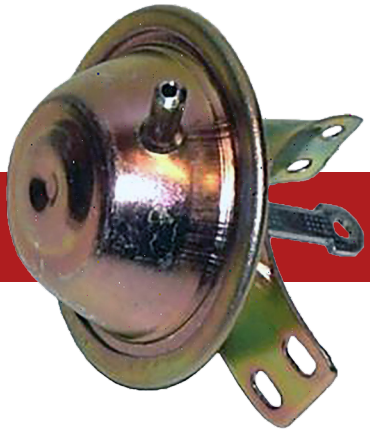
# Paruzzi Magazine

*Technical Publication for the classic Volkswagen*

11

## #31- Engine: crankshaft end play

page 04



## #32- Electrical: check the vacuum advance

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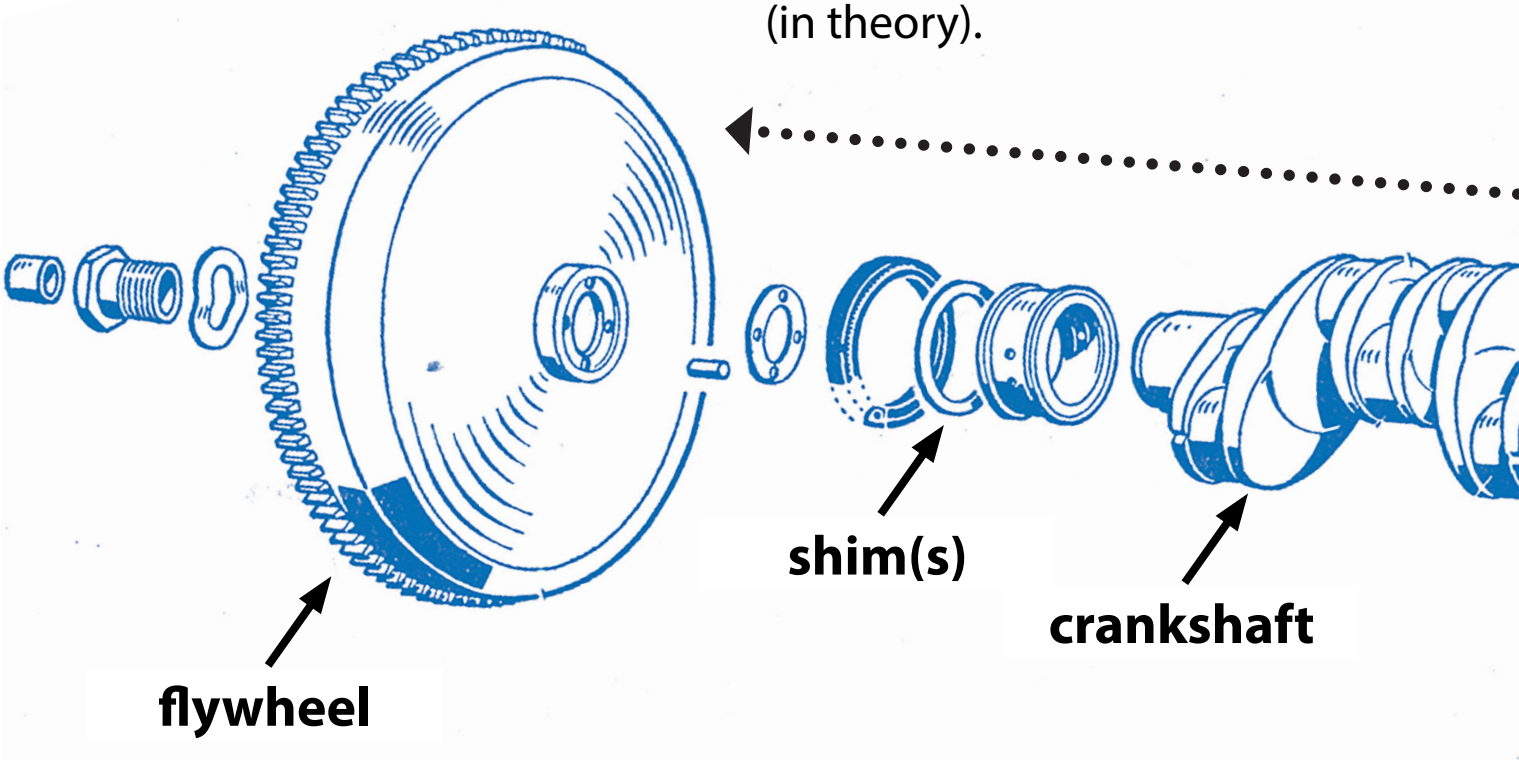
Paruzzi
CLASSIC CAR PARTS

## Introduction

We explained in edition 10 what the crankshaft clearance is, to be more precise the axial crankshaft clearance. We will explain in this article how to measure the clearance, or as the title says, checking the crankshaft end play. We won't explain how to adjust the end play yet, this is a complete different story. You can't just add or remove shims to adjust the clearance! This could have a disastrous result for your engine.

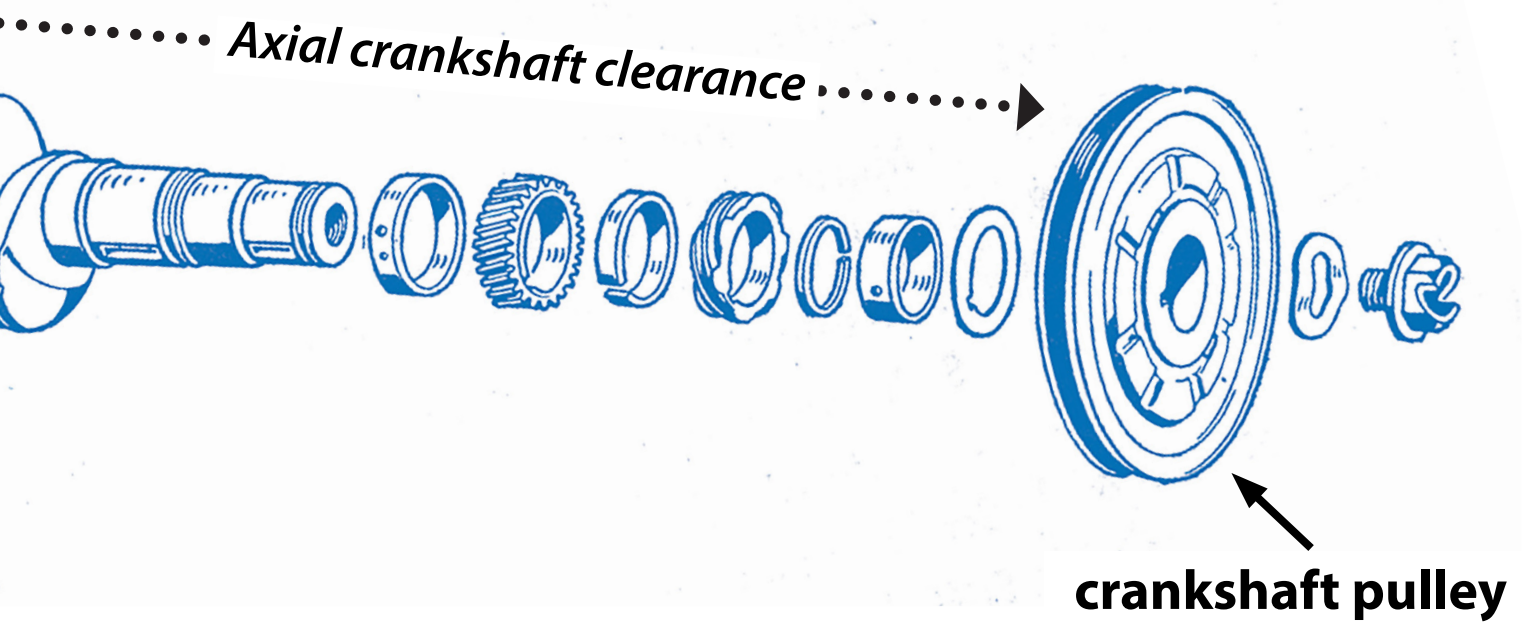
So, for now we will only check if the end play is within factory specifications to evaluate if your engine needs a complete overhaul, or not. We show on the drawing below what the axial crankshaft clearance is. You can measure the clearance on both sides of the crankshaft, on the crankshaft pulley side (right hand side on the drawing) and on the flywheel side (left hand side). Both measurements should result in the same value (in theory).



# crankshaft end play

How is it possible that the clearance gets bigger over time? This is due to wear of the engine parts, it is quite normal, the wear will happen faster on performance engines. The crankshaft clearance (or end play) will not evolve very quickly if the engine is not overloaded. Well maintained factory VW boxer engines will not wear that fast.

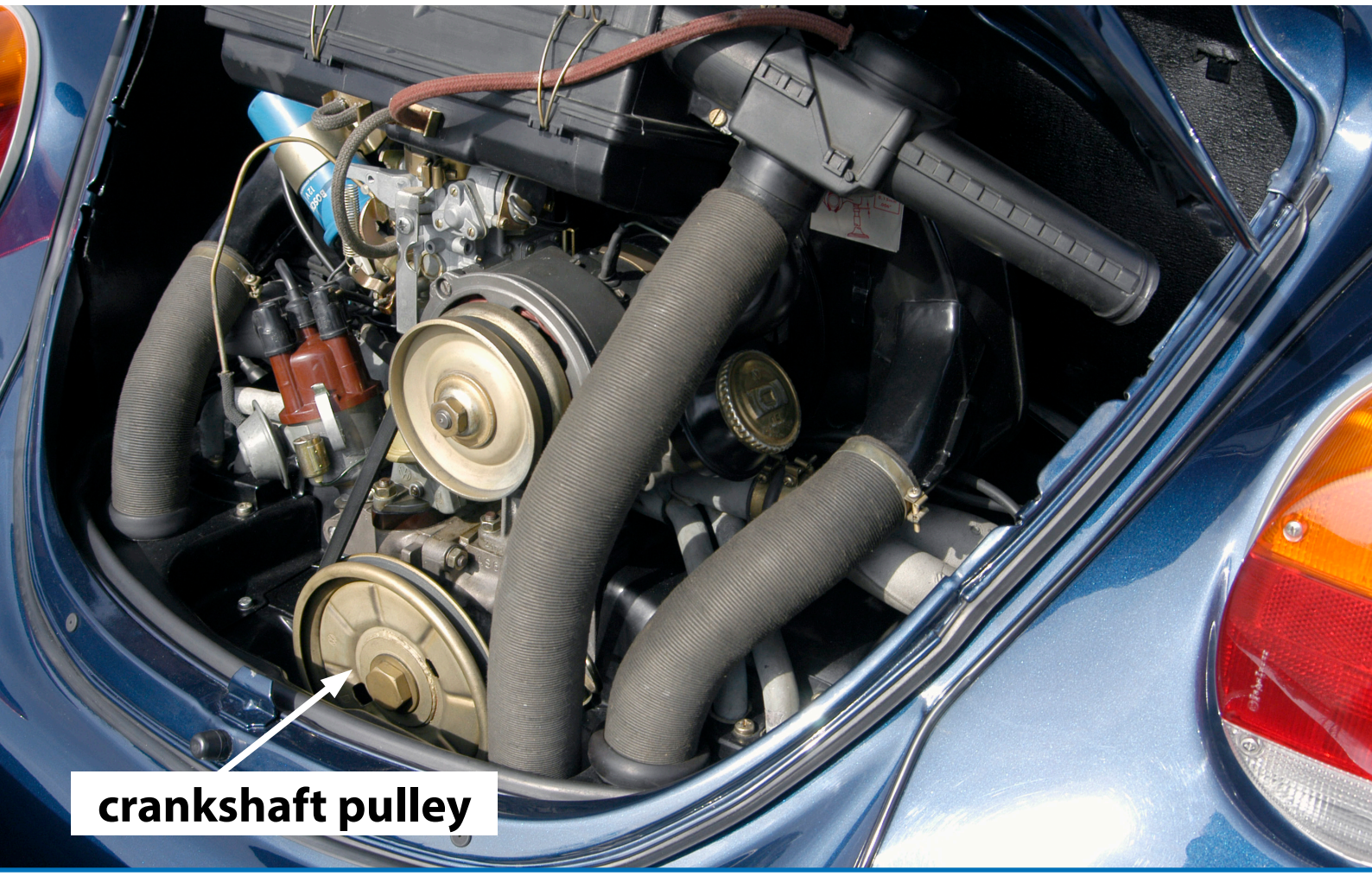
The crankshaft rotates in an oil bath in the engine crankcase. If the clearance is to big, there will be an excessive play on the pulley side and on the flywheel side. Oil leaks will appear around the flywheel and the crankshaft pulley as a result. We explained in edition 07 and edition 08 all the sources of excessive oil consumption.



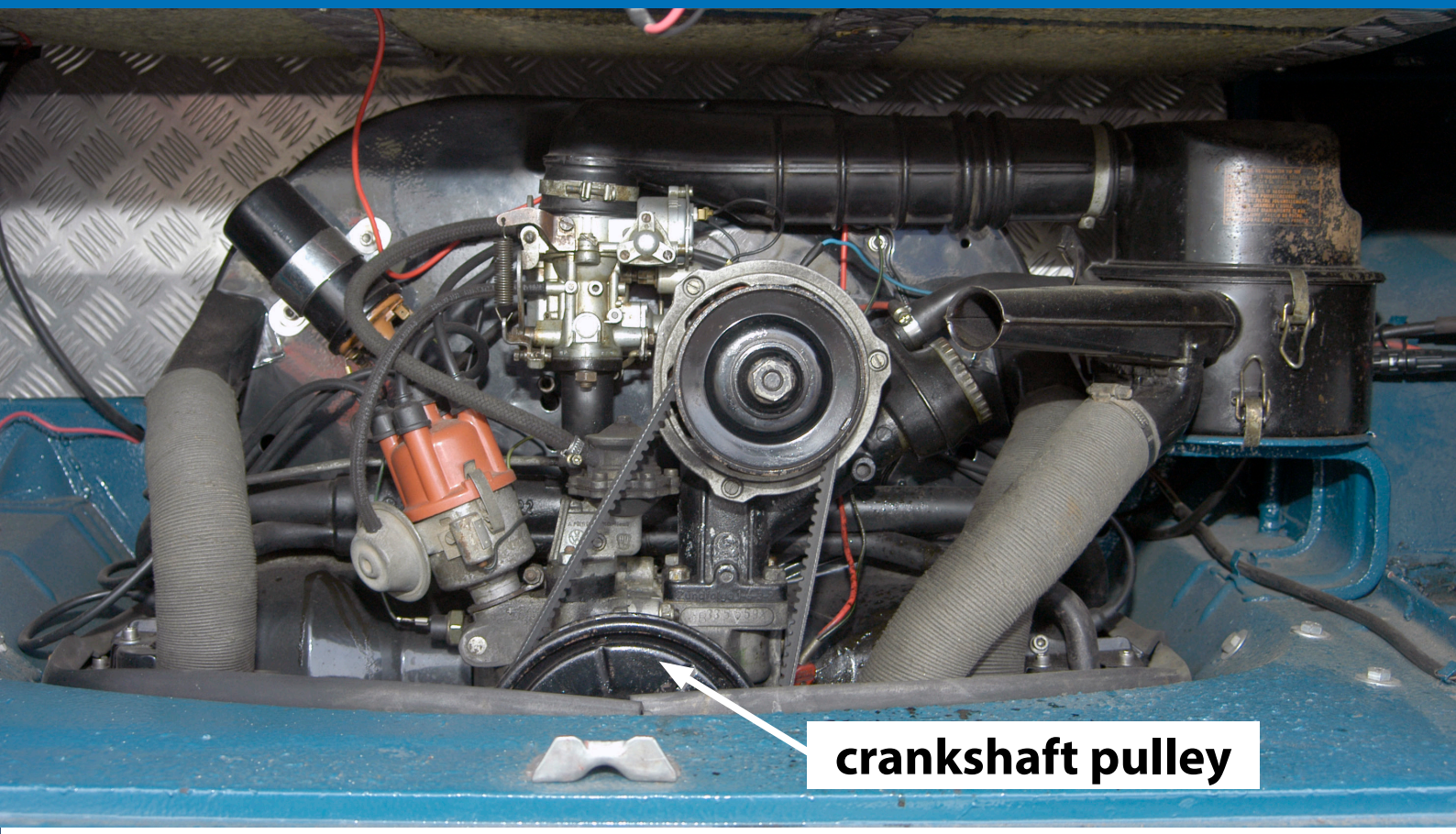
# Measuring crankshaft end play

## *1. Crankshaft pulley side*

You can check the crankshaft end play while the engine is installed in your VW, or for a more accurate reading you could decide to remove the engine. With the engine installed you can measure the clearance on the crankshaft pulley, this will not give you a very precise value because there is a lot of resistance caused by the pistons and the connecting rods. It is also quite difficult to measure the play because there is not a lot of room between the pulley and the metals sheets as shown on this VW 1303 Beetle engine below.



