available in our webstore.



HPMX carburetors

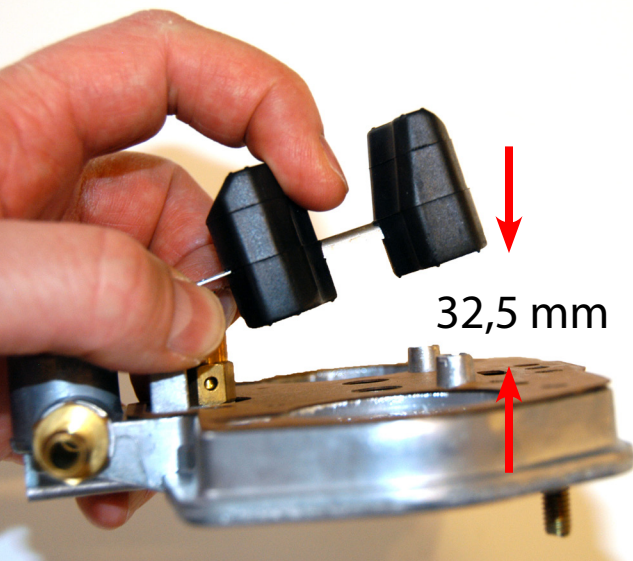
3. The carburetors are ready to go, as described by the manufacturer manual. We advise to check the float level before installing the HPMX set. Remove the carburetor top (remove 4 nuts each 10 mm and 5 bolts) and measure the float distance as described in the manual or on the next page. Watch out that the float and needle valve don't fall, these are secured

only once the carburetor top is in place. When measuring the float level, it is important that there is no pressure on the needle valve!

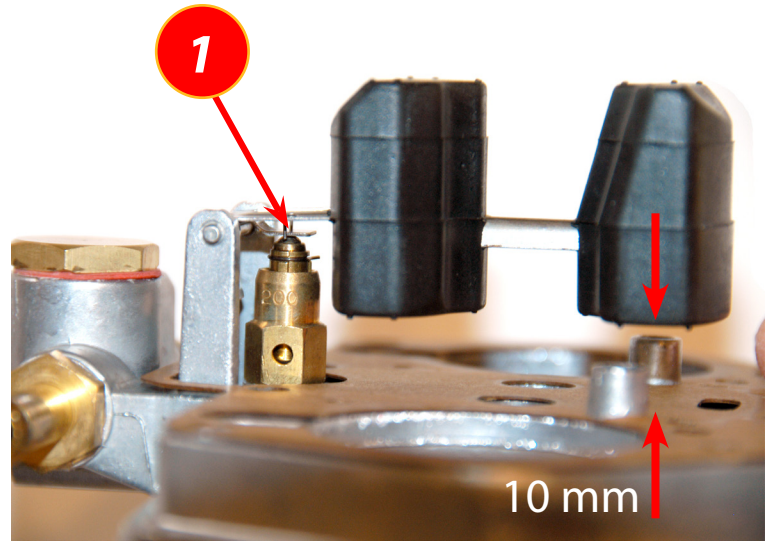


#10

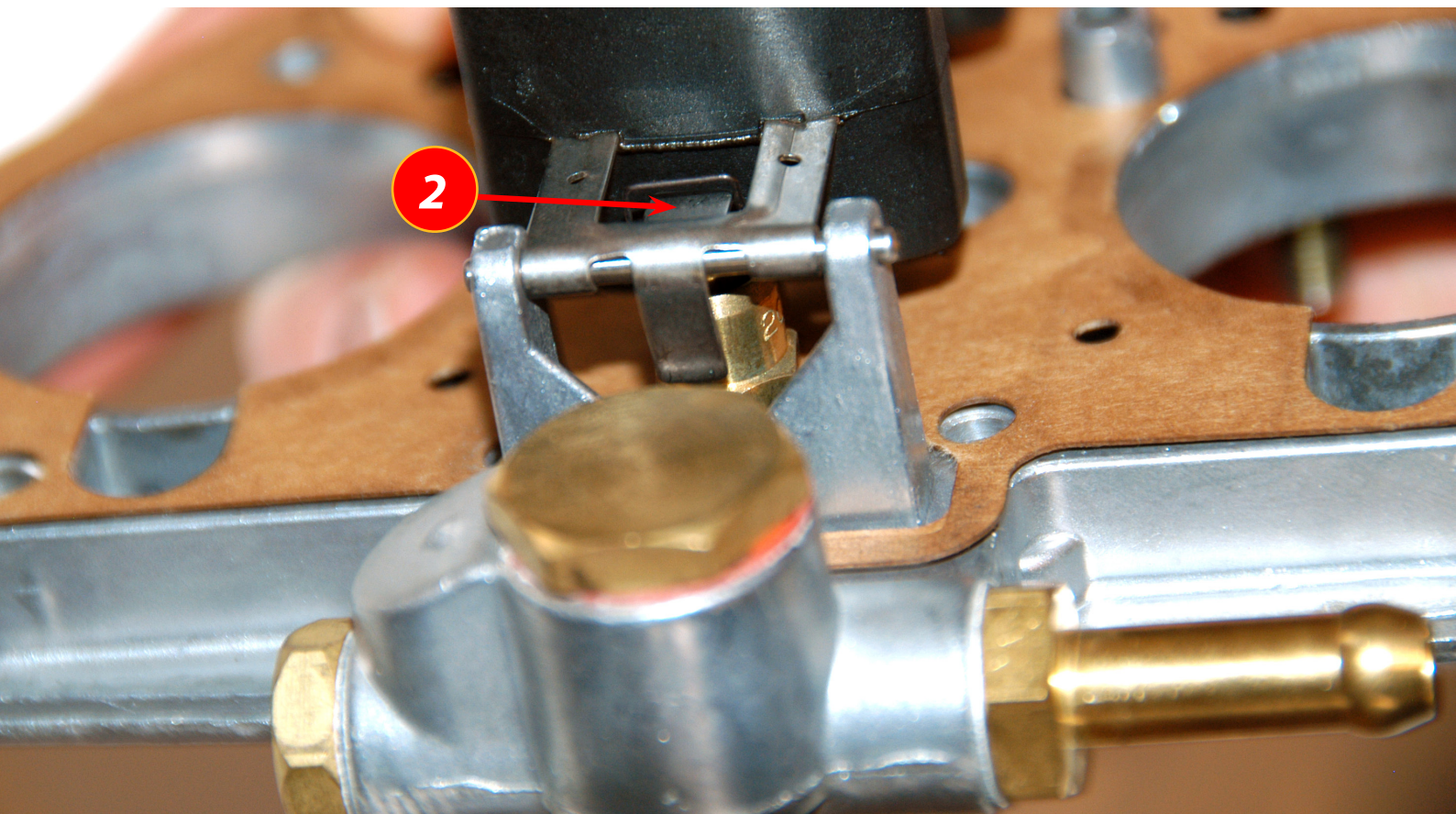
Carburetor



The distance of the float to the top of the carburetor should be 10 mm, without putting pressure on the needle valve (1). You will need to do this for both dual carburetors of course.



When the float is completely open you should have a distance of about 32,5 mm as shown in the picture above. You may change the float level by bending the metal support (2) gently, as shown in the picture below.

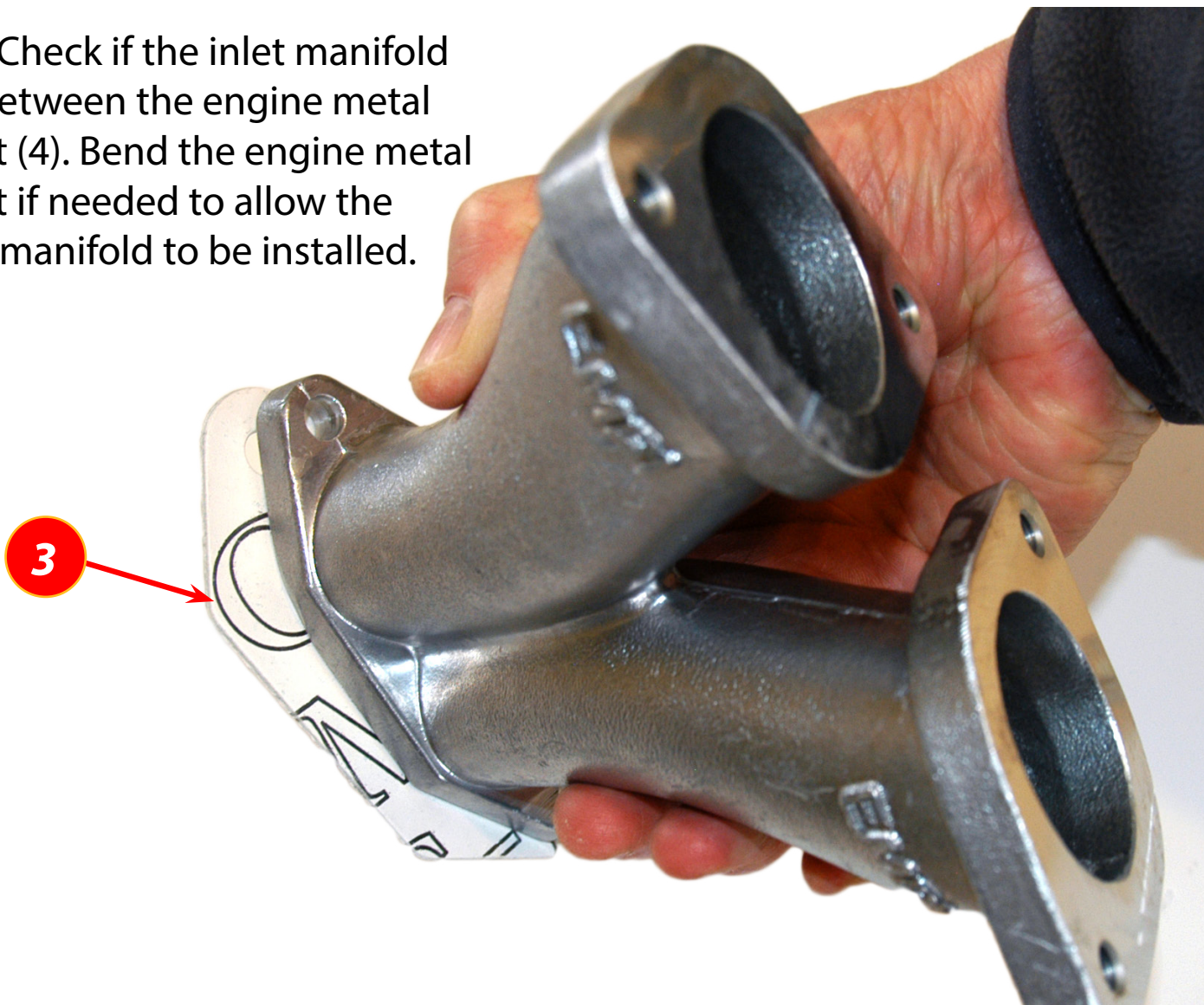


HPMX carburetors

4. The gasket between the cylinder head and the inlet manifold needs to be adapted to fit (3). Place the gasket carefully onto the inlet manifold, make sure it is centered properly, and cut to fit. The gasket delivered in the set is a little too big to fit the original engine metal sheet.



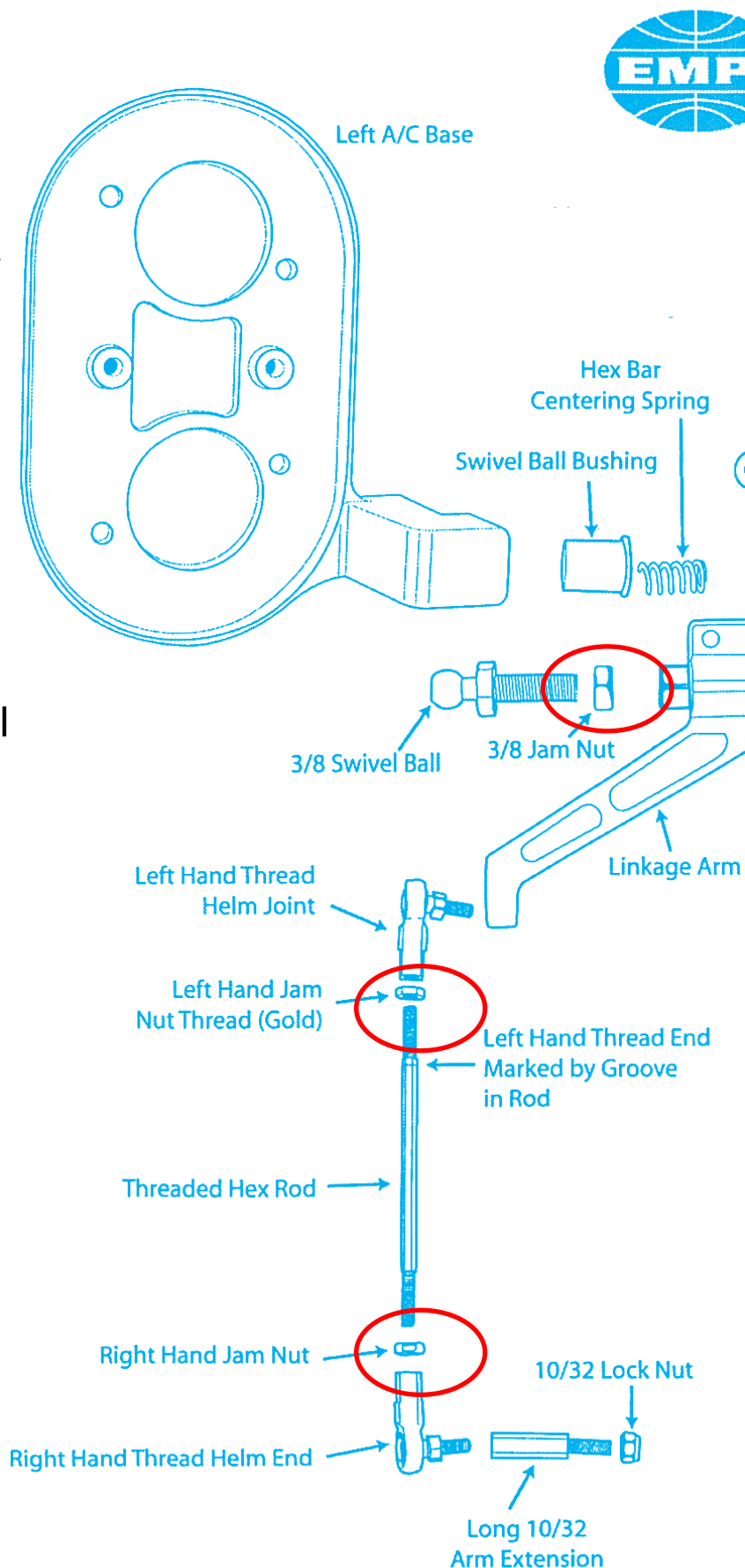
5. Check if the inlet manifold fits between the engine metal sheet (4). Bend the engine metal sheet if needed to allow the inlet manifold to be installed.



