Paruzzi Magazine

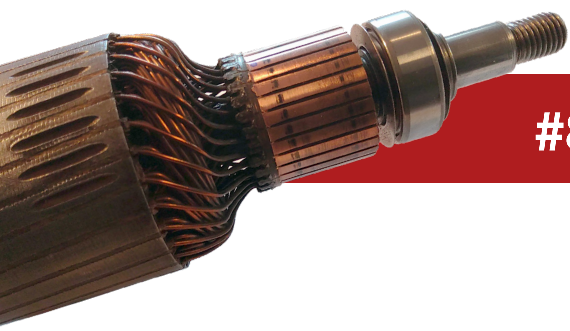
Digital Publication for the classic Volkswagen

CLASSIC CAR PARTS

28

#82- Rear axle: measuring wheel geometry

#83- Engine: oil pressure gauge



#84- Electrical: replace dynamo bearings

#82 Rear axle

Introduction

In the previous edition of this series, we measured the wheel geometry of the front axle. In this edition, we will measure the wheel geometry of the rear axle. The adjustment of both front and rear axles will follow in the next edition.

Wheel geometry should be adjusted after a total chassis overhaul, as well as after a severe shock, such as after an accident. A poorly adjusted rear axle will affect, or make impossible, the adjustment of the front wheel geometry. It will negatively affect handling, as well as cause a lot of wear on the tires and rear axle components.

Proper rear axle adjustment is required before you begin adjusting the front axle wheel geometry.

There are two settings to check regarding the rear axle:

- **Camber**
- **Toe**

In edition 25 we explain what wheel camber is, and in edition 26 we explain Toe. Caster and King Pin are settings of the front axle and thus are not applicable for the rear axle.

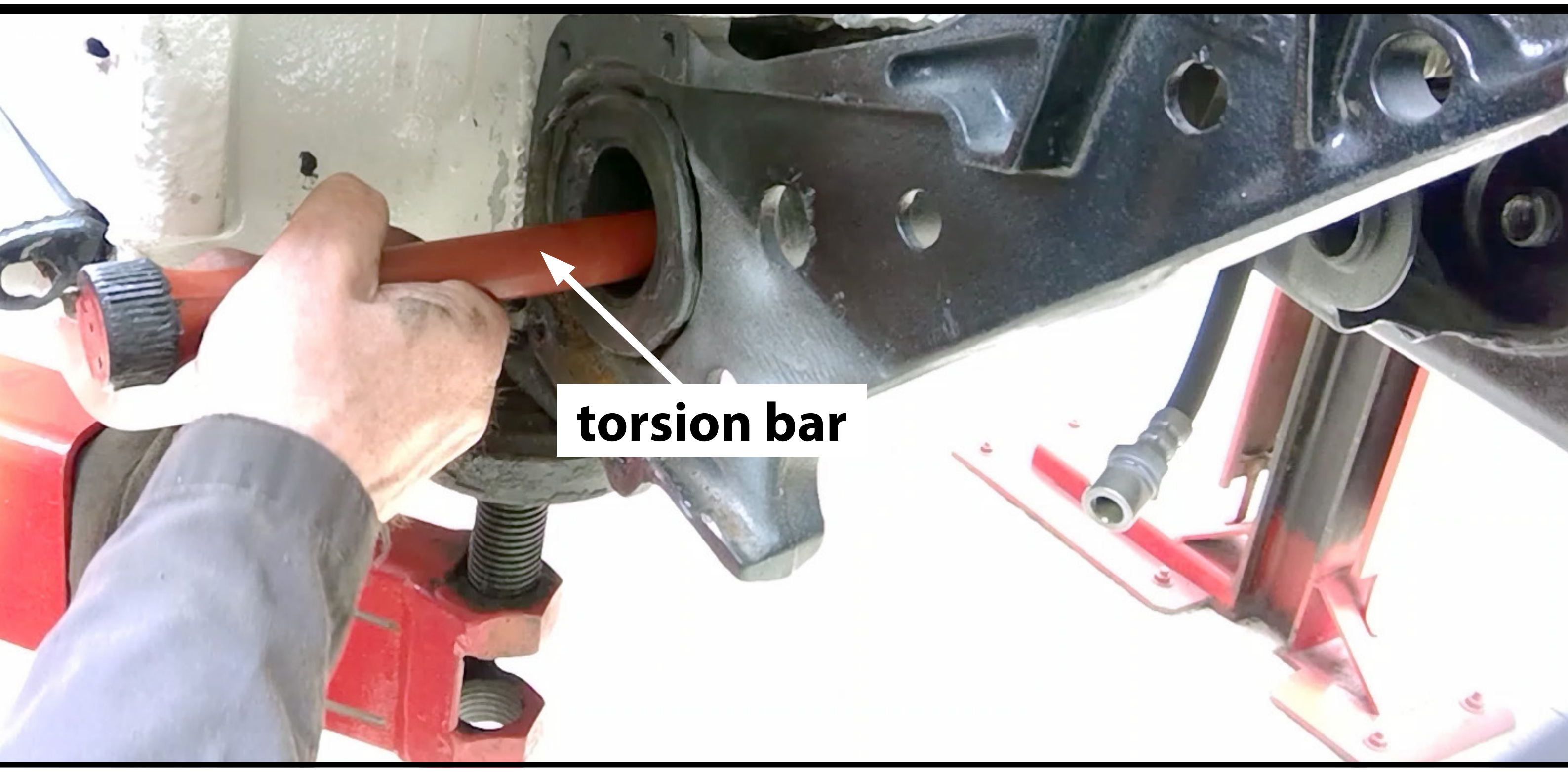
The rear axle of the classic VW has not changed very much during the different years of production. For the suspension, two torsion bars were used (see photo page 3 and drawing page 9). The rear axle can be adjusted in height by moving the torsion bars in the torsion bar pipe. Over time, due to corrosion, for example, or intense use, the torsion bars may begin to lose their spring force, causing the car to be lower in the rear. The height of the rear axle affects not only the rear wheel

Camber but also the front wheel geometry. So to achieve correct wheel geometry in the front, the car should first be adjusted to the prescribed height in the rear.

We will take measurements and consult the factory settings in the VW workshop manual. All data is given for factory original settings. So the rear axle height should be exactly to factory specifications.

If the car has been lowered, to extremely lowered, this data does not apply. Lowering the rear axle will disrupt rear wheel Camber, as well as wheel geometry in the front.

If you want to lower the rear of your VW and still maintain minimum ride comfort and/or handling, you will have to redetermine the wheel geometry taking into account the modifications that have happened to the rear axle and the front axle.



#82 Rear axle

Preparations

In preparation for the rear wheel geometry measurements, we can keep the same list we used in edition 27 to measure the front axle. We show the list again below. It is very important that the car is level to make the measurements. We refer to edition 27 starting on page 30 for this.

The rear axle will need at least 500 kilometers of running-in distance after the torsion bars are installed to ensure that the correct height is achieved (see box below). The rubbers of the torsion bars will still need to set after assembly, which will affect the height of the rear axle, thus also the wheel geometry. After a total restoration, or after replacing the torsion bars and/or torsion bar rubbers, you will need to perform a preliminary adjustment of the rear axle, to perform a final accurate adjustment after 500 km.

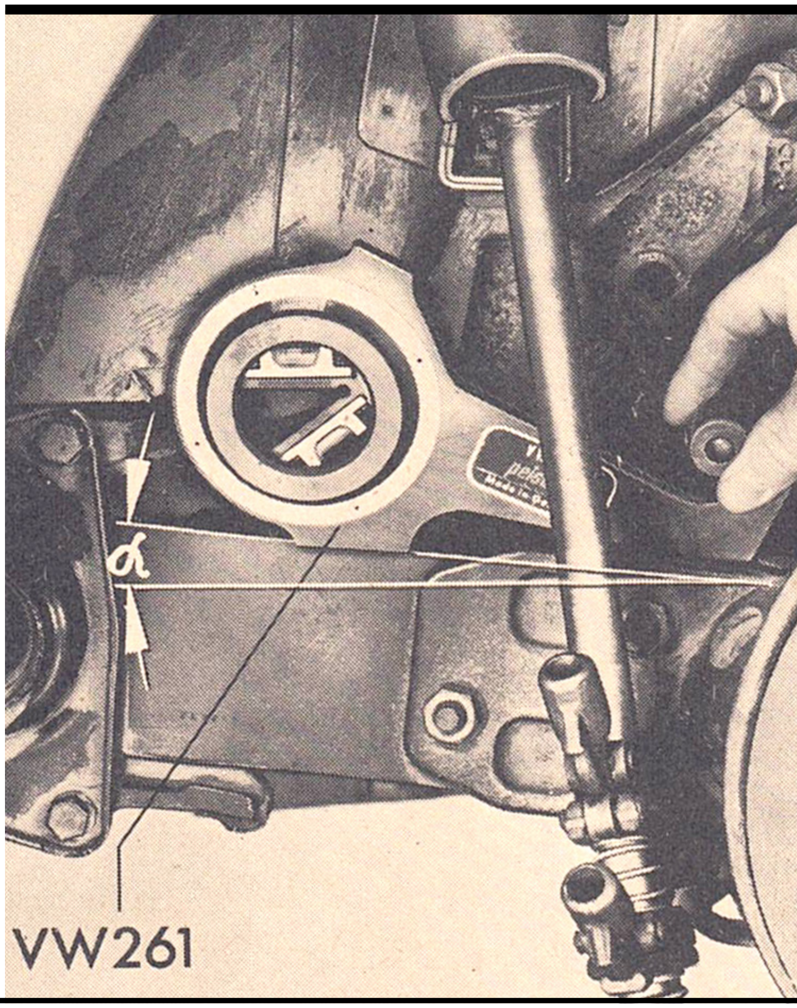
Before measuring or adjusting the rear wheel geometry, make sure that the spring plates have the correct angle, that the torsion bar rubbers are not damaged. The rear of the car is then adjusted to the factory height.

- mount the rims and tires that will be used on the car
- the tires are at the correct pressure and all four are in good condition (not bent)
- the car is completely empty, and the fuel tank is full to half-full
- the steering parts are in good condition and correctly adjusted
- the front torsion springs/leafs are in good condition
- the rear torsion bars are correctly adjusted and have been used for at least 500 km
- front wheel bearing play is properly adjusted
- King Pins, ball joints or MacPherson joints are free from unwanted play
- all lubrication points of the wheel axles are lubricated with sufficient grease
- the front wheels are in the straight-ahead position
- drive the car on level ground and make sure it is perfectly level

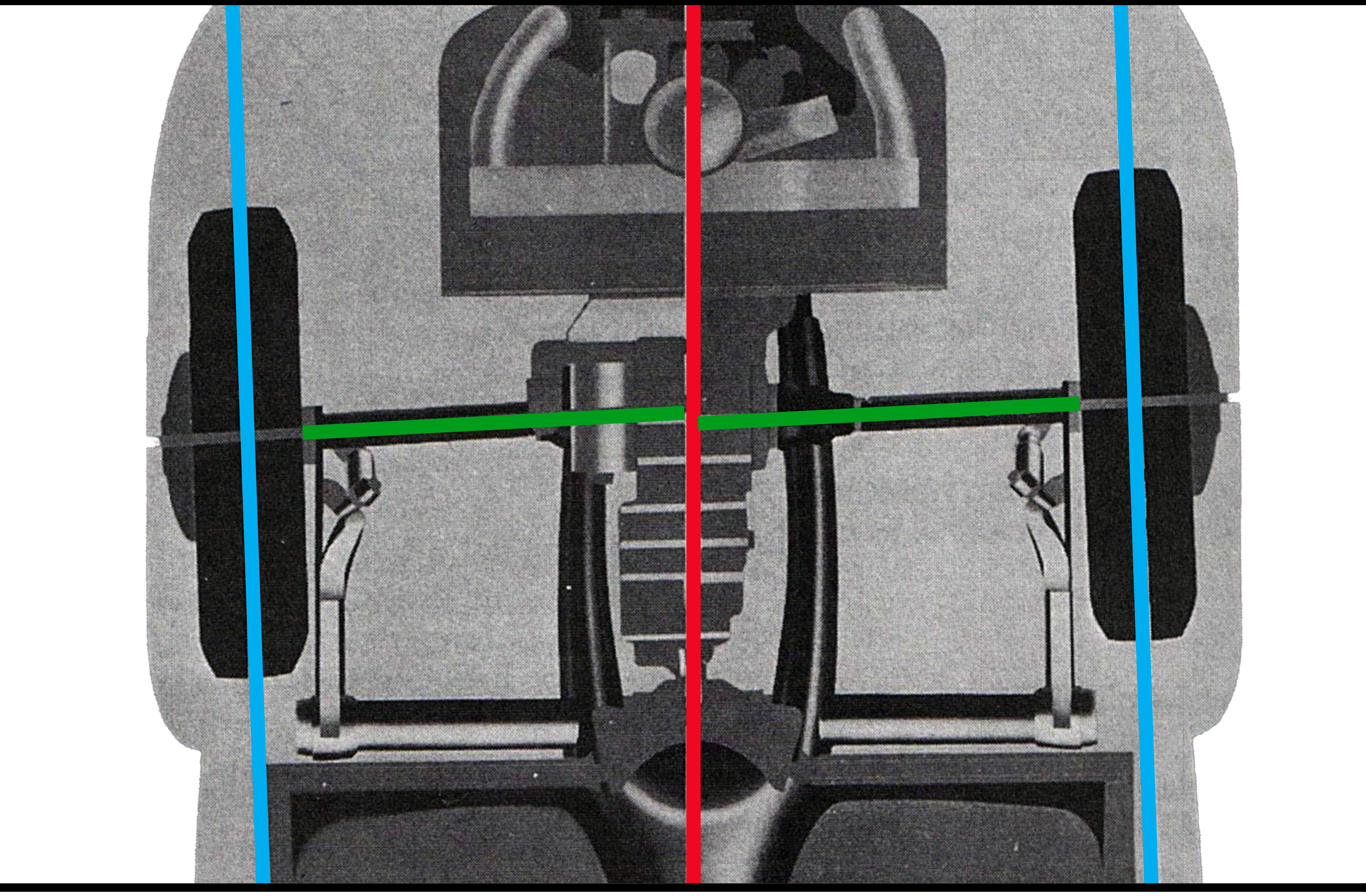
Adjusting the height of the rear of the VW Beetle or Karmann Ghia, we will discuss in a later edition of this series (see photo from the VW workshop manual below).

The car must be damage free. The rear axle should show no signs of deformation, leaks or damage. The rear wheels should be properly mounted, with the large crown nut of each wheel tightened to the proper torque (see edition 24). No play should be detectable on the rear wheels.

The photo at the top shows the VW 1303 whose rear height we will adjust in a following edition. You can clearly notice that the left side is much higher than the right side. The wrong adjustment of the rear axle height will negatively affect the wheel clearance.

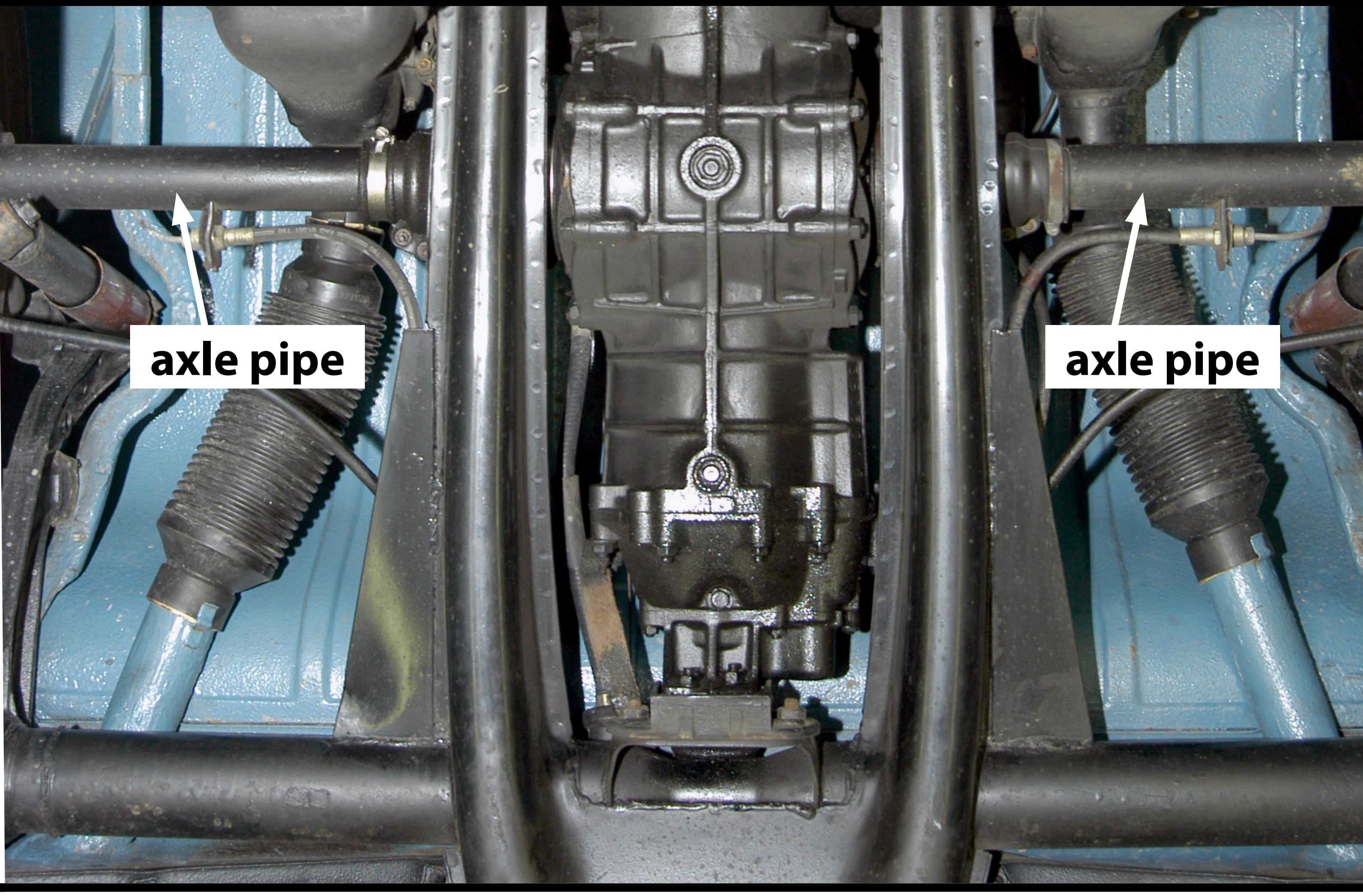


#82 Rear axle



In the drawing above we show the rear axle of a VW Beetle with swing axle. At the top you can see the engine, at the bottom the floorpans. The red line is the longitudinal line dividing the car in two lengthwise. The blue lines run through the rims. When the Toe is set to 0°, the blue lines should be parallel to the red line. The green lines in turn should make a 90° angle with the red line. The length of both green lines, which run from the end of the axle pipes to the center of the gearbox, should be identical. The same principle applies to a rear axle with intermediate shaft (IRS).

If the symmetry is no longer present, then the rear axle may have suffered damage, or wear, or a mistake happened during assembly or during restoration (welding).



In the photo above we show such a rear axle with swing axle. You can see that the axle pipes are nicely perpendicular to the gear-box and longitudinal axis of the chassis. We checked the distances between gearbox and bearing flanges, with a telescopic gauge (see edition 27), they are the same.

If a lot of toeing is set on a wheel, the axle pipe will no longer be perpendicular to the gearbox. The amount of toeing on the rear wheel is so small when adjusted correctly that on visual inspection, the axle pipe will appear to be perpendicular to the gearbox.

Before you begin measuring the rear wheel geometry, check that the rear axle is nicely symmetrical.

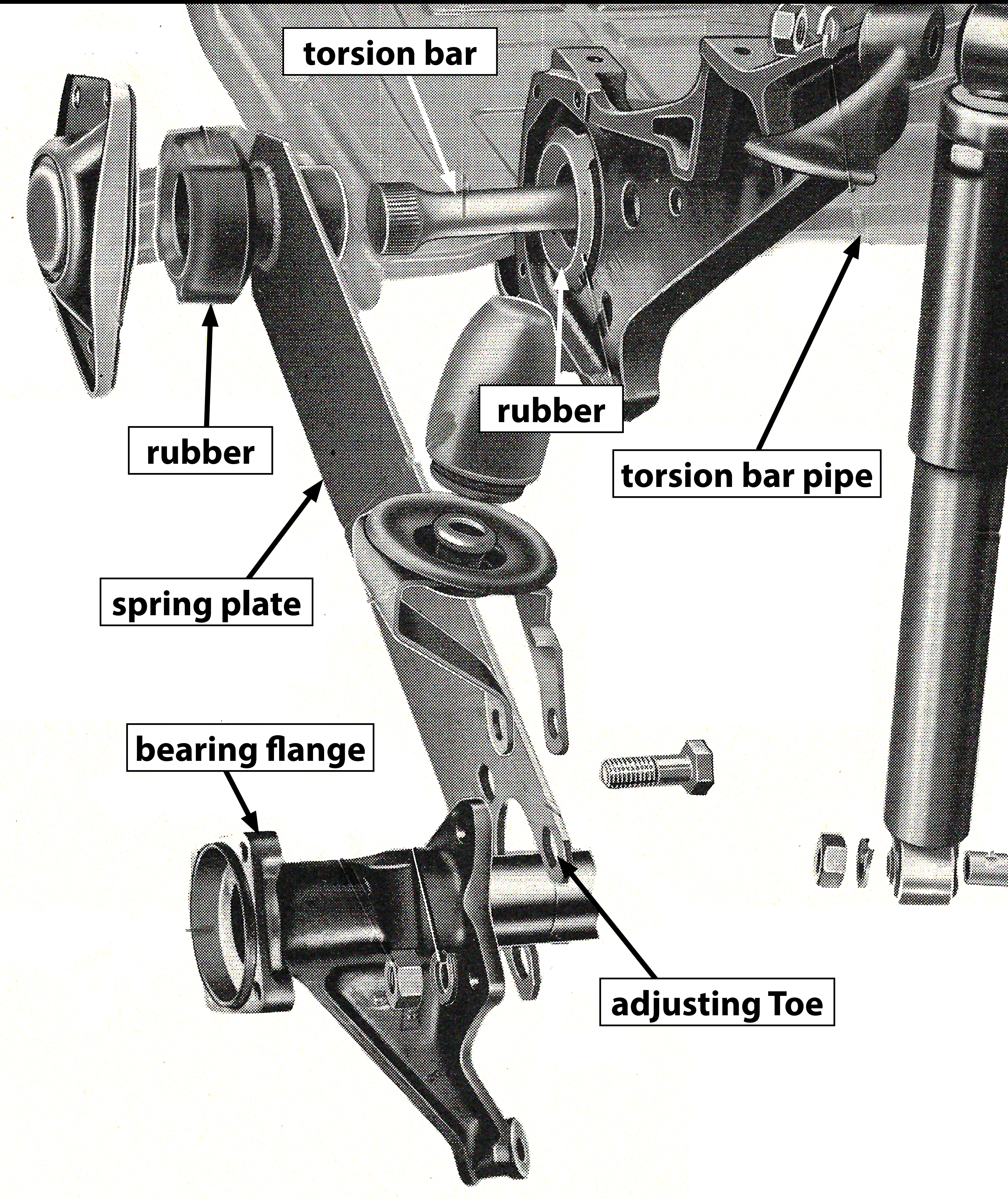
Camber

We begin by measuring rear wheel Camber. In edition 25, we explained what Camber is. Wheel Camber is determined entirely by the position of the torsion bars in the spring plate and in the torsion bar pipe. By turning the teeth of the torsion bar in relation to the spring plate and/or torsion bar pipe, you can very precisely adjust the height of the rear of the car, as well as wheel Camber (see also page 3).