# crankshaft end play




The picture above show the engine bay of a VW Bus, also not too much space to work on this type of engine. But, this type of measurement is easy to do in a few minutes and it is sometimes enough to have a first impression of the health of your engine.

Push the crankshaft pulley forward and pull backwards, you should feel a little clearance. A healthy engine should have a crankshaft clearance of 7 to13 hundredths (0,07 – 0,13 mm) of a millimeter.

You should be able to feel 0,07 to 0,013 mm without measuring equipment. If the crankshaft pulley tends to move back and forth with a "clunking" noise, the clearance could be to high. The next step would be to remove the engine and to measure the crankshaft clearance on the flywheel side using a dial indicator. To access the flywheel you will need to remove the engine and the clutch assembly, this could take a few hours depending on the type of engine and the state your car is in.

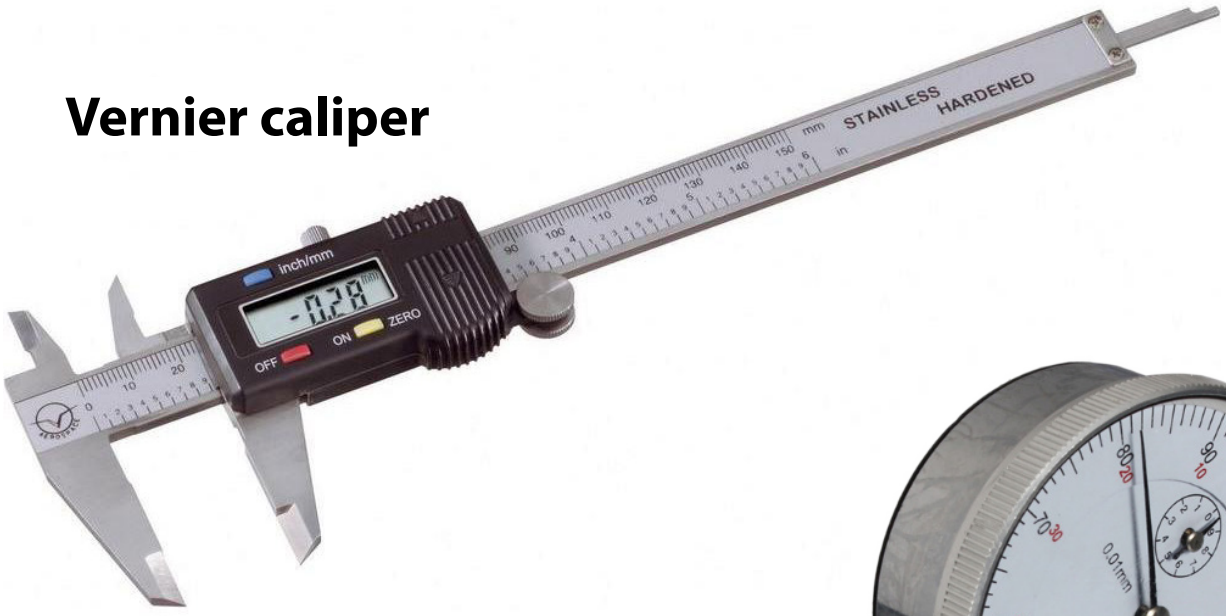
# #30 Engine

The quick check we just explained is something I tend to do every year during the maintenance of my Volkswagen.

Once your engine is removed you will have much more room to access the crankshaft pulley. To have a better measurement you could decide to check the crankshaft clearance by using a dial indicator as shown below, or a Vernier caliper.

The dial indicator is a better tool for this type of measurement. You don't need a very expensive one because the measurement you need to do here shouldn't be very accurate. You are not rebuilding an engine at this stage, just checking if the end play is within specs. If you plan to spend a lot of time in your workshop, investing in a good dial indicator is not a bad idea.

**Vernier caliper**

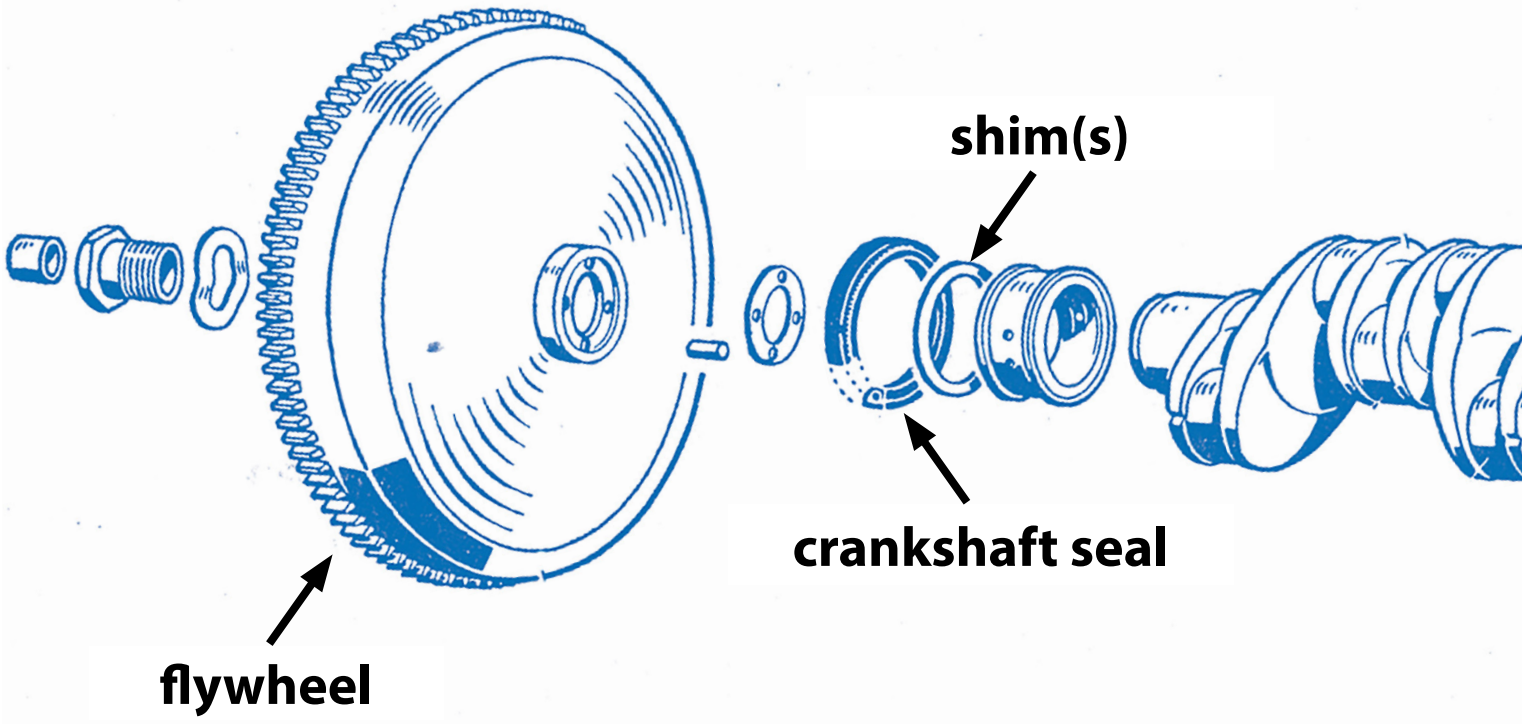



**dial indicator**

# crankshaft end play

Engines with high mileage could have a clearance up to 0,20 mm, this value is quite normal and you shouldn't worry about it. Start worrying when the clearance (or end play) is higher than 0,30 mm, then there is probably a lot of wear in the crankcase, crankshaft and the main bearings, your engine needs a complete overhaul. If the clearance is excessive, you should see a lot of oil leaking around the flywheel. We explained all the oil leak sources in edition 07 and edition 08, the crankshaft (flyweel side) bearing is one of them.

We will explain how to replace the crankshaft seal on the flywheel side in the next edition of this technical series. It makes no sense to replace the crankshaft seal on an engine with excessive end play (above the 0,30 mm spec). A new bearing will not solve the problem of the oil leak, it is a waste of time and money. Many unexperienced owners will try to reduce the end play by adding or adapting the shims, but never do that, please! Changing the shims setup on an "old" engine will have dramatic consequences for your engine.



As we said earlier, you can measure the crankshaft clearance on the crankshaft pulley side by hand or with a dial indicator. It is less precise than the measurement on the flywheel side (we will do that later in this article). It is easier to setup the dial indicator when the engine is removed. It is also possible with the engine in the car, but not so comfortable. We show the setup with engine removed on page 11.

Make sure the engine is not positioned in a "power stroke" so that the resistance of the pistons and connecting rods is as low as possible (refer to the concept of the Otto engine in edition 06). Rotate the generator pulley (dynamo or alternator, this is the top pulley on a type 1 engine) to find the lowest engine resistance. If the engine is still installed, make sure the clutch free play is set correctly (refer to edition 06 and edition 09) to understand how the clutch works.

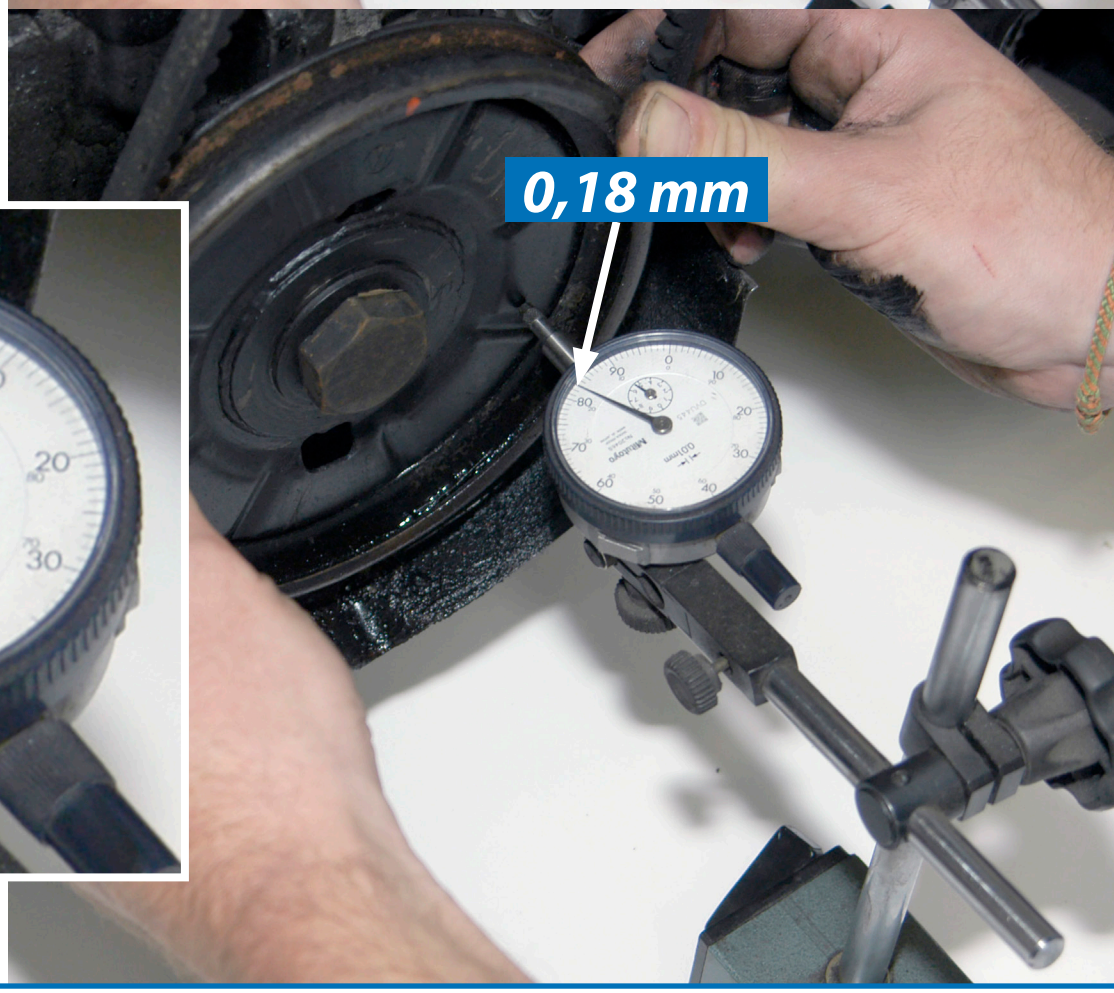
Read the dial indicator manual before you continue, every dial indicator is a little different. The general principals are the same but make sure you understand how it works.

Position the dial indicator against the crankshaft pulley to measure the end play or clearance. You will have to be creative sometimes to position the dial indicator. We show how to do that on page 11, using a magnetic base anchored on a metal plate. When pushing the crankshaft pulley forward we measured a play of 0,18 mm. Up to 0,20 mm is acceptable as explained earlier. But as we also said earlier, the end play measurement on the crankshaft pulley is not so accurate, but it is just fine to get a quick impression of the crankshaft end play. If you measure an end play close to 0,30 mm, you will need to measure on the flywheel to be sure, before deciding to overhaul your engine.



# crankshaft end play

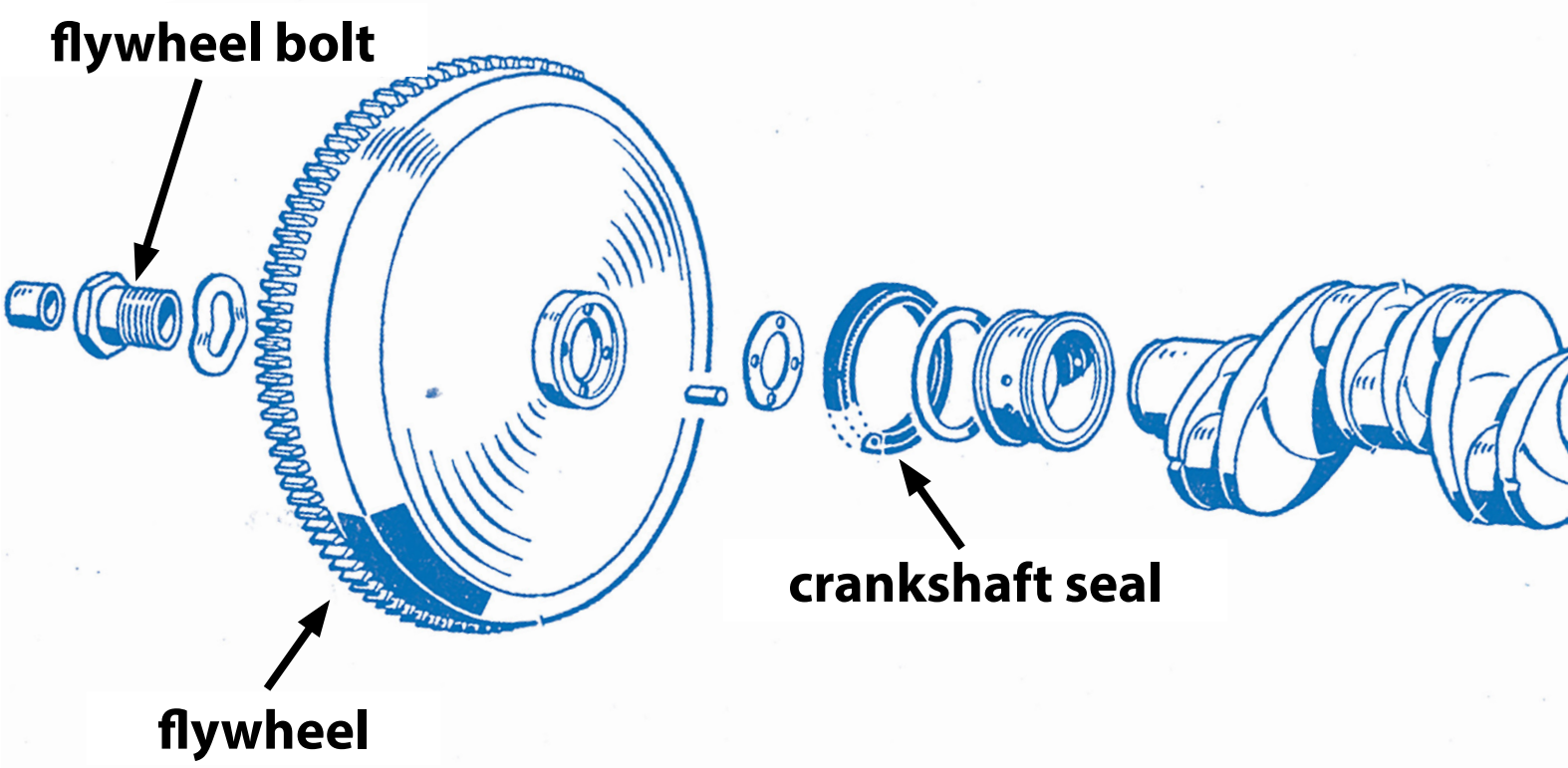


## 2. Flywheel side

Measuring the crankshaft clearance (or end play) on the flywheel side is much more accurate than measuring on the pulley side. But, it is of course much more work. You will need to remove the engine and the clutch assembly to access the flywheel. We explained how to remove the clutch assembly in edition 09.