6. Install the inlet manifold, the carburetors, the air cleaners, the cross bar linkage just as the original manual shows. We show the technical drawing here on the right to help you with the installation. The explanation that follows is typically for the type 1 engine EMPI Dual HPMX carburetor set, you may adjust if you have a type 3 or type 4 set.

There is a chance that the central aluminum hex bar needs to be shorten, not all engines have the same width between both cylinder heads. EMPI couldn't deliver one length fits all so they decided to include an hex bar that is a little too long for some engines. There is enough thread in the hex bar to shorten about 2.5 cm on both sides.

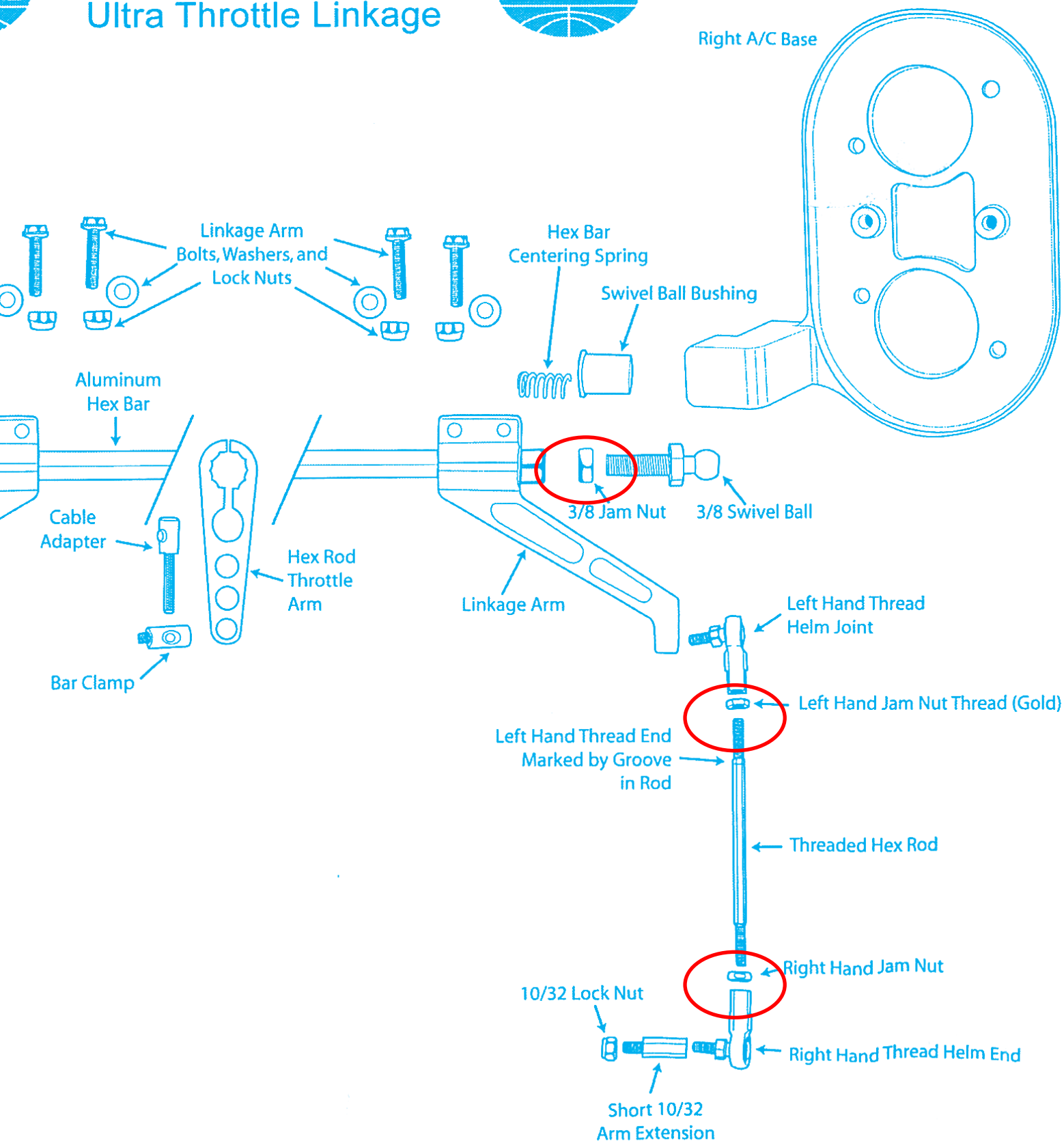
The parts with a red circle on the drawing are the ones you need to grease to make sure you can still loosen them after some month.



HPMX carburetors



Dual HPMX / IDF Hex Bar Ultra Throttle Linkage



7. Check the throttle valves on both carburetors to make sure they fully open and close and that this happens in sync.

8. Install the fuel hoses with clamps on the rear side of the fan shroud. This is a much safer (less fire hazard) way to install fuel lines and it looks much neater.

9. You will need to shorten the original Volkswagen throttle cable using the included tool set. Make sure when the accelerator pedal is pushed all the way that the throttle on both carburetors is not completely open, this could damage the throttle cable and the cross bar linkage hardware.

The engine is now ready to be adjusted. You may use an engine stand to do so, or you may install the engine in the VW.

You will need a Carbo Monoxide Meter (CO meter) to adjust the carburetors CO levels. You will also need a vacuum gauge to sync the carburetors. We show a vacuum gauge below, we have this professional gauge available in our webstore, this model is ideal to sync the dual EMPI HPMX carburetors. Ideally you would have two vacuum gauges to sync



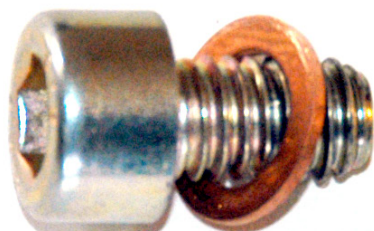
HPMX carburetors

Adjusting the dual carburetor

the left and right carburetor. You may purchase a CO meter in any professional after market retail store or online.

EMPI describes how to adjust this carburetor set by ear, but we think this is only for experienced professionals, you need to have adjusted many dual carburetors before you may claim you can adjust by ear. It is advisable to adjust the CO level per cylinder by adapting the exhaust on your Volkswagen. The problem is that when measuring the CO level in the exhaust pipe, you will measure

the exhaust of all cylinders, you are not able to measure the CO level per cylinder. The HPMX dual carburetors will feed every cylinder separately, so you need to adjust the CO level per cylinder, ideally you need to measure the CO level per cylinder. Measuring the average CO level in the final exhaust is not ideal, there will be an important difference between the carburetors, the cylinders will have a different fuel mixture which is not what we want. Drilling a hole in every outlet manifold tube will give you that CO measure point for each cylinder. Use a special rivet and nut (picture below) to seal the holes in the outlet manifolds.



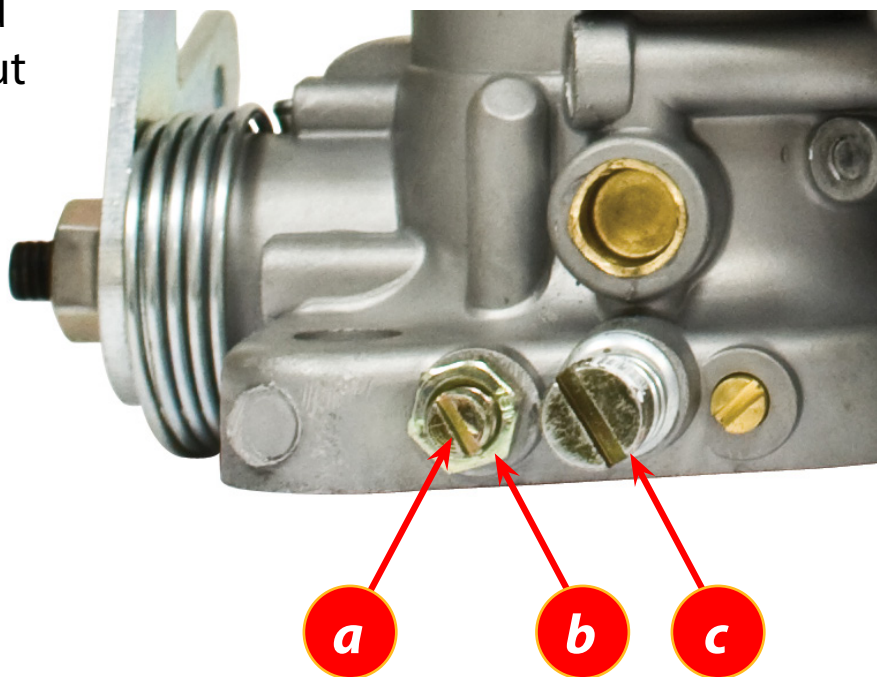
The adjustment procedure is described in the included manual. We will show now how we adjust the EMPI HPMX carburetor set in our workshop.

We advise to read our article about adjusting a single carburetor on a type 1 air-cooled engine in edition 01. This will give you some basic knowledge about carburetor adjustments in practice. You will understand the following information about adjusting a dual carburetor much better, read the article about single carburetor adjustment in [edition 01](#).



Basic idle adjustments:

1. The air bleed screw (a.) is to be lightly seated. Close the air bleed screw clockwise until lightly seated. Tighten the lock nut (b.) when bleed screw is closed. This is the screw you will use later to adjust the vacuum levels to be able to sync the carburetors.



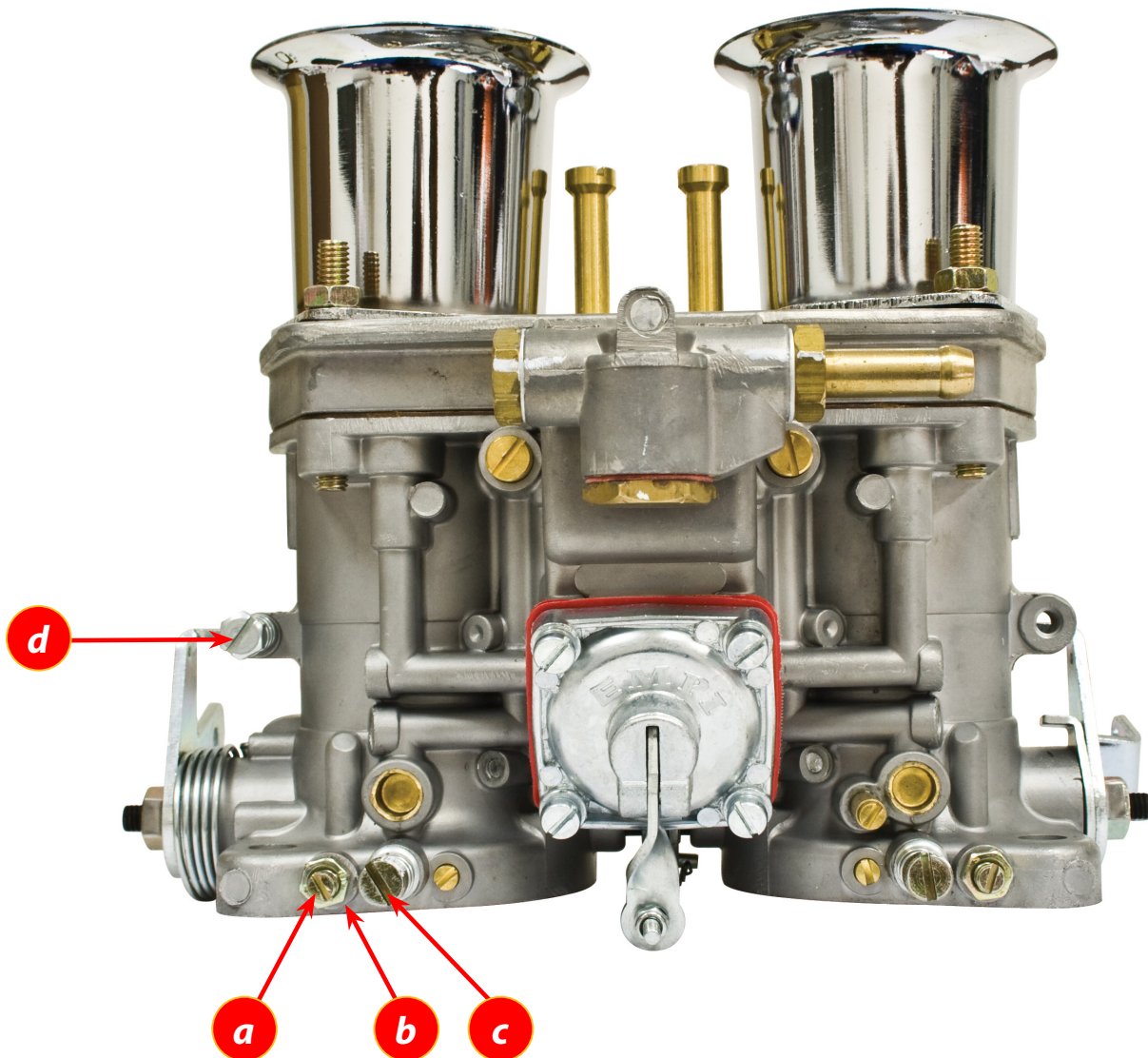
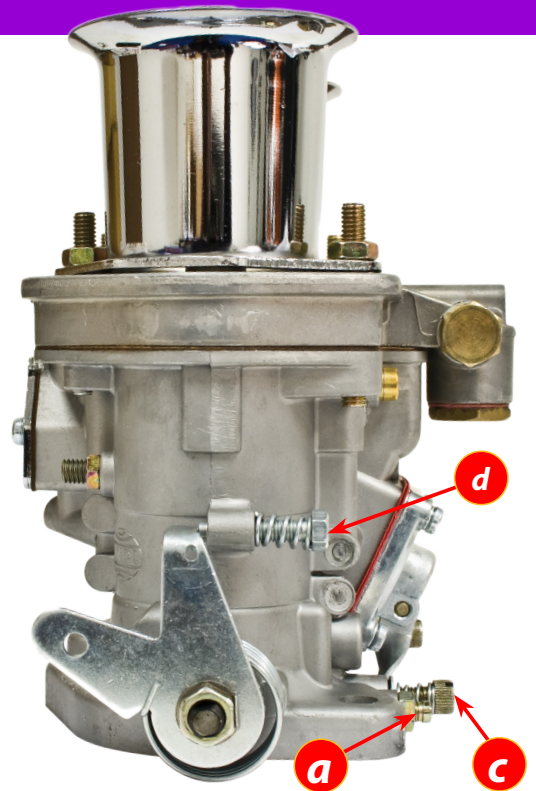
2. The mixture screw (c.) is adjusted from the closed position, turn clockwise until lightly seated. Counter clockwise out 1,5 turn for adjustment.