This adjustment is usually only used today to adjust the height, or rather the lowness, of the car. Originally, this adjustment option was intended to accurately adjust wheel Camber. There is an entire chapter devoted to adjusting the spring plate in the VW workshop manuals. We will discuss this when we explain how to adjust the rear height of the car, in a future issue.

It is recommended after installing new torsion bars and/or new torsion bar rubbers, to drive at least 500 kilometers before checking the adjustment of the wheel Camber. The torsion bars and rubbers tend to settle only after a while, and this affects the height of the car at the rear, and thus the position of the rear wheels (especially the wheel Camber).

Once the wheel Camber has been adjusted correctly by adjusting the position of the torsion bars, the Toe can be adjusted (see page 12). Toe is adjusted by moving the spring plate relative to the bearing flange (see drawing on page 9). We will discuss wheel geometry adjustment in edition 29.


torsion bar
rubber
rubber
torsion bar pipe
spring plate
bearing flange
adjusting Toe

#82 Rear axle

The wheel Camber of the rear wheels can be measured by the same method than the wheel Camber on the front wheels. We refer to edition 27 to learn more about that. Again, you can use a digital level to measure Camber fairly accurately. Make sure the preparations discussed earlier are done, and that the car is on the ground, level.

Do not perform the measurement when the rear of the car has just been jacked up. You will measure excessive positive Camber after jacking up. If so, drive around for a while to allow the rear axle to reset. You may need a rod or some tool, as shown in the photo, to make the measurement without removing the hub cap.

On the next page we show a summary of the values for wheel Camber from the original VW workshop manuals. These data assume a correctly mounted spring plate, according to factory specifications. Indeed, the mounting of the spring plate is decisive to obtain the correct wheel Camber.

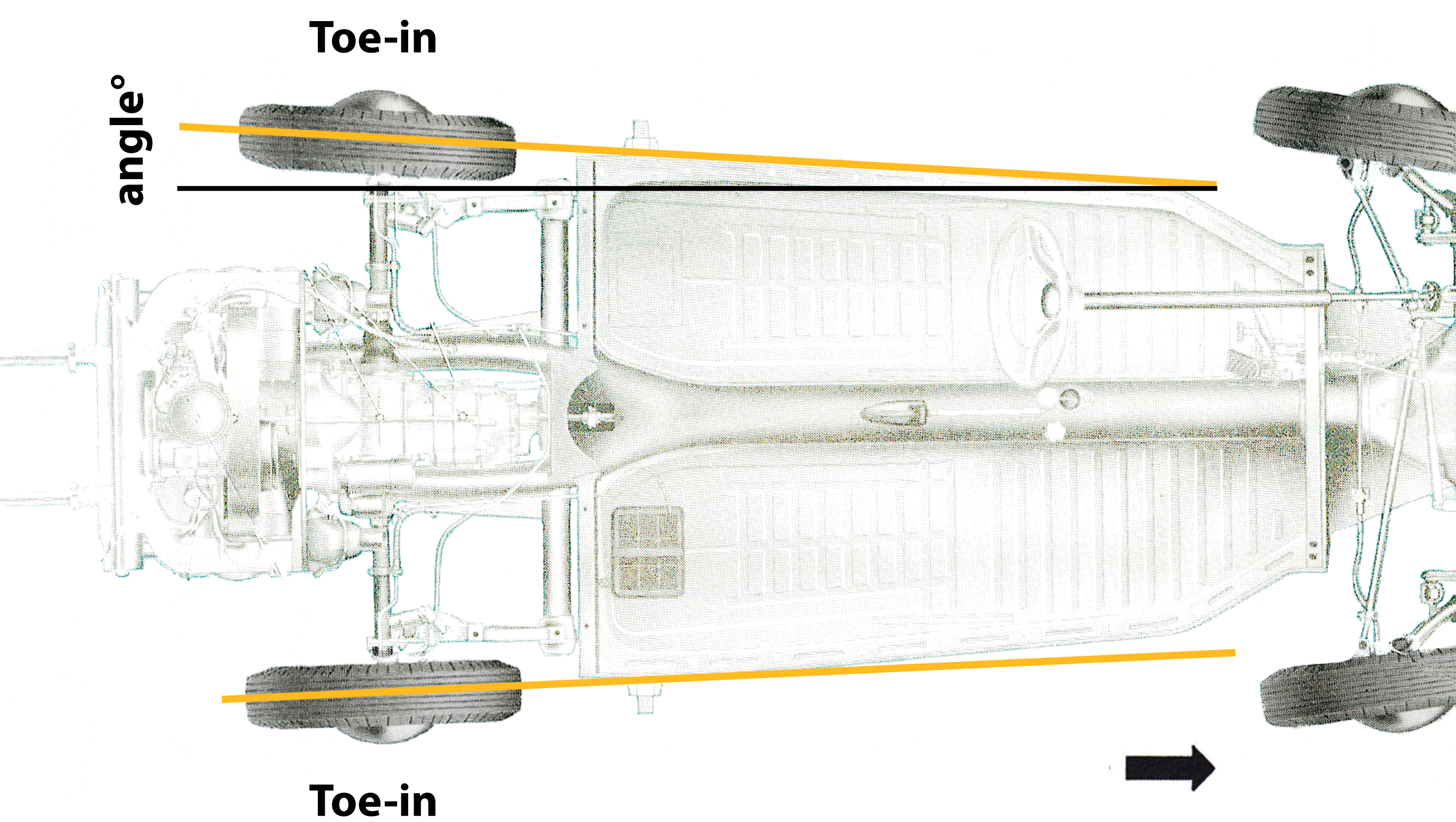
Not all models and years were listed, that would be too much information, always consult a VW workshop manual for your type and year of VW. These data are interesting to give to the specialist who will adjust the wheel geometry of your VW.

REAR WHEEL CAMBER	YEARS	Rear axle type	Camber	Deviation
Beetle and Karmann Ghia without	1961-1965	swing axle	+2°30'	+/-1°
Beetle and Karmann Ghia with stabilizer (type 111-118)	1961-1965	swing axle	+1°	+/-1°
Beetle and Karmann Ghia with stabilizer (type 141-144 and 151-152)	1961-1965	swing axle	+15'	+/-1°
VW 1200, VW 1300, convertible and Karmann Ghia without stabilizer	8/1959-7/1966	swing axle	+2°30'	+/- 1°
VW 1500 with stabilizer	8/1966 and later	swing axle	+1°	+/-1°
Beetle convertible and Karmann Ghia with stabilizer	8/1966 and later	swing axle	+15'	+/-1°
Beetle and Karmann Ghia	1966-1969	IRS	-1°20'	+/-40'
Beetle, VW 1303, Karmann Ghia	1970-1979	IRS	+50'	+/-40'
VW Bus except ambulance and fire truck	1950-1962	swing axle	+4°30'	+/-30'
VW Bus ambulance	1950-1962	swing axle	+1°50'	+/-20'
VW Bus fire truck	1950-1962	swing axle	+4°30'	+/-20'
VW Bus Delivery Van, Kombi, Micro Bus, Pick-up	1963-1967	swing axle	4°30'	+/-30'
VW Bus Ambulance	1963-1967	swing axle	+3°	+/-30'
VW Bus fire truck	1963-1967	swing axle	+4°30'	+/-20'
VW Bay Window Bus	1988-1979	IRS	-50'	+/-30'
VW Vanagon empty	1980-1991	IRS	-15'	
VW Vanagon loaded	1980-1991	IRS	+1° 10'	
Type 3 sedan	1968-1973	swing axle	+1°45'	+/-1°
Type 3 squareback	1968-1973	swing axle	+2°30'	+/-1°
Type 3 sedan	1968-1973	IRS	+1°20'	+/-0°40'
Type 3 squareback	1968-1973	IRS	+1°20'	+/-0°40'
VW Golf (to chassis 1763241690)	1974-1984	IRS	-1°	+/-35'
VW Golf (from chassis 1763241691)	1974-1984	IRS	-1°15'	+/-35'

Toe

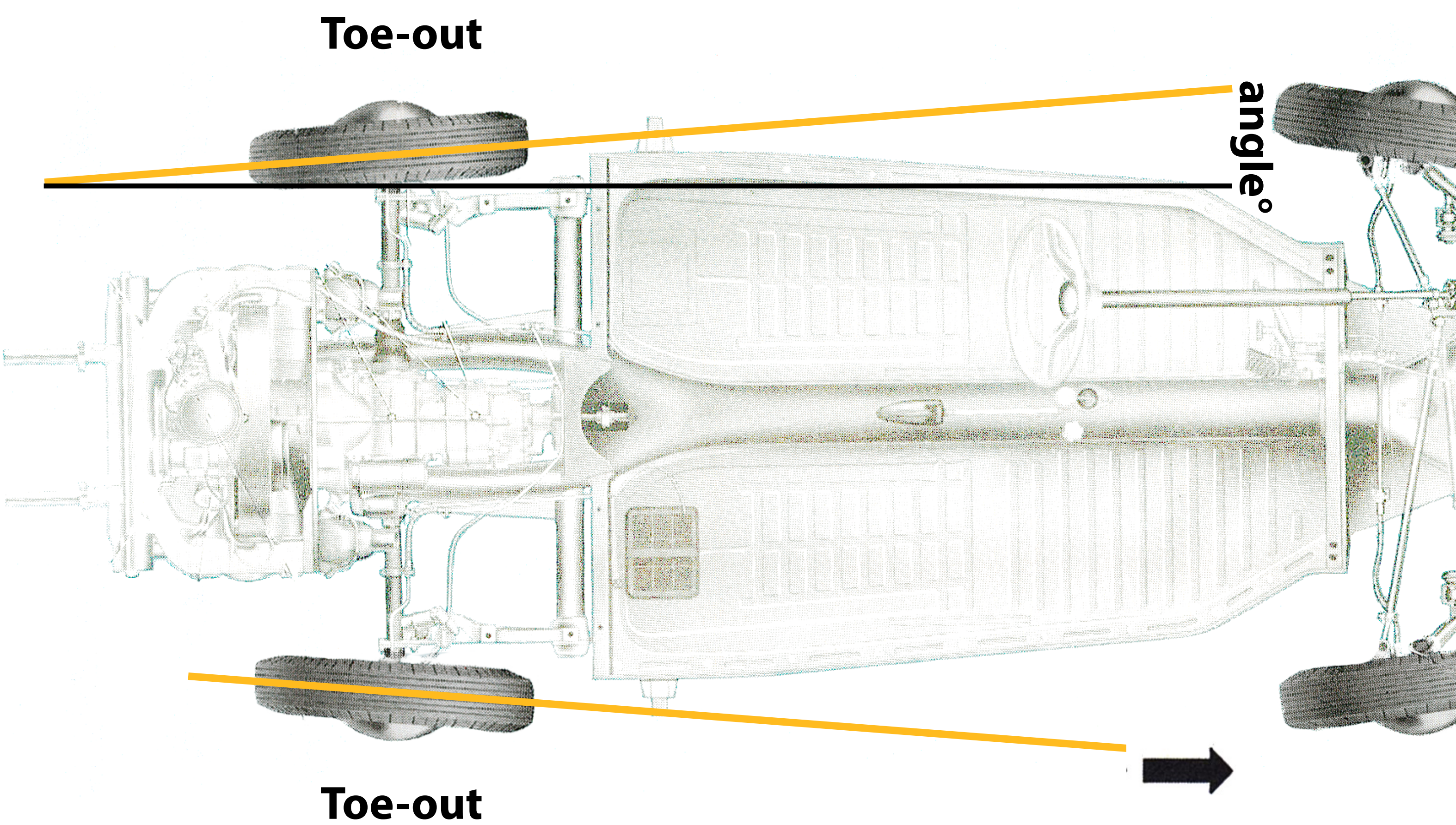
You did the preparations and the Camber was measured? The values for Camber are within factory specifications. You are then ready to measure the Toe on the rear axle. Also read edition 26 and edition 27, there we explained what toeing is, and how to measure front wheel Toe. Below is a VW Beetle with swing axles.

The drawing shows exaggerated Toe-in to better show what we mean by Toe-in. The front of the rear wheels are closer together than the rear. With Toe-out it is just the opposite, the front of the rear wheels is further apart than the rear. We show excessive Toe-out in the drawing on the next page.



The values for rear wheel Camber on the classic Volkswagen are very small, on the order of magnitude of a few minutes, with an allowable deviation of barely 10 minutes (10'). Read edition 27 to learn the difference between an angle expressed in decimal degrees and an angle expressed in degrees, minutes and seconds.

Professional devices that serve to measure wheel geometry can measure up to 1 minute, and even seconds, without any problem. An enthusiast does not have that capability. You will leave the final adjustment to a professional anyway, but you want to be able to estimate in your own workshop whether the toeing is going in roughly the right direction.

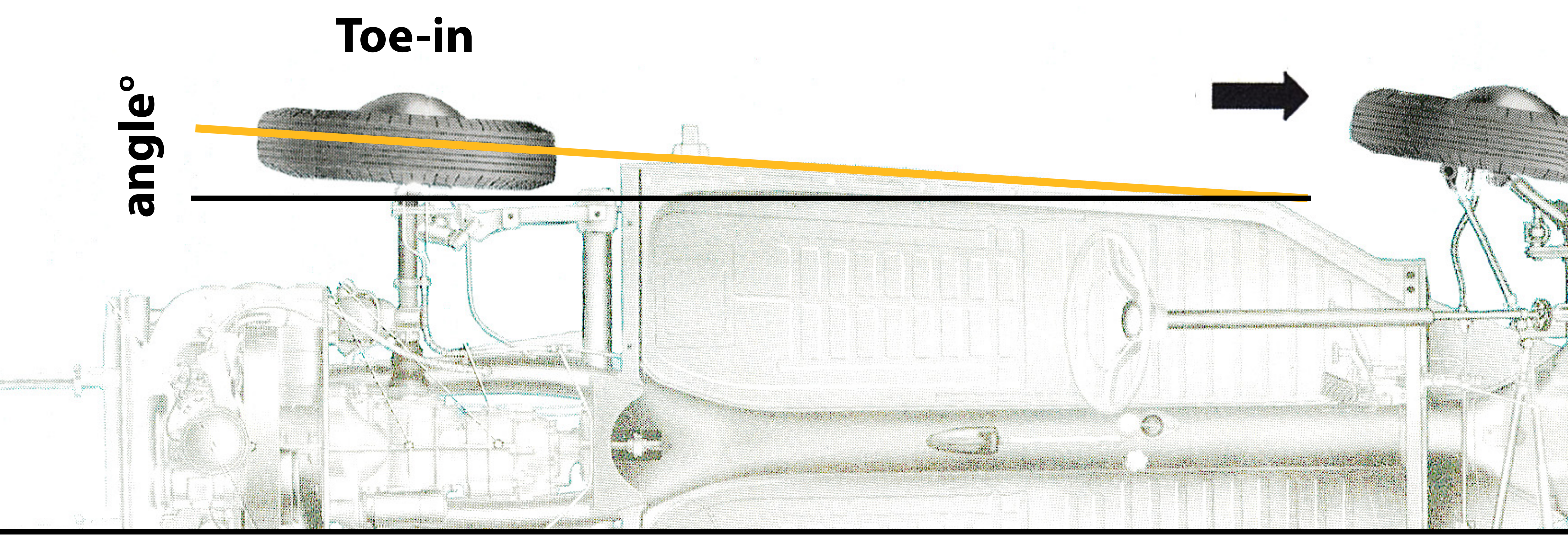


#82 Rear axle

We will measure the rear Toe-in with a telescopic gauge, as we did for the front wheels in edition 27. The problem arises now, that the VW workshop manuals indicate rear Toe-in in degrees and minutes. Sometimes this is barely 5' (5 minutes), corresponding to 0.08° on the digital protractor (see edition 27 page 33 for the conversion). Measuring such small angles is in practice not realizable with a basic protractor, it can only be done with extremely precise geometry tools. But if we convert minutes or degrees into millimeters, we can measure the Toe-in on the rear wheels with basic tools.

And yes, we do hear this a lot: "*why did they teach me to calculate a cosine, sine, tangent, cotangent, and so on, when will I ever need that in my life?*"

And yes, triangulation or trigonometry, does come in very handy when you're doing engineering. In this particular example, we can convert the angle given by the books into millimeters, and we can measure that with our telescopic gauge. If you want to know how that works, study the next page carefully. If you just want to know how to convert an angle into millimeters, without the theory behind it, jump directly to page 16.



measuring wheel geometry

triangulation or trigoniometry

The black line is the longitudinal axis, it runs parallel to the longitudinal axis of the car. The orange line is the line that runs through the rim, the angle with the black line is the Toe angle of the rear wheel. As mentioned earlier, that angle is very small, barely a tenth of , or less, of a degree. The drawing on the previous page shows exaggerated Toe-in, to make the explanation possible. The triangle below is a reproduction of the one on the previous page, but even more exaggerated. The angle of the orange line is 13°, while a Toe angle in practice is barely a tenth of a degree, so 100 times smaller.

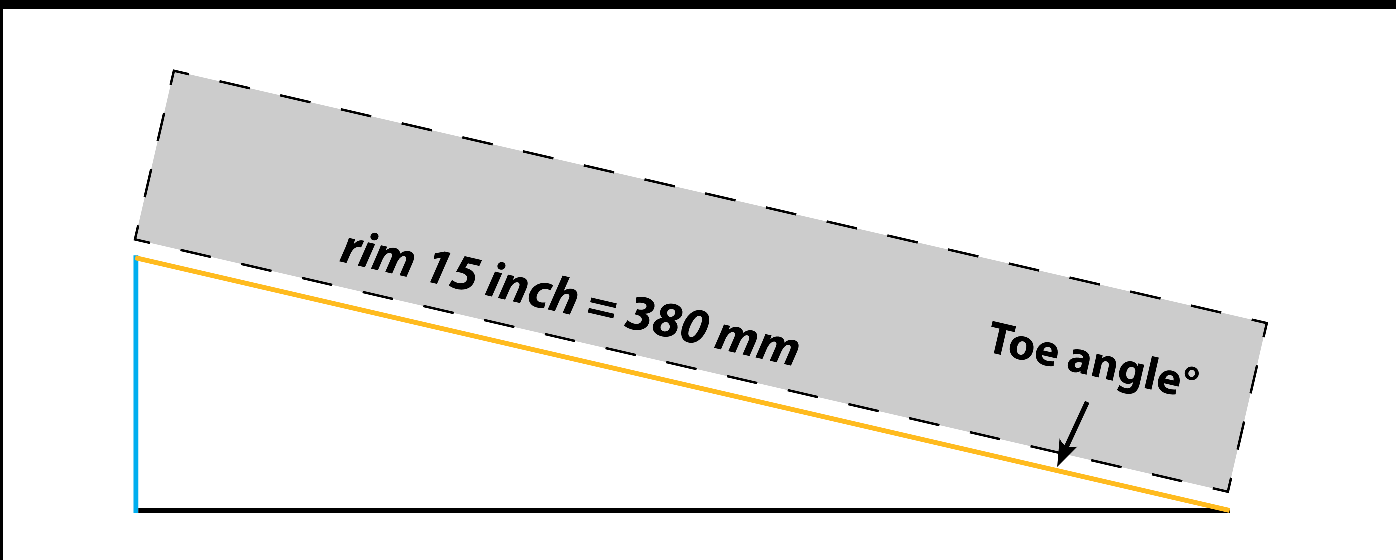
What we can do with triangulation is to calculate the length of the blue line, when we know the angle and the length of the orange line.

The orange line represents the rim against which we will measure. We will measure against the rim edges. For a 15-inch rim, that diameter is 15 inch, or converted to millimeters, it is 380 mm. If we need a Toe angle of +10' (+10' / 60 =0.17° decimal degrees), then we can calculate the length of the blue line with the sinus of that angle:

blue line
=rim diameter x sin(Toe angle°)
=380 mm x sin(0.17°)= 1,14 mm

if you need to calculate the angle
angle° = $\sin^{-1}$ (blue line/rim)

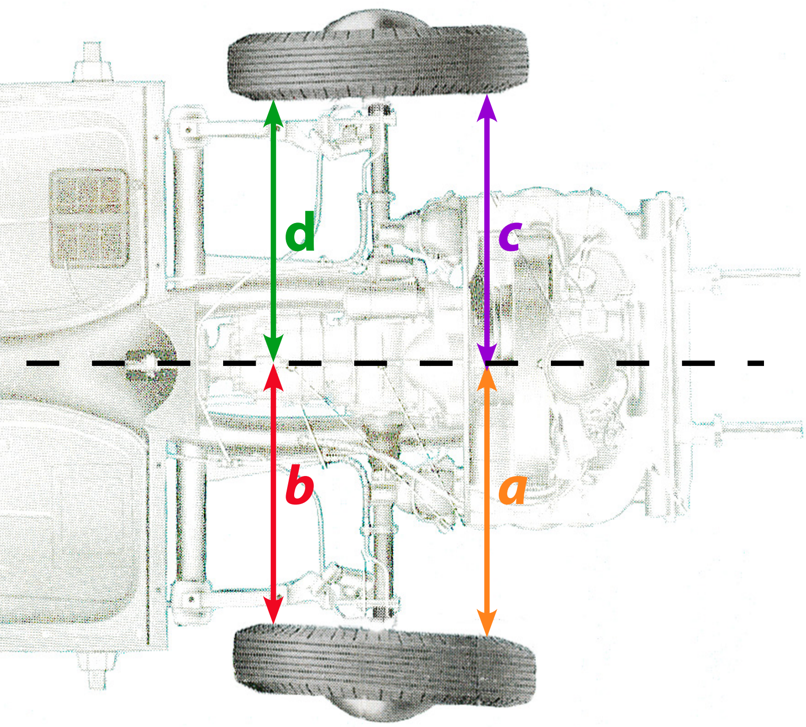
So, by measuring the difference in distance between the front and the rear of the rim to the transmission center, we can calculate the Toe angle.