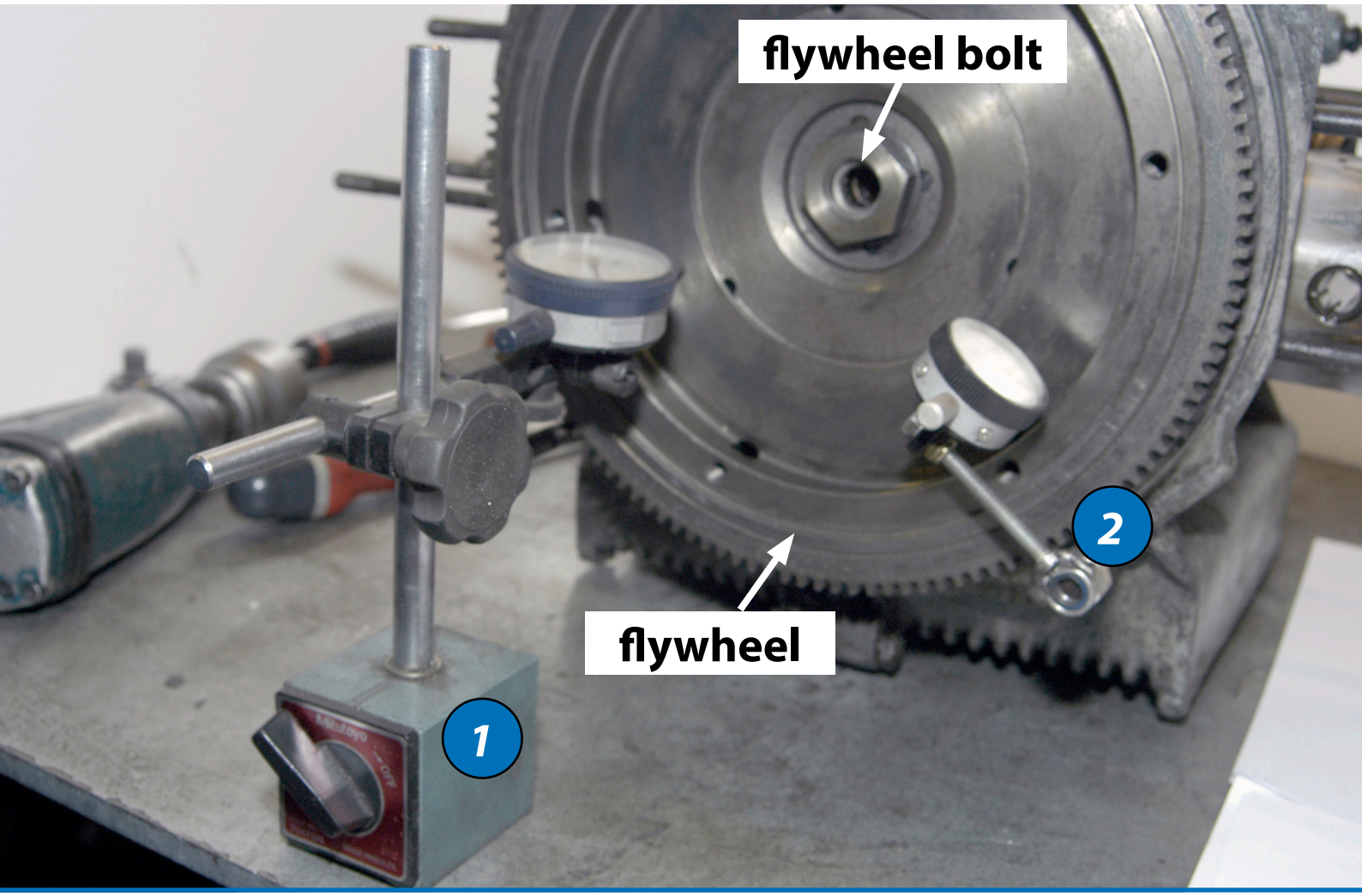
This is a much more reliable technique, the result can be used to decide about what you need to do next. If the end play is lower than 0,20 mm you could decide to replace the crankshaft seal to solve the oil leak. If the end play is higher than 0,30 mm you will need to overhaul your engine, replacing the crankshaft seal will have no effect because the end play is too high anyway.



# crankshaft end play

The gland nut should be firmly tightened (doesn't have to be at 350 Nm). The crank seal will create some resistance, ideally disassemble the seal first to get a better feel for the play. The crankshaft pulley should be mounted.

Makes sure the engine is not positioned in a "power stroke" as explained on page 10. Install a dial indicator against the flywheel, we show two techniques to do that below (1. using a magnetic base and 2. with our in-house developed tool secured on the crankcase).



# #30 Engine

# crankshaft end play

De setup with magnetic base (shown as circle with number 1 on page 14) needs a workshop table with a metal surface. The switch is used to push a magnet onto the table to secure the dial indicator base.

The second setup is shown below on this page (circle with number 2). We developed our own tool to secure the dial indicator onto the crankcase as you can see on the picture below. Both setups are working fine.

# #30 Engine

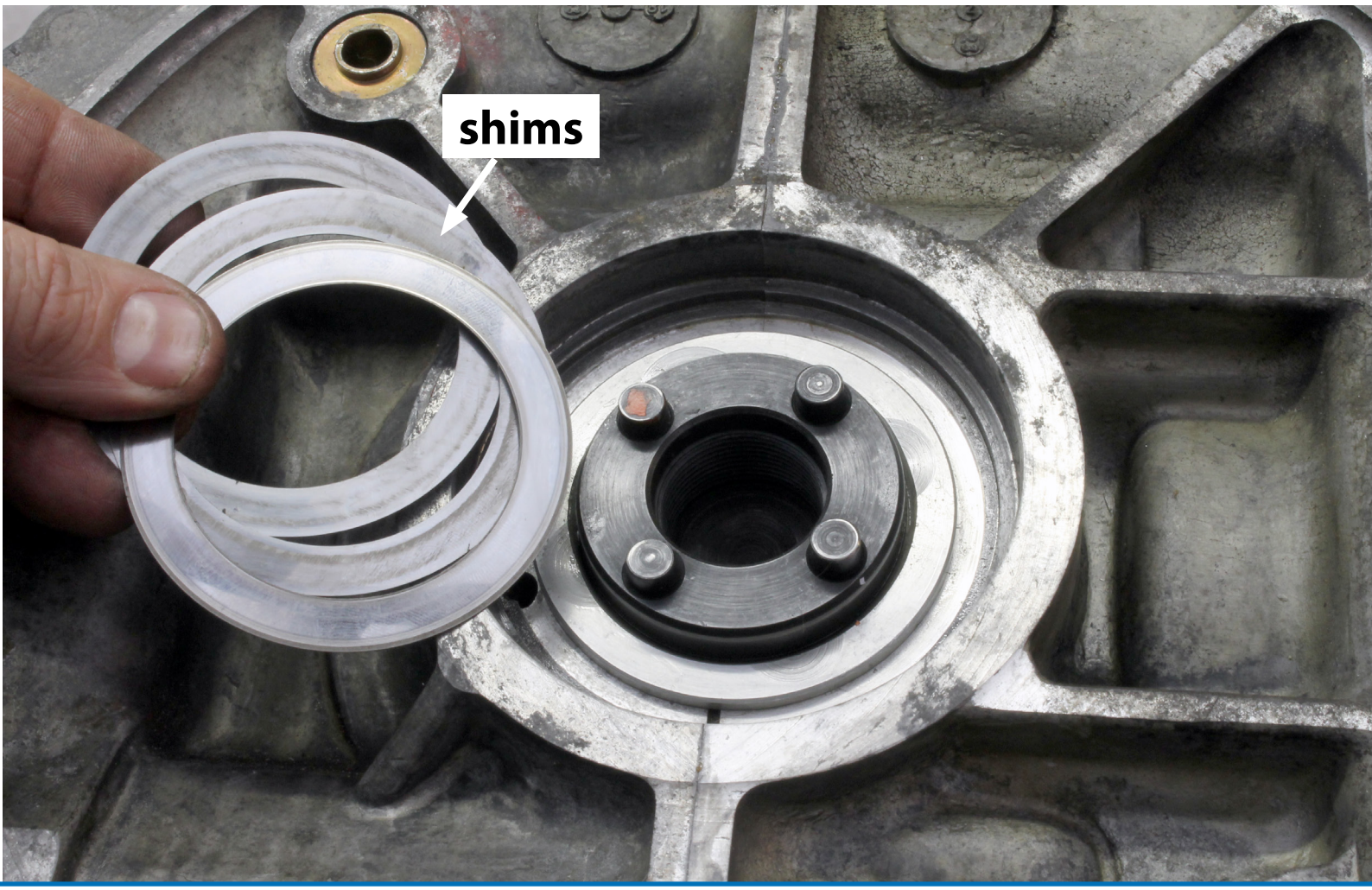

Once the dial indicator is installed against the flywheel, push the flywheel forward and position the dial gauge on the zero line (read your dial indicator manual to know how to do that). Then pull the flywheel and read the dial indicator. This is the crankshaft clearance or end play.

We measure 0,20 mm now while we measured 0,18 mm on the crankshaft pulley earlier. Only 0,02 mm difference. The end play value is lower than 0,30 mm so our engine is still in pretty good shape and replacing the crankshaft seal makes sense. Replacing the bearing when the end play is bigger than 0,30 mm makes no sense, only a complete engine overhaul will help.

## Adjusting the axial clearance

Adjusting the end play (or crankshaft clearance) should only be done during a complete engine overhaul. **Replacing the adjusting shims to adjust the end play is only allowed during a complete engine overhaul!**

Three shims are used to adjust the end play. These shims are available in different thicknesses. You will use different shims to achieve the factory specified crankshaft end play. These shims are available in sizes between 0,24 mm and 0,36 mm. We won't explain how to do that right now, this will be explained when we talk about engine overhaul.

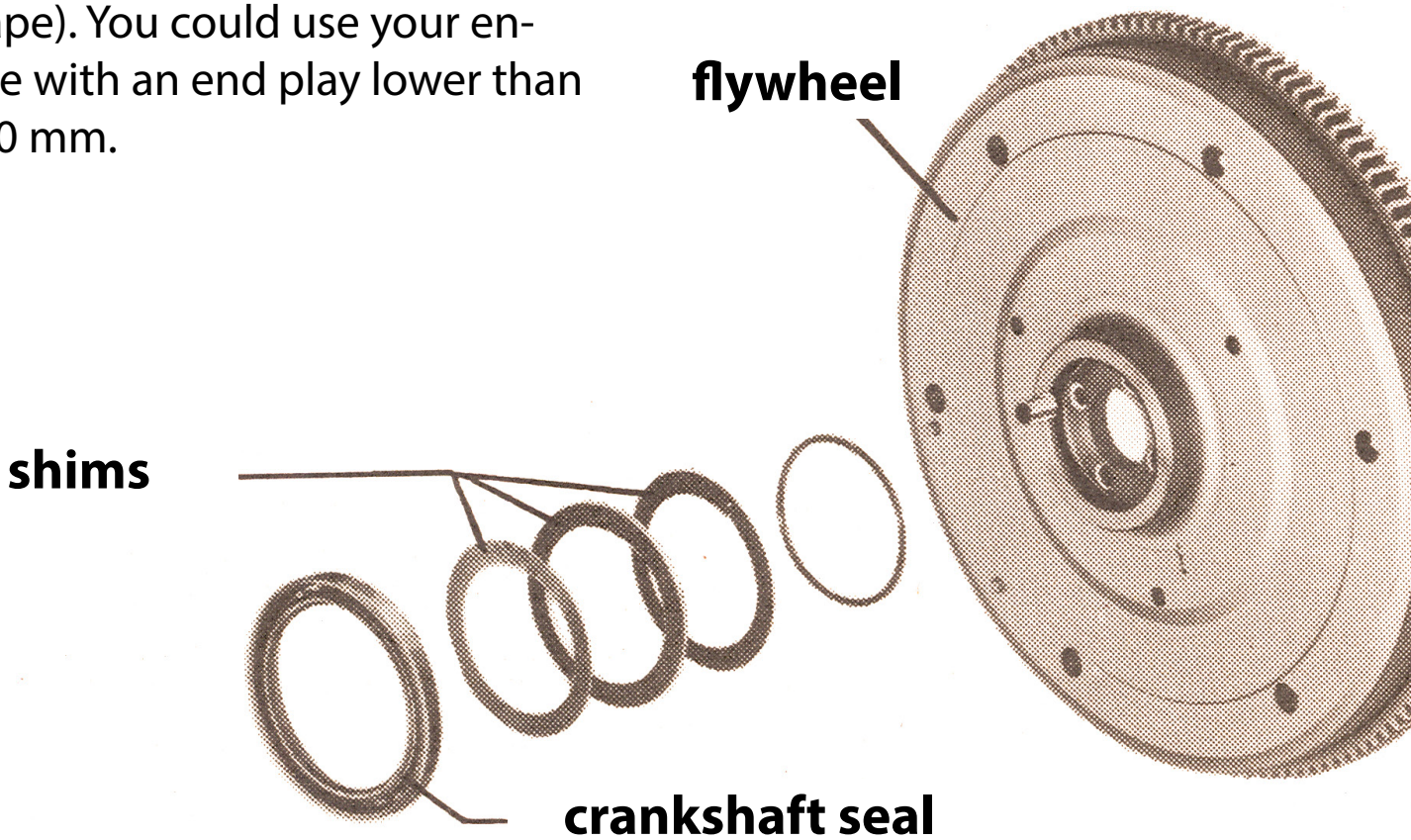


## Conclusion

The crankshaft clearance (also known as end play) is an important value that will tell you if your engine is still fine or if it needs a complete overhaul.

A new engine will have an end play between 0,07 mm and 0,13 mm. Your engine shouldn't leak oil if the end play is lower than 0,20 mm (if the crankshaft pulley and the crankshaft seal are well installed and in good shape). You could use your engine with an end play lower than 0,30 mm.

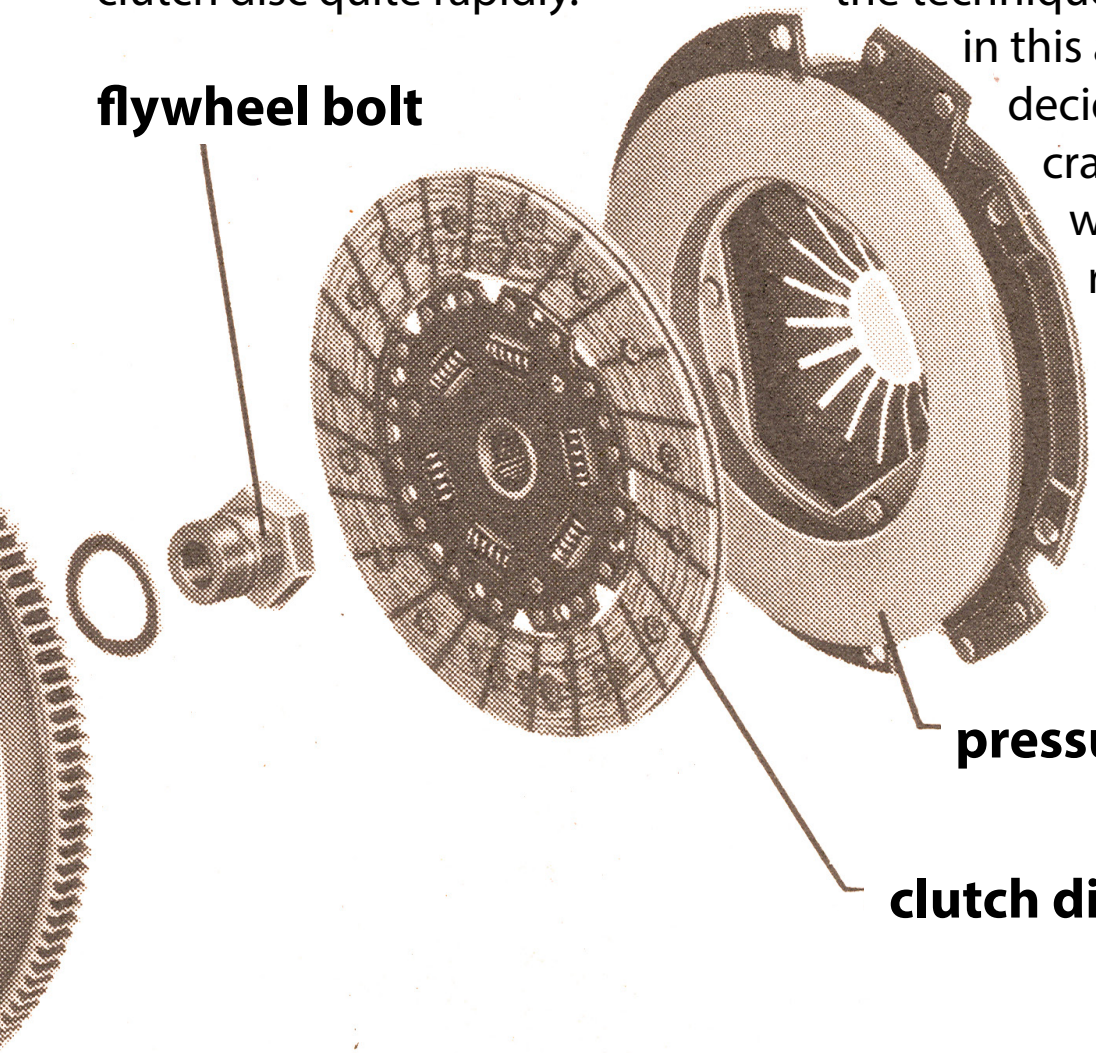
Your engine will need a complete overhaul when the end play is bigger than 0,40 mm. You can drive your car with an end play higher than 0,40 mm of course, if you don't mind a high oil consumption, a dirty crankcase and leaking engine oil on the road making (we don't advise this of course). At some point of time your clutch assembly will be so dirty that you will have to overhaul your engine anyway.