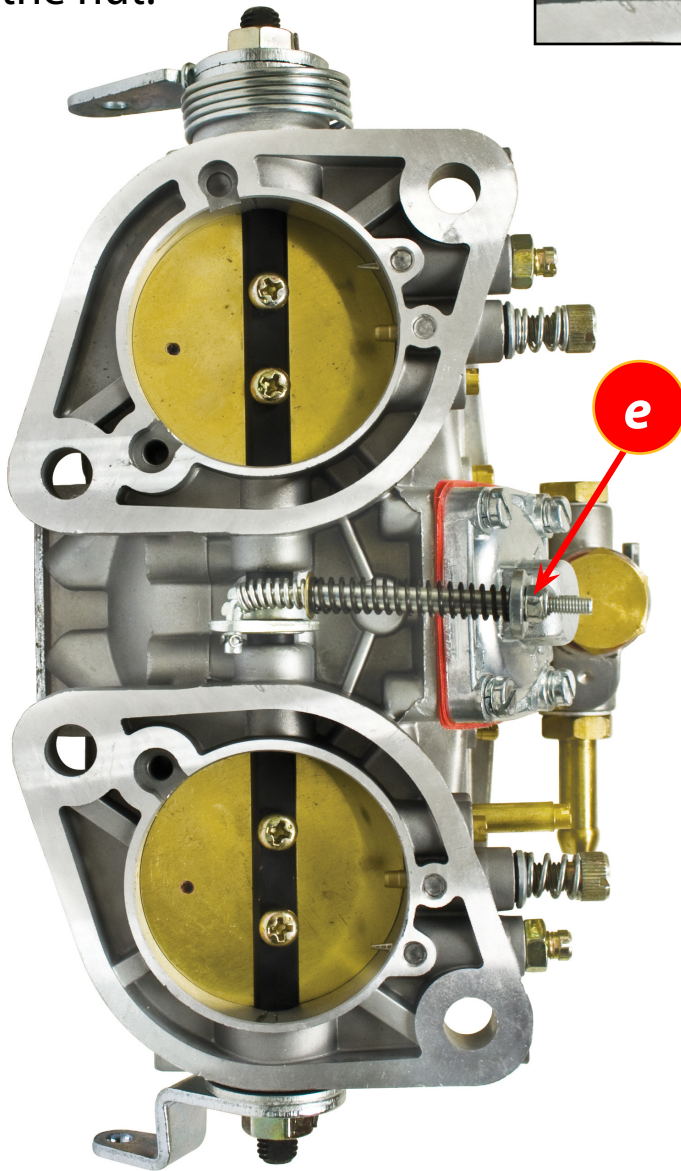
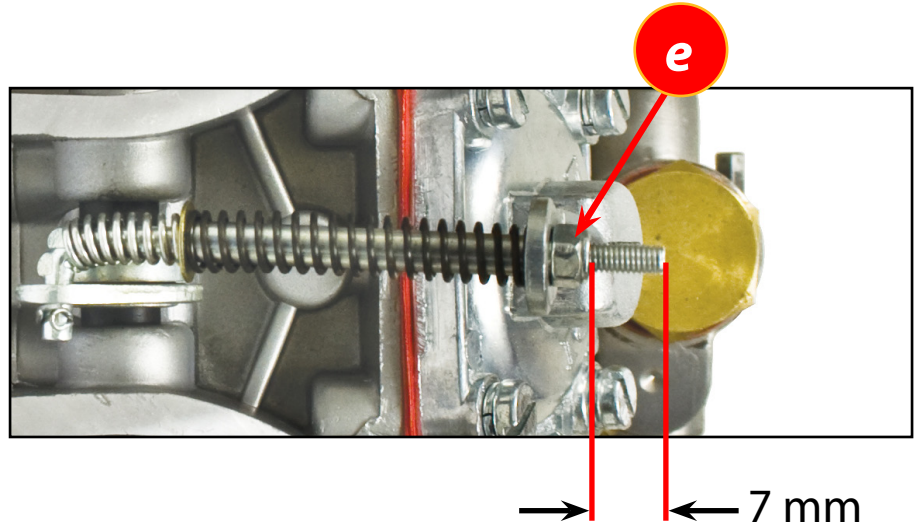
HPMX carburetors

3. Adjust the idle speed screw (d.) from the first point of contact with the linkage arm. Adjust the idle speed screw clockwise 0.5 turn after the first contact with the linkage arm.

Repeat step 1 and step 2 for the 3 other carburetors. You need to execute step 3 only once per carburetor.



4. The accelerator adjustment nut (e.) should be set so that there is 7 mm thread left starting from the top of the nut.



The basic adjustment for the idle mixture is done. You may keep the engine on the engine stand or install it in your VW to continue with the next step, syncing your carburetors. If you sync your carburetors on an engine stand you will need to remove your carburetors to install the engine in your VW. There is just not enough space to install your engine with the dual carburetors mounted. You may install your engine without syncing your carburetors and do the syncing adjustment once the engine is in your car, both are fine.

We continue now with the procedure to synchronize your dual HPMX carburetors.

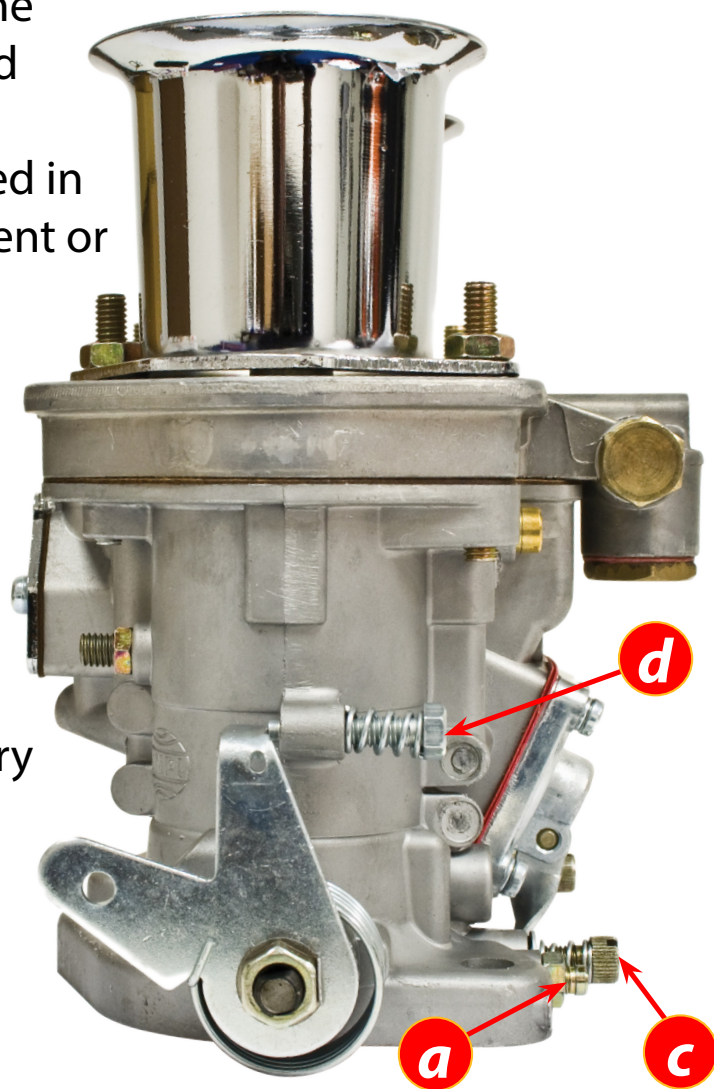
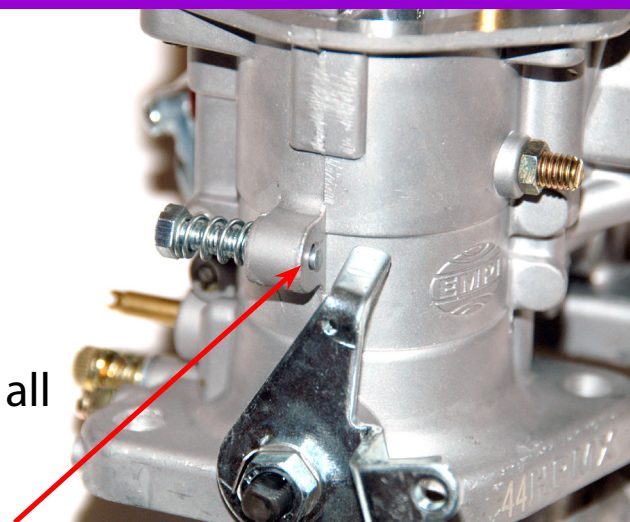


HPMX carburetors

Synchronizing & idle mixture:

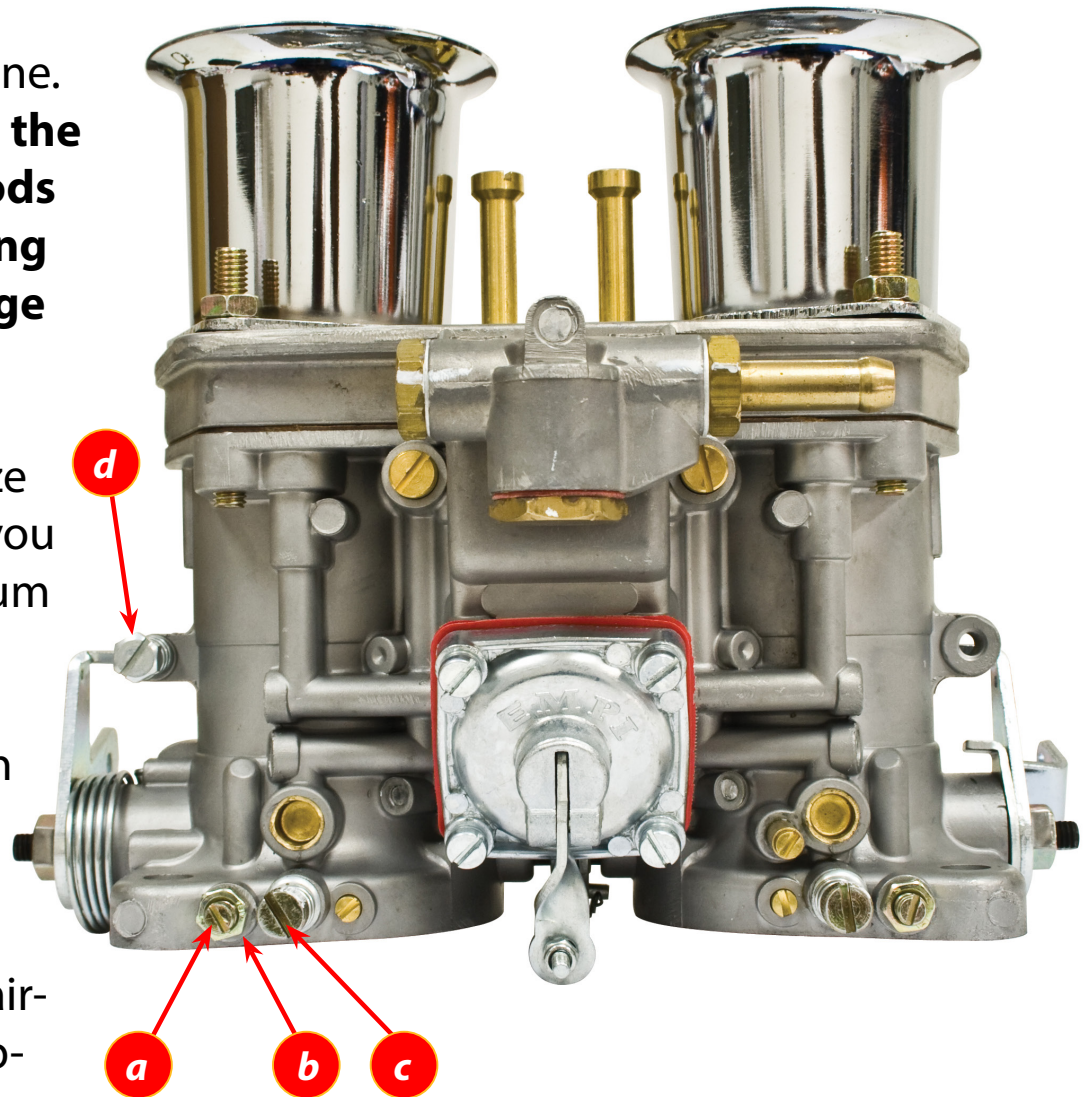
- 1.** Remove the air filter assemblies.
- 2.** Disconnect the throttle linkage rods on all carburetors.
- 3.** Turn counter clockwise the idle speed screw (d.) on each carburetor, until the tip of the screw is flush with the casting (picture top left). Check for binding or sticking of the throttle plates. With the idle speed screw in this position, the throttle plates should be completely closed in the bores. Correct any misalignment or binding before proceeding.
- 4.** Turn clockwise the idle speed screw (d.), until the tip of the screw just touches the carburetor lever. From this contact position, turn each idle speed screw exactly one full turn in (clockwise). This is your preliminary set point.

Execute these 4 steps for each carburetor, there are a total of 2 idle speed screws (1 per side).



5. Start the engine.
Caution: Be sure the loose throttle-rods are not interfering with other linkage components.

6. To synchronize the carburetors, you will use the vacuum gauge and place it onto the velocity stack as shown below, you will adjust the idle speed screws (d) until a balanced air-flow reading is obtained on the vacuum gauge. Connect a tachometer and set the idle speed for each carburetor with the idle speed screw (d). Each carburetor should have the same amount of vacuum to be in sync. Always measure the front carburetor velocity stacks from the left and right side carburetor.



Make sure air doesn't leak between the carburetor top and the velocity stack (there is no seal or gasket).



HPMX carburetors

7. After the carburetors are synchronized, reinstall the linkage rods as described in the manual and on the drawing shown earlier. If the linkage rod is not correct the throttle lever position will be affected. To adjust linkage rod length loosen the right and left handed nuts and turn the rod shaft to shorten or lengthen the rod as necessary.