Rear axle

If I still haven't been able to get you excited with trigonometry, you can opt for this shortcut.

For a 15-inch rim, a 10-minute angle corresponds to 1.13 mm. An angle of +5' (plus 5 minutes) then corresponds to 1.13 / 2 = 0.56 mm. If we want to perform the reverse calculation, we can say that 1 mm corresponds to 8.85'. We will need this quick conversion later.



Now that we can calculate the length of the blue line, we can start measuring it with our telescopic gauge, as we did with the front wheels. This time we are not measuring between the two rims, but from the rim edge to the centerline of the car. As a reference point you can take the seam of the gearbox or from the engine. Obviously, the measurement will not be very accurate, but what we are trying to do here is to make an initial measurement, after restoration or after a repair, and then use professional wheel geometry equipment later on to accurately adjust the tracking.

We show the principle in the drawing on the left. You first measure against the back of the rim flange in the case of Toe-in as in the drawing. You measure at the center of the rim, we show how on the next page. The result is ***a***. Then you measure the rim at the front, which is the length ***b***.

measuring wheel geometry

The result is:

a - **b** = Toe left side wheel

You repeat this for the other side and obtain:

c - **d** = Toe right side wheel

When **a** is greater than **b**, we have Toe-in on the left side. The same is true for the right wheel, when ***c*** is greater than ***d***, there is Toe-in on the right side as well.

Take the example below for the measurement of this VW 1303 convertible:

a - **b** = +1.5 mm = Toe left side
c - **d** = 0 mm = Toe right side

The total Toe is:

(+1.5) + (0) = **+1.5 mm**

We use a plus sign, to indicate that the value is positive. A positive value indicates that we are dealing with Toe-in. A negative value would indicate Toe-out.

If we now convert that to degrees and minutes, using the quick conversion where 1 mm corresponds to 8.85' for a 15-inch rim, we obtain:

$$1{,}5 \times 8.85' = 13.3'$$

Convert to decimal degrees:

$$13{,}3' / 60 = 0.22°$$

We can achieve the same thing with triangulation:

$$\text{angle}° = \sin^{-1}(\text{blue line/rim})$$
$$= \sin^{-1}(1.5 / 380) = 0.22°$$

On page 19, we see that the tracking for the VW 1303 should be 0°, with a deviation up or down of 15'. So, minimum -15' and maximum +15'. At 13.3', our 1303 convertible is within specifications.

A second example, now with Toe-out on the right wheel:

a - **b** = +1.5 mm = Toe left side	
c - **d** = -1 mm = Toe right side	

Total Toe is:

$$(+1.5) + (-1) = +0.5 \text{ mm}$$
$$+0.5 \times 8.85' = 4.42'$$

The table on the next page, shows the total Toe, left and right combined, with maximum allowable deviation. The values are very small, that in practice they will be very difficult to measure without precision tools. In the VW workshop manuals you will also find the maximum deviation between left and right.

Ideally, both wheels have the same Toe value, and the total Toe is within the listed value in the table. There may be a difference between the two wheels, but it should not exceed the number indicated in the VW workshop manual. We refer to pages 6 and 7, the total symmetry of the rear axle should also be correct.

If you come out roughly within the values in the table, then your VW is OK to drive a few hundred miles, or do the drive up to the specialist, for final tuning. In the end, that was the point of this article.

REAR WHEEL TOE	YEARS	Rear axle type	Toe	Deviation
Beetle	1958-1960	swing axle	-5'	+/-15'
Beetle and Karmann Ghia without	1961-1965	swing axle	-5'	+/-10'
Beetle and Karmann Ghia with stabilizer (type 111-118)	1961-1965	swing axle	-5'	+/-10'
Beetle and Karmann Ghia with stabilizer (type 141-144 en 151-152)	1961-1965	swing axle	-5'	+/-10'
VW 1200, VW 1300, convertible and Karmann Ghia without stabilizer	1966-1969	swing axle	+5'	+/-10'
VW 1500 with stabilizer	8/1966 and later	swing axle	+5'	+/-10'
Beetle convertible en Karmann Ghia with stabilizer	8/1966 and later	swing axle	+5'	+/-10'
Beetle and Karmann Ghia	1966-1969	IRS	0°	+/-15'
Beetle, 1303, Karmann Ghia	1970-1979	IRS	0°	+/-15'
VW Bus	1950-1962	swing axle	-20'	+/-15'
VW Bus Transporter	1963-1967	swing axle	25'	+/-25'
VW Bus Ambulance	1963-1967	swing axle	15'	+/-25'
VW Bay Window Bus	1988-1979	IRS	+10'	+/-20'
VW Vanagon empty	1980-1991	IRS	+5'	+/-10'
VW Vanagon loaded	1980-1991	IRS	+5'	+/-10'
Type 3 sedan	1968-1973	swing axle	-5°	+/-10'
Type 3 squareback	1968-1973	swing axle	-5°	+/-10'
Type 3 sedan	1968-1973	IRS	+5°	+/-15'
Type 3 squareback	1968-1973	IRS	+5°	+/-15'
VW Golf (to chassis 1763241690)	1974-1984	IRS	+10'	+/-30'
VW Golf (from chassis 1763241691)	1974-1984	IRS	+20'	+/-20'

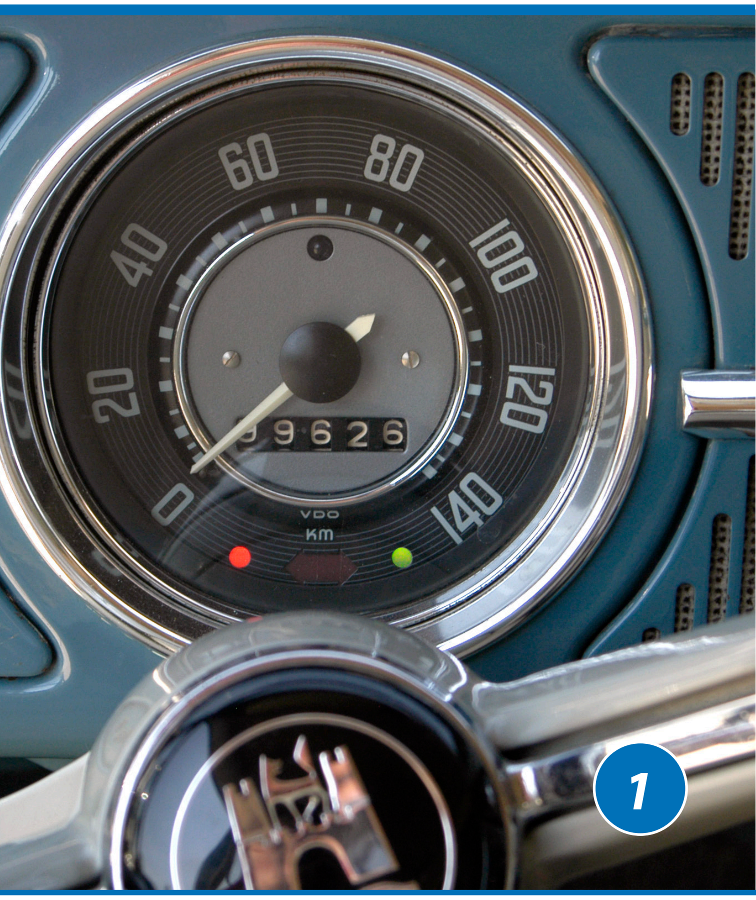
We do not mention all the special versions such as the fire truck, ambulance, ... These are heavier and have different settings for toeing, as well as for wheel Camber, consult your VW workshop manual.

The alignment adjustment is done by moving the spring plates opposite the bearing flange (see page 3). The adjustment of the rear axle's tracking and wheel Camber, we will discuss in the next edition.

#83 Engine

Introduction

When you start the engine for the first time after an engine rebuild, as well as when you just drive around, you will want to keep a close eye on a number of engine parameters. The most important information you would want to keep an eye on are oil pressure, engine oil and cylinder heads temperature. VW has provided bitterly few engine diagnostics as standard in the dash.



A generator light that goes out when the dynamo or alternator supplies the battery with charging current (red light on photo 1, we discuss this in edition 29) and a light that goes out when the engine oil has reached a certain pressure (green light on photo 1). This is not much to work with.

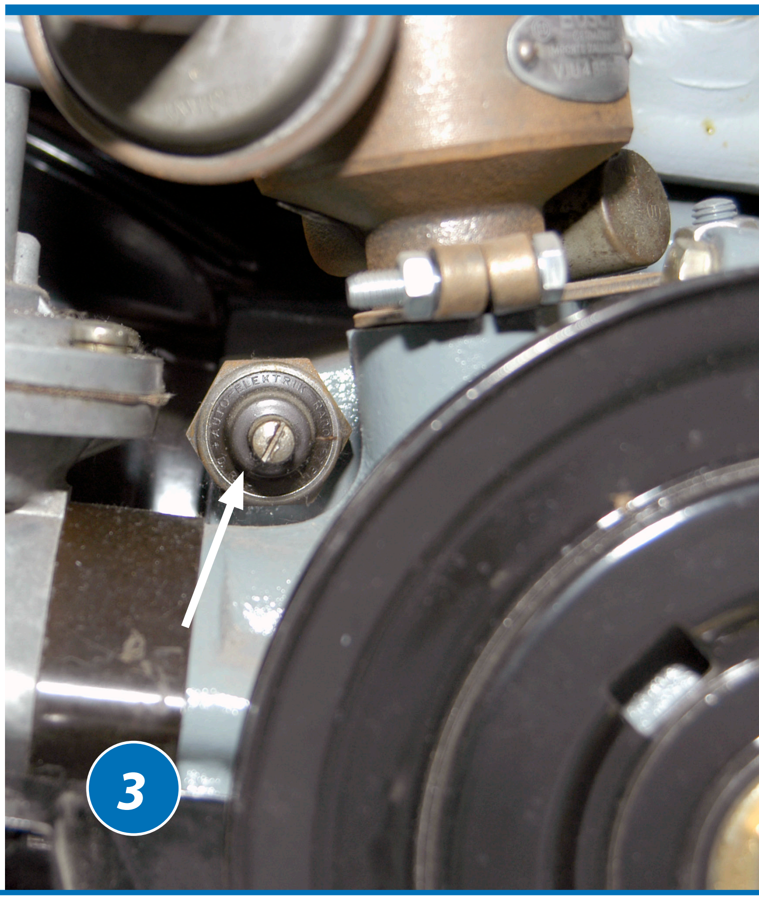
We will discuss measuring oil pressure in this article, in the next edition we will measure oil temperature and cylinder heads temperature. The circuits will be explained, and we will also discuss how to interpret the information you see. Because, clocks are handy, but they don't always tell everything.

You can use the information in this article to build a test setup to tune your engine or as a final setup with clocks in the dash.

Oil pressure sensor

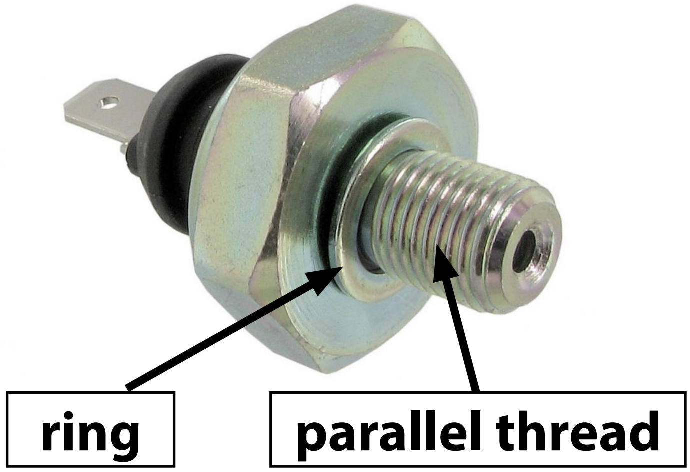
By default, our VW is equipped with a light in the dash to keep an eye on oil pressure (photo 1). When the engine is not yet running, but the ignition is on, the light will come on. It will go out when the engine is idling, and remain extinguished until the engine is turned off (ignition still on, of course). To make this possible, there is an oil pressure sensor or oil pressure switch installed in the engine crankcase. The standard oil pressure sensor screws into the crankcase just above the oil pump to monitor oil pump operation. We show below both the version on a younger Type 1 engine (photo 2), and this one on a 25/30 hp engine (photo 3).

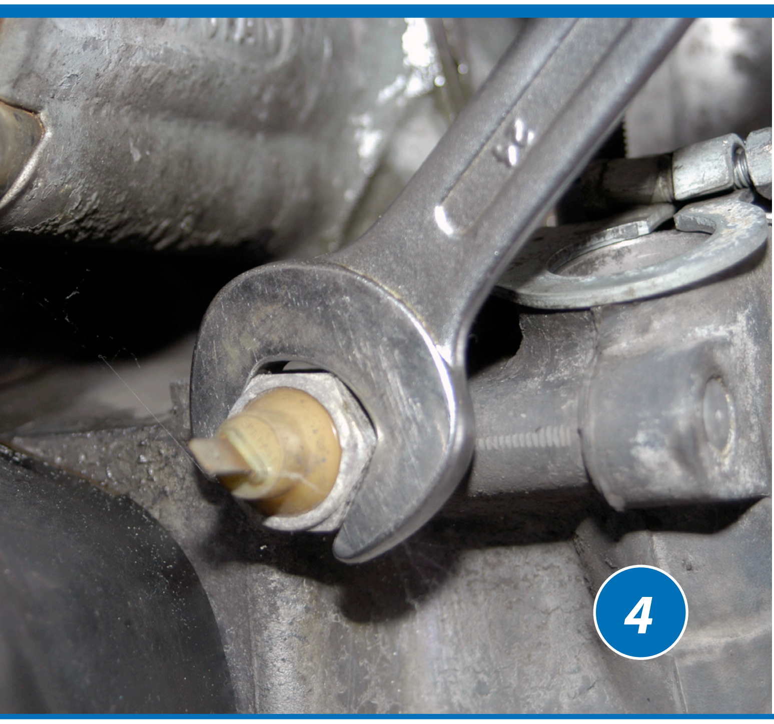

2

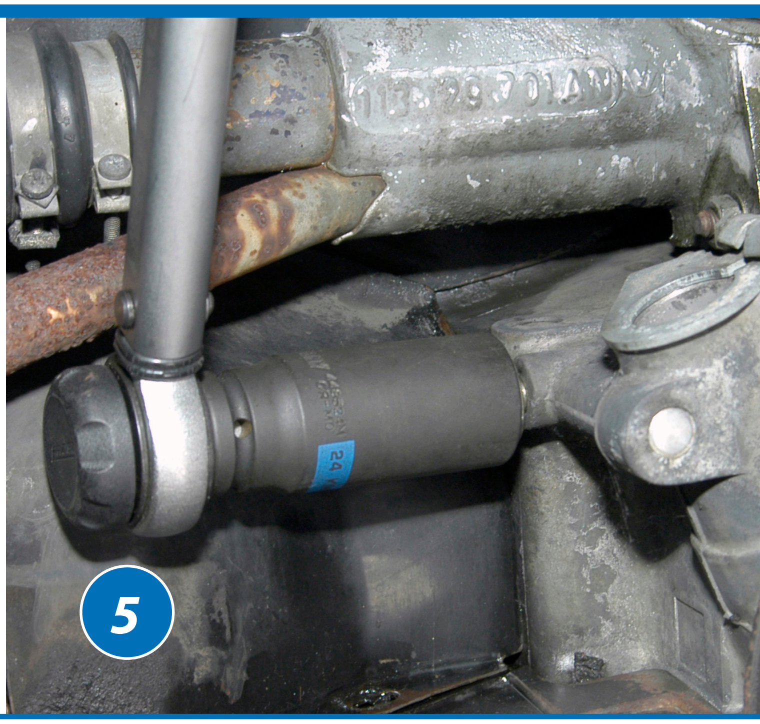

3

The sensor (photo right) has an M10 thread (with pitch 1.0) to thread into the engine crankcase. Note that the connection on air-cooled engines is tapered! There is no sealing ring on air-cooled engines, because the sensor does not have to be screwed down to the crankcase to seal, but seals due to the taper.

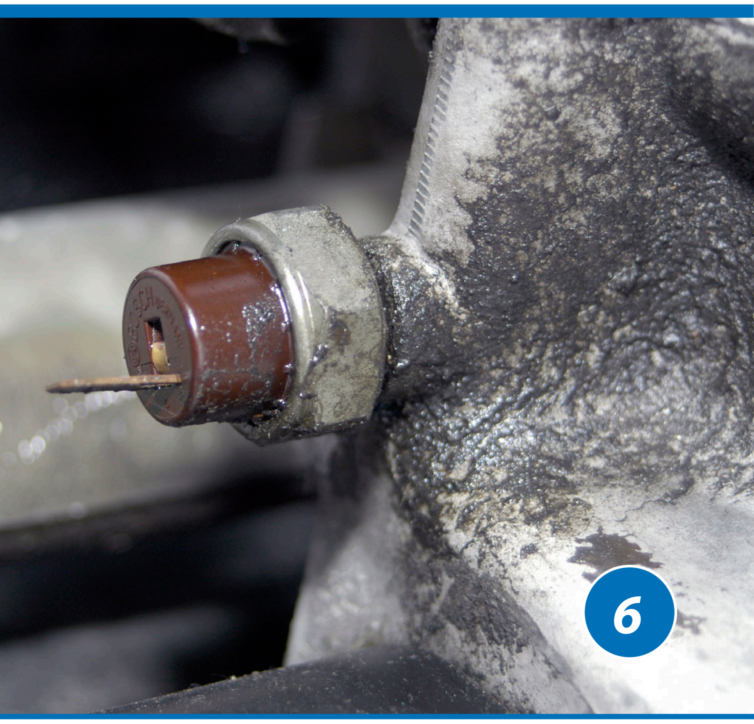
In contrast, the version for water-cooled engines does come with a sealing ring (photo at right). So this one has a parallel thread, and is supposed to seal with the ring against the crankcase.







If you screw in the sensor with tapered thread too far with too much force, you will at best break the sensor, at worst you will damage the crankcase. With a long socket wrench (photo 5) you will manage to tighten or loosen the sensor without having to loosen the distributor. With a tapered connection, you have to be very careful. You will tend to over-tighten the sensor. Turn the sensor in the crankcase until you feel resistance (photo 4), tightening half a turn further is usually enough for a good seal. Whether the seal is good enough, you will experience while running the engine at high rpm (warm engine), during a few seconds. If no oil leakage is noticeable, then the sensor is sealing well in the crankcase. You may see a small oil leak, a quarter turn is sometimes enough to stop the leak.



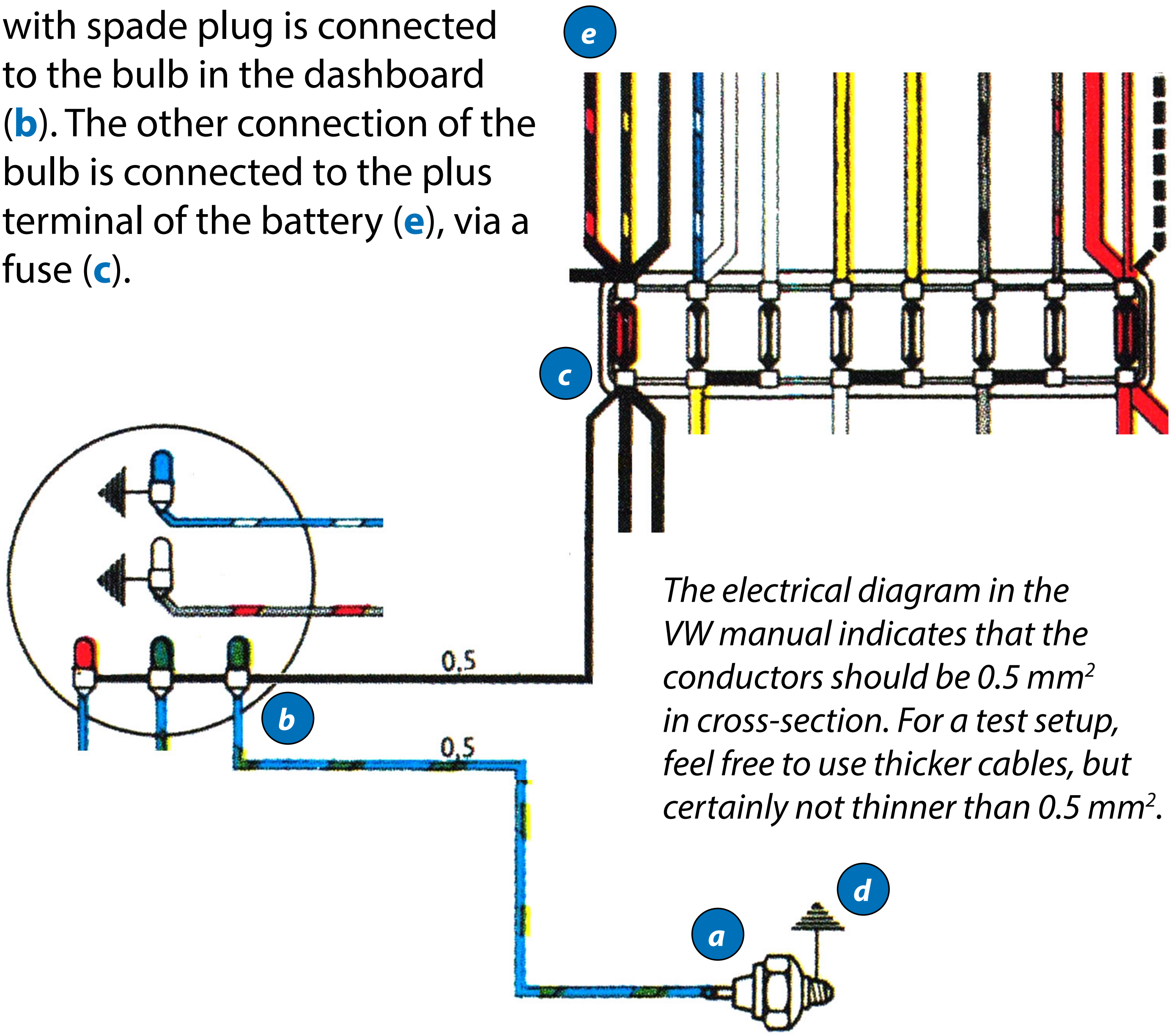
6

We show in photo 6 a leaking sensor. The reason may be that the sensor is not tight enough, or it may have been overtightened and a crack developed, either in the sensor, or in the crankcase. In both cases, this will lead to oil loss, as well as oil pressure loss.