# crankshaft end play

The drawing below shows clearly that when the end play is to big, oil will drip through the crankshaft seal. The clutch assembly is installed between the flywheel and the crankcase, the leaking oil will damage the clutch disc quite rapidly.

We experience this same issue over and over, VW owners replace the crankshaft seal while the crankshaft end play is too big. It is a waste of time and money. So, make sure you measure the end play using one of the techniques we explained in this article before you decide to replace the crankshaft seal. We will explain how to replace the crankshaft seal in the next edition of the series.




Paruzzi
CLASSIC CAR PARTS


FG 984H

## How it works

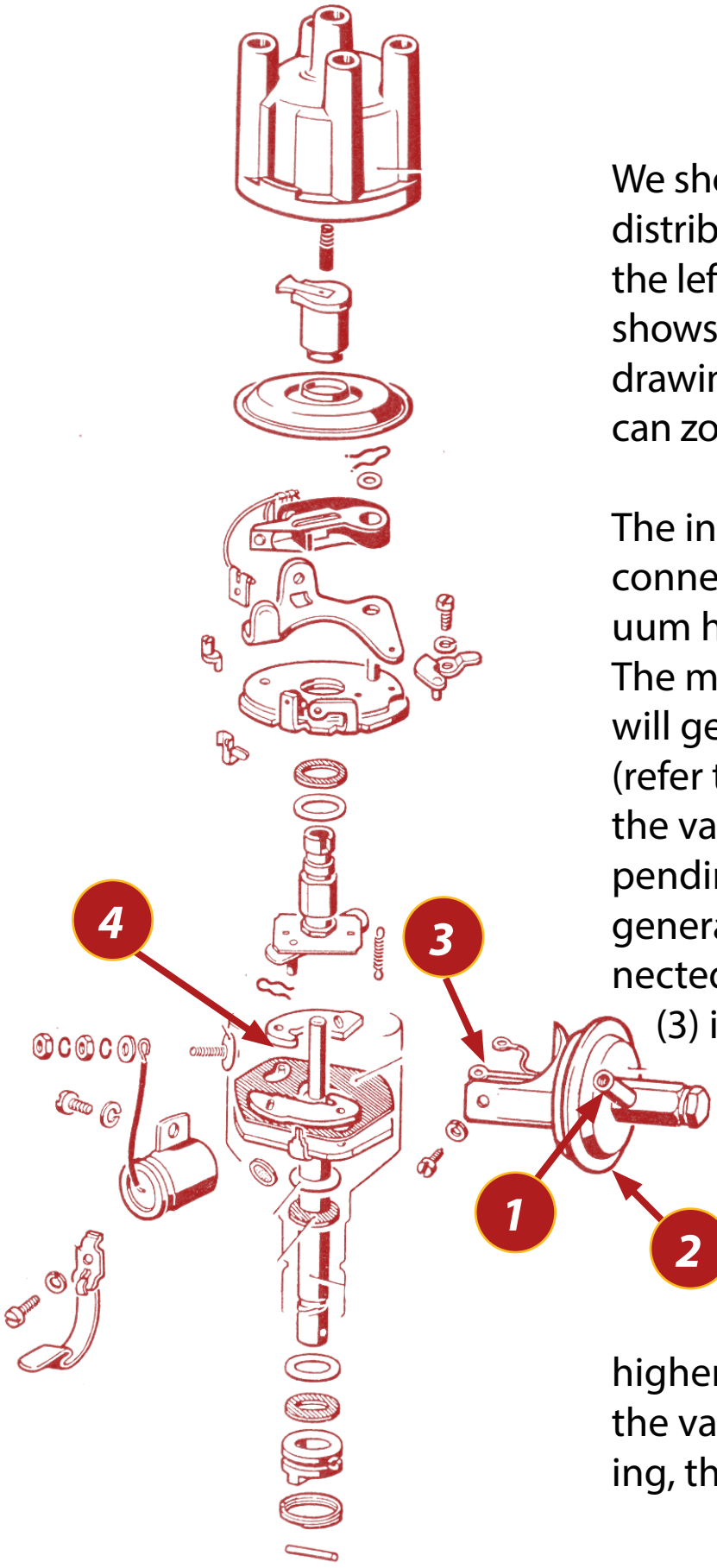
We explained the concept of the ignition of our classic Volkswagen in the previous edition of this technical series. The ignition advance principles were explained on page 22 and starting on page 24 of the previous edition we introduced the two types of advance used in the air-cooled Volkswagens.

Both types of ignition advance have been used on our classic Volkswagen such as the VW Beetle, Karmann Ghia, VW Bus, VW Thing/type 181, type 3 and type 4. You can't associate a specific built year or model with the mechanic advance or vacuum advance. But, both systems do exactly the same, they advance the ignition moment when the engine accelerates.

We will explain how the vacuum advance works. You can recognize a distributor with vacuum advance to the vacuum housing installed on the distributor housing as shown on the picture on the left hand side.

We will explain more in detail now how the vacuum advance works before we start checking if it works. This will help to better understand what you do during the test.

# check the vacuum advance

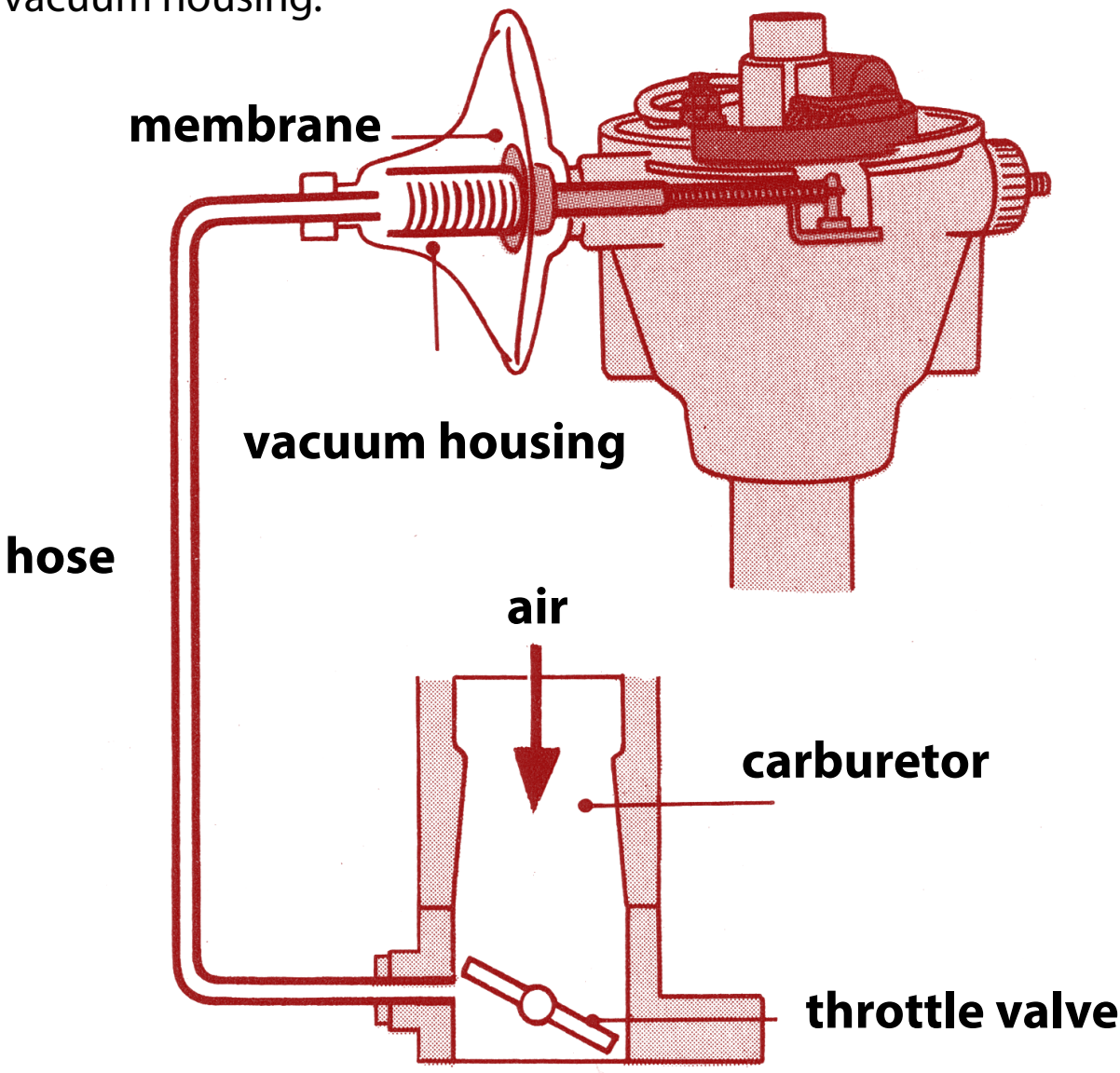



We show a technical drawing of a distributor with vacuum advance on the left hand side (the drawing also shows a mechanical advance). If the drawing is not detailed enough, you can zoom in if you want.

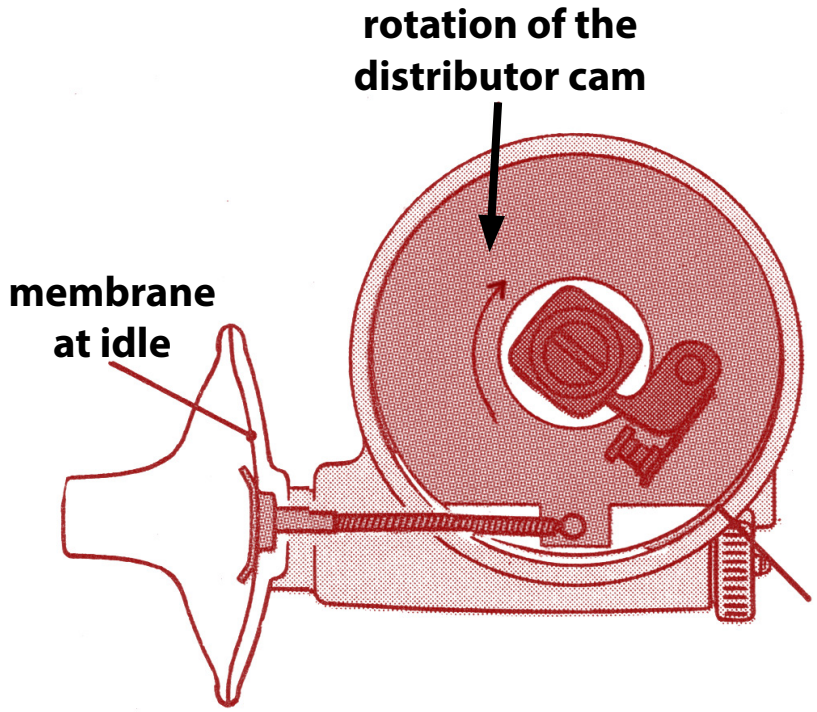
The inlet manifold or carburetor connects with a hose (1) to the vacuum housing (2) on the distributor. The moving pistons in the cylinders will generate a vacuum in this hose (refer to edition 10). A membrane in the vacuum housing will react depending on how much vacuum is generated. This membrane is connected via a shaft to the base plate (3) in the distributor. When the shaft moves outwards the base plate rotates and the distributor cam will move in relation to the ignition points. This is how the ignition time is advanced, the higher the engine runs the stronger the vacuum in the vacuum housing, the more ignition advance.

The drawings on this page and the next page explain the concept of the vacuum advance more in detail. Below is the intersection of a carburetor also showing the air intake (from the air filter) and the throttle valve. The vacuum hose connects the carburetor (or inlet manifold, depends on the type of engine) to the vacuum housing.

On page 25, we show the top view of a distributor with vacuum housing. The first drawing (top) is showing the distributor at idle speed with the membrane in resting state. The second drawing shows the distributor at higher engine speed, you see the membrane expanded.



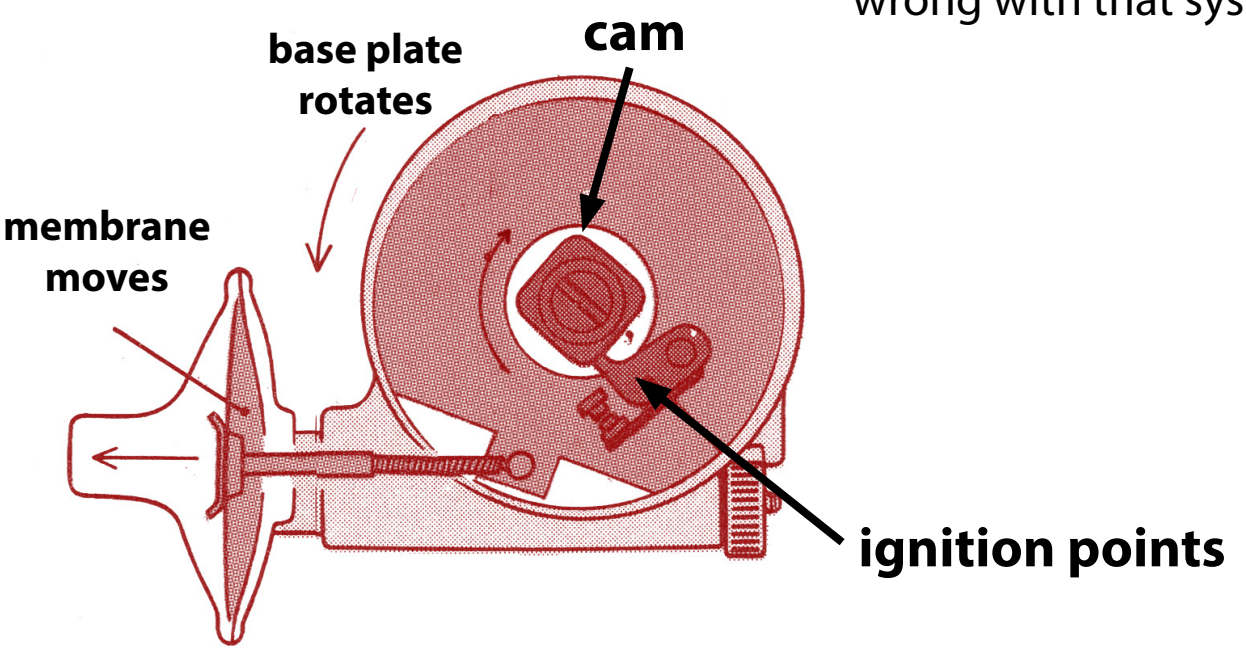
# check the vacuum advance




**no advance**

Once the membrane is fully expanded at high engine speed the shaft rotates the distributor base plate to achieve the maximum advance. Look carefully at the position of the cam in relation to the ignition points. This is exactly what you want to achieve, the ignition time is advanced when the engine runs faster.

Now that you have a better understanding on how the vacuum advance works, we can discuss what can go wrong with that system.