Caution: When linkage rods are properly adjusted the vacuum gauge reading will remain as originally set. When rods adjusted, lock the rod nuts in place. If this is not the case, it means that the linkage rods influence the idle speed and the synchronization, it shouldn't be the case.

8. It is now time to adjust the CO using the CO meter.

9. Connect the rpm gauge.

10. The engine should be at operating temperature before adjusting the CO level.

11. Turn the idle mixture screw (c.) clockwise until the engine rpm begins to fluctuate on the tachometer.

12. Turn the idle mixture screw (c) counter-clockwise slowly, until the idle speed becomes steady. The rpm will rise, the engine will run more steady at idle speed. Turn more slowly counter-clockwise until the rpm doesn't change anymore. Turn the mixture screw slowly clockwise until the rpm just starts to go down.

Repeat these steps for each carburetor. The 4 mixture screws shouldn't have more than one quarter turn difference at the end of the adjustment procedure. If you have measurement holes in the outlet manifolds as described earlier, you may adjust the CO level per carburetor.

13. Once the idle mixture has been set, fine tune the idle speed if necessary, to meet the engine manufacturer's specification using the idle speed screw (d). Try to keep the adjustment equal on all carburetors.

14. Recheck the carburetor synchronization with the vacuum gauge if any idle speed adjustment is made and check the linkage rod position. Compare also the front and rear carburetors for vacuum differences. Small differences in vacuum levels can be adjusted using the air bleed screws(a). Turning the air bleed screw (a) counter-clockwise will let more air in.

15. Shut down the engine. Disconnect the tachometer and the vacuum gauge. Install the air cleaner units. You are ready with synchronizing your dual carburetors and adjusting the idle mixture.

We have listed a number of key points that are critical during the installation and the adjustment of the dual carburetors:

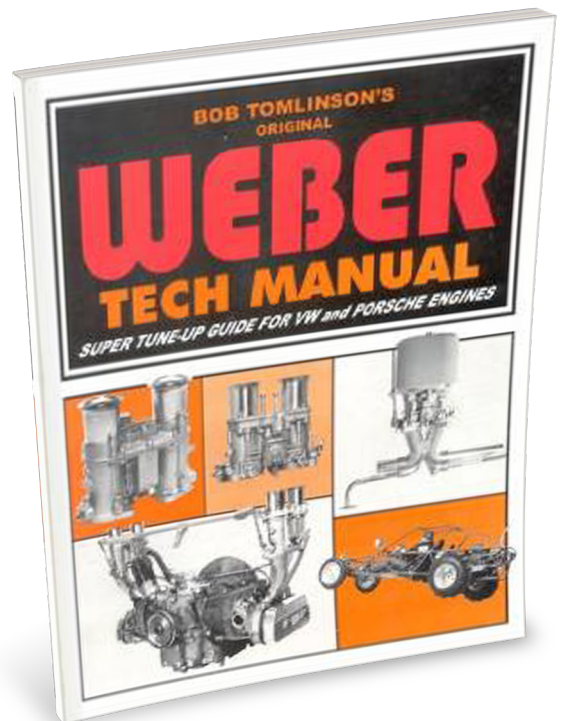
- Make sure your carburetors are not only synchronized at idle speed but also at 2000 rpm. If you can't synchronize your carburetor at both rpm's, choose 2000 rpm as your main reference. Your engine runs most often around 2000 rpm during normal use. Synchronization adjustment at 2000 rpm should be done by adjusting the length of the linkage rods, not with the idle speed screw.
- Once the adjustment is done, the mixture screws shouldn't differ more than a quarter.
- Once the adjustment is done, the mixture screws shouldn't be turned more than one full turn counter-clockwise. If they have less than half a turn counter-clockwise, this could mean that the idle jets are



HPMX carburetors



Dual carburetors run better with a rotating electrical fuel pump because they deliver a constant fuel pressure. The Pierburg fuel pump (picture left) is the ideal fuel pump for this application (part number [03686](#)).



too small, more than 1.5 turn means the idle jets are too big.

- The throttle valve screw shouldn't be turn counter-clockwise more than 0.5 turn (zero point is when the screw lightly touches the throttle valve). If you need to turn this screw more than 0.5 turn, the idle jet needs to be bigger.
- If the engine holds back at an rpm level lower than 2000 (with the acceleration pump well adjusted), this means that the idle jet is too small.

A good book that will help you to understand even more about the Weber IDF carburetor is publication from Bob Tomlinson's. The EMPI HPMX is identical to the original Weber carburetor.

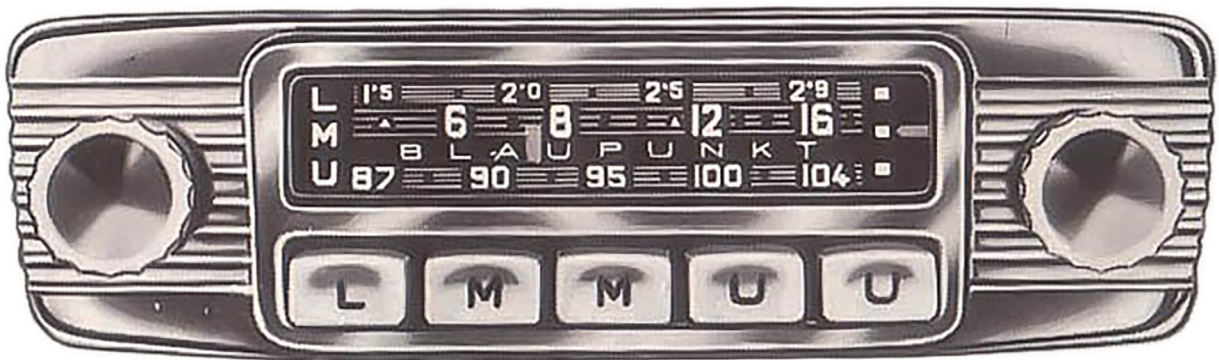




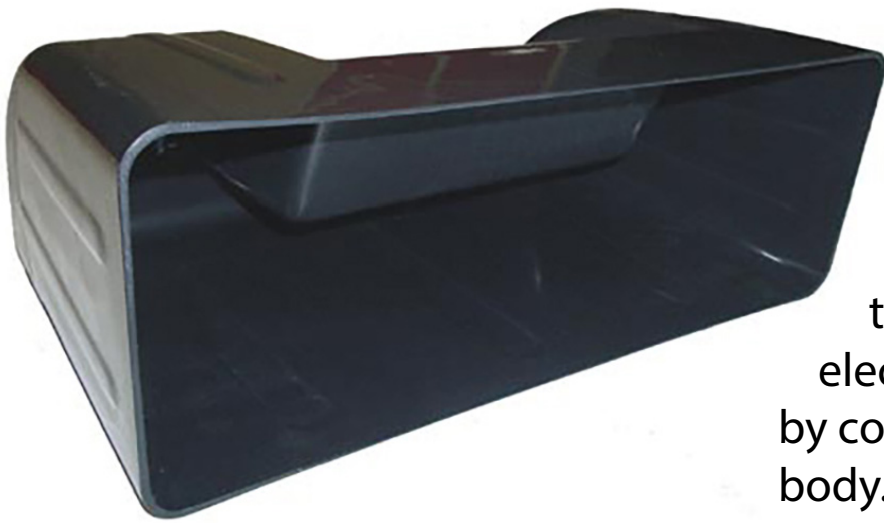
Installing the radio receiver

Did you ever own a Classic Volkswagen with a genuine radio or with any other vintage radio receiver? If so, you should be familiar with the issue of radio signal interference. It sounds like an annoying sound, murmur, zoom, crackle, that comes out of your speakers. These interferences can have many different sources, they can be eliminated however. The goal of this feature is to help VW enthusiast to solve the radio interference problems.

Every radio includes a radio signal receiver, this receiver will capture the radio signal that broadcast companies send out, but it will also receive unwanted signals coming from other sources. These unwanted signals will also be amplified by the radio amplifier, they will be added to the music and be heard as annoying distortion of the wanted signal.

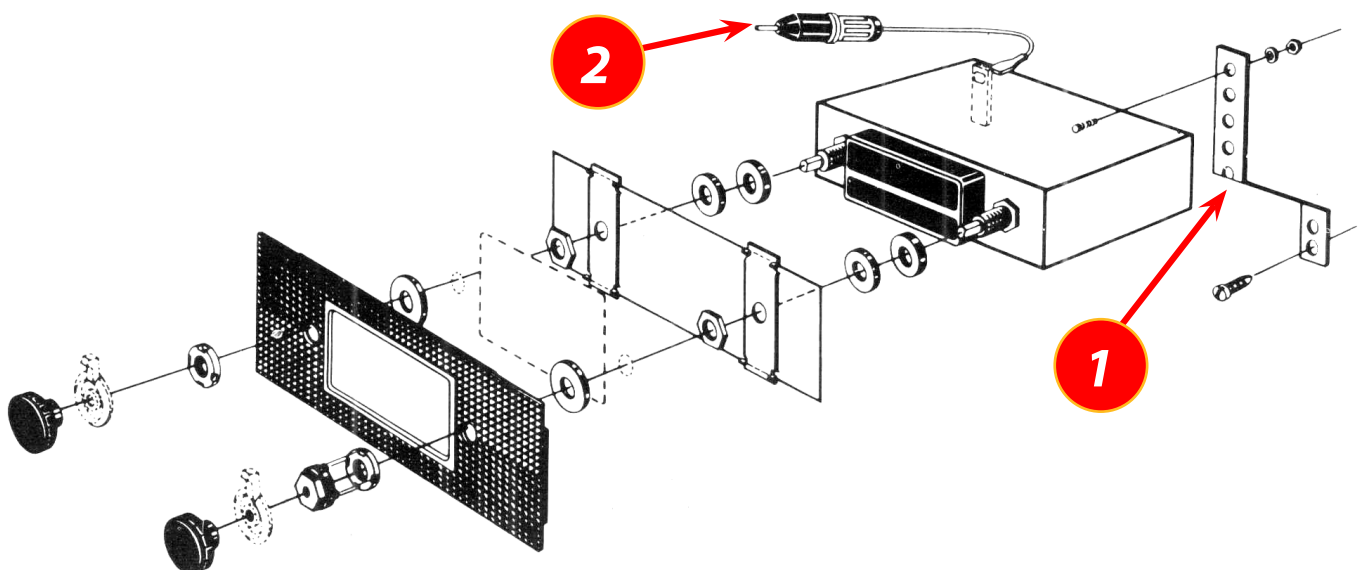


radio interference



The original VW radio is installed onto the dashboard. If you want to install a more contemporary radio-cd player you will probably want to hide it in the glove compartment, using a special glove box (picture above).

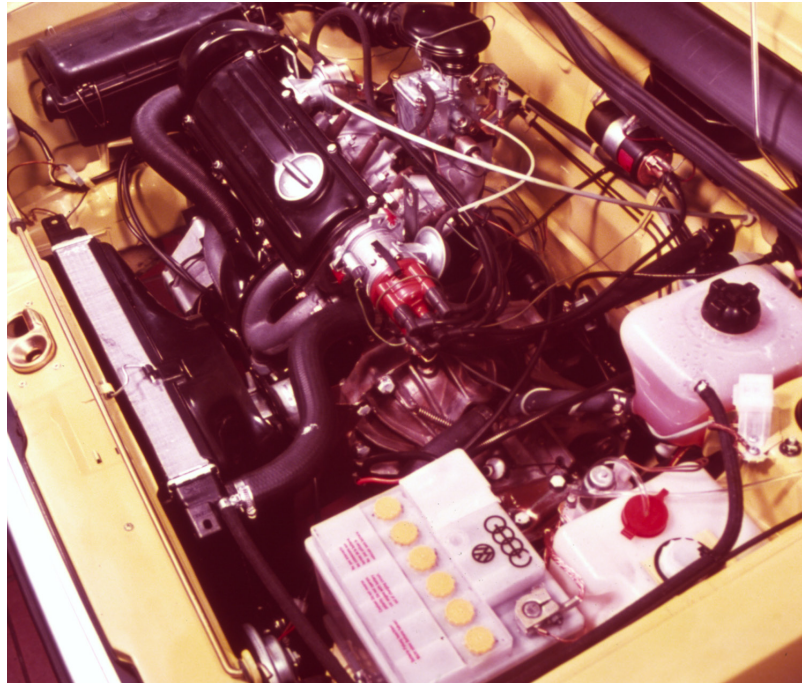
The metal bracket (1) at the back of the original radio (if applicable for your radio model) needs to be grounded to the electrical minus of your VW by connecting it to the car body. The radio receiver has an additional ground connection via the antenna plug (2) and/or the 6 V / 12 V ground connection. It is of the utmost importance that the metal surface used to ground electrical equipment is free from grease or paint, so that the electrical contact is optimal. Some radio models use the metal bracket as the only ground connection, so make sure the electrical conduction is optimal.



You want to know more about the importance of optimal electrical conduction for your classic Volkswagen? Read the feature about the battery in [edition 01](#).

The radio can not be connected directly to the battery terminals in an air-cooled VW, the battery is installed under the back seat or near the engine depending on the model. Connecting the radio positive plug directly to the battery using a line fuse (3) would be ideal. The battery in the water-cooled Volkswagens with the engine in the front is much closer to the radio (picture on the right) .

The air-cooled VW positive 6 V or 12 V will be connected to one of the fuse box connections.



Watch out when connecting a vintage radio, make sure the radio is compatible with your VW electrical tension (6 V or 12 V) ! Adding an extra line fuse is to be advised, but make sure the line fuse connections are in good shape (use a soldering iron preferably), to avoid extra tension loss and interference.