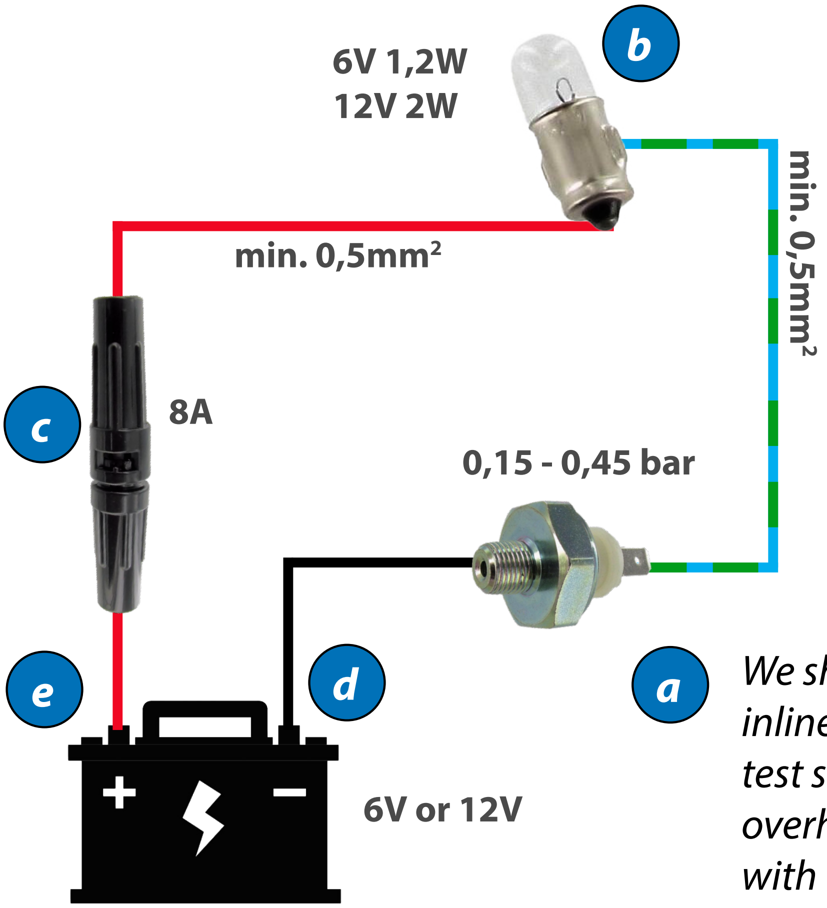
The oil pressure sensor is an electrical switch operated by a pressure, i.e. a manometer. The switch is closed at rest, that is, when there is no oil pressure, or rather, when the oil pressure is lower than the minimum critical value for the engine. We show the electrical circuit on the next page.

Below we show the simplified representation of the electrical circuit of the oil pressure sensor. If you consult the electrical circuit of, say, a VW 1300, you can find the parts and connections below. The sensor (**a**) is connected to ground (the chassis) through its housing and the engine sump (**d**). The connection with spade plug is connected to the bulb in the dashboard (**b**). The other connection of the bulb is connected to the plus terminal of the battery (**e**), via a fuse (**c**).

If you want to mimic this circuit on an engine on the workbench, you only need to connect the spade plug of the sensor to a 12 V or 6 V bulb, preferably with a line fuse in between. We show the very simplified circuit on the next page. More information on fuses in edition 05.



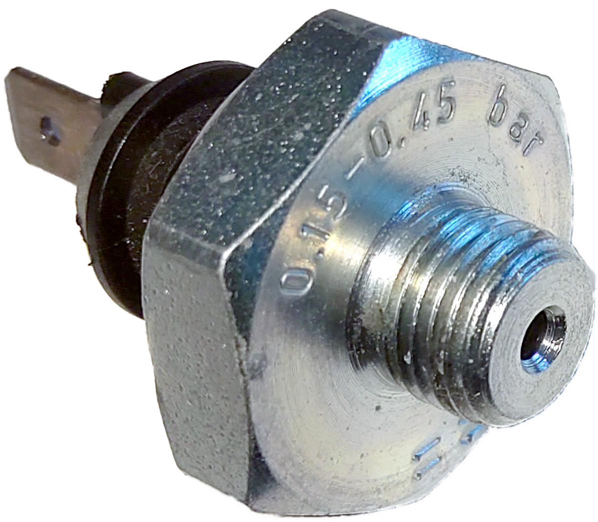
The electrical diagram in the VW manual indicates that the conductors should be 0.5 mm² in cross-section. For a test setup, feel free to use thicker cables, but certainly not thinner than 0.5 mm².



- a oil pressure sensor
- b oil pressure light
- c fuse
- d ground (chassis)
- e to battery (6V or 12V)

We show here the circuit with an inline fuse as you would make for a test setup, to test the engine after an overhaul. The standard sensor works with both 6 volts and 12 volts.

On the original oil pressure sensor of a Type 1, Type 3 and Type 4 engine, the pressure at which the sensor switches is between 0.15 and 0.45 bar (or kg/cm²). These values are indicated on the housing of the sensor (photo at right). The switch will be closed below 0.15 bar of oil pressure, the light bulb in the dash gets power and glows. If the oil pressure is higher than 0.15 bar, the switch will want to switch, eventually opening. At 0.45 bar the switch is permanently open, the circuit is not conducting and the bulb goes out completely.



#83 Engine

light does not come on

It is important to verify that the oil pressure control light comes on when you turn on the ignition, before the engine is running. If the light does not come on, then either the light itself is broken, or the oil pressure sensor, or the fuse in the fuse box has blown, or the electrical connections are damaged or loose. Time to diagnose the oil pressure circuit and fix the problem.

light stays on

If the light comes on while the engine is idling, the oil pressure is too low, at least lower than 0.45 bar, or there is no oil pressure at all. It is also possible that the oil pressure sensor switch remains in the closed position, making it appear that there is no oil pressure. The decision when the light is on continuously, then, is always, stop the engine immediately.

light goes out

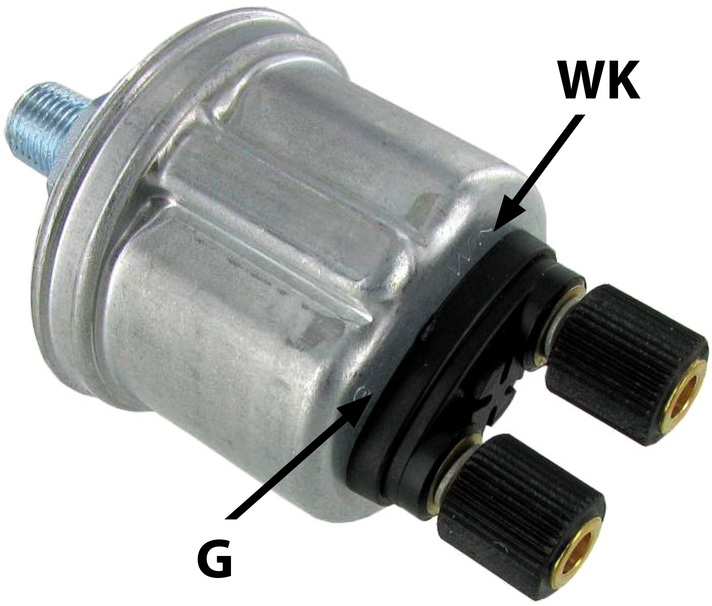
When the light goes out, it only indicates that the oil pressure is at least higher than 0.45 bar. It makes it feel good that everything is fine, but a standard Type 1 engine running at operating temperature (70°C to 100°C engine oil temperature) should have an oil pressure between 0.7 bar and 3 bar.

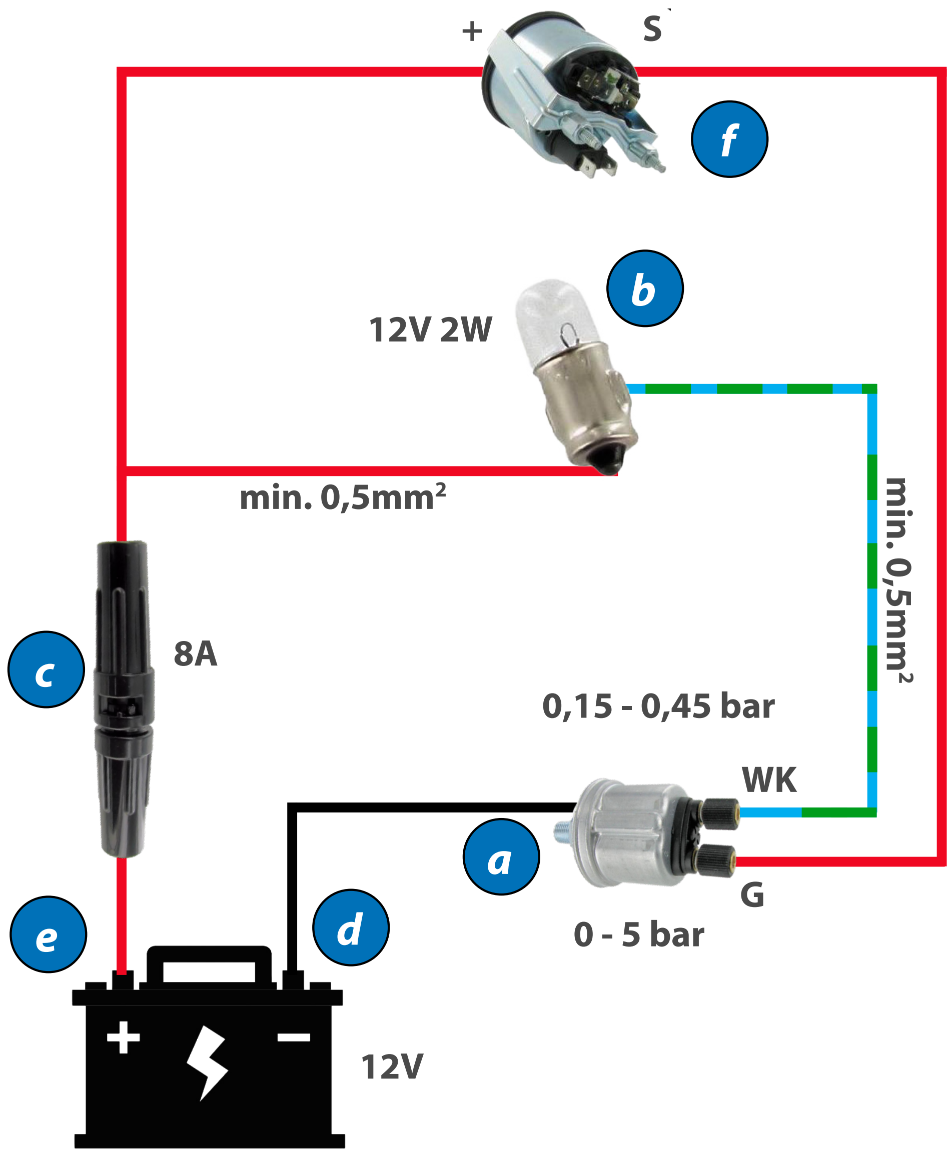
The standard solution offered by the VW factory to monitor oil pressure is very simple, that's the least we can say. A better solution would be to be able to see the oil pressure in bar at any time. For that, you need to replace the oil pressure switch with an oil pressure sensor that does more than open and close, but takes a continuous reading of oil pressure, along with an oil pressure gauge that shows oil pressure in bar or PSI. In a future edition, we will explain in more detail what oil pressure means.

Oil pressure gauge

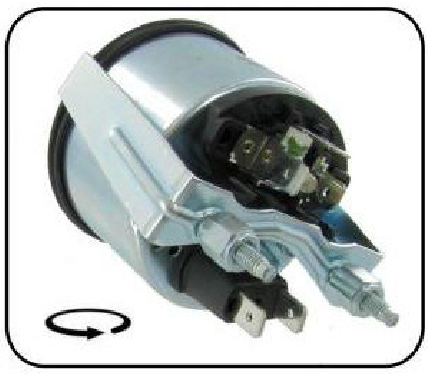
A more accurate reading of the oil pressure is helpful, but it should also not lead to paranoia when the oil pressure suddenly drops or rises. You should use such a gauge with a "how to use manual". We use an oil pressure gauge when we adjust an engine, or after a total engine overhaul. You can use a 52mm VDO gauge for this (photo above right), which you can then also install under your dash.
You will have to use an oil pressure sensor (sender) that is suitable for that gauge. The VDO oil pressure sensor we show here (photo below right) has two connections. To the connection marked with the letter WK (W stands for Warning light), connects the cable that would connect to the standard sensor. This acts as a switch just like the standard oil pressure sensor. This way you retain the function of the oil pressure warning light in the dash, nice touch.

The other connection, marked G (G for Gauge), is for connecting the oil pressure gauge. It works like a variable resistor, the resistance varies with the oil pressure and causes the gauge needle to display the oil pressure.





The connection of the VDO gauge with sensor is shown in the drawing on the left. Terminal G (Gauge) of the sensor is connected to terminal S (Sensor) of the gauge. Terminal + on the gauge goes to the plus terminal of the battery with fuse. WK is used to connect the oil control light in the dash.



- **a** **VDO oil pressure sensor**
- **b** **oil pressure light**
- **c** **fuse**
- **d** **ground (chassis)**
- **e** **to battery (12V)**
- **f** **VDO oil pressure gauge**

The VDO oil pressure gauge has two additional plugs to connect the night light (two terminals at the bottom of the photo above).
You can use the existing cable from the original sensor to connect the VDO gauge under the dash, if you don't want to install a new cable. Then you have to disconnect the oil pressure indicator light and connect the cable to the VDO gauge. The oil pressure indicator light will then no longer have any function.

oil pressure gauge

Not every oil pressure sensor fits every oil pressure gauge! The VDO oil pressure gauge has both a switch, to control the indicator light as with the original sensor, and an adjustable resistor (R, see drawing on the right). The adjustable resistor is controlled by the engine oil pressure. It is the adjustable resistor that will vary the current through the VDO gauge (via terminal G) with the oil pressure.

The gauge expects a well-defined current value to indicate, say, 1 bar, another value for 2 bar. That current will be determined by the adjustable resistor R. If the sensor and gauge are not designed for each other, you may be able to read an oil pressure, but the value will not be correct, or the gauge may not indicate anything at all. Each gauge will therefore indicate whether it is intended for a 12-volt or 6-volt system, keep that in mind.

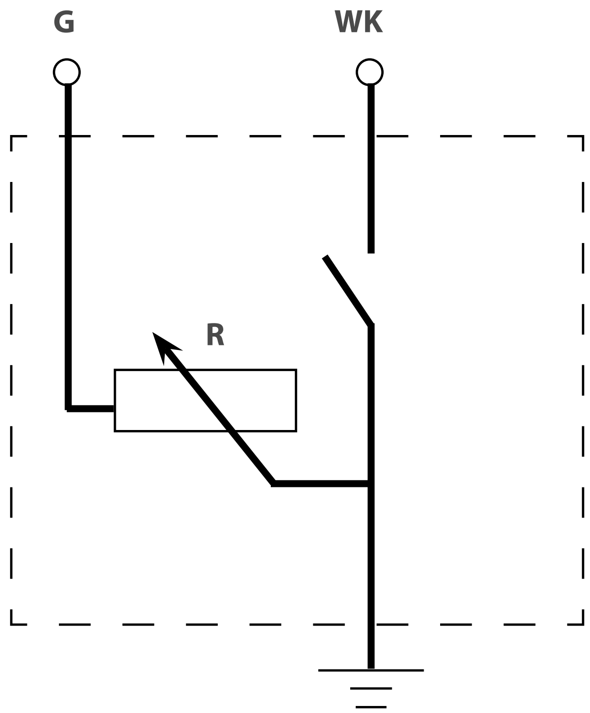
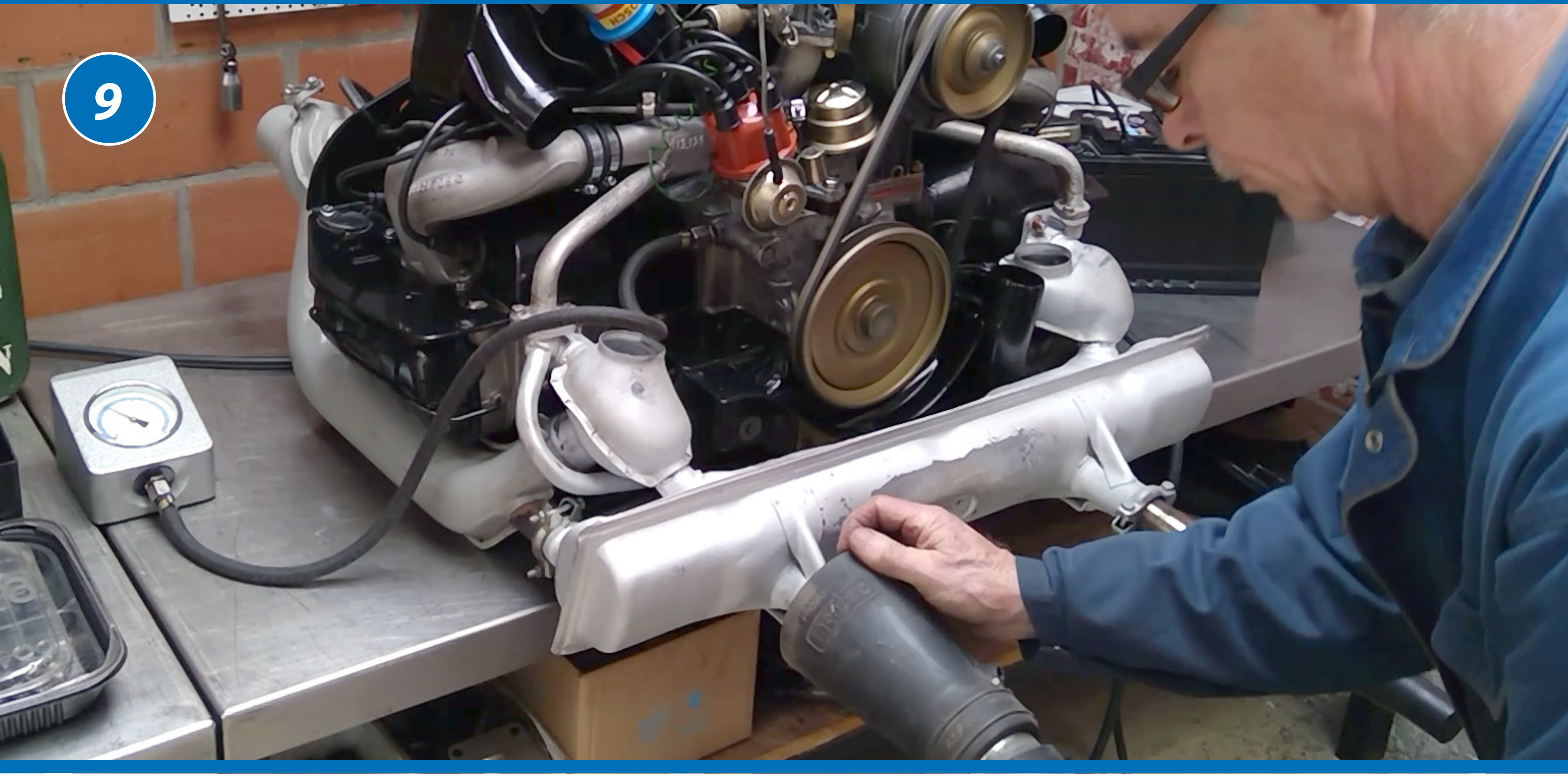


Photo below: Turn the sensor by hand until resistance is felt, then tighten with the wrench with little force. The sensor comes standard with a washer, you do not need this washer for air-cooled engines, the sensor will not seal against the crankcase anyway (conical thread).

#83 Engine

This VDO gauge is available with different oil pressure ranges, from 0 to 5 bar (photo page 27) and from 0 to 10 bar (photo right). You will need to use the sensor or sender with the same measurement range. As we mentioned earlier, the oil pressure of a standard VW Type 1 engine will be somewhere between 0.7 bar and 3 bar. You'll basically have enough with a sensor/gauge combination with a maximum range of 5 bar for a VW factory engine. If you go with high-performance engines, you will need a higher oil pressure range.

If you want to mount this gauge, possibly together with a temperature gauge or voltmeter under your dash, you can use the corresponding 52 mm mounting plates. Below we show the test setup that we will show in our video series:
www.paruzzi.com/uk/youtube



9

If you only want to read the oil pressure while adjusting, you can also use a standard pressure gauge that you screw into the engine sump (photos 9 and 10). This type of gauge usually comes with adapters with different thread diameters. You will need an M10 (pitch 1) adapter. Photo 9 shows an AS 1600 engine during its first start after a complete overhaul. The engine oil is still cold and thick, which ensures that the oil pressure will be higher than when the engine is at operating temperature (from 70°C). At 3 bar (photo 10), we are reassured that the oil pump is working properly, and that there are no significant pressure drops. Such an oil pressure gauge needs a user manual, as mentioned earlier, but it is an indispensable tool for any mechanic.