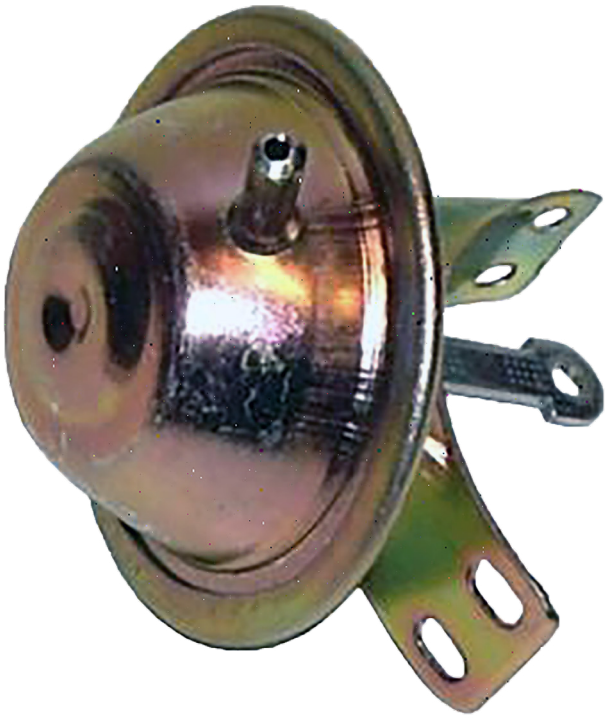

**maximum advance**

## Diagnose

The vacuum advance system is very simple as we just explained, so, what can go wrong?

**1.** The membrane in the vacuum housing could get damaged. This doesn't happen too much, but it can happen. The best thing to do then is to replace the vacuum housing, you can order this unit separately, click on the picture to view all vacuum housings available in our webstore.

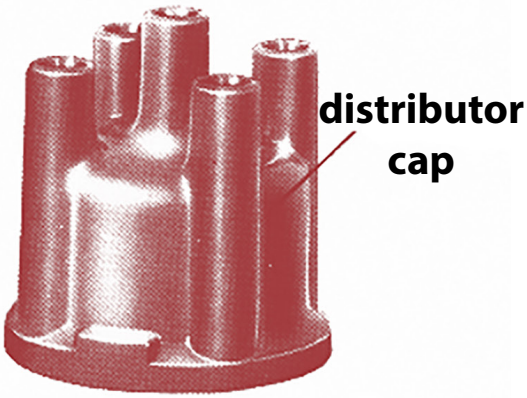
**2.** The distributor base plate could get stuck or be harsh to move. The membrane is not strong enough to rotate the base plate and the advance system doesn't work as it should. Sometimes it is enough to grease the moving parts in the distributor, but be cautious with the amount of grease you use. Use grease that is not too liquid, and don't use too much, you don't want the ignition points to be covered with grease.



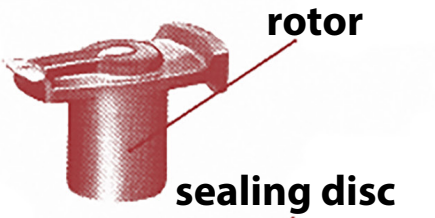
**3.** Maybe the vacuum is not strong enough to move the membrane, check the vacuum hose or replace it if any doubt. A cracked hose will allow additional air to enter the inlet manifold, which creates a poor mixture, the engine will heat up and fail. You will not have problems at idle if the ignition advance doesn't work. The engine will not work well at higher speed though. We will test the vacuum advance first statically and then dynamically. For the dynamic test the ignition circuit should be in good shape, it is not that important for the static test.

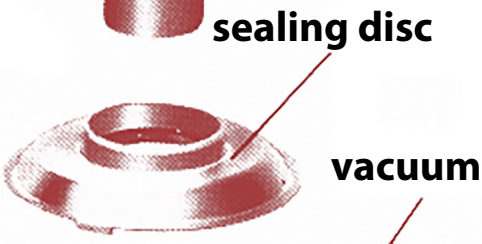
# check the vacuum advance

We show a distributor with vacuum advance on this page. The sealing disc is an important part, it will protect the ignition points against the moving parts at the bottom of the distributor.









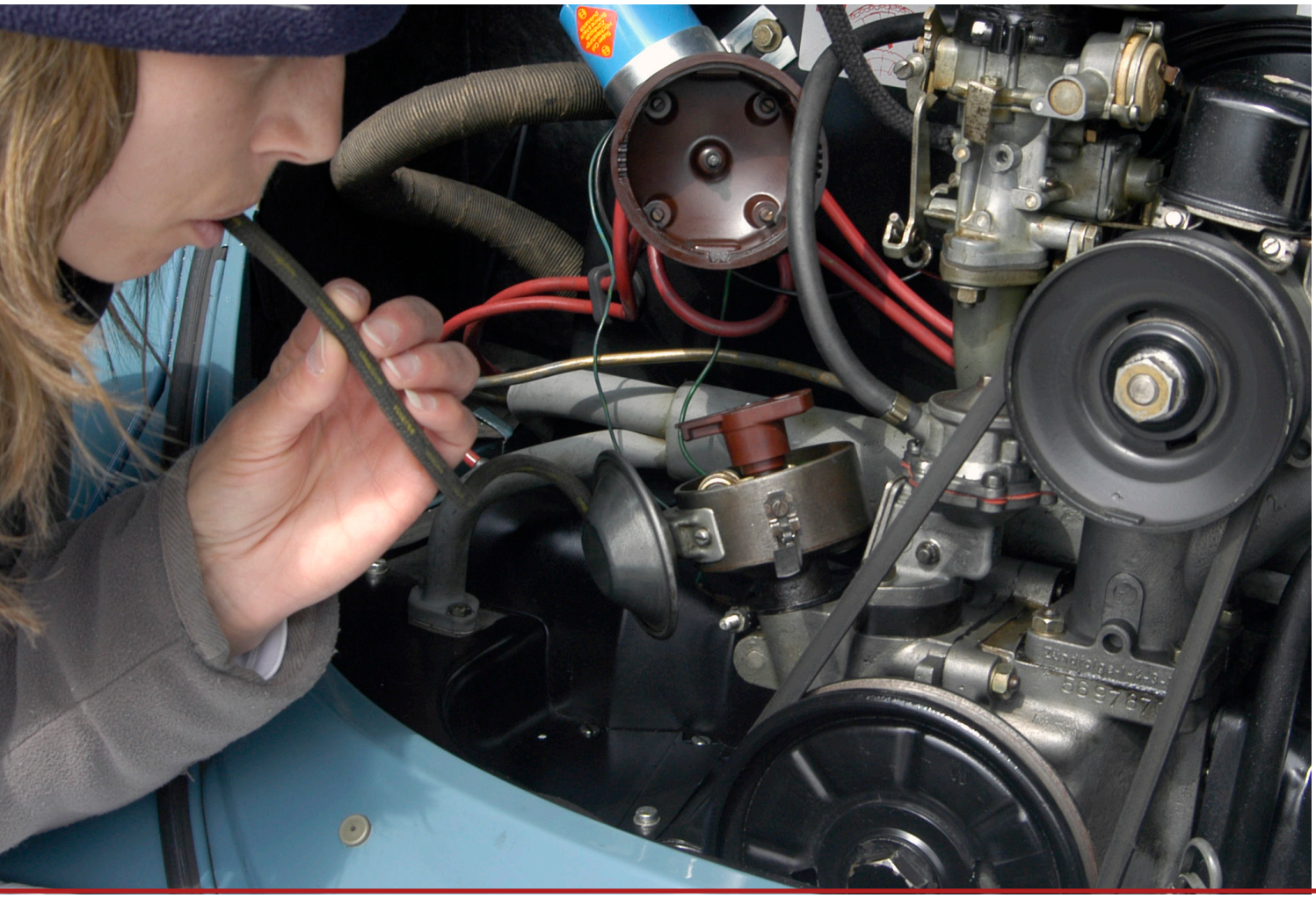

The drawing on the right shows where this plastic sealing disc should be installed. This disc is missing on most old Volkswagens, the ignition point get dirty and the ignition starts to fail because the contacts don't conduct as well as they should.

## Testing the advance

We will discuss two techniques to check if the vacuum advance is functioning properly, the static and the dynamic methods. The **static test** doesn't require the electrical circuit to be in perfect shape, we will check the advance with the engine turned off. During the **dynamic test** we will check the advance while the engine is running. The engine needs to be well tuned when testing dynamically.

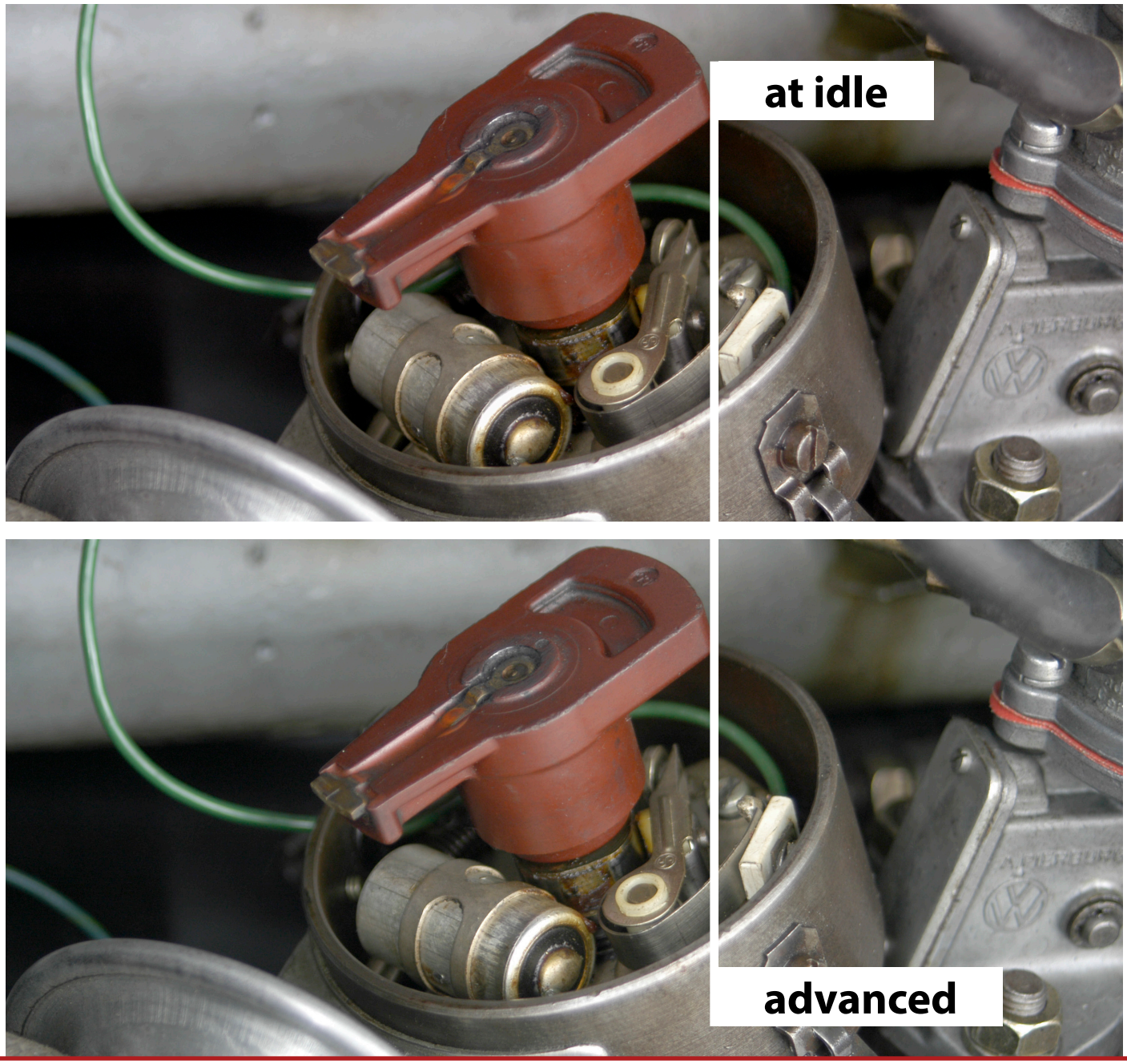
### *Static*

We start with a static check. Turn off the engine, remove the distributor cap without disconnecting the spark plug cables. We will discuss two static testing methods now.



# check the vacuum advance

**Static Method 1**: Disconnect the vacuum hose from the carburetor or inlet manifold, apply suction on this hose as we show on the picture on page 28. The vacuum you create should activate the membrane in the vacuum housing, the base plate will rotate in the opposite direction of the cam. We have added a line on the pictures below to show how the ignition points rotate in relation to the rotor and cam.

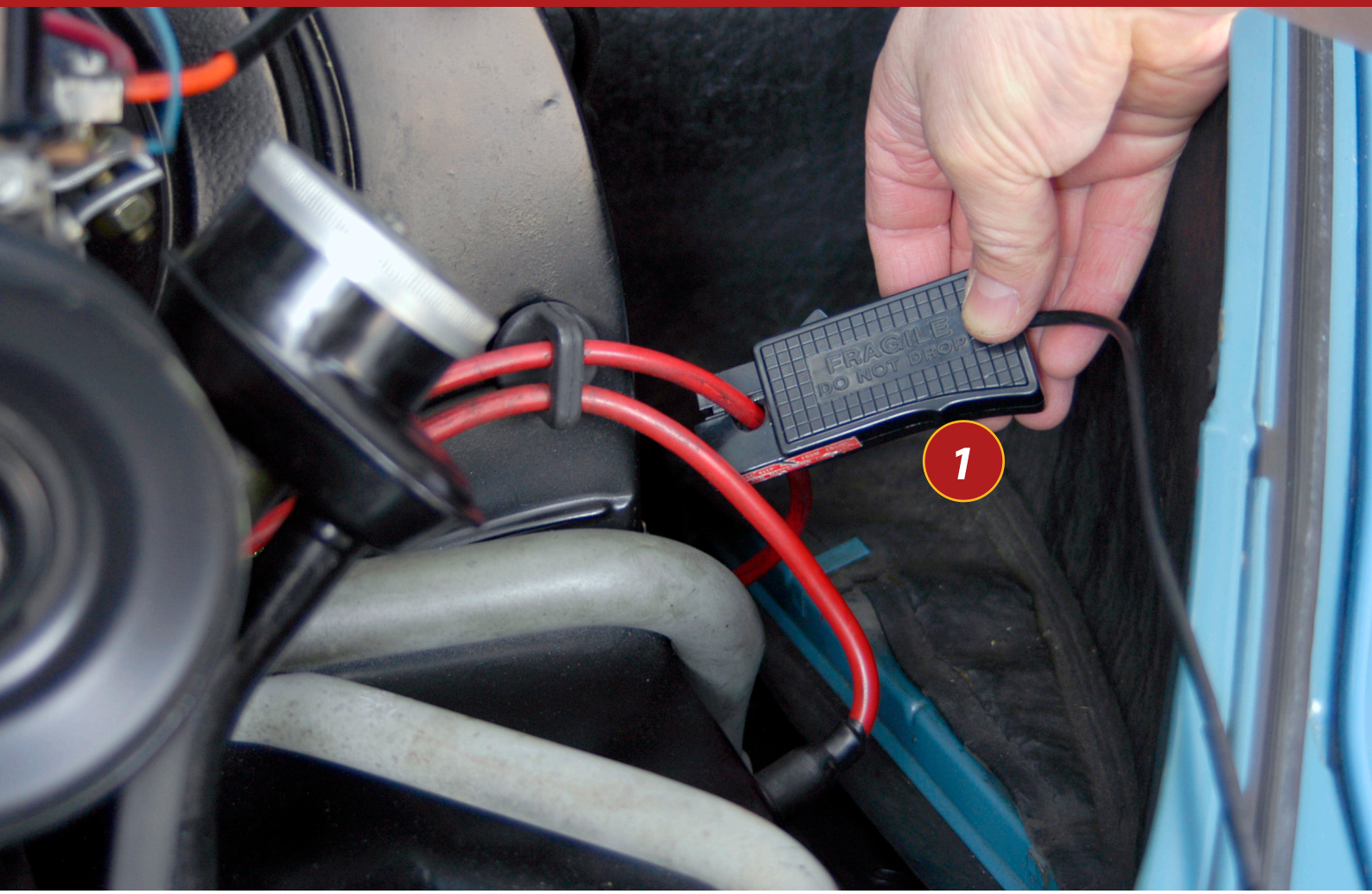


**Static Method 2**: You could also rotate the base plate counter clockwise with a screw driver and then close the vacuum hose with your thumb. The base plate should stay put if the hose, the vacuum housing and the membrane are in good shape. If you suspect that the vacuum housing or membrane is broken, replace it with a new one. If the vacuum hose is old and cracked, replace it.