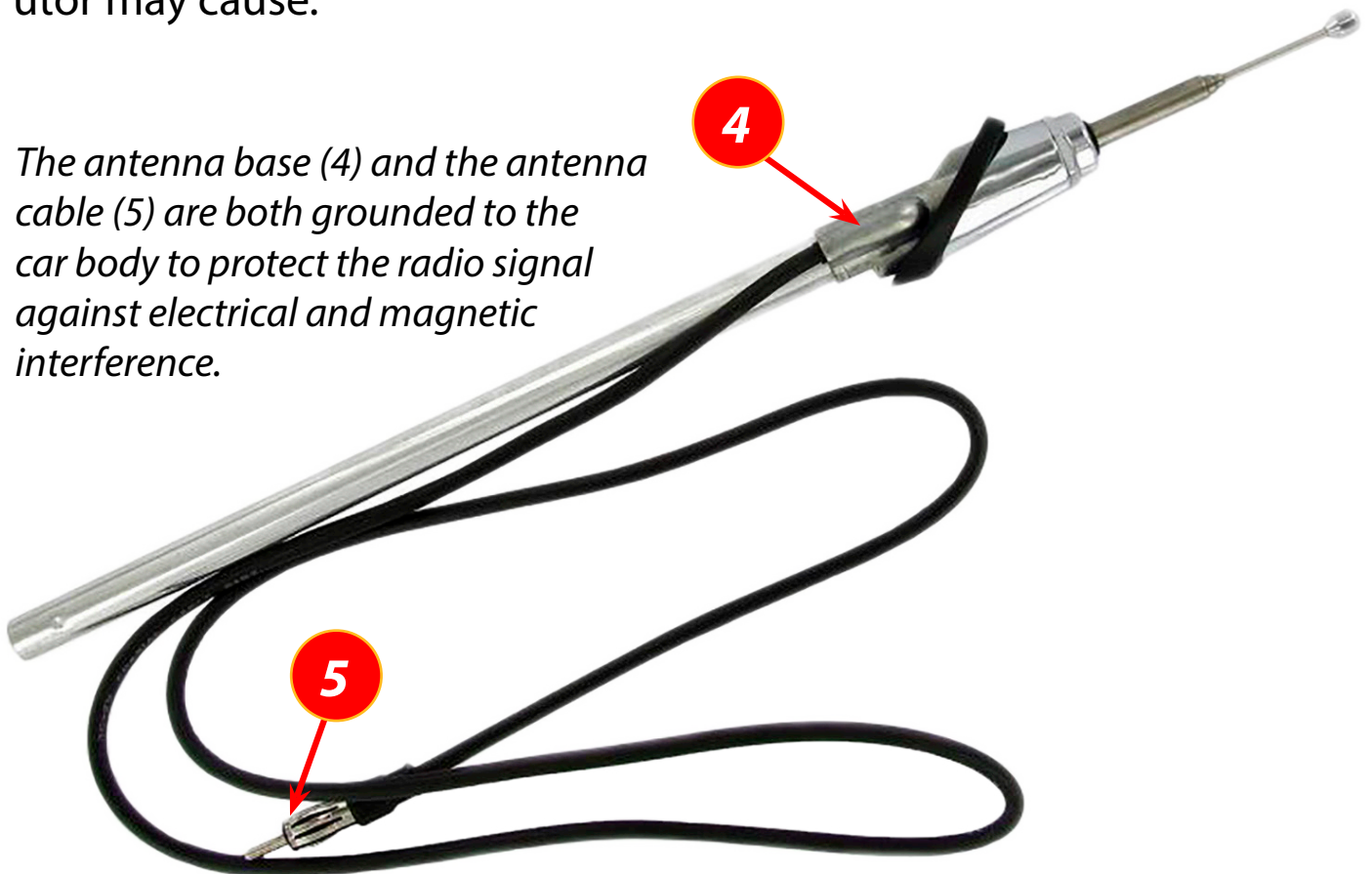
radio interference

Installing the antenna

The antenna plays an important role to have the best signal possible, choosing the best location for the antenna will reduce interference. The antenna should be installed on the opposite side of the distributor and the ignition coil, even if the antenna gets close to the spark plugs this way. The interference of spark plugs (with suppressors) is much less than the interference the distributor may cause.

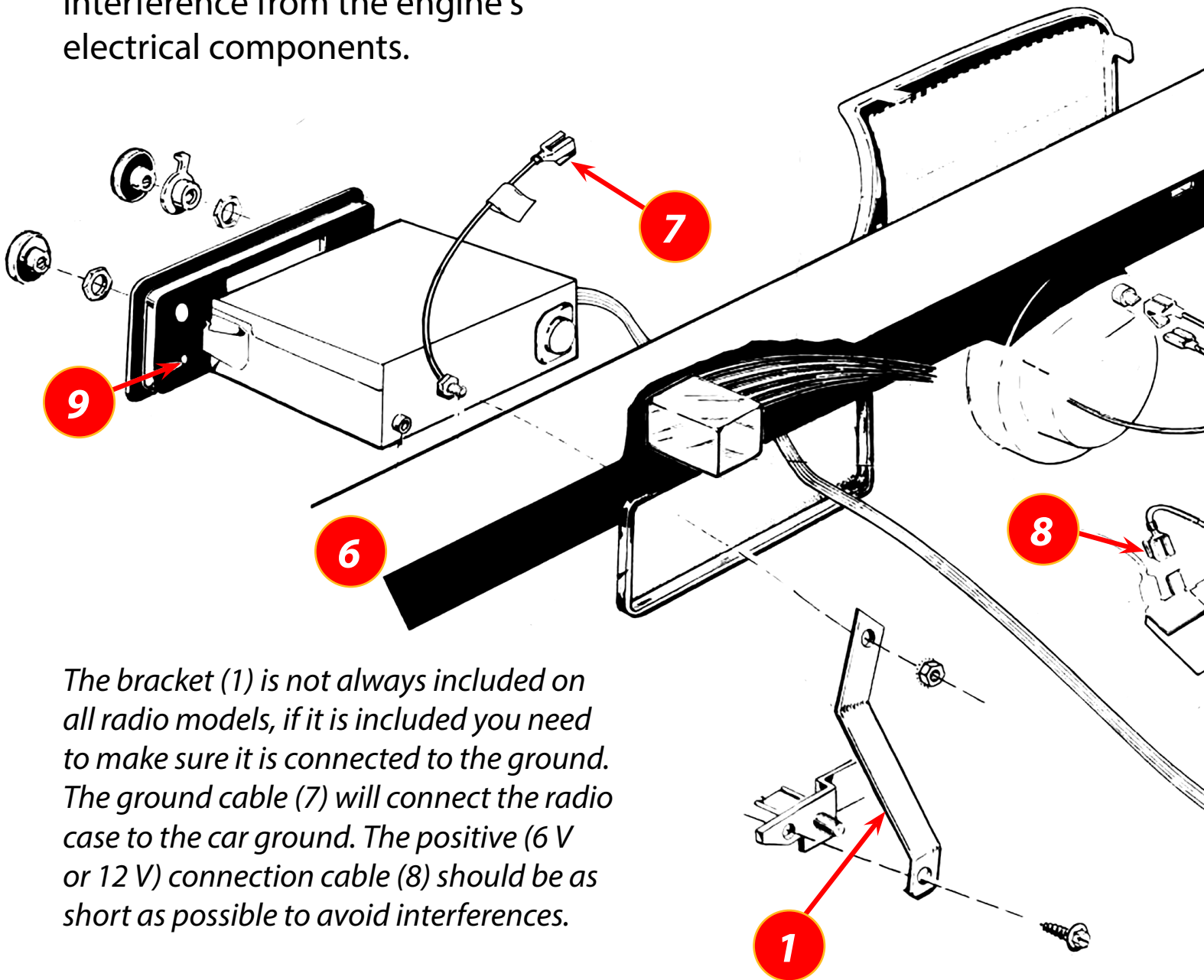
The location of the classic Volkswagen antenna is mostly predefined by the factory. You will find a hole in the body on the left front side of the car, this hole is covered with a plastic plug. The engine of the air-cooled Volkswagens is located at the back so far away from the antenna and the direct interference range of the distributor, ignition coil or spark plugs.

The antenna base (4) and the antenna cable (5) are both grounded to the car body to protect the radio signal against electrical and magnetic interference.



The best place for the antenna to be installed is close to the dashboard (6), the antenna cable is then as short as possible. Make sure the antenna cable is not running through the engine compartment (for air-cooled Volkswagens), to avoid direct interference from the engine's electrical components.

The shielding of the antenna cable must be and remain properly grounded. The antenna is connected to the radio with a coaxial cable. This is a cable with on the inside a copper conductor (braided in this case

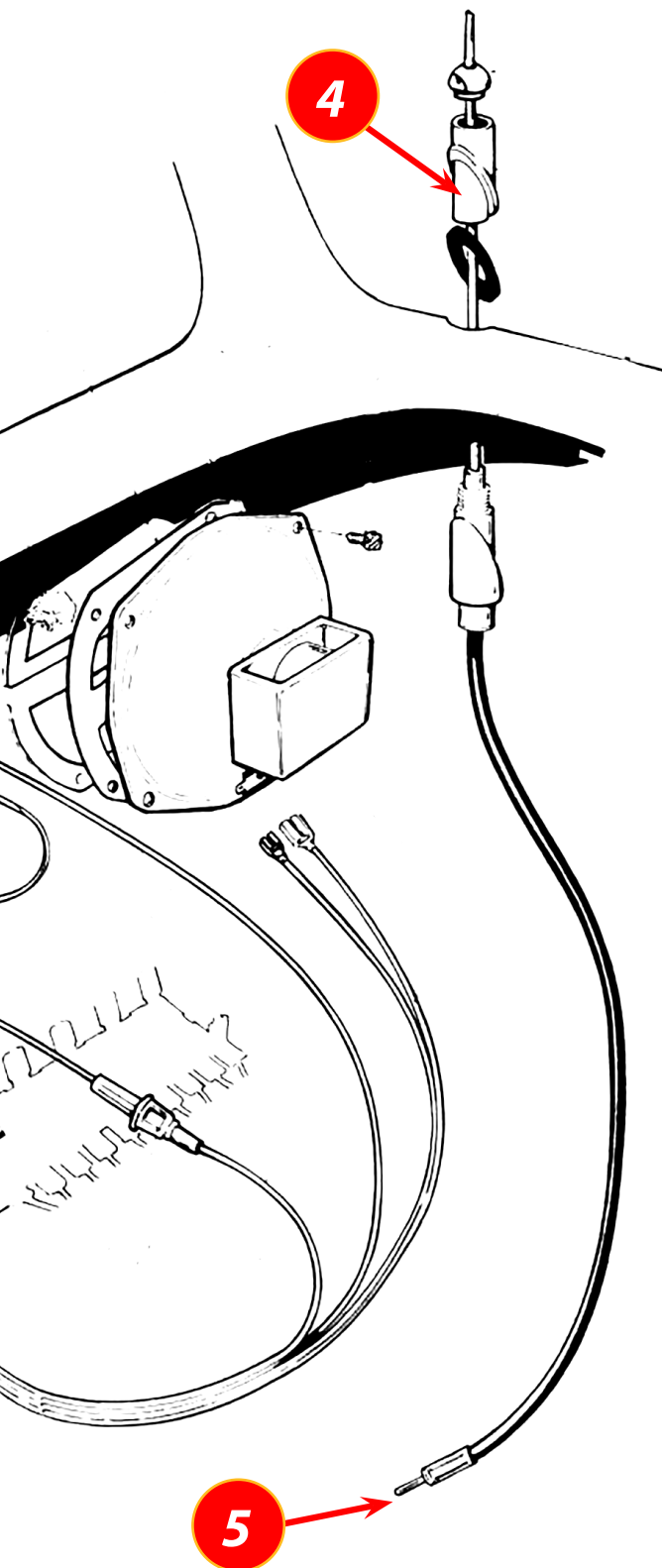


The bracket (1) is not always included on all radio models, if it is included you need to make sure it is connected to the ground. The ground cable (7) will connect the radio case to the car ground. The positive (6 V or 12 V) connection cable (8) should be as short as possible to avoid interferences.



radio interference

to be able to bend) and on the outside a braided copper shield.

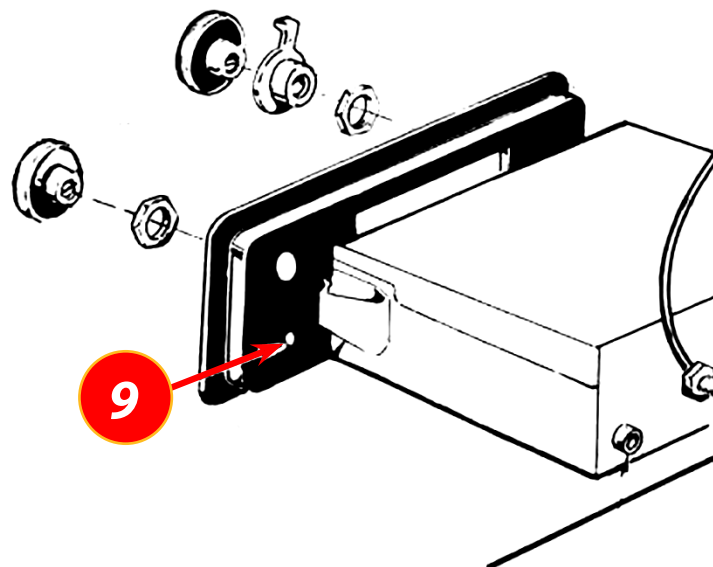
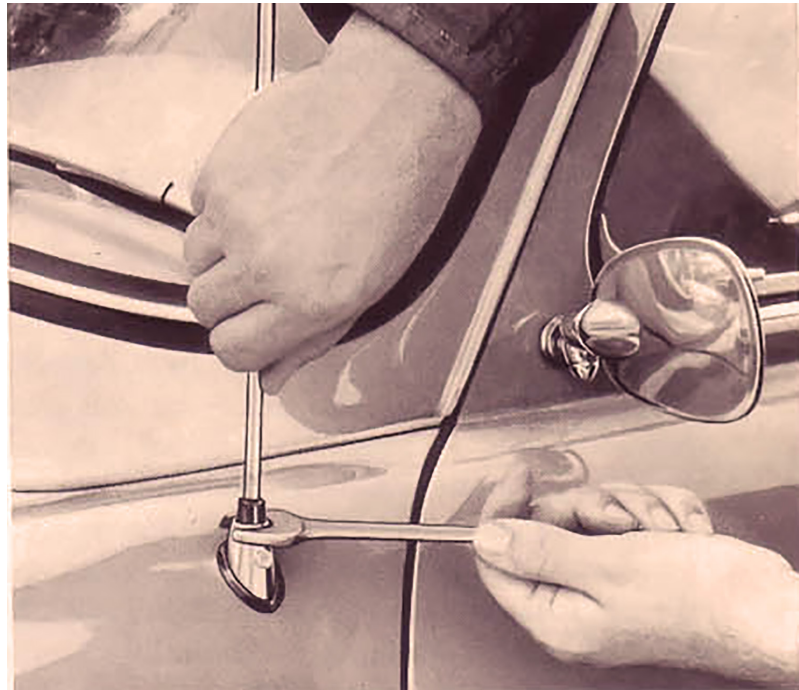


The antenna is connected to the radio using a coax cable. This cable has an inner copper conductor carrying the radio signal, the outer cable is a braided copper cable (mesh) and is connected to the ground. The outer ground cable protects the radio signal from interference, just as a Faraday cage. A Faraday cage or Faraday shield is an enclosure formed by conductive material or by a mesh of such material. Such an enclosure blocks external static and non-static electric fields by channeling electricity through the grounded mesh. Exactly what we need, the inner cable carrying the radio signal is protected from external interferences. This will work fine only if the outer cable has a good connection with the ground. So, don't add extra connections to the antenna cable if possible. If you need extra length to get from the antenna to the radio, use a coax cable including plugs, don't try to make your own cable.

