

**LOOK  
LISTEN  
DO IT BETTER**



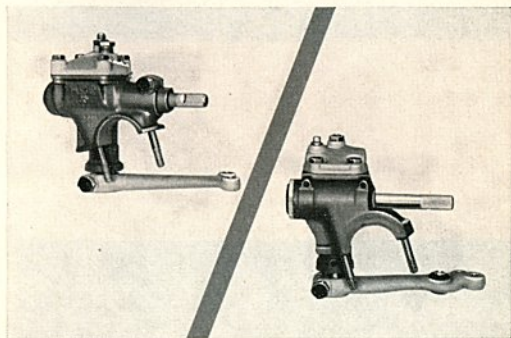
**ROLLER STEERING FOR  
VOLKSWAGEN**

**Slide Series No. 19**



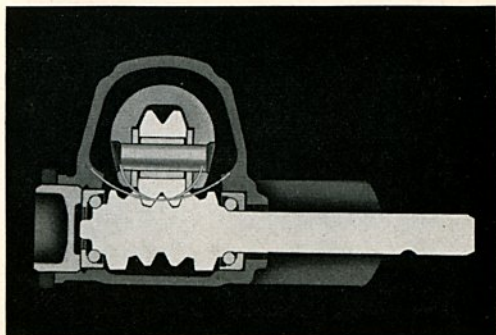
# ROLLER STEERING FOR VOLKSWAGEN

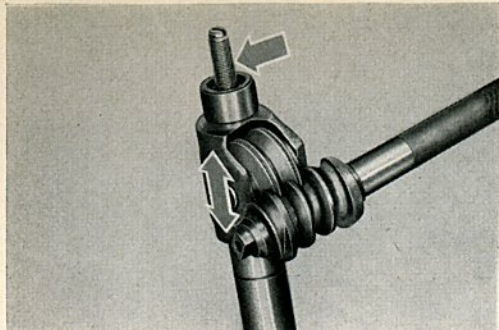
**19/1** You all know that since 1961 the Volkswagen 1200 De Luxe, the Volkswagen 1500 as well as all Karmann Ghia models have been equipped with a roller steering. Externally the previous sector steering gear — on the left — and the roller steering — on the right — look practically identical. There are, however, considerable differences between both versions and you will have to know these if the roller steering is to be assembled and adjusted correctly.



**19/2** Here are the special features of the roller steering:

The steering roller and steering worm only have firm contact in the range around the center position. This results from the fact that the arc described by the roller when pivoting on the roller shaft is smaller than the arc on which the teeth of the worm are arranged. When the steering wheel is turned more than a quarter of a turn with the vehicle stationary, a steadily increasing amount of play is noticed. When driving, however, the self-centering force is such that this play is not noticeable. The roller shaft is adjustable so that perfect contact can always be achieved between roller and worm in the center position — the range in which the steering is subjected to the most stress. The rotary movement of the worm is transmitted to the roller shaft by rolling friction instead of sliding friction. This makes the steering lighter in operation.

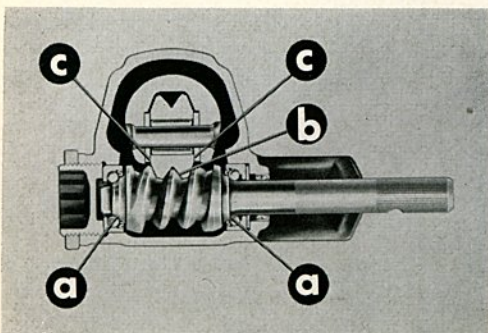




**19/3** The upper arrow points to the adjusting screw which is situated in the steering gear case cover together with the roller shaft. By turning this screw the roller shaft is moved up and down in the direction of the dual arrow and bears on the steering worm. Only when the roller shaft is correctly adjusted can you give the customer maximum driving comfort and safety.



**19/4** The steering gear adjustment must be checked at each inspection. To this end the vehicle must be positioned on its wheels. Hold the steering wheel as shown here and move it lightly to and fro until resistance is felt in both directions. If the tie rod ends and steering coupling are in perfect condition the range of play should be approximately 25 mm (1") measured at the steering wheel circumference.

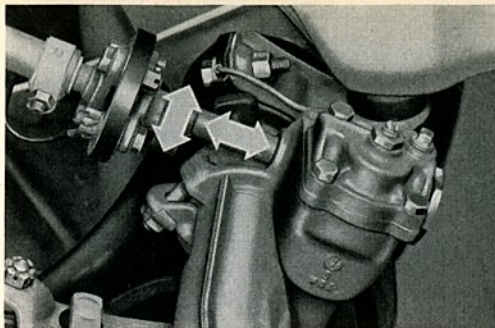


**19/5** If there is excessive play there are three points which can be the cause:

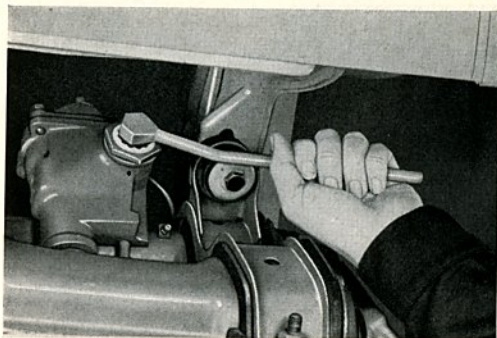
- a - steering worm play
- b - play between steering roller and worm
- c - axial play of steering roller

Only the play at a and b can be eliminated during Inspections. Checking the axial play is a repair operation and has, therefore, to be carried out separately.