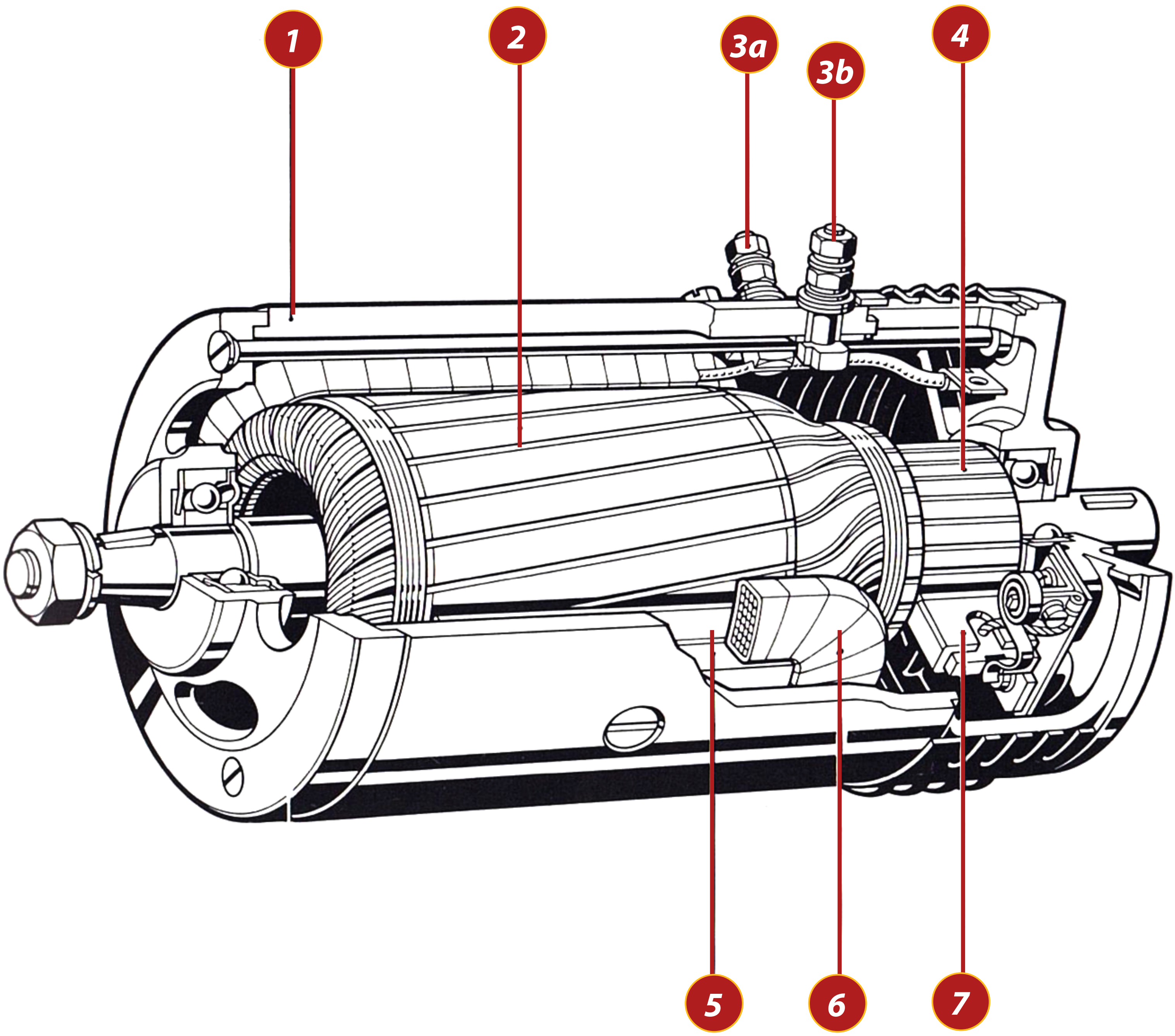
10

#84 Electrical

Introduction

You will find a DC generator (dynamo) in the oldest classic VWs. Below we show again the cross-section of a dynamo from a VW Type 1 engine.

Below we show a completely assembled Bosch dynamo. In [edition 26](), we also explained how an electric current can be generated by spinning a coil in a mag-



1 alternator housing or yoke

2 armature with armature windings

3a DF field windings => DF voltage regulator

3b D+ => D+ voltage regulator

4 commutator

5 pole shoe

6 field windings

7 carbon brushs

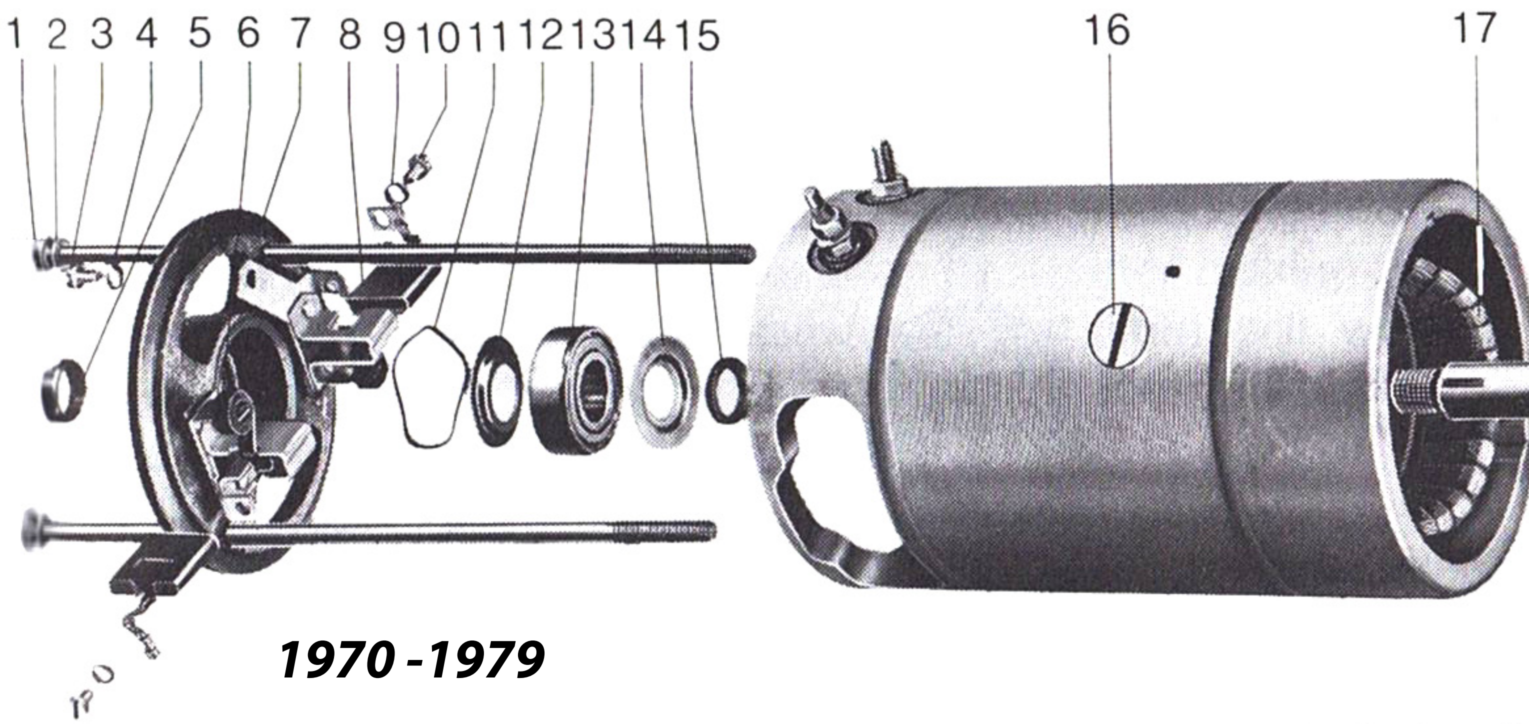
netic field. We also discussed every part of the dynamo.

Read edition 26 before you start replacing the bearings of your dynamo.

Generator bearings last a very long time, but they are wear parts. Wear will be promoted by an over-tightened generator pulley. On the next page, we show where the bearings are located in the dynamo of a 1970 Type 1 AB 1300 engine.

A dynamo has two sealed ball bearings. These are bearings that do not require grease, but are factory ready to mount (photo at right). Below we show the dynamo that we will fit with new bearings.

The bearing on the pulley side is shown on the left side of the drawing (no.13). This is the bearing that will suffer the most, due to the continuous pulling and pushing force of the V-belt on the pulley. The bearing on the right (also no.13, on this type of alternator both bearings are identical) is the one on the cooling fan side.
The forces on that side are more gradual, less abrupt, so in principle this bearing should show less wear.
It does seem a lot and complex, but if you read this article a few times, everything becomes much

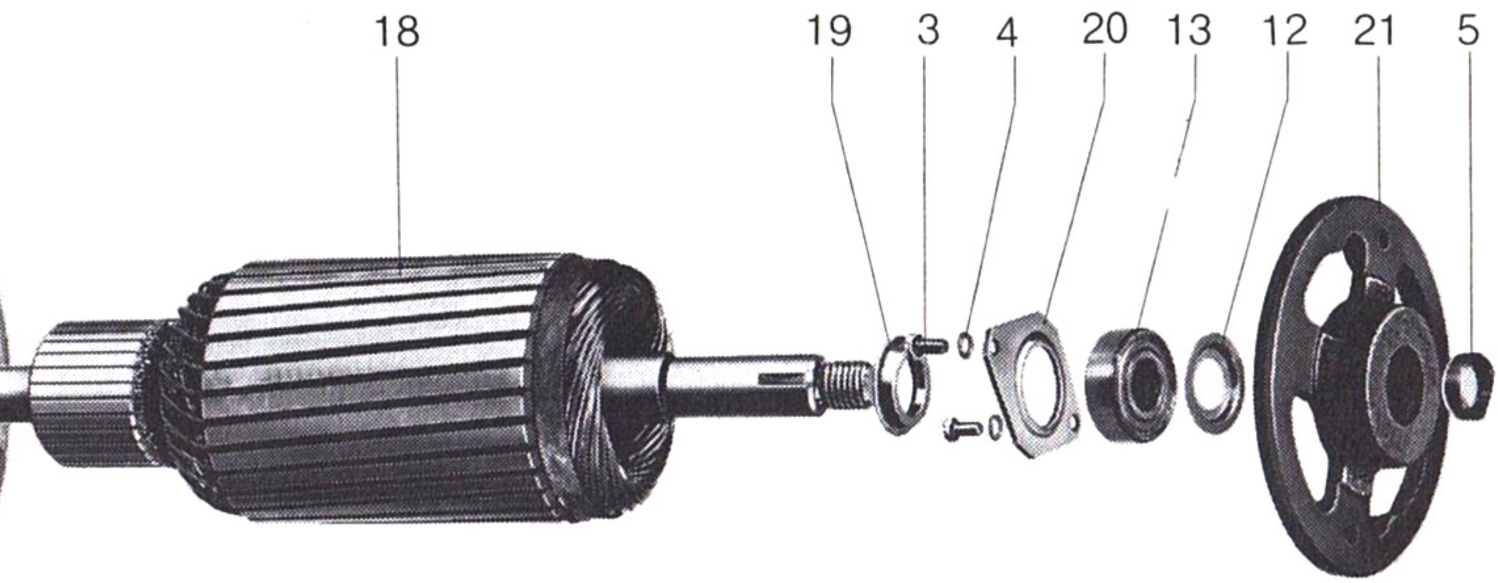


1970 -1979

clearer.
The bearings both rest on the outside against a dished washer (no.12) and on the inside against a splash shield (no.14 and 19). The bearing on the pulley side is mounted against a thrust washer on the inside (no.15) and a thin spring washer on the outside (no.11). A spacer ring is mounted on both ends of the shaft of the armature (no.5).

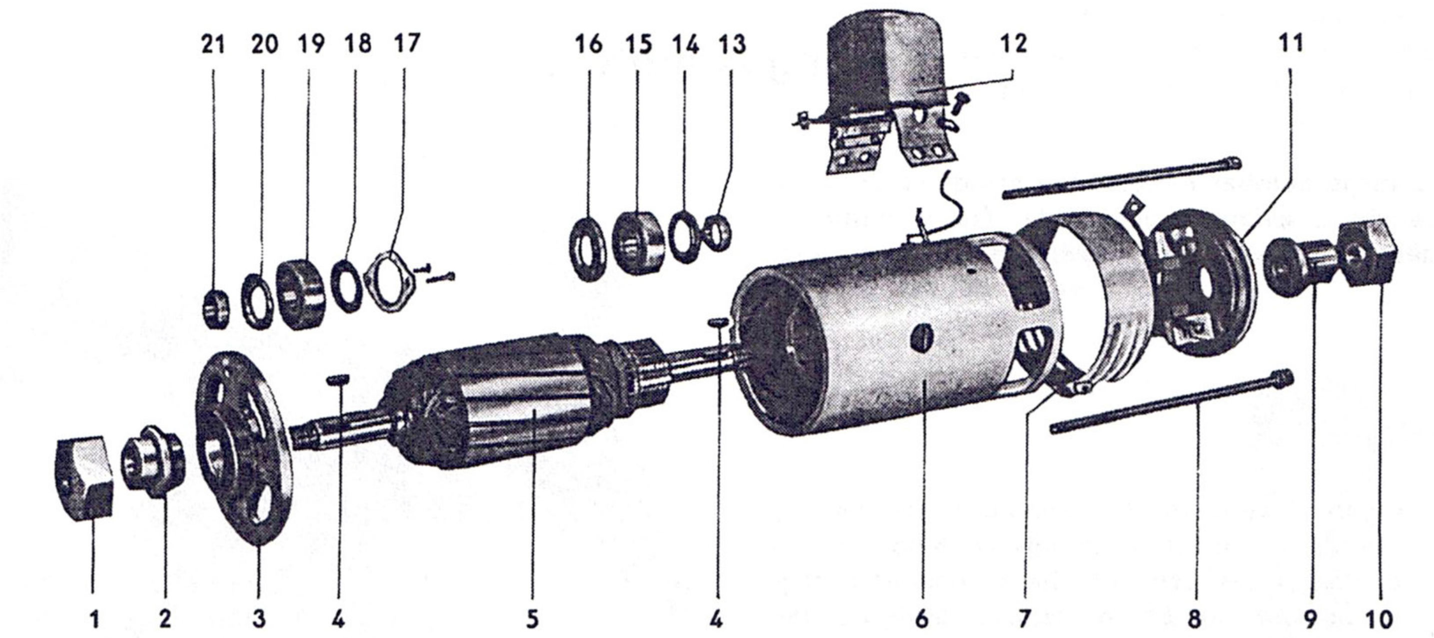
Pay close attention to this order while assembling the alternator.

1. long screw through housing
2. washer
3. screw
4. spring washer
5. spacer ring
6. carbon brush spring
7. bearing cover pulley side
8. carbon brushes
9. spring washer
10. screw
11. thin spring washer
12. dished washer
13. sealed ball bearing
14. splash shield
15. thrust washer
16. screw field windings
17. field windings
18. armature
19. splash shield
20. retaining plate
21. bearing cover cooling fan side



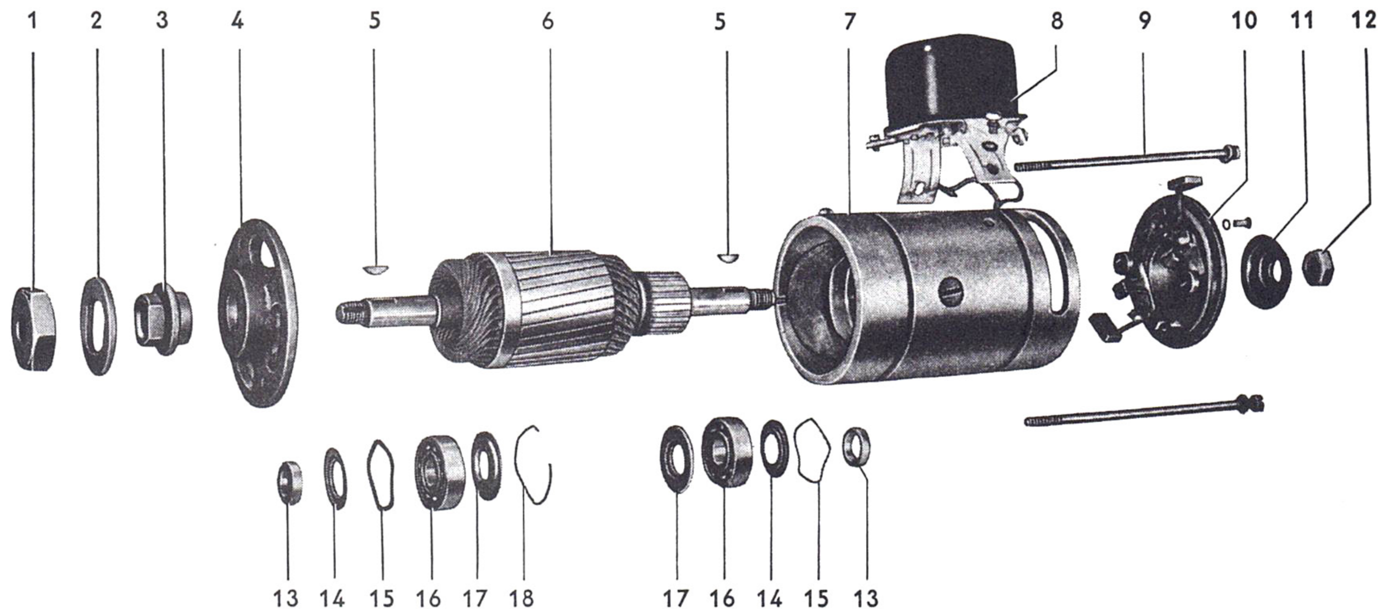
This is the last type of dynamo you will encounter on a Type 1 engine. The voltage regulator on this model is not mounted on top of the dynamo housing as it was on the older types we show on the next page.

1952-1957

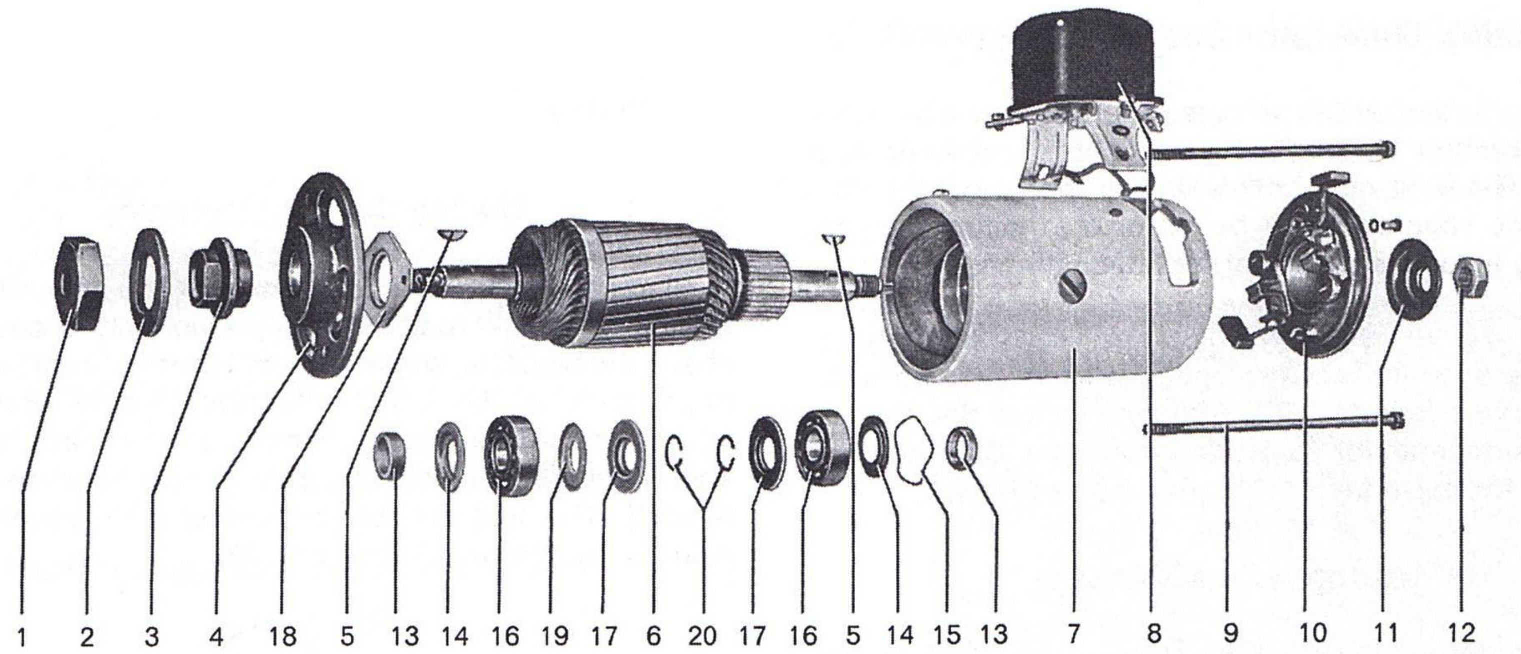


These are the dynamos for older Type 1 engines. The parts and the order of the parts inside the dynamo can be quite different depending on the year of manufacture or brand. But the principle remains the same. The carbon brushes are alternately on the left or right on the drawings, keep that in mind. On these

1958-1960



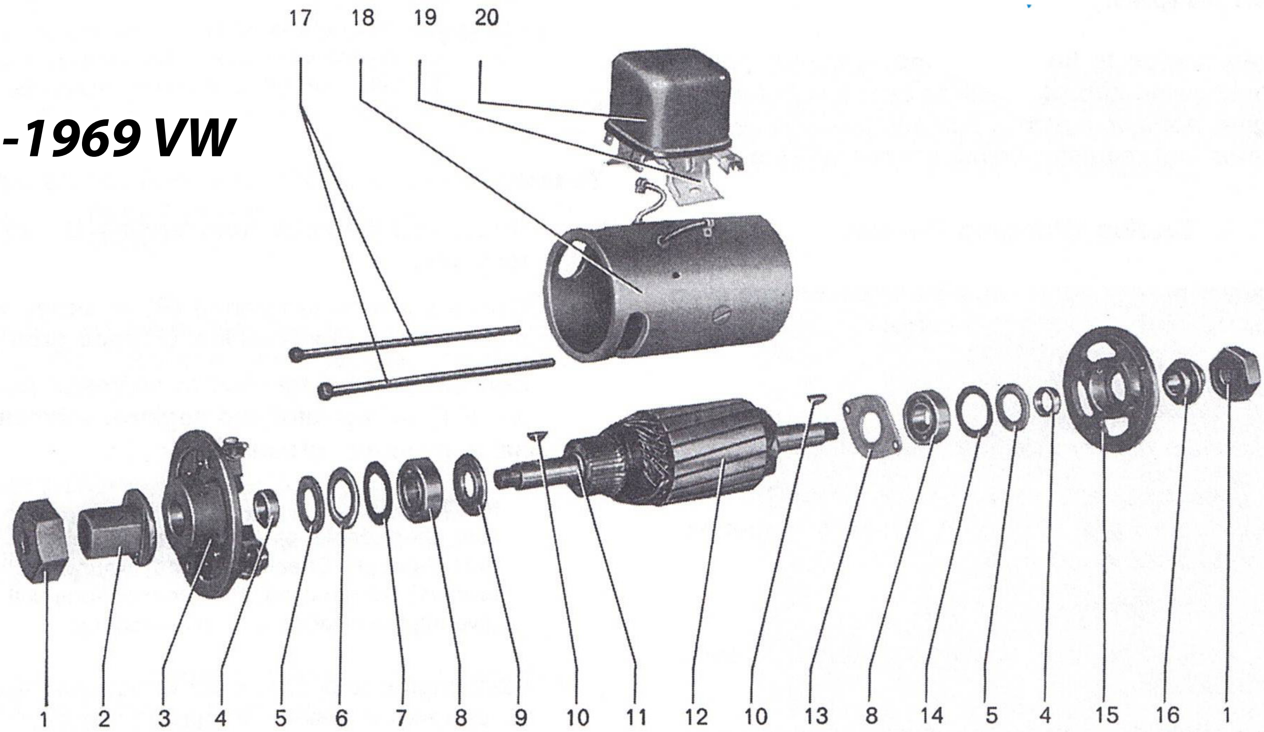
1961-1969 Bosch

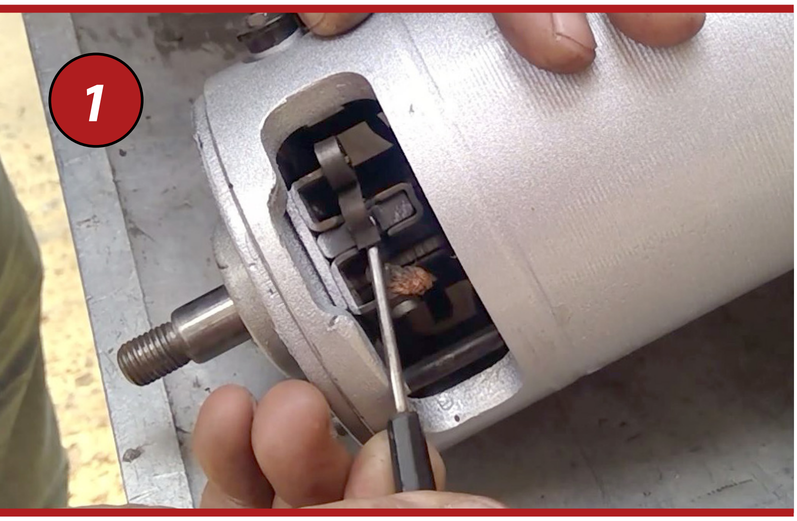


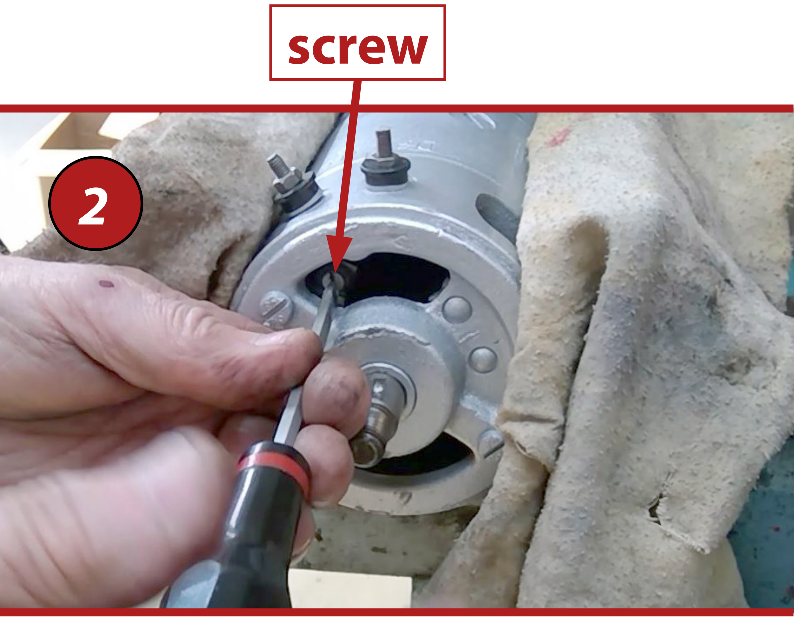
dynamos, the voltage regulator is mounted on top of the generator housing. Shorter cables mean less loss and fewer failures.