Make sure the antenna is secured to the car body as shown in the picture on the left, the antenna base is also connected to the ground.

The antenna cable is connected to the back of the radio and runs through the front of the car. Make sure the antenna cable doesn't run next to electrical or magnetic sources such as an electrical clock, the electric motor from the wipers. The antenna is protected from most interferences but not from strong interferences close by, such as the magnetic field from electric motors.

If present in the radio receiver, tune the antenna trimmer (9). You see the opening of the antenna trimmer on the drawing on the right.



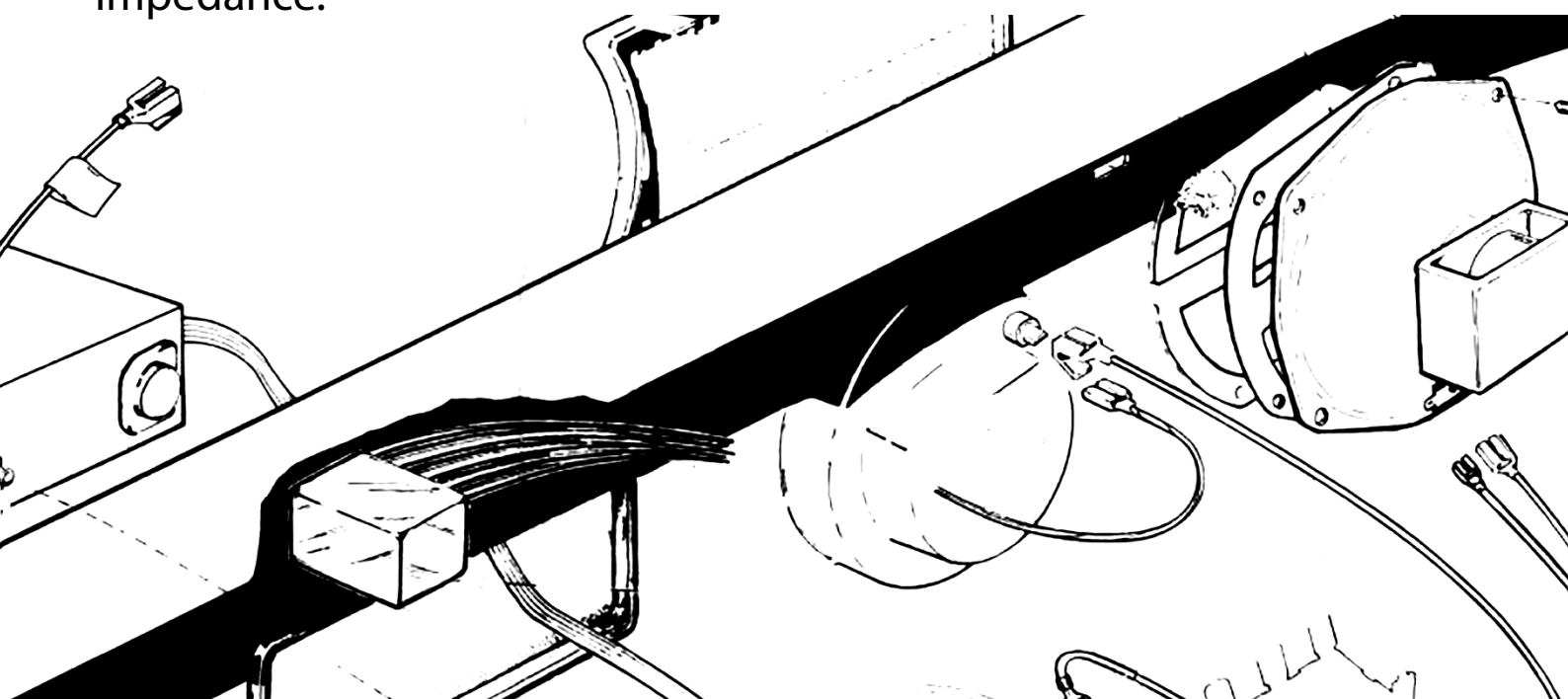
radio interference

Sources of interference

You will find an antenna trimmer on most old radio's. This trimmer is used to change the electrical impedance (the high frequency resistance) for AM frequencies. FM frequencies are less sensitive to antenna impedance differences. Modern radio receivers are compensating differences in impedance automatically.

So, if you have a real old radio and you want to listen to AM radio stations, you'll need to use the trimmer to remove interference from differences in antenna impedance.

Interferences caused by electrical components of the car will be clearly audible. Once you have installed the radio and the antenna and you turn on your radio, you will hear the interferences through the speakers (rattling, crackling, screeching, ...). To be able to remove these sounds you need to find the source(s) of these interferences. Every sound can be matched to a specific type of interference, that is good news, so let's start the diagnose.



Ignition interferences

The ignition is a strong source for interference. The spark plugs, the ignition points, the distributor are generating sparks, which can cause interferences. These interferences will be transported via the electrical wiring, these interferences will be amplified by the radio and causes these unwanted sounds in your speakers. These interferences may start on the high voltage side of the ignition or the low voltage side.

It is very difficult to find the exact source of the interference coming from the ignition. The coil, distributor and spark plugs will generate the same ratchet sound.

Generator interferences

The electrical generator (dynamo or alternator, refer to [edition 02](#) for more explanation about the electrical generator) is also a strong source for interference. We need to differentiate between the direct current generator (the dynamo was used on the older VW models) and the alternate current generator (the alternator was used on the younger VW models). The dynamo and the alternator will generate different types of interferences.



radio interference

Alternator

An alternator will cause lot's of low frequency interferences. The interferences are caused by the ripple tension from the tension rectifier. The alternator will also generate high frequency interferences in the Low range (L) and Middle range (M).

We show a 12 volts alternator below from Bosch including a built in tension rectifier, the rectifier will transform the alternating 12 V voltage into a direct current (or direct tension). The rectifier is included in the alternator in this model. The regulator is also built in. For more information about the rectifier and the regulator, we suggest to read the feature in [edition 02](#).



Dynamo

A dynamo causes stronger interferences than an alternator because all the generated current runs through a commutator. The commutator generates sparks, these sparks will generate a lot of high frequency interference but not much low frequency interference.



We show a 12 volts dynamo in the picture above. We don't need a rectifier in this case, the tension generated by the dynamo is already a direct current (or direct tension), ready to be used by our classic Volkswagen. The regulator will be found on top of the dynamo or under the back seat depending on the VW model.

Regulator interferences

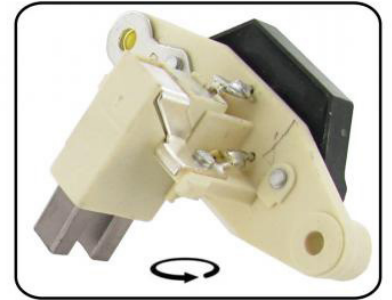
The tension regulator (refer to [edition 02](#) for more information about the tension regulator) used in combination with the dynamo is made of electrical components such as electrical relays (10), these relays cause short wave interferences (K) and/or FM (Frequency Modulation) interferences. The source for these interferences are the contacts of the relays, these are generating sparks, which in there turn generate interferences. The regulator (11) used with the younger alternators are made of electronic components that of course don't have relays.



10



11



Accessory interferences

Electrical accessories can cause additional interferences. Many accessories use an electric motor, these motors have a commutator just like the

dynamo and can cause the same type of interferences. Other accessories uses electrical switches or relays, causing parks. Electrical wiring can also cause interferences once they are close to interfering accessories.



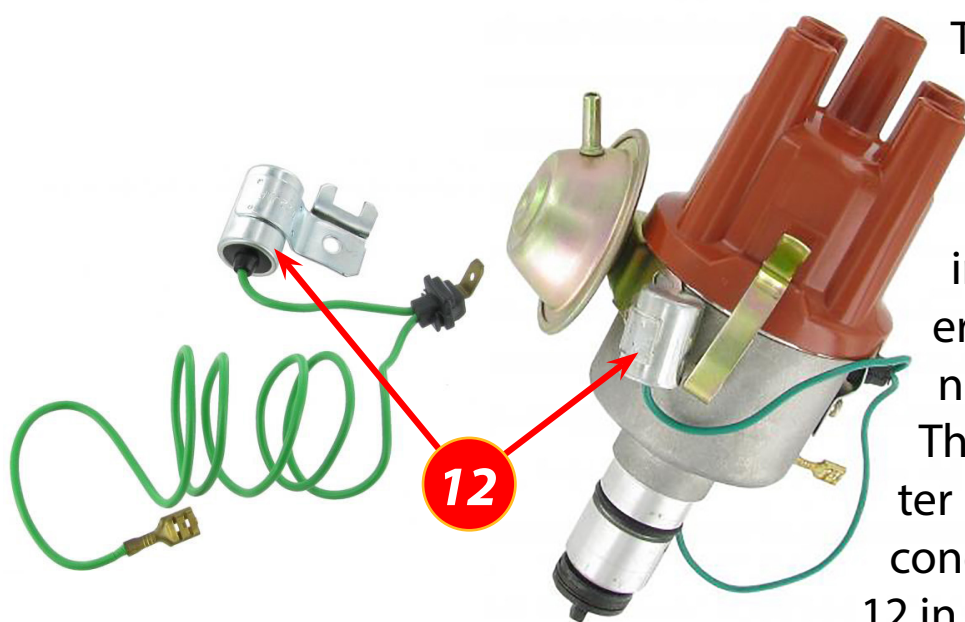
radio interference

Static interferences

The tire friction with the road and the friction of the bodywork with the dry air will cause static charge. This static charge will add up until it disappears (discharge) via the ground. These discharges may cause strong interferences.

Suppressing

There is a broad choice of suppressors to fight against radio interferences. Suppressor condensers should always be present to counter the interference cause by the coil and the generator (dynamo or alternator), this will eliminate the long range and middle range interferences.

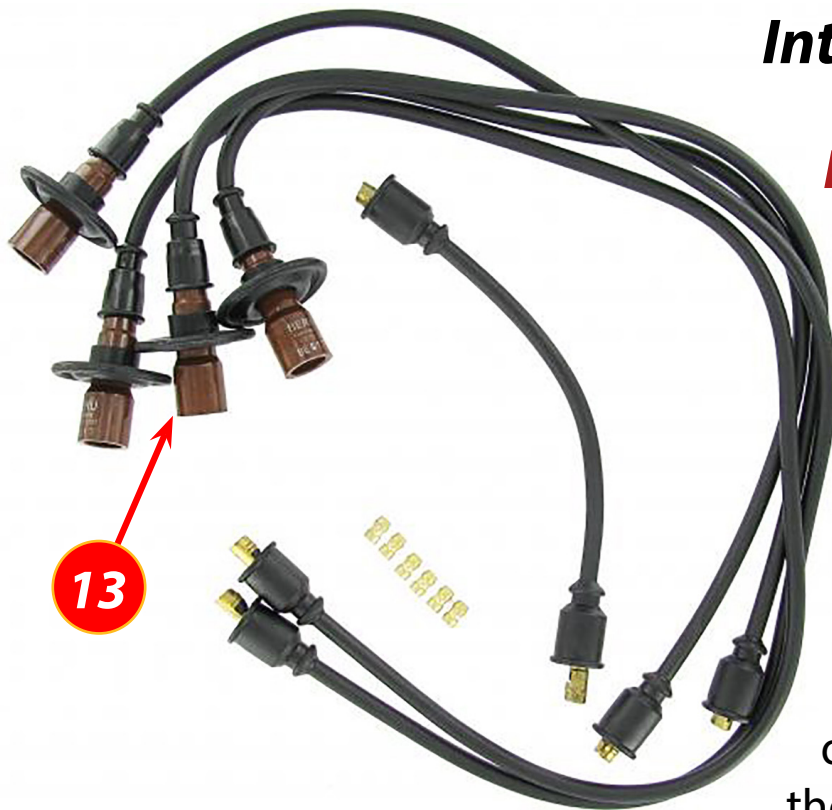


The condenser value should be around 2 μF (micro farad). The generator condenser is included with the generator, that is why you are not aware that it is there. The coil condenser, or better known as the distributor condenser is more visible (nr° 12 in the picture on the left).

If this condenser is broken, the ignition points will brun-in (refer to [edition 02](#) for more information about the distributor).

Most used interference suppressors:

- condenser (capacitor)*
- ground strap*
- suppressing resistance*
- suppressing filter*



Some engines get interference from the spark plug cables, so you need to install spark plug cable with suppressors built in the heads (13, suppressor in the spark plug heads). These suppressors are always necessary for the short wave (K) and/or FM, in combination with a condenser suppressing the regulator interference and/or filters for some accessories such as the wiper electrical motor.

Interference diagnose

Ignition interference

Ignition interferences can be heard while driving as well as while standing still. When you rev the engine the frequency of the ratchet sound will follow the rpm of the engine.

Ignition interferences can be diagnosed by shutting down the engine at high rpm. If the interference sound in the speakers disappears at once when the engine shuts down, the interference is probably caused by the ignition.

We show the suppressing condenser on the picture on the right (14) installed on an original Bosch dynamo. The picture next to it shows suppressing condenser (15) next to the regulator under the back seat.



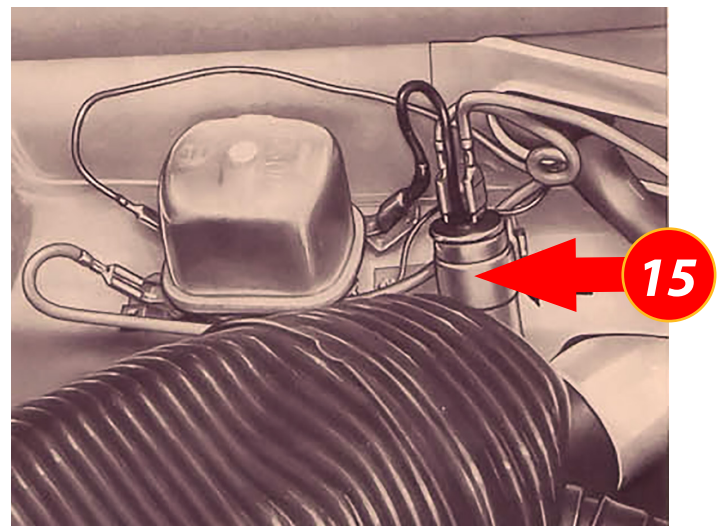
radio interference

Generator interference

Interferences caused by the generator can be recognized by the whooping sound, the frequency of this sound gets higher when the engine rpm gets higher. There is a little difference between the sound generated by a dynamo and an alternator. The dynamo causes a more '**grating sound**'. The generator interference can also be diagnosed at high rpm. Shut down the engine at high rpm, if the interference doesn't disappear suddenly when shutting down the engine, but slowly disappears, the cause is probably the dynamo/alternator or the regulator.