## *Dynamic*

The dynamic test is done with running engine. You will need an ignition timing strobe light, one as shown below for instance. You'll find strobe lights in every price category, we have one that is very affordable in our web-store, it will do just what you need for an air-cooled engine. Read the manual carefully before using your strobe light.

# check the vacuum advance

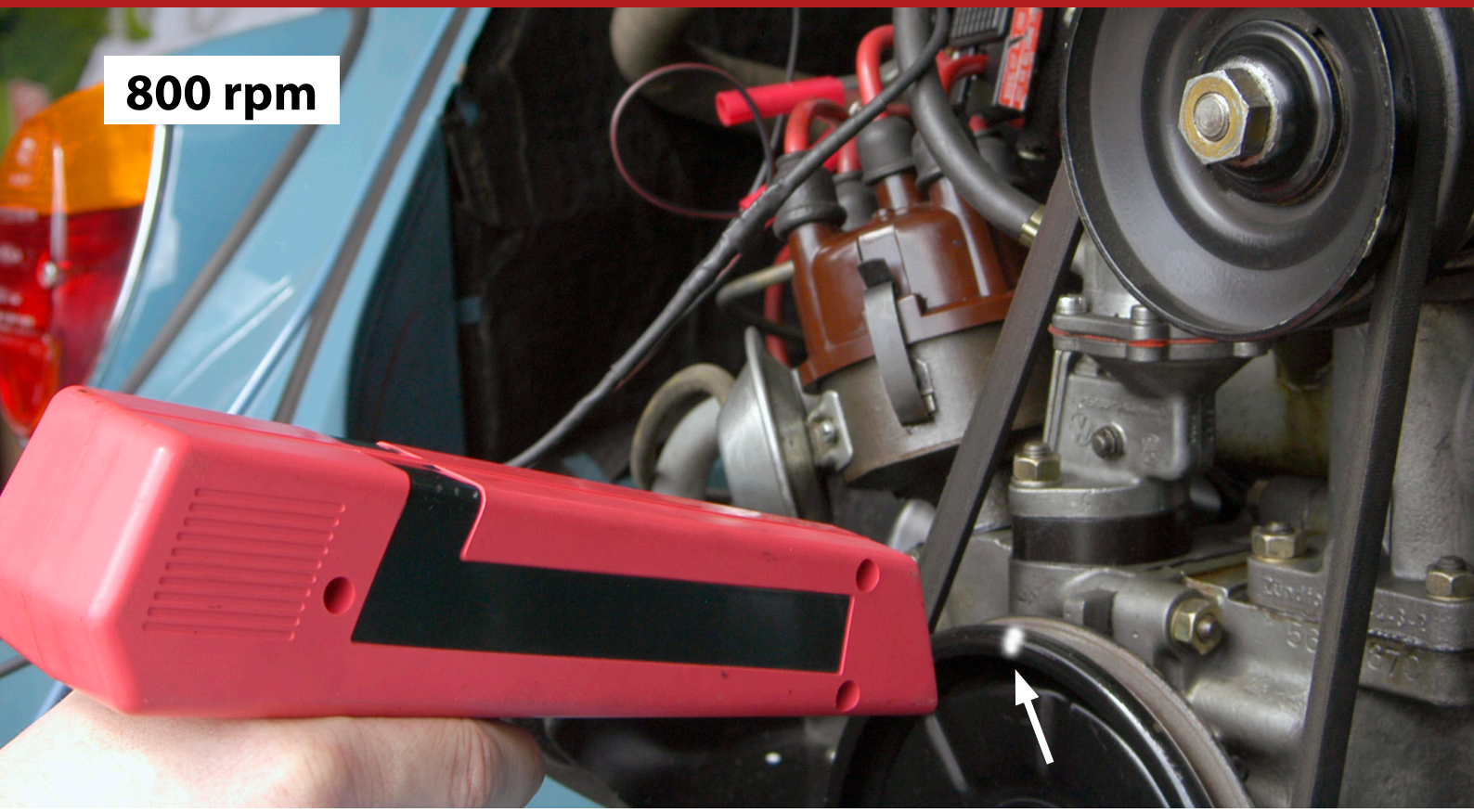


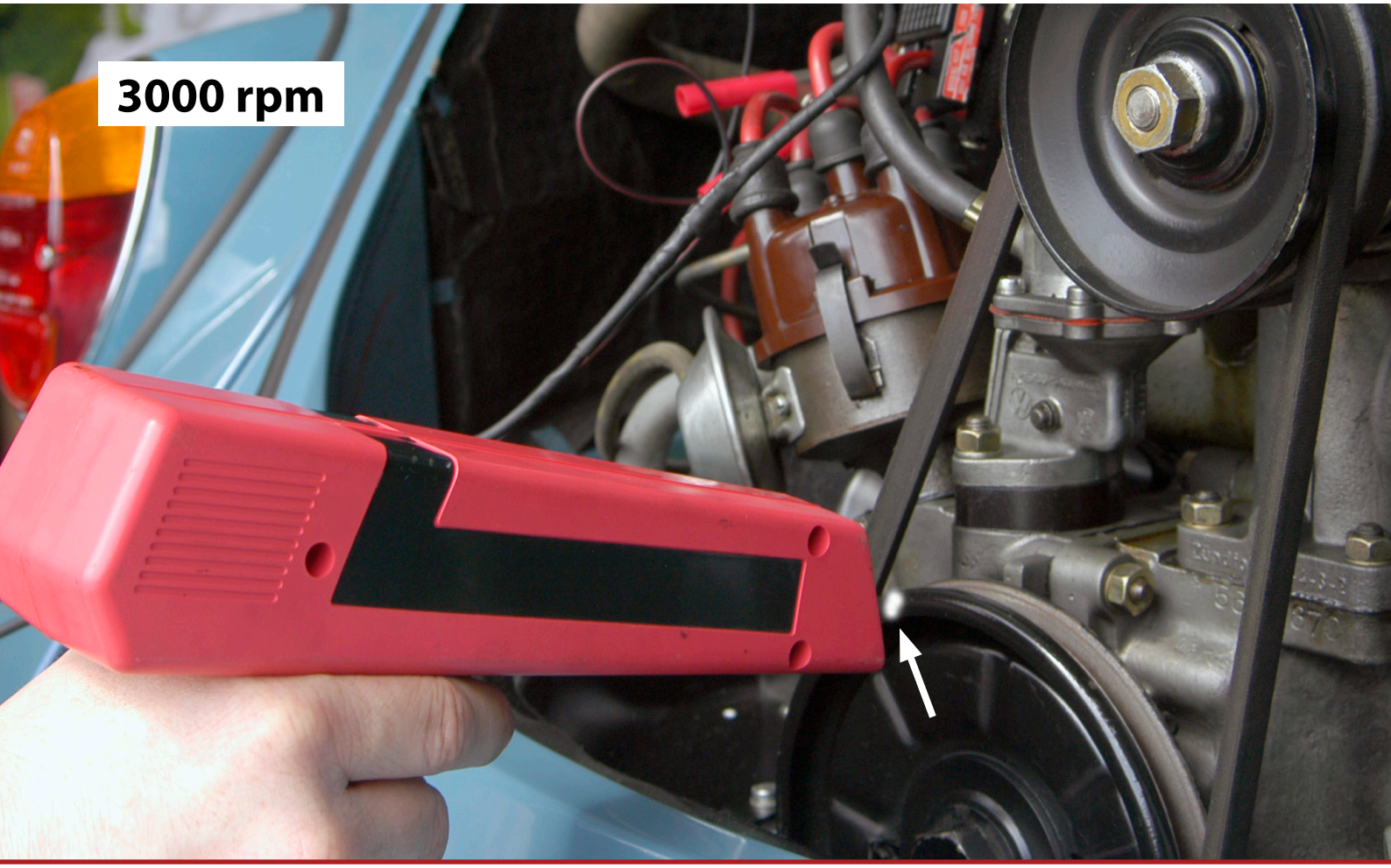

Have the engine run for a few minutes to make sure that the choke is not activated anymore. The throttle pedal and throttle cable should be adjusted properly. The throttle adjustment will have an effect on the ignition timing. Connect the timing light to its power supply (your car battery or its own power supply depending on the model). If your timing light doesn't have a power supply integrated, you need to connect the plus clamp to the ignition coil clamp number 15, the minus clamp should be connected to the car electrical ground. The green cable goes to the coil minus (number 1 clamp). The cylinder 1 spark plug cable is used to adjust the ignition. Connect the ignition light induction clamp (1) to the cylinder 1 cable as shown on the above picture.

# #28 Electrical


The induction clamp on the timing light should have an indication printed on one side (this side towards plug, or just a drawing of a spark plug). Make sure that side of the clamp faces the spark plug of cylinder 1. It is the high voltage from the coil/distributor that will power the timing light every time the cylinder 1 spark plug generates a spark. We will use this technique to find out if the vacuum advance works. Start the engine. The engine should be at operation temperature to make sure the choke is deactivated. Point the timing light towards the crankshaft pulley as we show on the picture on page 33. Watch out, this is an optical illusion, the pulley is rotating but you have the impression that it doesn't move. Push the throttle pedal or the lever on the carburetor, the pulley should move counter clockwise. We show what is happening on page 33, look at the small white dot we painted on the pulley.

# check the vacuum advance



You can use the dynamic testing method for both the vacuum advance and the mechanical advance.

***WARNING!***

**The pulley is not really standing still during the test!**

The strobe light effect is a phenomenon known from the disco party era. A strobe light is firing a strong intermittent light pulse. When pointed to a moving object, only the time frames when the object is illuminated will be visible for us human beings. It is as if you watch a series of pictures. The timing light we used for this dynamic vacuum advance test uses the same principle. When you point the stroboscopic lamp towards the rotating pulley, you will only be able to see the pulley when cylinder 1 is fired. If the cylinder 1 is fired earlier at higher rpm, the ignition will happen sooner, it is as if the pulley is rotating counter clockwise.

The goal of the vacuum advance system is to change the ignition time depending on the engine speed. What you want is that the ignition happens earlier when the engine is running faster. We explained this principles in the previous edition of this technical series on page 22.

If the ignition advance is not working properly, you should experience problems when accelerating, your engine will tend to stall, you will not be able to reach the maximum speed and the fuel consumption will be higher than normal.

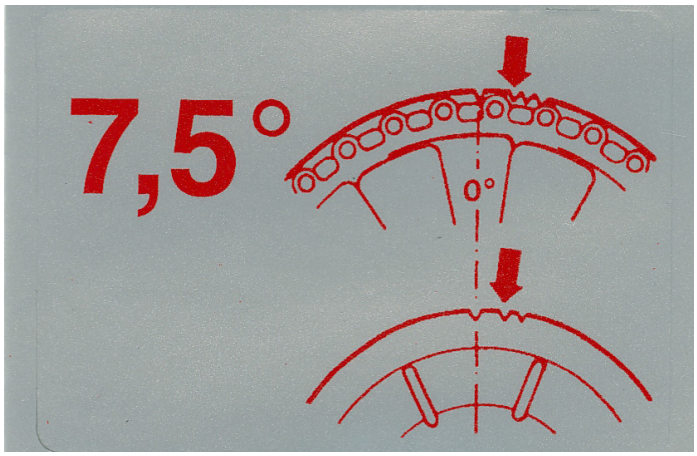
The advance curve of the vacuum advance can be changed by modifying the spring of the distributor base plate. We don't advise to experiment with this if you don't have the equipment to measure the advance curve.

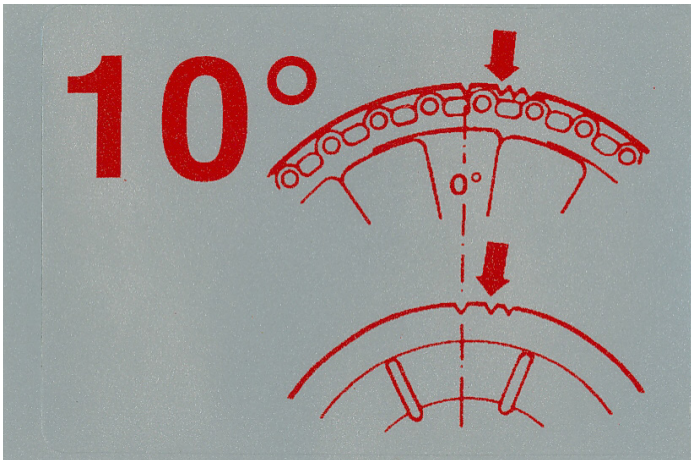


## Conclusion

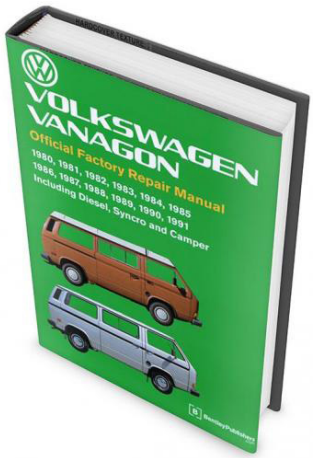
How much advance is needed will depend on the type of engine. We will discuss this in the future in this magazine. We only checked if the advance was working in this issue.

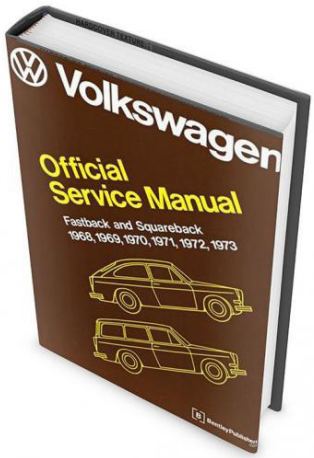
Technical specifications are available for all engine types, we refer to the Bentley (English Volkswagen Workshop Manuals) series, this is a reproduction of the original VW workshop manuals from Volkswagen USA. We will explain how to adjust the ignition in the following editions of this magazine.

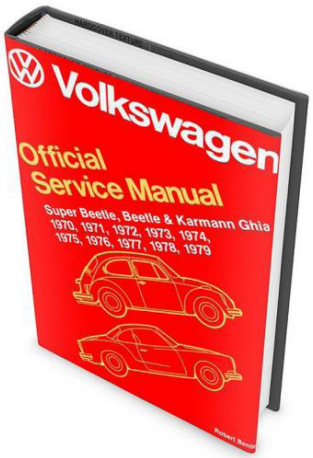


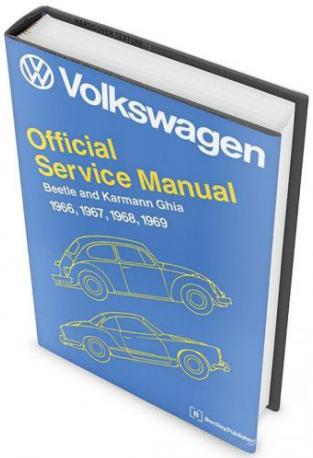




*We will explain how to adjust the ignition points gap, in edition 13 we will set the ignition advance.*