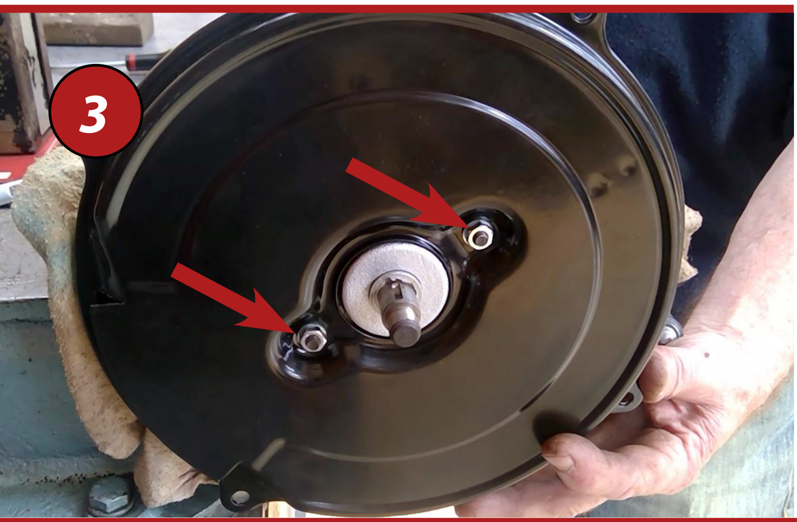
Consult the Volkswagen workshop manual for your engine type, or a Bosch technical manual for more information.

1966-1969 VW







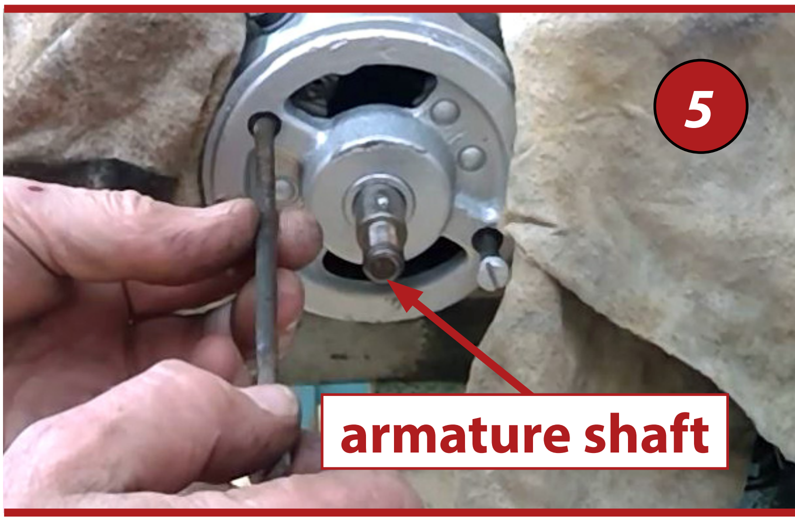


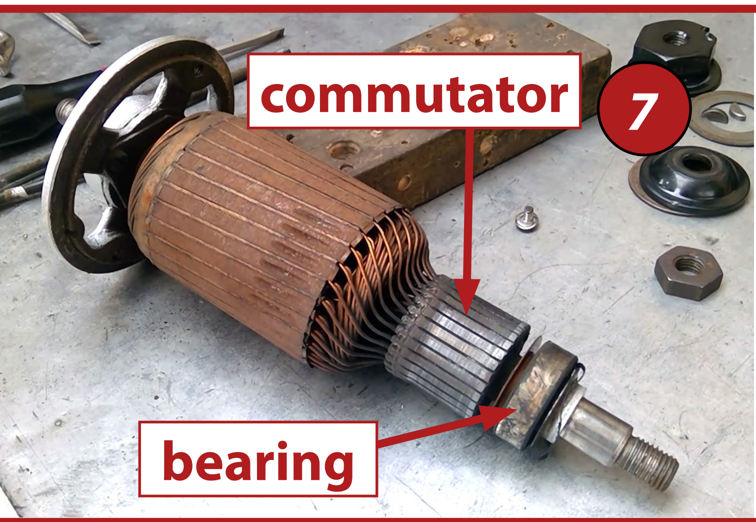
We will replace the bearings of a 105 mm dynamo from a VW Type 1 engine. The drawing of this type of dynamo is shown on pages 34 and 35. We will mention in the text the number from the drawing in parentheses each time.

We start the disassembly on the pulley side of the dynamo, this is also the side where the carbon brushes can be seen. This is the left side on the drawing on page 34. Fix the dynamo in a vise, use soft attachment jaws, from aluminum for example, so as not to damage the alternator housing, or a cloth (photo 2). Relax the springs (no.6 in the drawing) that hold the carbon brushes (photo 1), before loosening the bearing cover. You don't need to remove them; a push is enough to push them aside. Completely loosen the screw (no.3) located behind the bearing cover (photo 2). Without having removed this screw, the bearing cover cannot be removed. This screw is connected to the D+ carbon brush.

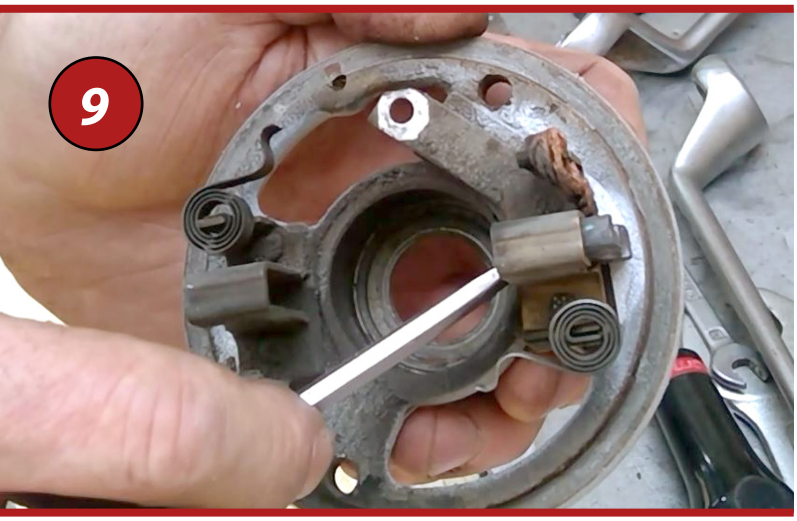
replace dynamo bearings

If the sheet metal of the cooling fan on the other side of the dynamo is not yet disassembled, you can do so by unscrewing the two nuts (photo 3). Now loosen the two long screws (no.1) that hold the bearing cover to the dynamo housing (photos 4 and 5). With a push against the armature shaft (photo 6), slide the armature (no.18) out of the dynamo housing (photos 6 and 7). We had tested this armature earlier, and it appeared to work fine. The commutator was worn in, which we had to grind down. We will now replace both bearings. The pulley side bearing is visible here (photo 7), the other bearing is hidden in the bearing housing on the other side.

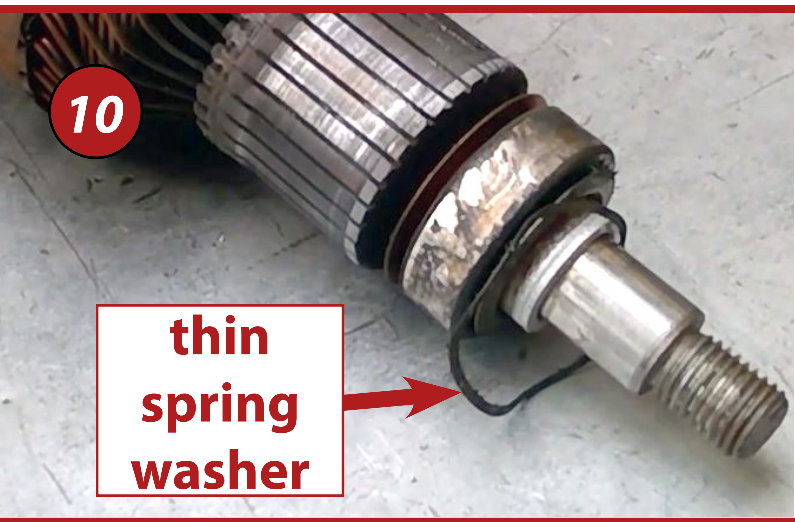


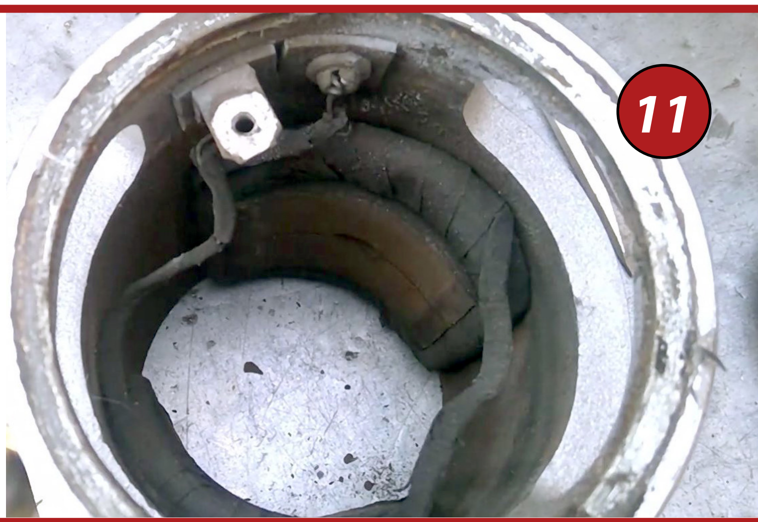


The bearing cover (no.7) may now come off. It sticks a bit to the dynamo housing due to a layer of zinc paint applied by a previous owner. The carbon brushes (no.8) with the springs (no.6) are now visible on the inside of the bearing cover (photo 9). These carbon brushes are very worn, and will be replaced.



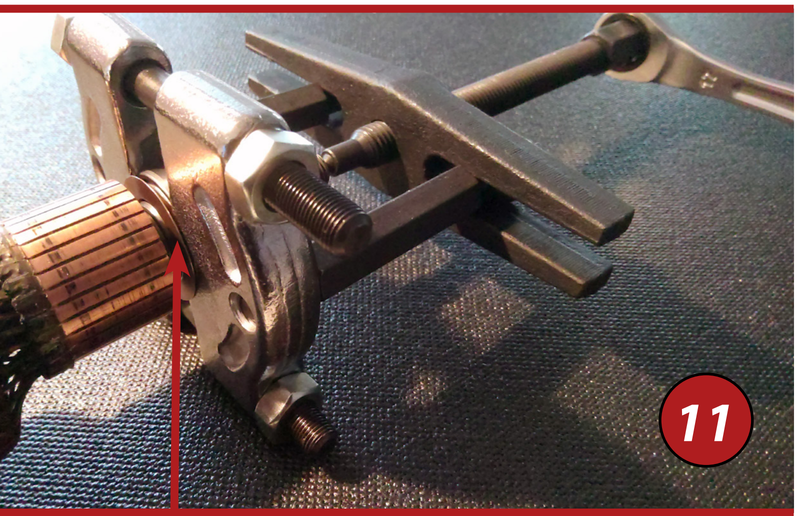
In photo 10, you can see the thin spring washer (no.11) on the shaft of the armature. Store it carefully, this spring washer is very fragile. How the field windings (photo 11) are tested, we will show in a later edition, when we perform a comprehensive diagnosis of the dynamo.

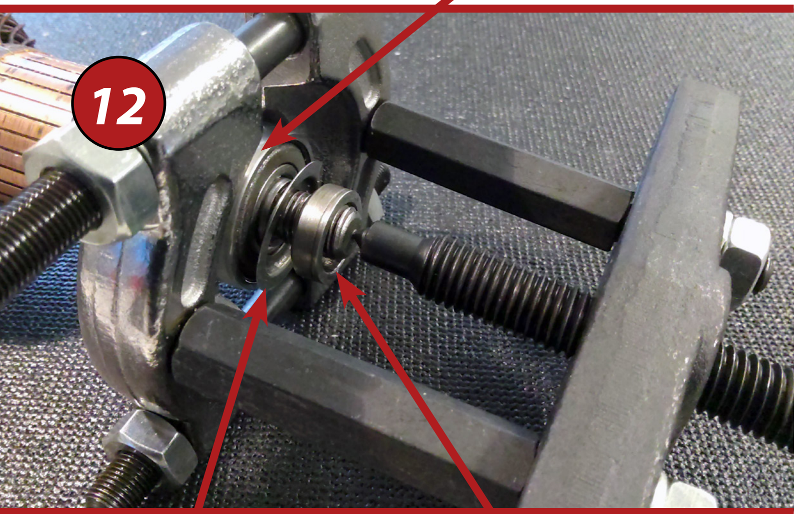


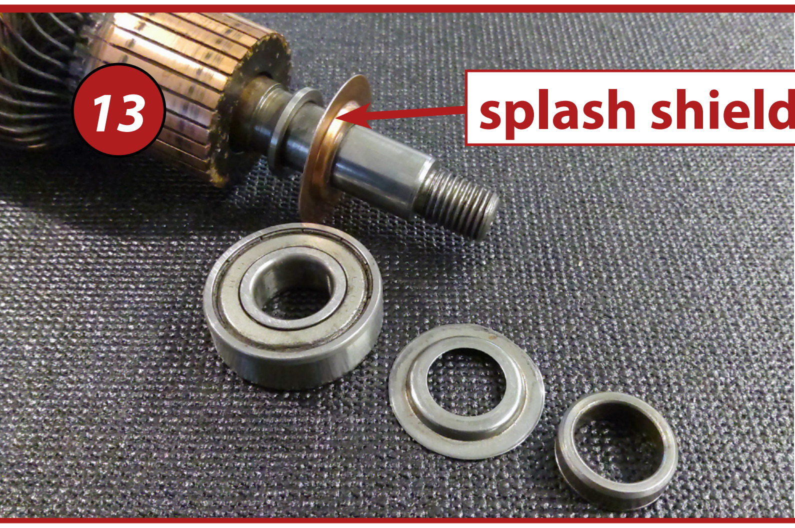


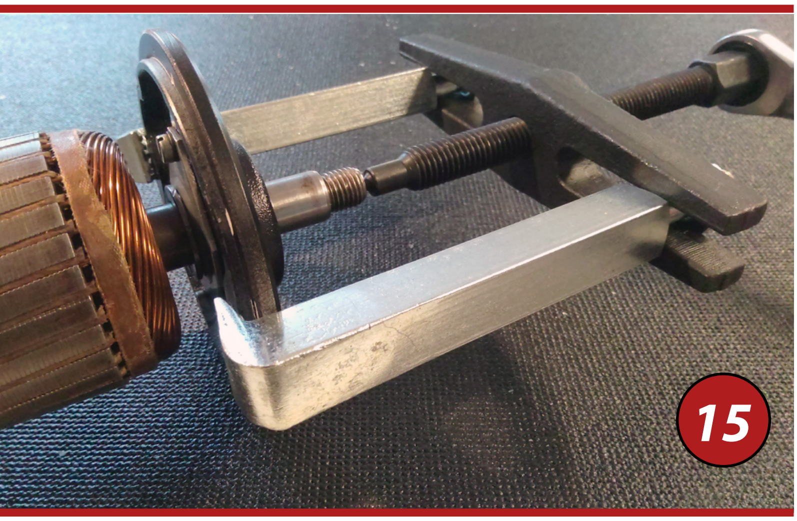
replace dynamo bearings

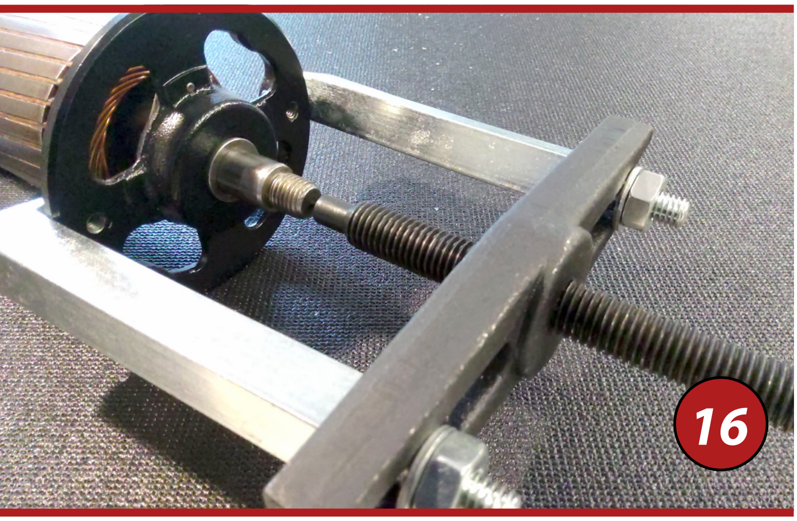
We start by removing the bearing on the pulley side. To pull the bearing loose, we use a bearing puller (photo 11). You must be careful not to damage the copper splash shield while positioning the puller. By tightening the threaded rod of the bearing puller against the armature shaft, the bearing comes loose (photo 12). Along with the bearing, the spacer ring (no.5) and dished washer (no.12) come off (photo 12). Behind the bearing there is the copper splash shield (no.14) (photo 13) and behind it another thrust washer (photo 14). This thrust washer is mounted with its beveled side against the splash shield.



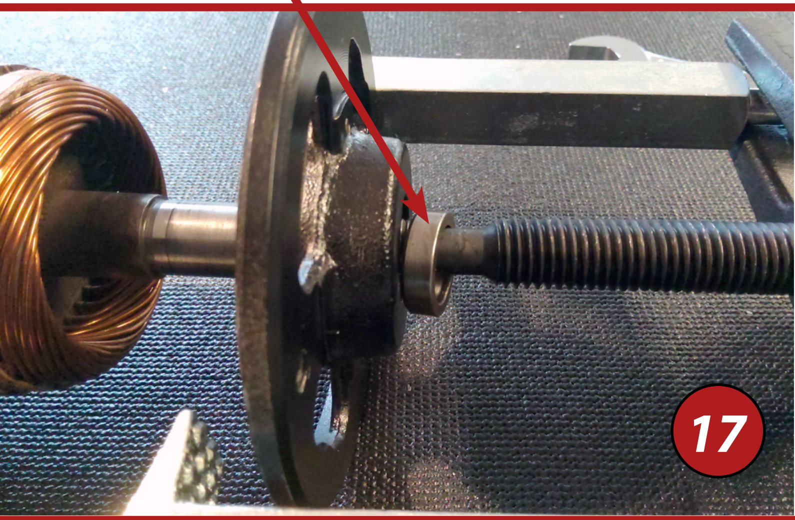


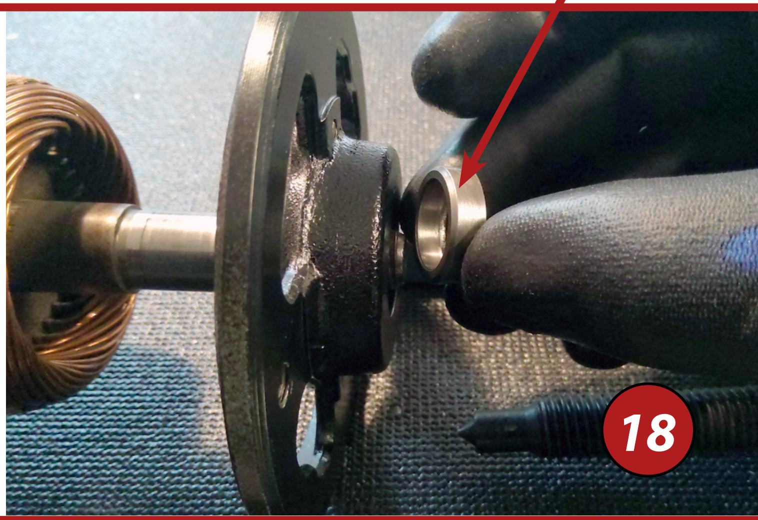






The bearing on the other side of the dynamo, which is the cooling fan side, along with the bearing cover (no.21) is pulled off with a bearing puller (photos 15 and 16). The grippers are fairly wide, to grip as close to the center of the cover as possible, to prevent distortion. The bearing is not very tight on the armature shaft on this dynamo; with little force, the bearing housing comes loose along with the bearing (photo 17). Also note here the presence of a spacer ring (no.5) (photo 17), which comes loose when the bearing cover is almost pulled over the armature shaft. Photo 18 shows that the bevel is mounted against the bearing.