Regulator interference

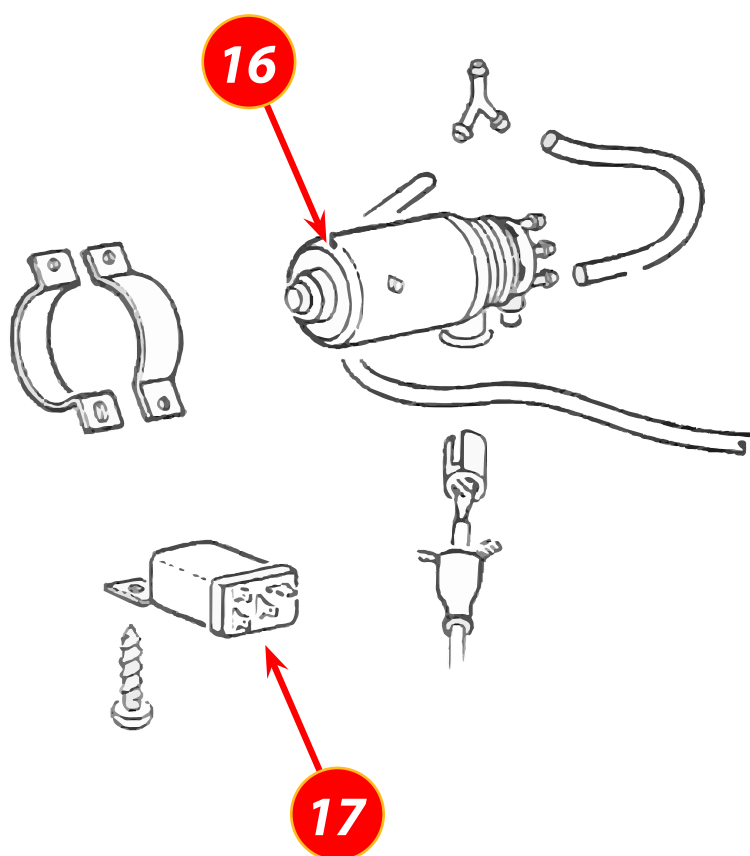
The regulator causes a rattling noise generated by the opening and closing contacts from the relays (of course this is not valid for the electronic regulator), a sound that is quite easy to differentiate from the sound generated by the generator. The sound caused by the regulator is almost the same as the sound caused by the ignition, the sound is less regular however.



The regulator interference can be found as following. Start the engine. If the interference is not present at idle speed, rev up the engine and the interference should appear. Once the interference is there, switch on the high beam (or any other high consuming electrical accessory). If the interference disappears the cause is probably the regulator.

Other accessories

If you think accessories are causing the interferences, working by elimination is the best way to proceed. So, remove every accessory completely from the electrical circuit to find the equipment causing the problem. An electrical clock, the wiper motor are typical accessories causing interferences. An electrical temperature gauge or fuel gauge using a bimetal can cause interference.



Injection engine

The injection engine uses an electrical fuel pump (16). This pump can cause interference because it uses a contact or relay to switch the pump on and off (17). You may disconnect the fuel pump for some seconds while the engine is running to find out if the pump is causing the interference. The engine will continue to run without the fuel pump for some seconds, don't worry.



radio interference

Bad contacts

Bad ground connection are really difficult to diagnose. You will need to check the complete electrical wiring and make sure all connections, ground straps are fine. Read the article in [editions 01](#) and [edition 02](#) for more information.

Fine tuning

AM-range

Tune your radio receive in between two radio stations. If you still hear interference: tune into a weaker radio station and decide if the level of interference is fine. Set the volume as high as possible and the high tone at maximum.

FM-range

Tune in on both strong and weak radio stations, try to have the best reception possible. Listen carefully if you still hear some interference.

The interference will be the strongest when you tune in just next to the radio station frequency. Set the volume as high as possible and the high tone at maximum.

Conclusion

Before you start with the diagnosis you need to make sure that the electrical wiring is fine. Bad contacts or bad battery connections will make the diagnosis very difficult or even impossible. Make sure the ground strap from the battery is in good shape (read [edition 01](#) of this technical series).

Also make sure that the antenna is positioned correctly as described in this article. Good luck and enjoy the music.





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What they do?

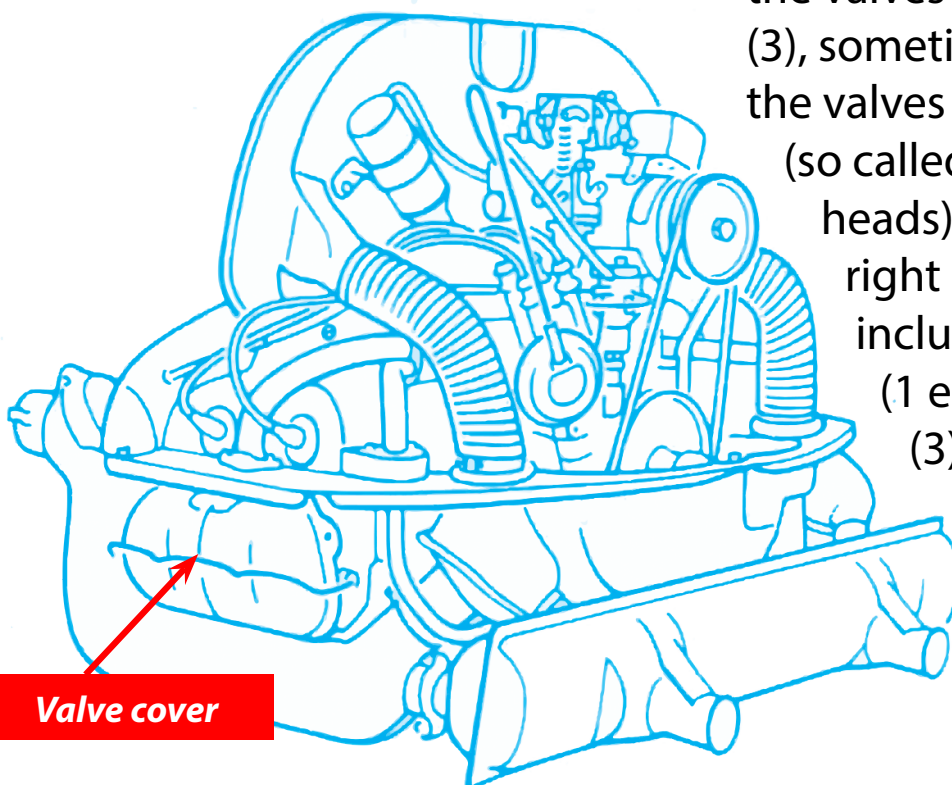
The valves in our classic VW engine will allow the fuel mixture to flow from the inlet manifold to the cylinders (inlet valves), the fuel mixture will be compressed by the pistons and leave the cylinders via the exhaust valves. The adjustment of the inlet and exhaust valves is of the utmost importance for a good working engine. The valves will allow your engine to breathe.

Where they are?

Where are the valves?
The valves are located on the left and right bottom side of the engine, hidden behind valve cover. The valves are part of the cylinder heads.

The valves

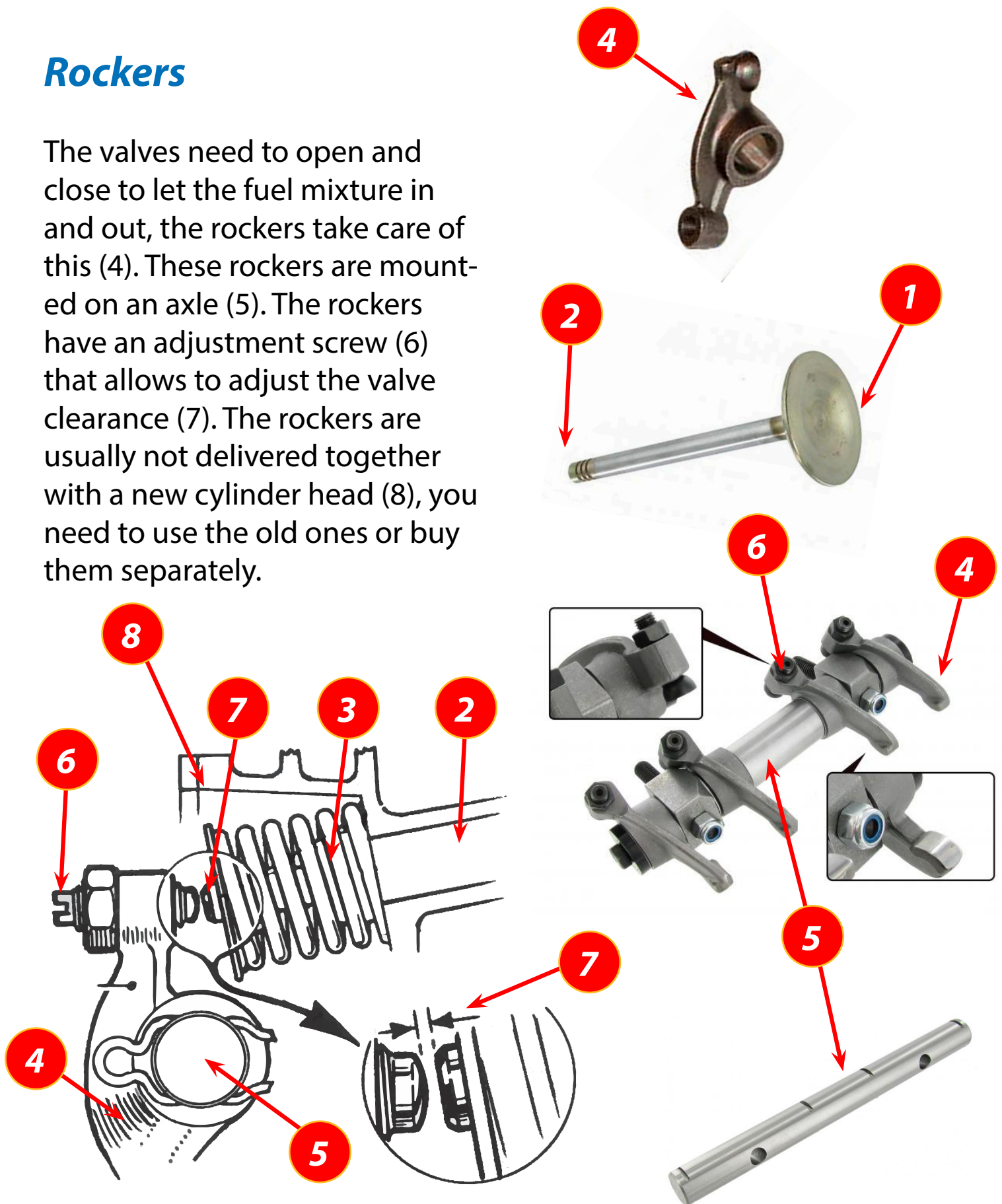
You will find the inlet valves, exhaust valves and the valve stems (2) in the cylinder head. Some of the new cylinder heads are delivered without the valves and valve springs (3), sometimes they include the valves and valve springs (so called complete cylinder heads). The drawing on the right shows a valve system including the valve stem (1 en 2) and valve spring (3). A complete cylinder head includes all of these components.

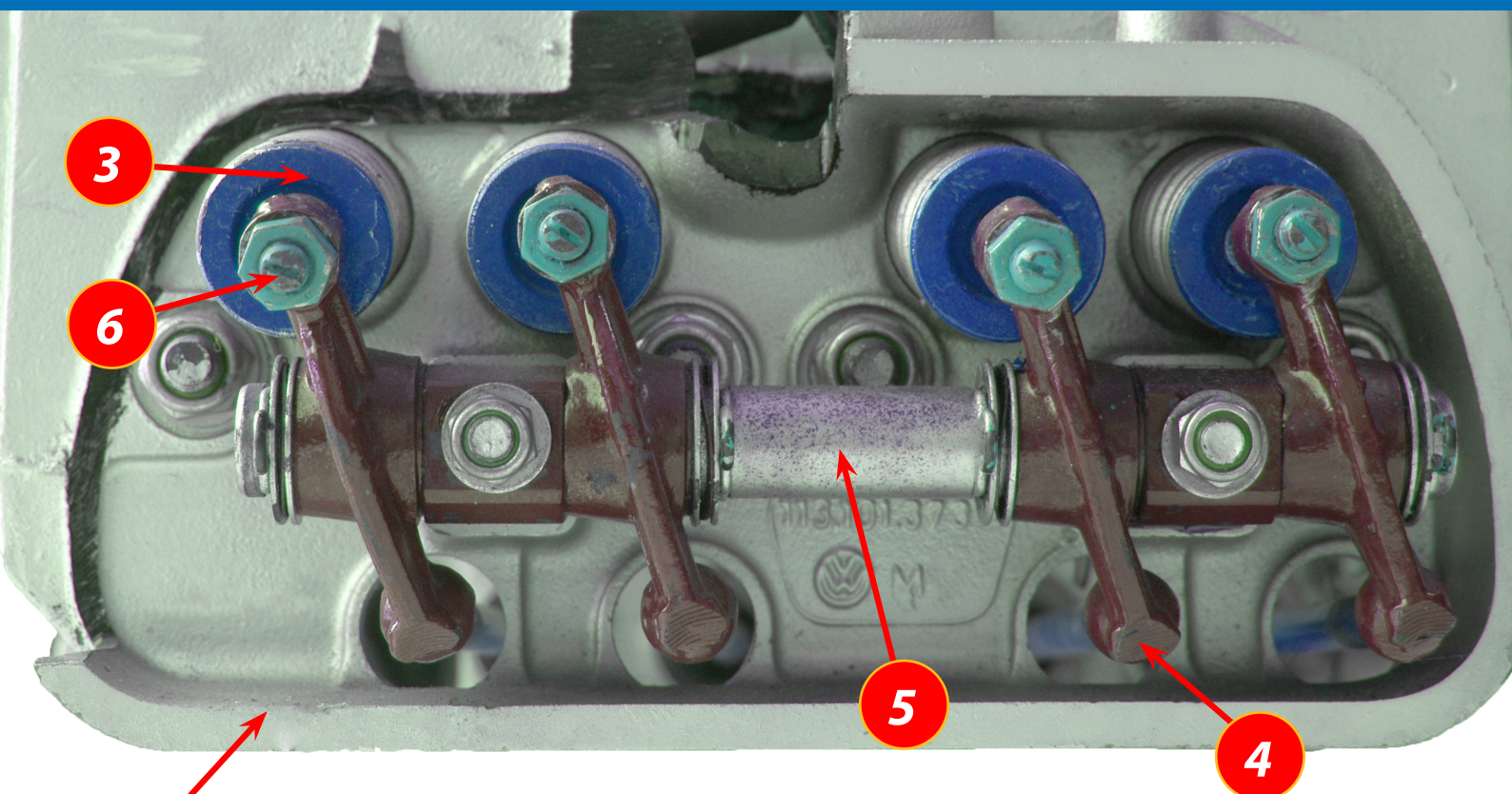


what is valve clearance?