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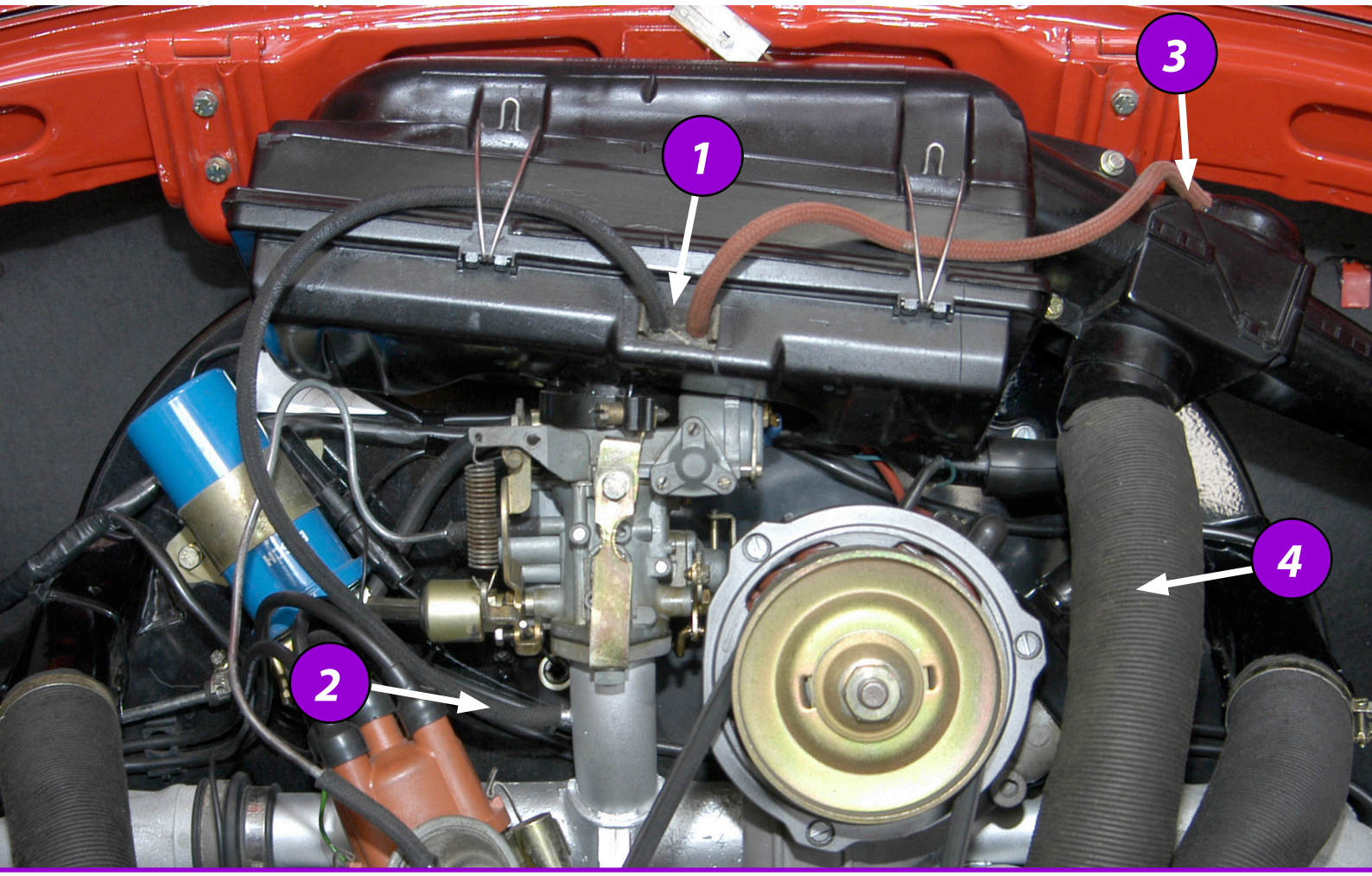
# #29 Carburetor

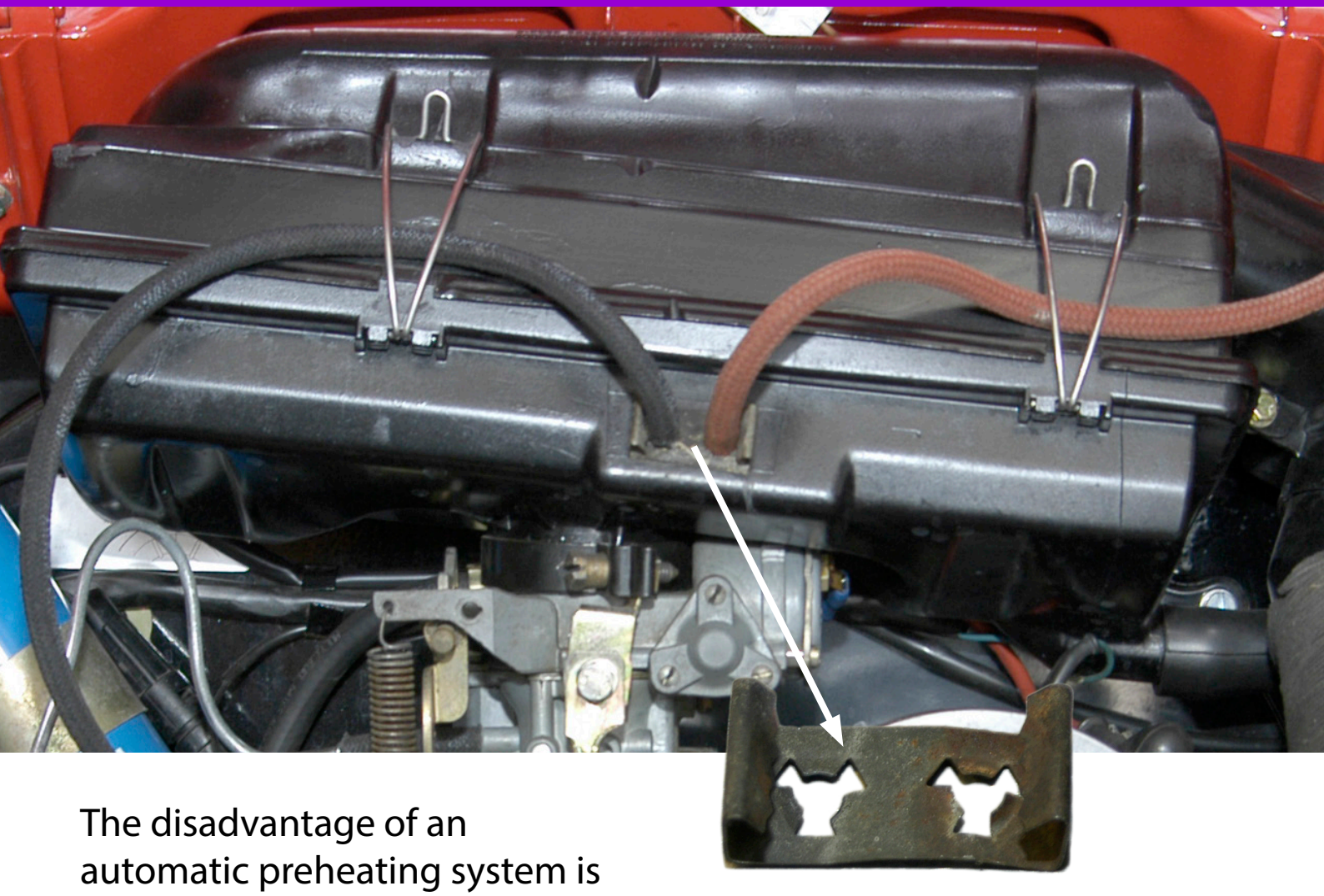
## How it works

We explained in edition 10 how the air filter preheating is working. The paper filter based air filter was explained on page 35, the preheating thermostat was discovered on page 35. VW owners tend not to spend too much time checking this preheating system unfortunately. It is crucial for the air-cooled engine.

The preheating will make sure that the air flowing through the carburetor has the correct temperature. The big advantage of the paper filter based air filter shown below is that the preheating temperature regulation is done fully automatically.

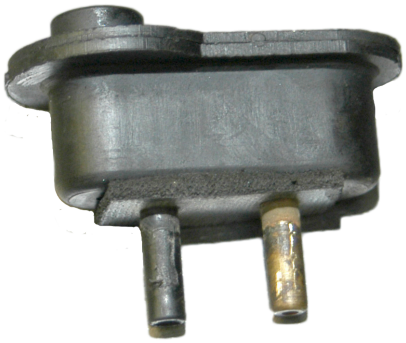


# air filter thermostat

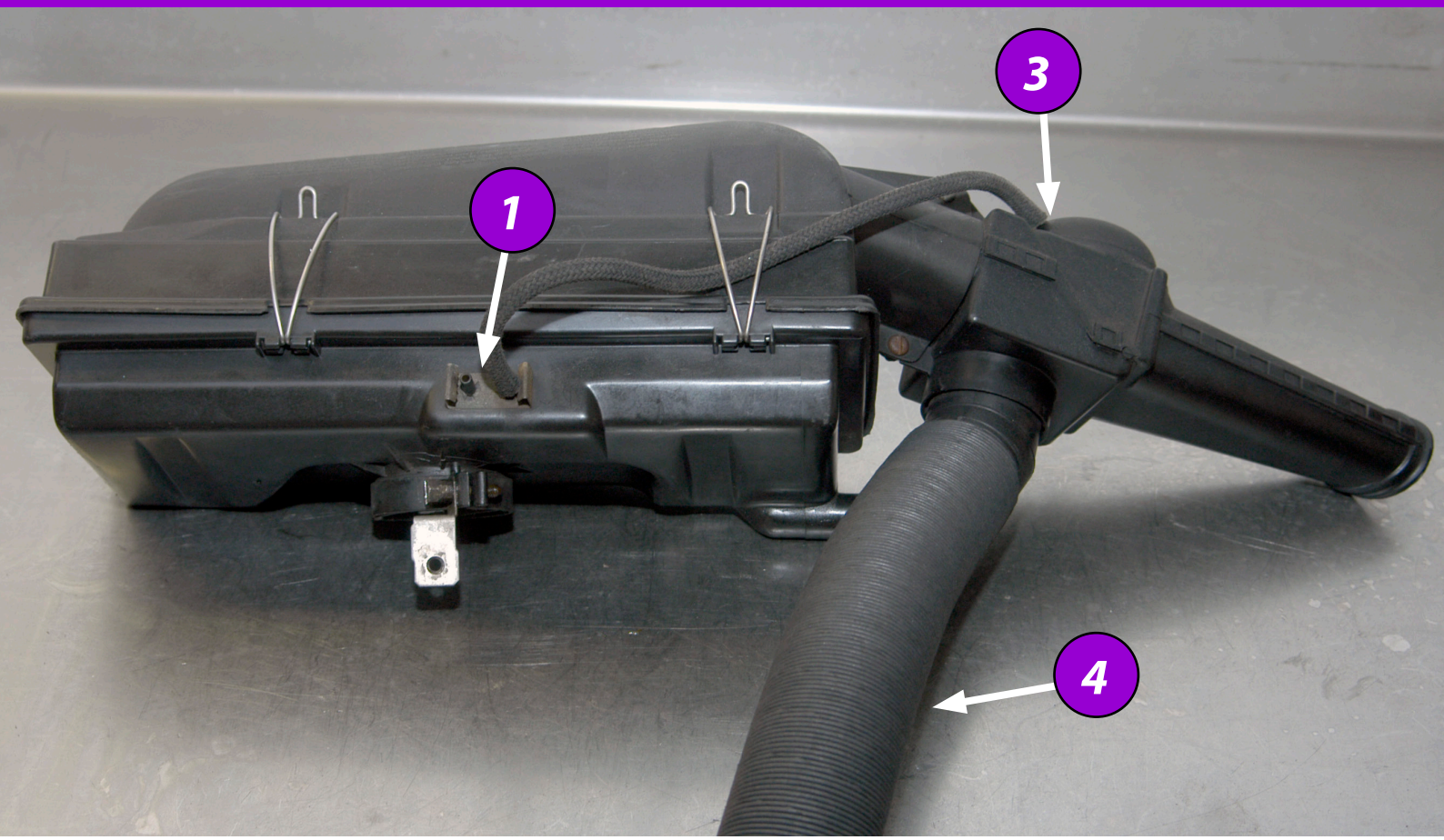


The disadvantage of an automatic preheating system is that the owner tends not to pay attention to it during the regular maintenance.

We show a VW 1303 with such a paper filter based air filter on page 38. The built-in thermostat is shown as number 1 on the picture on page 38 (you can only see the two metal tubes on the outside) and also on this page on the right hand side. The thermostat is secured on the plastic air filter housing with a metal clip as shown on the picture above.



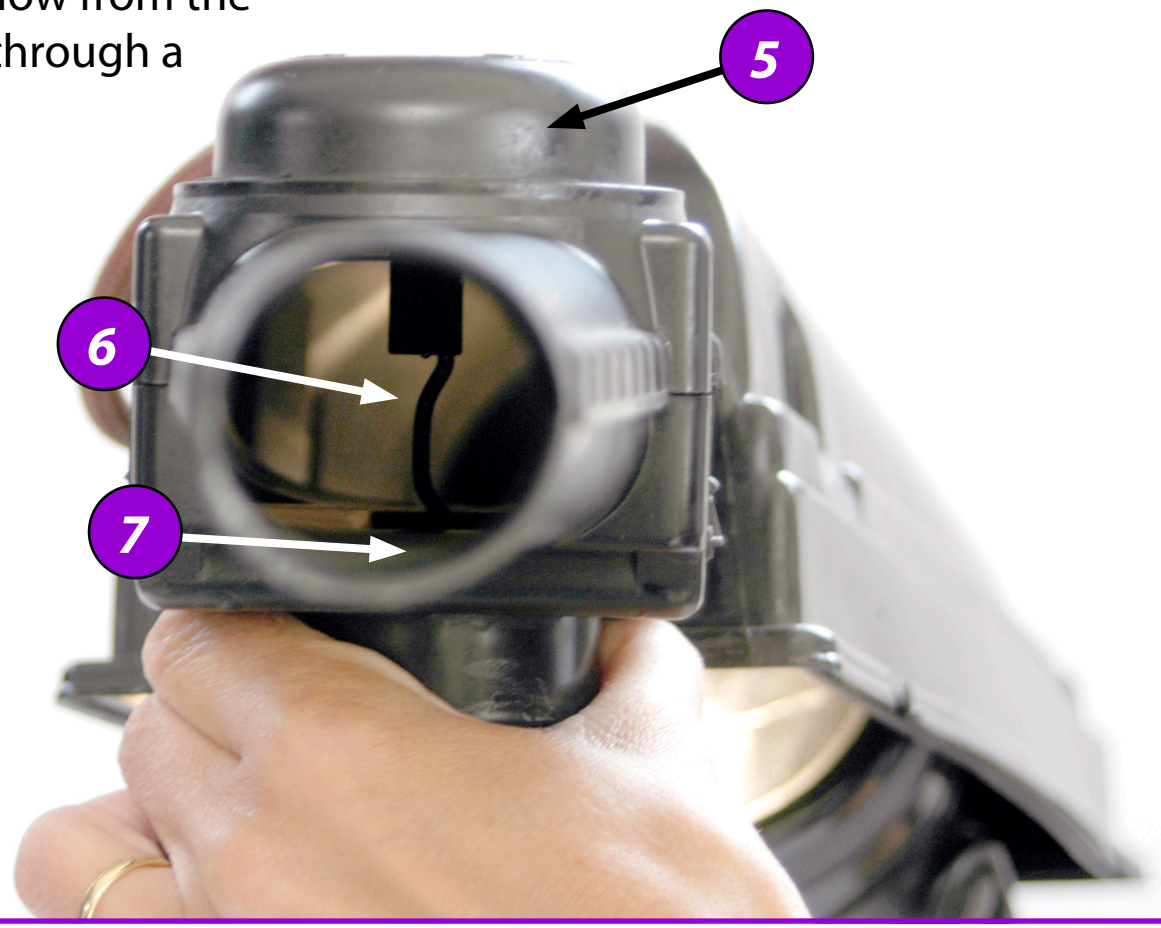
# #29 Carburetor




# air filter thermostat

How the preheating works on this type of air filter is very easy to understand. The picture on page 38 shows the vacuum hose (number 2 on the picture on page 38) connected to the inlet manifold. The pistons move forth and back in the cylinders, this will create a vacuum in the inlet manifold. This vacuum will be used to activate the membrane in the air filter breather tube (number 5 on the picture below). This membrane will open a valve (7) that allows the warm air to flow from the exhaust system through a paper hose (4).