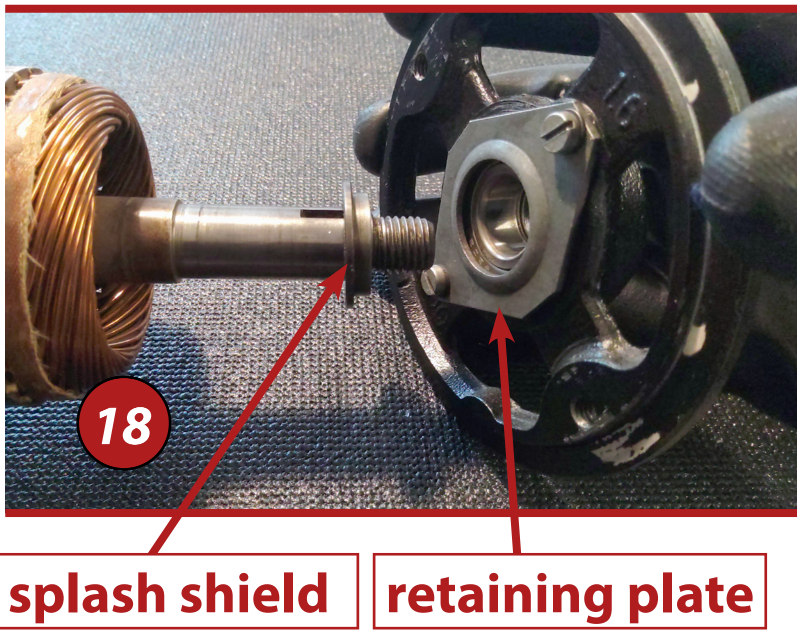


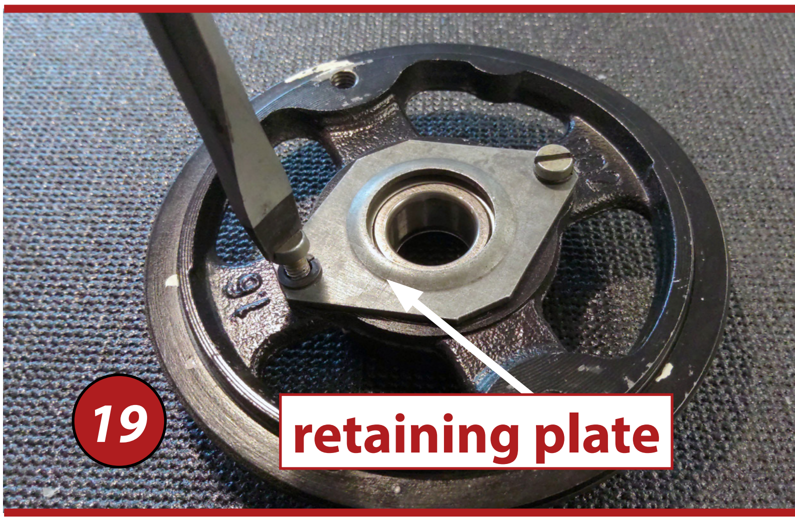


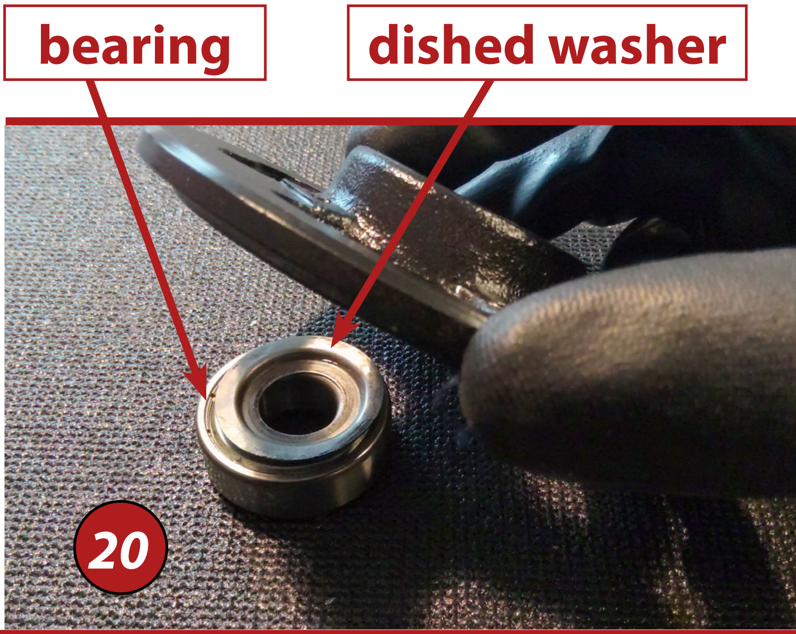
replace dynamo bearings

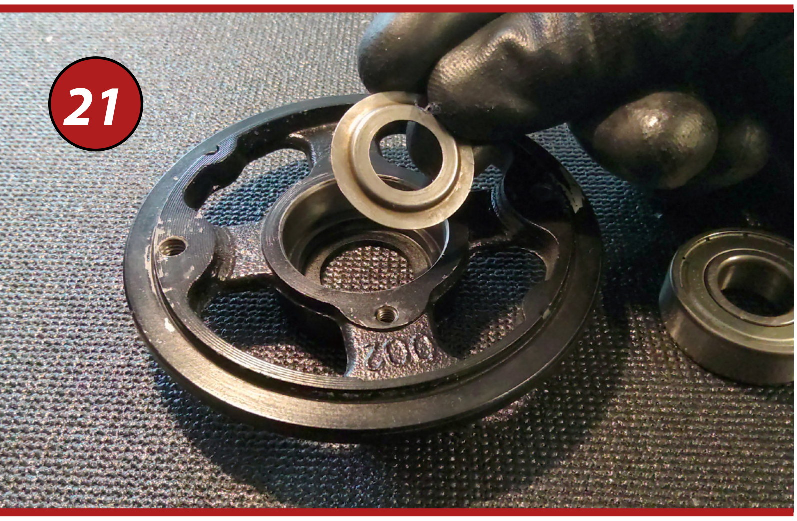
The bearing is not yet visible here, it is hidden behind a retaining plate (no.20) with two screws (photo 18), in the bearing cover (no.21). Also note here the presence of a splash shield (no.19) against the armature. The narrowest side of this splash shield fits into the retaining plate and, after assembly, exerts pressure against the bearing. After removing the retaining plate, by loosening two screws (no3) with spring washers (no4) (photo 19), the bearing is visible . The bearing is not very tight in the bearing cover. Using a driver, or a push with your finger, tap the bearing loose without much force. Photo 20 shows the bearing with its dished washer (no.12).

After thoroughly cleaning all parts, ordering two new bearings, we are ready to reassemble the dynamo. We will not discuss in this article how to diagnose the dynamo, that will be discussed in a future edition.

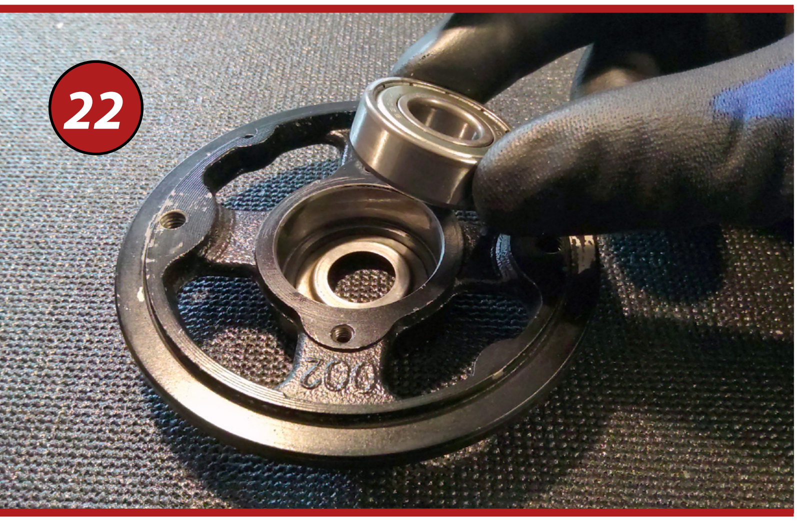






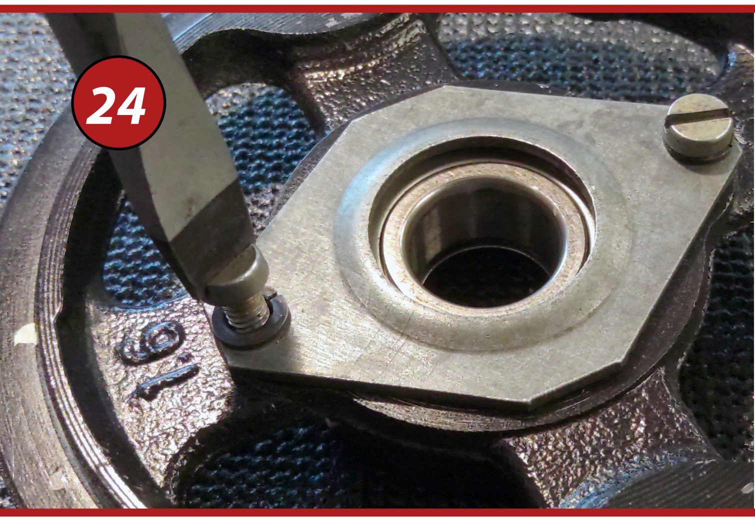


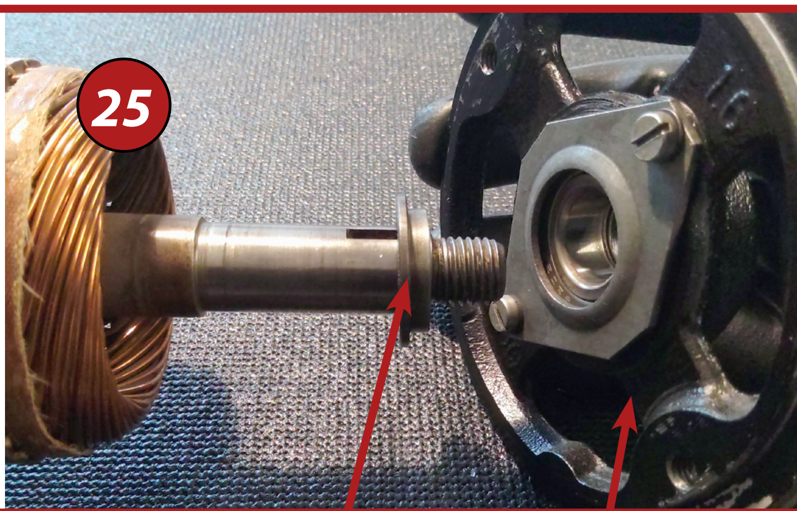
For assembly, refer to the drawing for the type of dynamo you are overhauling. The parts are different for each type. You can document the assembly sequence with pictures while disassembling the dynamo, but that is not always a guarantee. The dynamo may have once been disassembled and carelessly reassembled. The drawings from the VW workshop manual will help you with that.



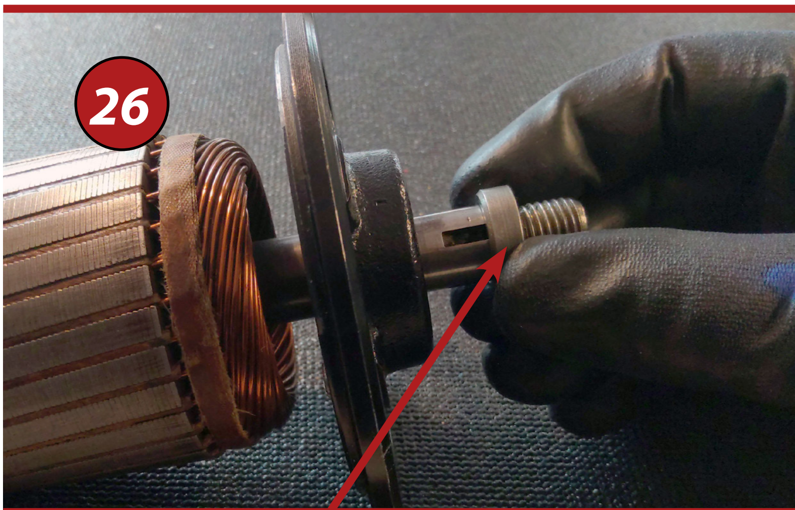
We start by installing the new bearing on the cooling fan side. Refer to the drawing on page 34 and the disassembly photos to assemble all the parts in the right place. Place the dished washer (no.12) with its raised side facing up into the bearing cover (photo 21). Place the bearing in the bearing cover (photo 22), the direction does not matter with this type of ball bearing. The bearing falls into the bearing cover without having to apply force.

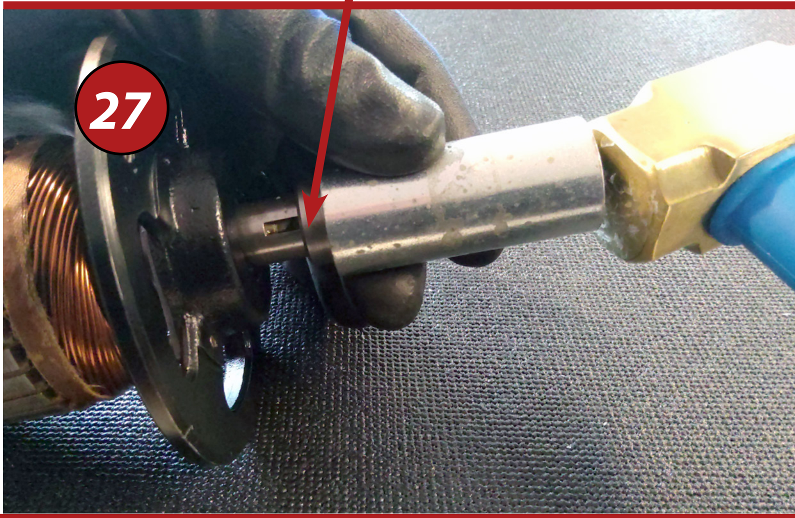
replace dynamo bearings

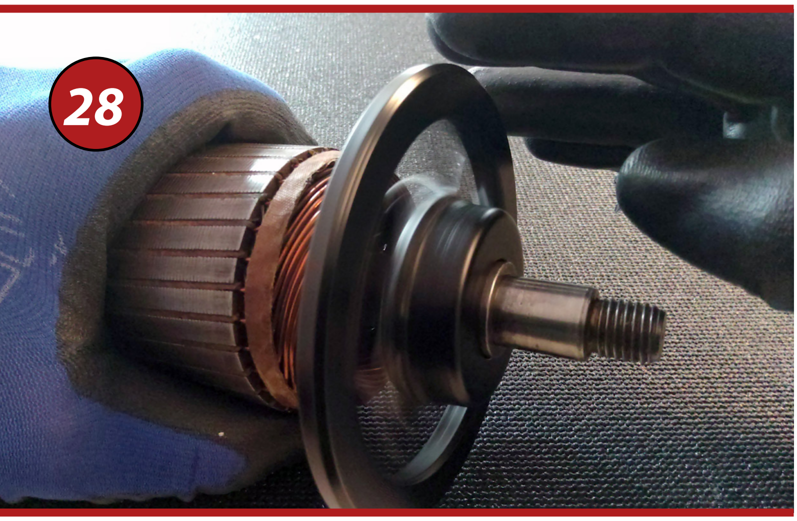


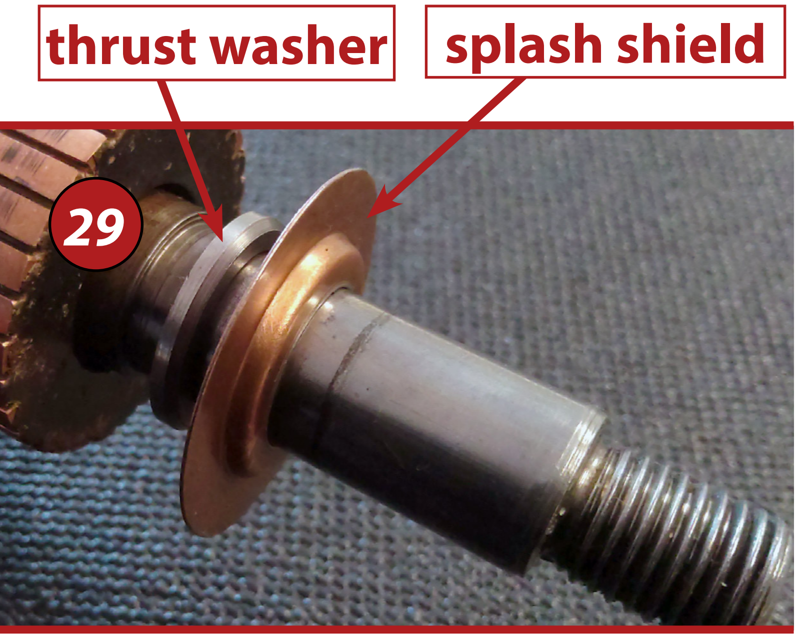


Fasten the retaining plate (no.20) with the two small screws with spring washers (photos 23 and 24). Use an appropriate screw-driver to tighten the two screws. Slide the splash shield (no.19) onto the armature shaft, with its smallest diameter facing outward (photo 25). Push the bearing housing onto the armature shaft; this usually succeeds by hand. Slide the spacer ring (no.5) over the armature shaft with its bevel facing the bearing (photo 26). The spacer ring has a tight fit on the anchor shaft, use a metal tube or socket wrench to push the spacer ring over the armature shaft (photo 27). When the knocking sound becomes dull, it means the ring is against the bearing.







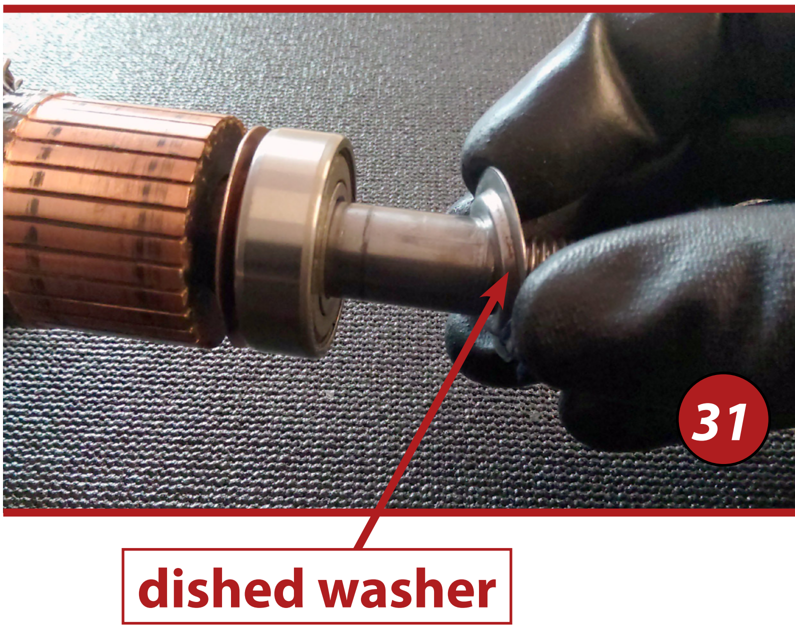


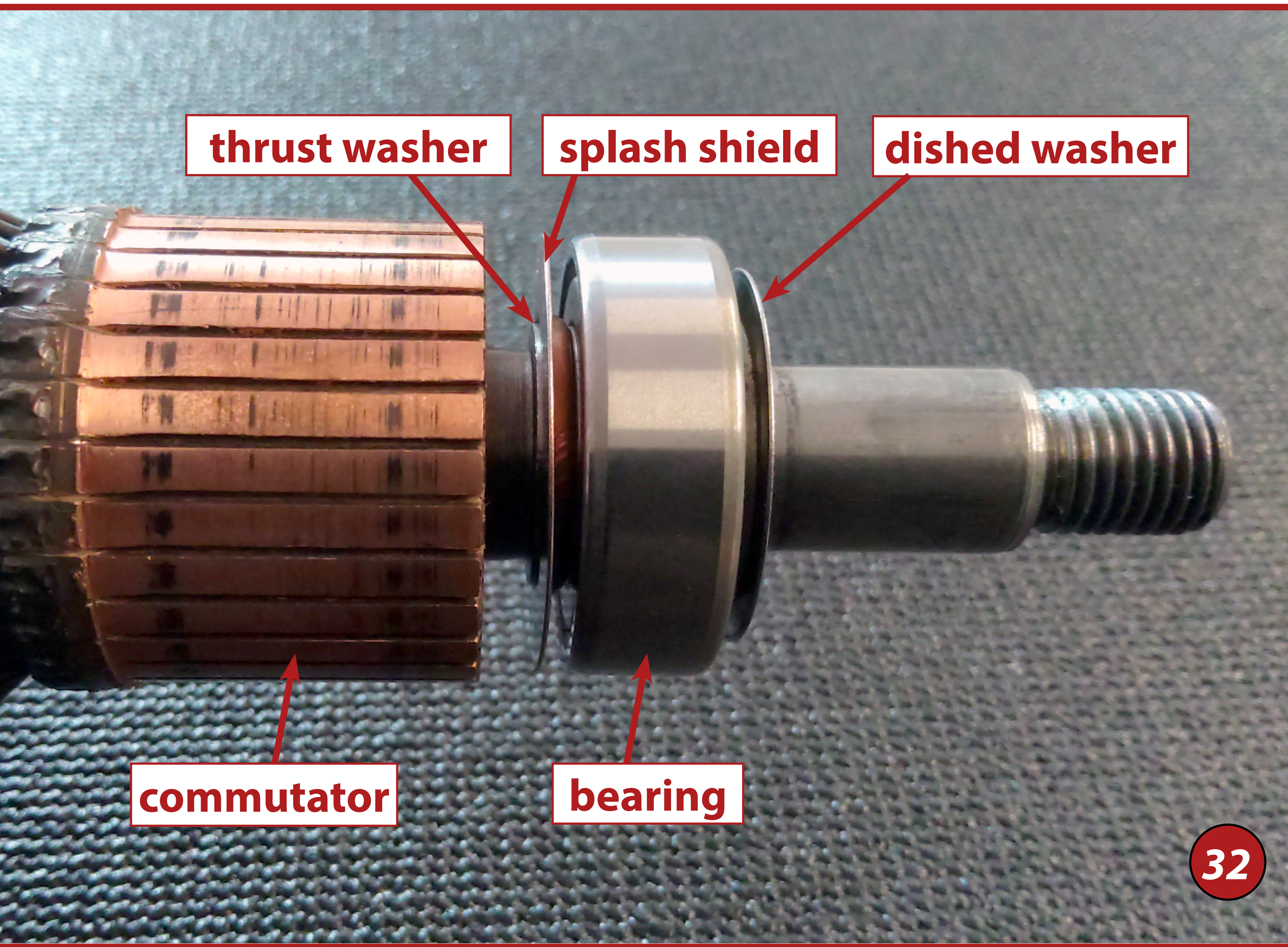
The bearing cover on the cooling fan side, should now rotate silently on the armature shaft with the new bearing, as it should (photo 28). If you hear sanding noise, or crackling, then the spacer ring (no.5) may not have been pushed all the way up against the bearing.