Rockers

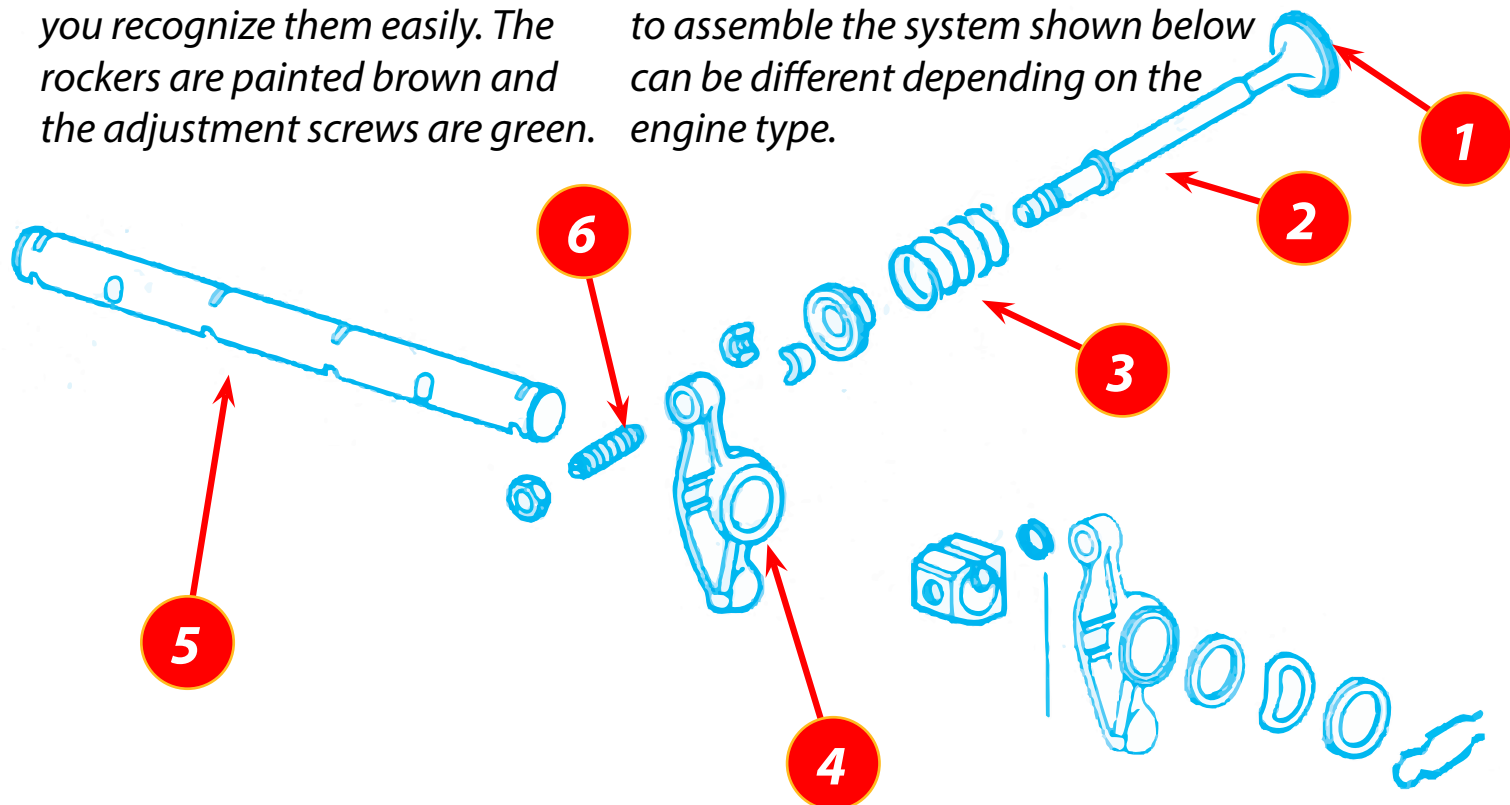
The valves need to open and close to let the fuel mixture in and out, the rockers take care of this (4). These rockers are mounted on an axle (5). The rockers have an adjustment screw (6) that allows to adjust the valve clearance (7). The rockers are usually not delivered together with a new cylinder head (8), you need to use the old ones or buy them separately.





8 We show above a cylinder head including the valves and rockers. The valve springs are painted blue so you recognize them easily. The rockers are painted brown and the adjustment screws are green.

Below, the technical drawing showing the valve stem, the valve, the rocker and the rocker axle. All these parts are available via our webstore. The parts and the number of parts to assemble the system shown below can be different depending on the engine type.

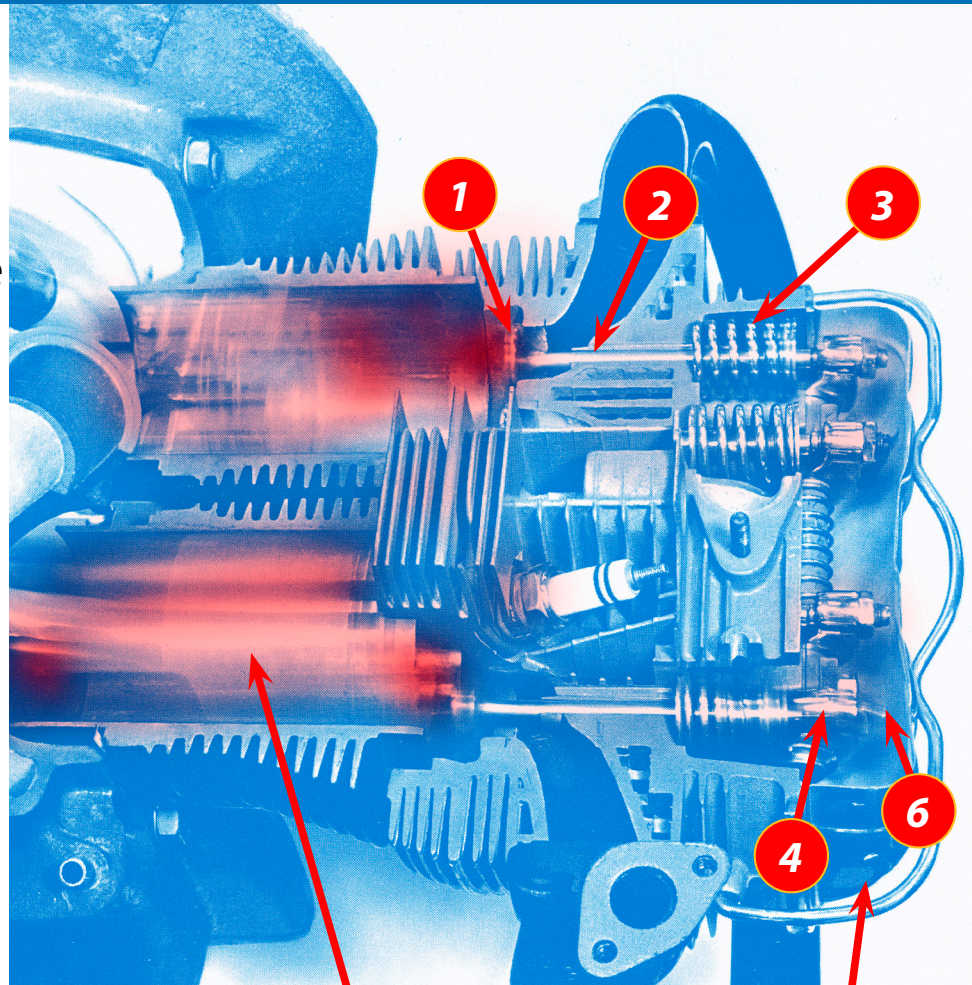


what is valve clearance?

Valve clearance

There is a need for some clearance between the valve stem (2) and the rocker (4), the adjustment of the clearance is done using the adjustment screw (6). The valves are continuously in contact with the hot fuel mixture, the temperature of the valves is quite high. If you could watch the inside of the engine while running, you would see that the valves are dark red from the heat deployed inside the cylinder.

We will use the drawing above quite often in this technical series, it shows the inside of the cylinder and cylinder head. The valves are made from a very high quality steel that resists high temperatures.



Piston

Valve cover

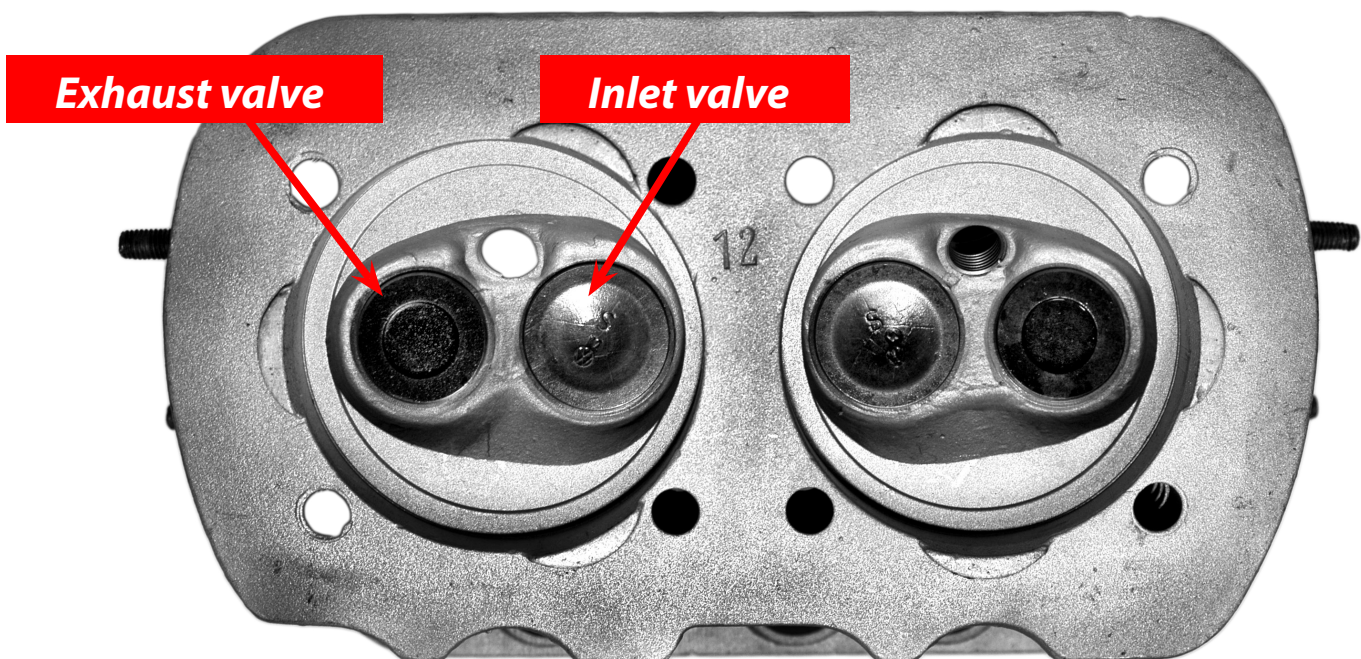
The valve stem will extend due to the high temperature. To be sure that the valves will close under all circumstances (cold and hot engine) we need to have some clearance between the valve stem and the rocker.

Cooling

It is important that the valves close properly but it is also important that the valves are kept cool. The valves have to absorb a lot of heat from the inside of the cylinder, making sure this heat is dissipated is crucial for the survival of your engine. The cooling happens because the valve seat and the valve are touching and because the valve seat is much cooler than the valve. The exhaust valves get much warmer than the inlet valves.

If the valve clearance is too small, the contact between the valve seat and the valve will not be sufficient. The valve temperature will rise so high that the valve will burn.

We show a cylinder head below seen from the cylinder side, you can see the 2 inlet valve and the 2 exhaust valves, under the valves are the valve seats.



what is valve clearance?

Fuel mixture

If the valve clearance is too big, the valves will open too late and they will close too soon. This will create an annoying (or familiar) ticking sound, but is not the main problem. The main issue is that the valves will open for a shorter time than wanted.

The inlet valve will open for a smaller period of time, so there will be not enough fuel mixture flowing into the cylinder. The exhaust valve will open for a smaller period of time will not be able to get the exhaust fumes out of the cylinder. It is clear that there will be some performance issues.

The cylinder head (view from the outside), we will explain how to adjust the valves in the next issue of this magazine.



Too much or not enough?

It is now clear that the sound of the engine is not always a good diagnose to find out if the valve clearance is fine. The less sound the engine makes, doesn't mean the engine is well tuned.

Not enough valve clearance:

The valves open too fast and close too soon, the valves don't get enough time to cool down and will burn-in. The valves are not closing as they should, the performance of the engine goes down. The engine makes a ticking sound.

Too much valve clearance:

The valves open too late and close too soon. The engine will not perform well due to too much valve clearance.

If you have to choose between too much or not enough, I guess choosing a **too big valve clearance** is less dangerous than a too small valve clearance.

Adjust the valves

Well adjusted inlet valves and exhaust valves are essential. It makes no sense to start with the adjustment of the ignition or carburetors before you make sure that the valves have the corrected clearance.

We will discuss the valve clearance in the next edition of this magazine.

Performance engines

If you have a performance engine with chrome push rods, you need to follow other rules than described earlier. High performance engine valves are adjusted at operating temperature to have zero clearance. These push rods tend not to extend with heat, or very little. Setting the valve clearance at 0.15 mm for these type of engines would not be a good idea. Ask the engine manufacturer for the specs.



what is valve clearance?



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