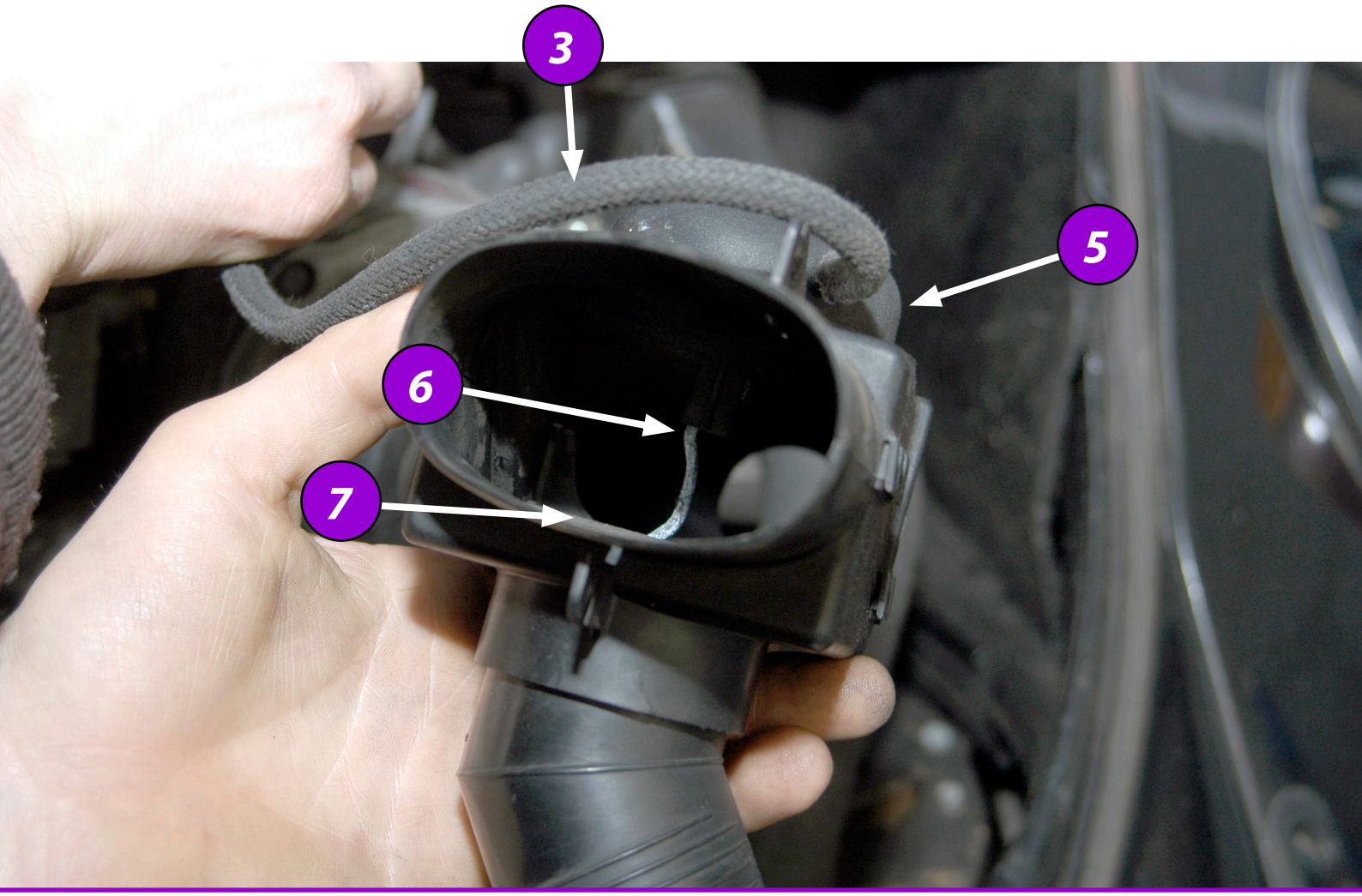
The thermostat is positioned between the vacuum hose (2) and the hose that activates the membrane (3). The thermostat works as a switch to activate the membrane (number 5 below). Sound a little complicated maybe? But if you look at the picture on page 38 it should be more clear how it all works. Once you understand the basic principle of this system, it is very easy to understand how the hoses are connected and why.



## Breather tube

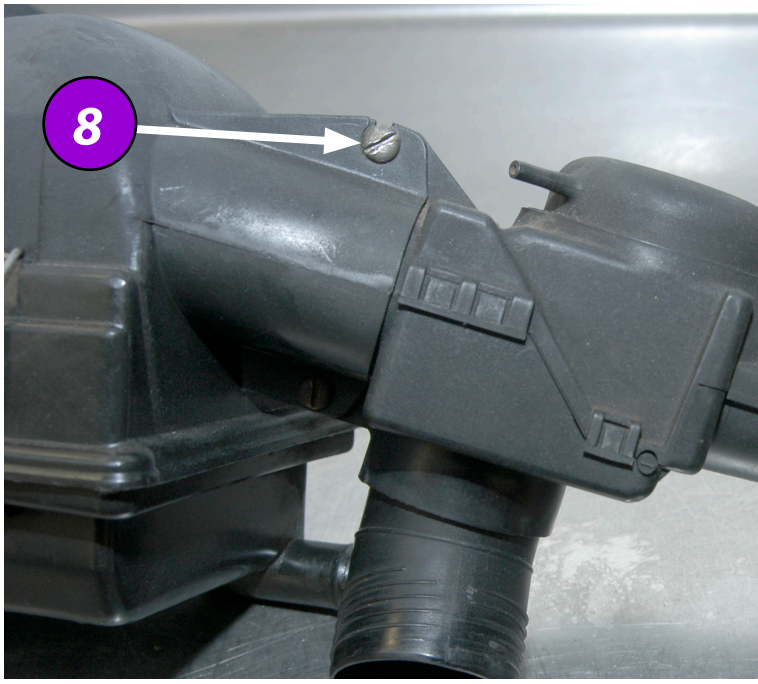
The membrane (5) is connected to a shaft (6), this shaft will operate a valve (7), this valve will allow the warm air running through the paper hose to flow. You can check how it works by remove the vacuum hose (3) from the air filter housing, apply suction on that hose as we show on the pictures below and on the next page.

The picture on this page shows the closed valve, once a vacuum is generated in the hose the valve will open en allow the warm air to flow into the air filter. The membrane/valve assembly are mechanical components that could seize after some time. It is important to check these air filter parts on a regular basis..



# air filter thermostat

It is possible that the thermostat is working fine but the valve is seized or the membrane is broken. If these components fail, you could replace the breather tube only. It is very easy to replace the breather tube (8). Once you made sure that these components are working fine, you need to check the thermostat.




# #29 Carburetor

# air filter thermostat

If you can't find a second hand breather tube, you may decide to dismantle the tube to check the valve and the membrane, maybe you can repair them.

You need to be very cautious, the breather tube was not really designed to dismantle. If the plastic housing is brittle from the engine heat you could damage the plastic housing.

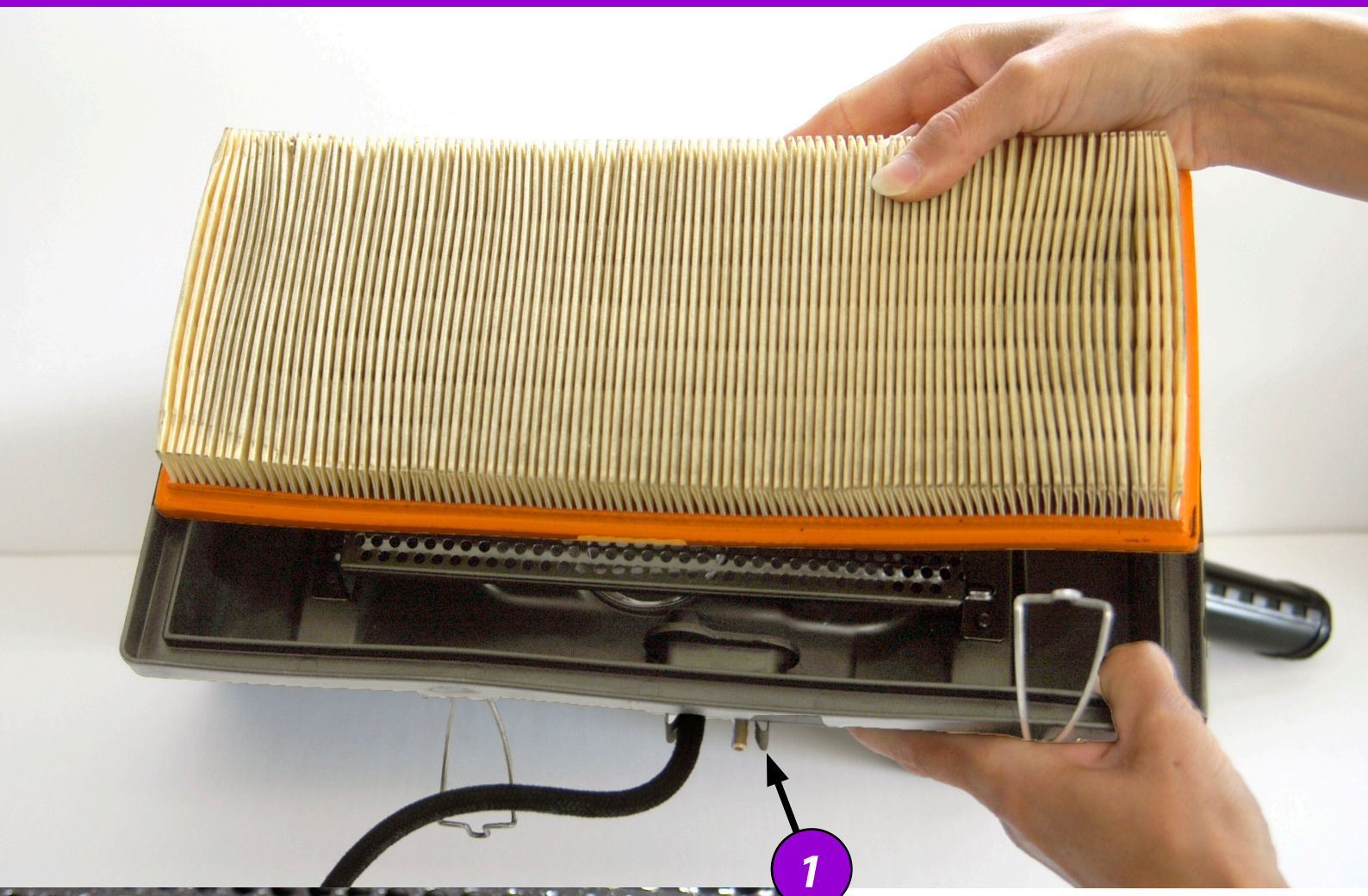
# #29 Carburetor

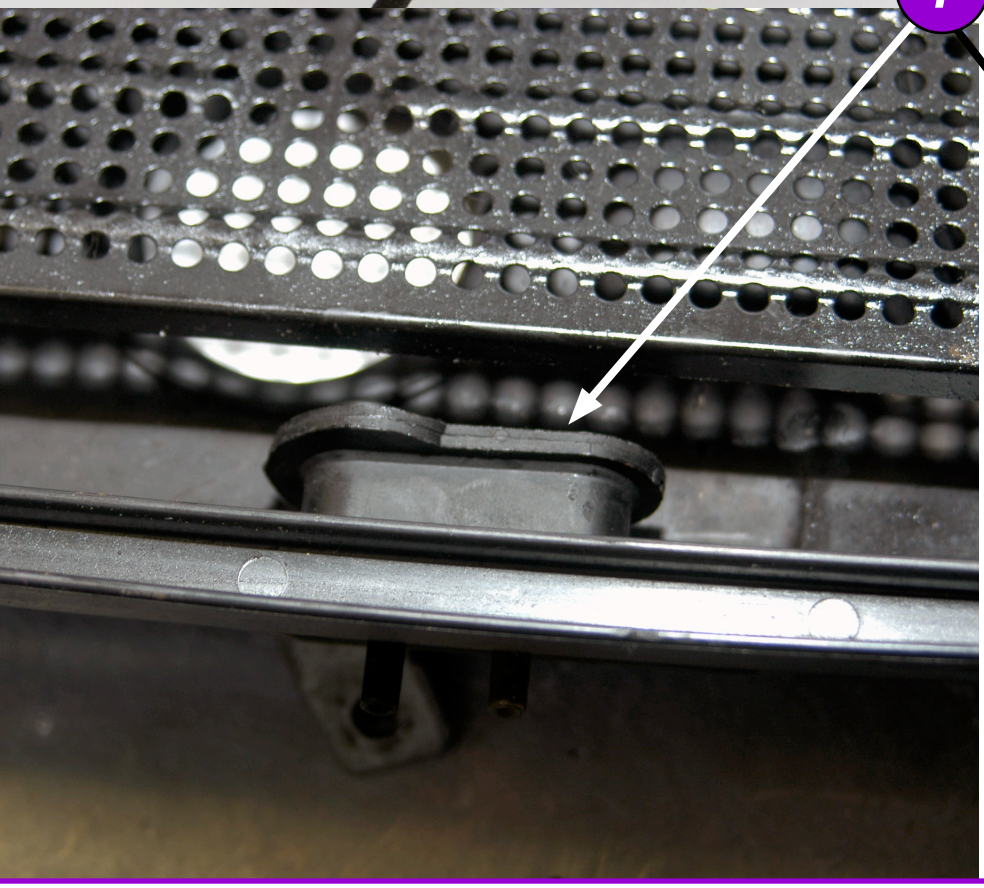
## The thermostat

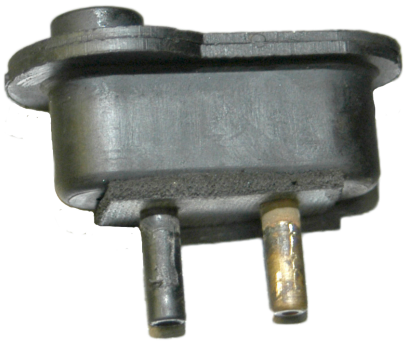
You need to open the air filter housing to access the thermostat. Unlock four metal clips to remove the air filter housing lid (as shown on the picture above). Remove the paper air filter to access the thermostat. You can replace the paper air filter if it is dirty, or use it again if it is a new one.

The thermostat (1) is now visible as shown on page 47. Remove the metal clip carefully to detach the thermostat. Be careful, the air filter housing plastic could be very brittle.

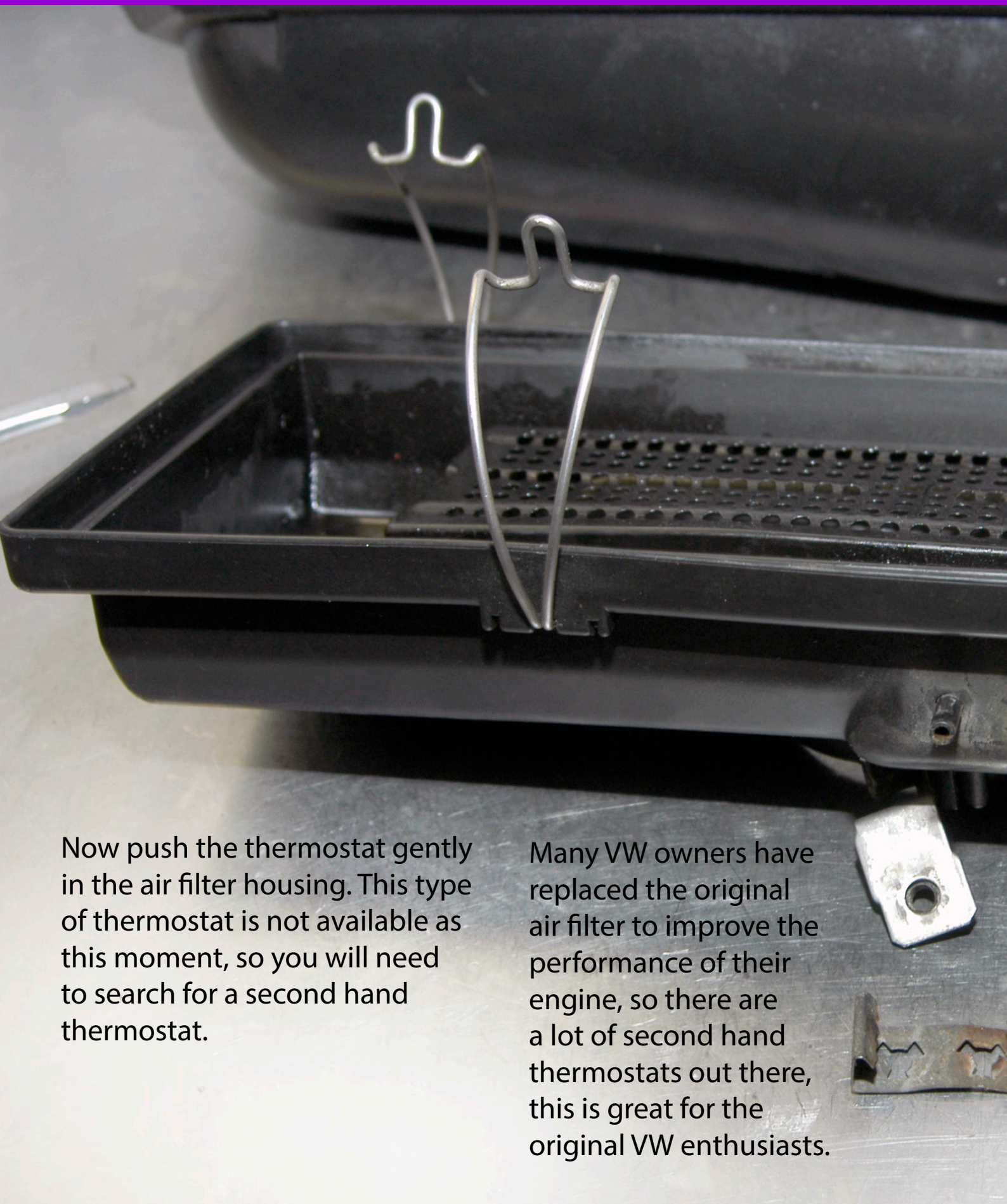
# air filter thermostat





# #29 Carburetor



Now push the thermostat gently in the air filter housing. This type of thermostat is not available as this moment, so you will need to search for a second hand thermostat.

Many VW owners have replaced the original air filter to improve the performance of their engine, so there are a lot of second hand thermostats out there, this is great for the original VW enthusiasts.

# air filter thermostat

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