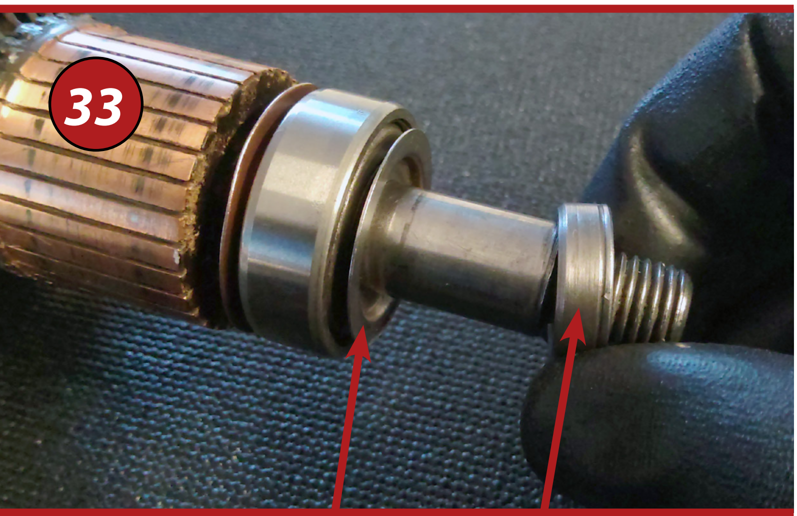
We continue with the bearing on the other side of the dynamo, which is the side of the dynamo pulley and the carbon brushes (for the Type 1 engine, on the Type 3 the carbon brushes are on the other side). First the thrust washer (no.15, also called thrust ring) is slid over the armature shaft (photo 29), make sure the flat side is pushing against the armature, the slanted side of the thrust ring fits into the copper splash shield (no.14). You mount the splash shield with the concave side against the thrust ring, as shown in photo 29. You can push the bearing on with an appropriate socket wrench (photo 30) and a hammer, you push against the center ring of the ball bearing.

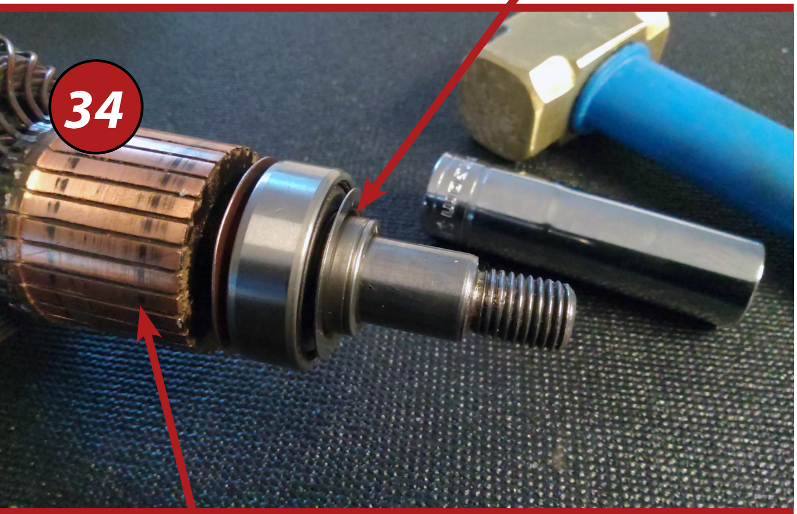
replace dynamo bearings

Next is the dished washer (no.12) (photo 31), with its convex side against the ball bearing, concave side outward. The bearing should also rotate on this side without side noise. In photo 32 we show all the parts up close. This may be very different depending on the year of construction of your engine or dynamo. Refer to the drawings on pages 34 to 37.

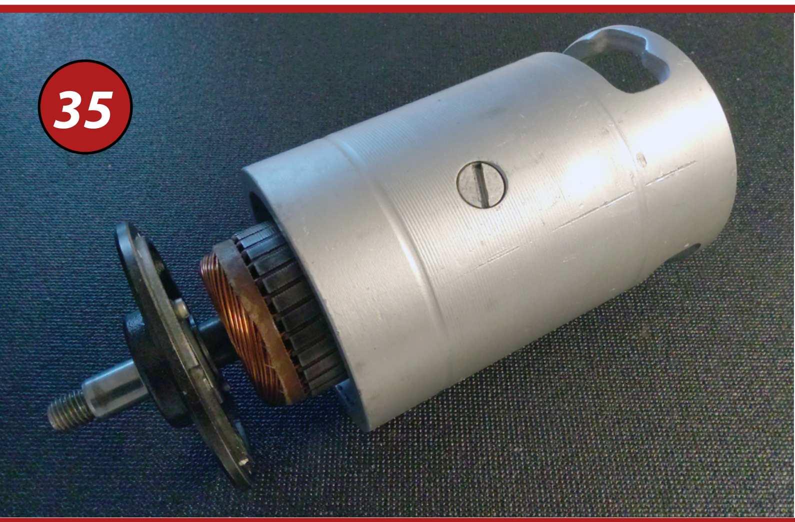


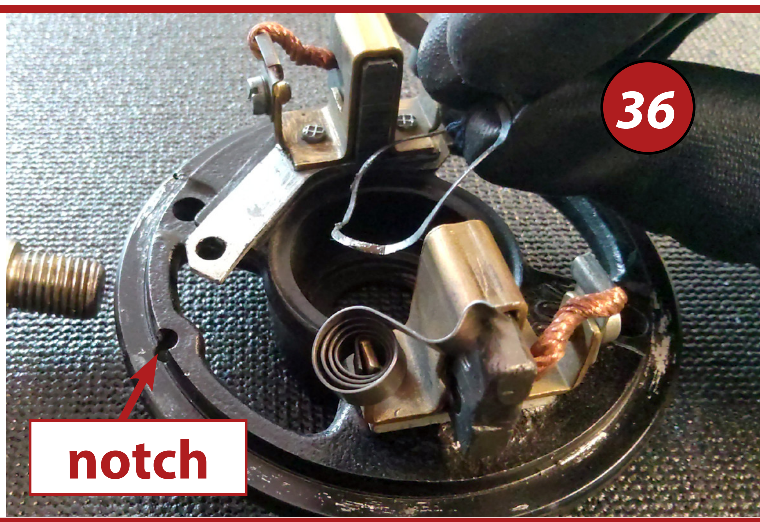






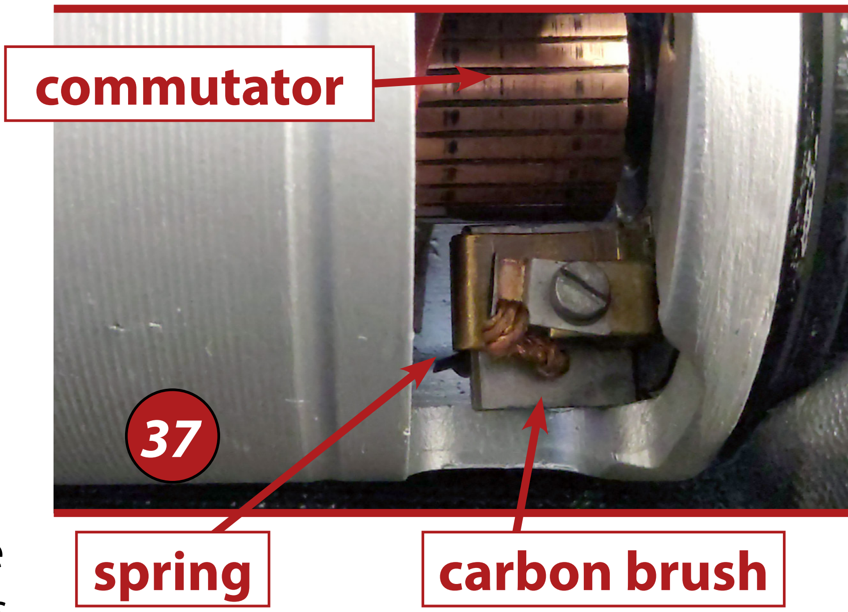
The spacer ring (no.5) on the dynamo pulley side fits very snugly on the armature shaft. You can use a socket wrench and a hammer to push it into place. The bevel should push into the hollow side of the washer (no.12) (photo 33). Photo 34 shows the spacer ring (no.5) mounted on the armature shaft. Clean the commutator thoroughly with degreaser. Now slide the armature into the dynamo housing (photo 35). Be careful not to damage the field windings. The bearing cover (no.7) is still rotating now, it will later come into place with the two long screws (no.1). On the other side comes the bearing cover with carbon brushes (photo 36). Place the thin spring washer (no.11) in the bearing cover, use some grease to

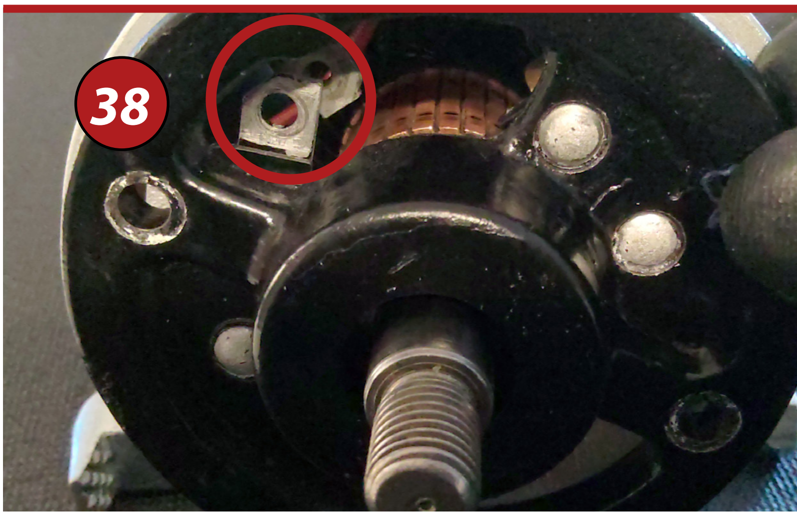


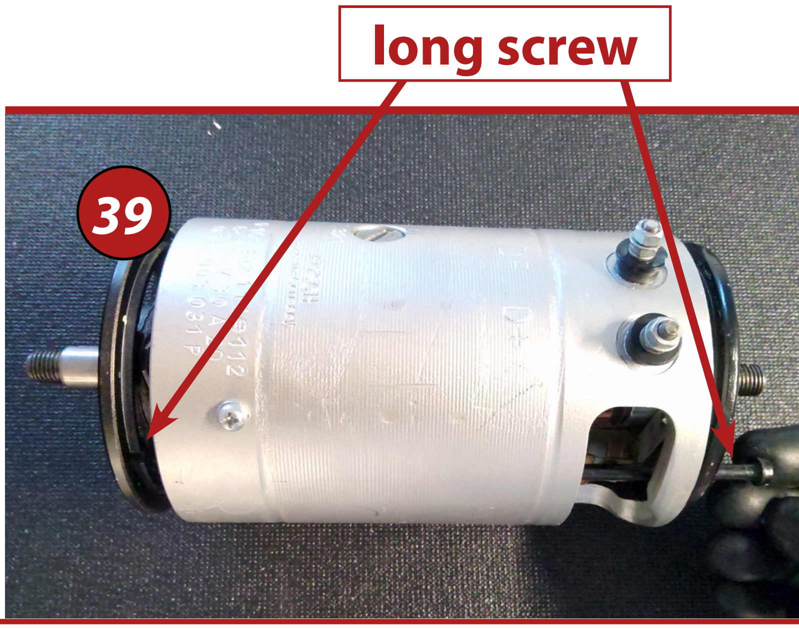


hold the washer in place during assembly (photo 36). Make sure the two springs of the carbon brushes are relaxed to push the carbon brushes as far apart as possible (photo 37). This is done to avoid damaging the brushes when assembling the bearing cover. Photo 37 shows how the carbon brushes do not touch the commutator because the springs are relaxed. The bearing cover on the carbon brush side (no.7) cannot be assembled incorrectly, the screw with washer (no.3 and no.4) on the inside of the bearing cover should be able to be tightened in the dynamo housing (photo 38, indicated by circle). There is also a notch in the cover that fits into the dynamo housing (photo 36).

You can now install the two long screws in the two bearing covers, through the alternator housing. If screw no.3 is not yet tightened, you have more room to turn the long screw on the cooling fan side into the bearing cover (photo 39).







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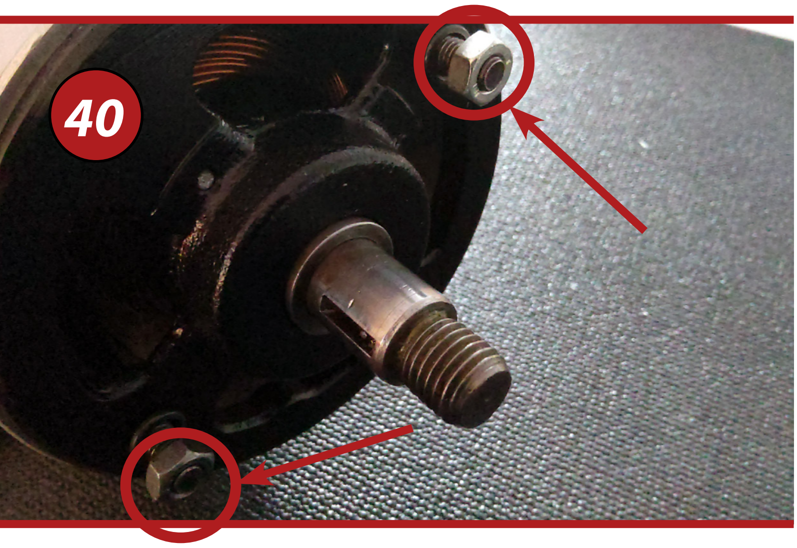
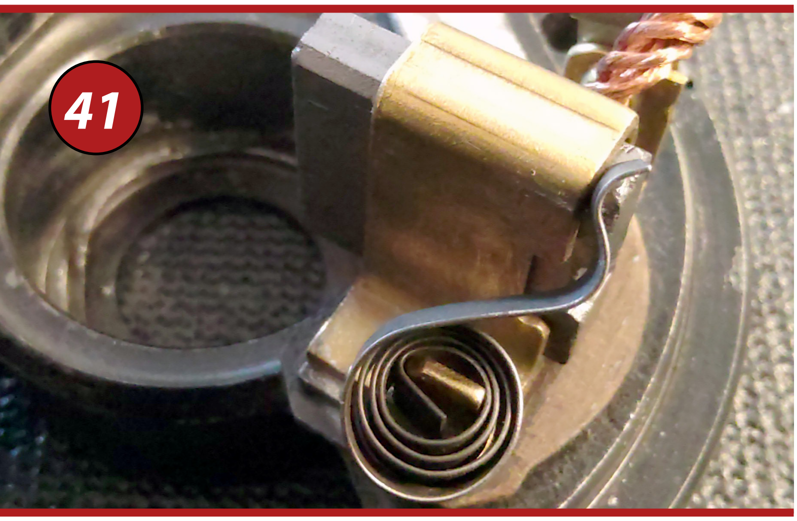


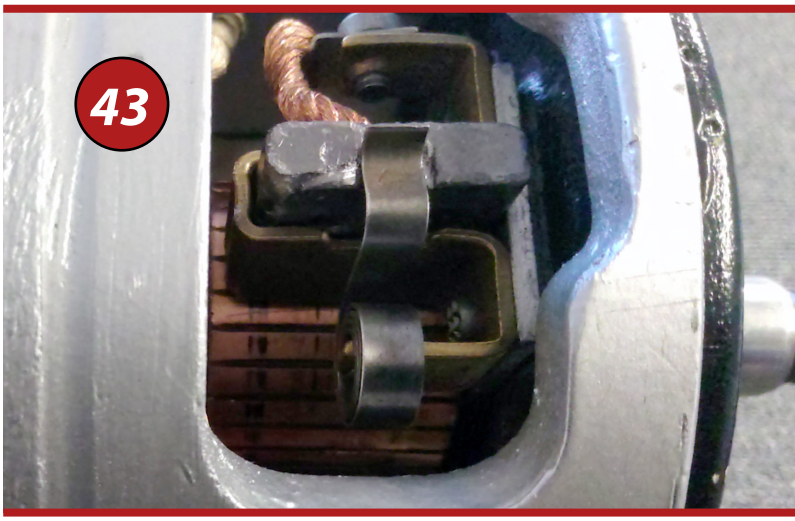


Now tighten all screws securely, check that both bearing covers fit properly to the dynamo housing. You can turn the nuts with spring washers on the long screws (photo 40). Later you will use these to fasten the sheet metal of the cooling fan.

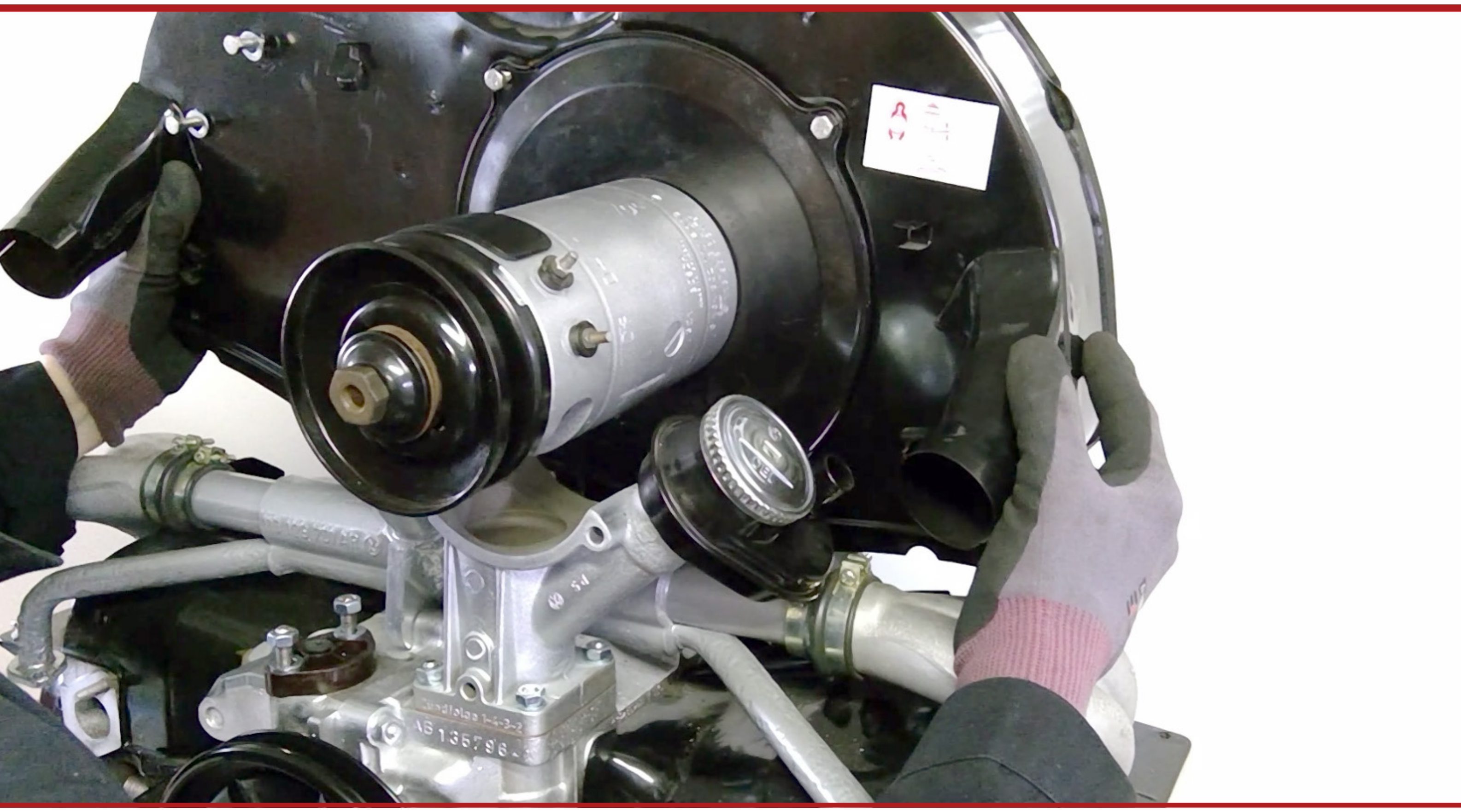
Photo 41 shows the correct assembly of the springs that hold the carbon brush in tension against the commutator. Once the bearing cover is secured, you can push the springs into place. Hold the spring firmly against its holder (photo 42), you don't want the spring to pop out now, this would mean you have to disassemble the bearing cover again. With a finger firmly pressed on the spring (photo 42), you can use a screwdriver to push the spring over the carbon brush. Push the carbon brush all the time against the commutator, so you don't have to stress the spring unnecessarily. The end result is shown in photo 43.

The rotation of the armature shaft should now occur without noise. It may be a little stiff because the carbon brushes are resisting, but that is perfectly normal. It will also take a while for the carbon brushes to run in on the commutator, which can also cause additional noise.

Now just install the sheet metal for the cooling fan and the dynamo pulley, and your DC generator is ready to go (photo below).



In edition 29 we will discuss the connection of the dynamo and in edition 30 the diagnosis. The diagnosis of the dynamo is done differently than with an alternator. But, you will read all about that in the next editions.



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