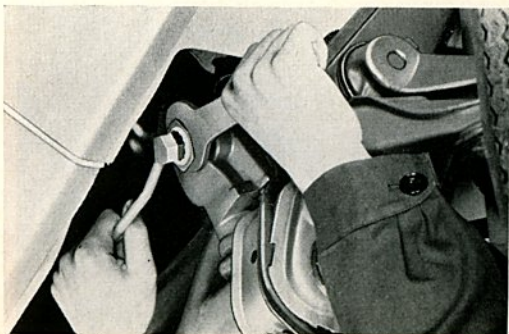
**19/6** By turning and moving the steering worm in the direction of the arrows you can clearly establish if the worm has play. Before checking in this manner the wheels are turned to the left or right. To enable you to see this we have removed the fuel tank for this picture as well as for a few other pictures in this slide series. If when checking the play it is established that the worm is not seating correctly in its bearings...



**19/7** ...the steering worm adjusting screw will have to be tightened. After loosening the lock nut you can tighten the adjusting screw with the wrench VW 278a until play is no longer felt. You will notice this point if you turn the worm to and fro whilst tightening the adjusting screw.

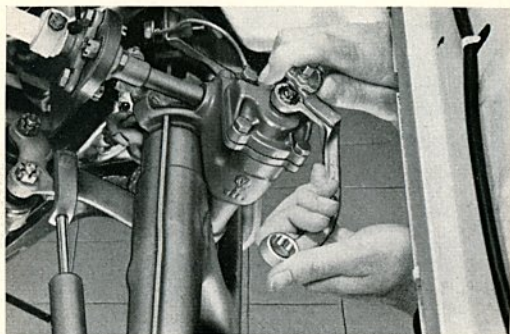


**19/8** Here you see the lock nut being tightened. Hold the adjusting screw with the wrench whilst tightening to prevent it from turning as well. It is very easy to check whether the steering worm is too tightly adjusted: turn the worm from lock to lock by moving the steering coupling; when doing so there should not be any tight positions in the bearings. If there are any, the adjusting screw has been overtightened and the adjustment must be repeated as otherwise there is the danger of its ball bearings becoming damaged. Here you have seen how steering worm play can be eliminated.

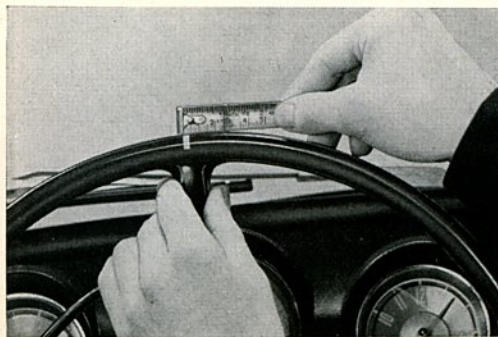




**19/9** If the play at the center position is still not within the range of 25 mm (1") the roller must be adjusted to the worm anew. Only when the roller contacts the worm correctly will the steering movements be transmitted exactly to the wheels. Now turn the wheels of the stationary vehicle 90° to the left or right.

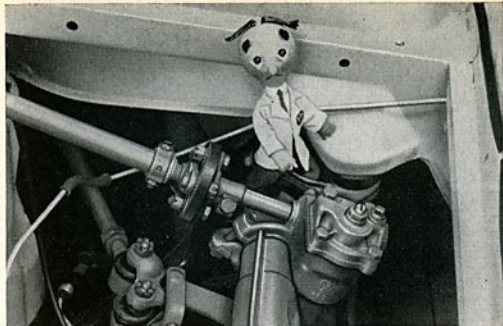


**19/10** Loosen the lock nut and back off the adjusting screw about one turn. By doing so you disengage the mesh between roller and steering worm. The screw must then be tightened until you feel the roller contact the steering worm. A special wrench given in the catalogue of "Special Service Tools" is very suitable for adjustments to Type 3 vehicles. In the case of Type 1 the steering can be adjusted with the same special wrench or with a box wrench and a screwdriver.

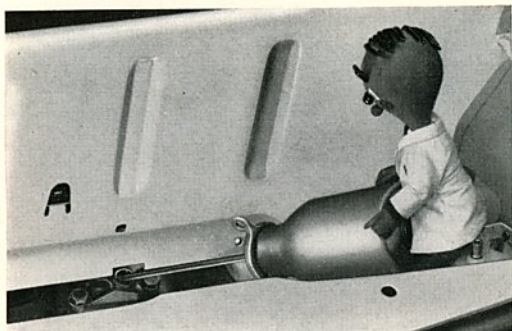


**19/11** Do not forget to check the results of your work. After the adjustment and at a 90° lock the range of play should be approximately 25 mm (1") when turning the steering wheel lightly to and fro. If the play is still excessive the roller shaft must also be adjusted at this lock. A further hint: the steering should self-center after negotiating a corner at between 15—20 kph (9—12 mph) or at least to an angle of 45°. If this is not the case, the roller is too tight on the steering worm and there is the danger that both parts will suffer damage.

**19/12** If after checking and eliminating the play at the steering worm and the play between roller and worm, the range of play is still not within the prescribed limit, the roller shaft has to be removed and checked. This is not within the scope of the Inspection operations and has to be classified and treated as a repair.

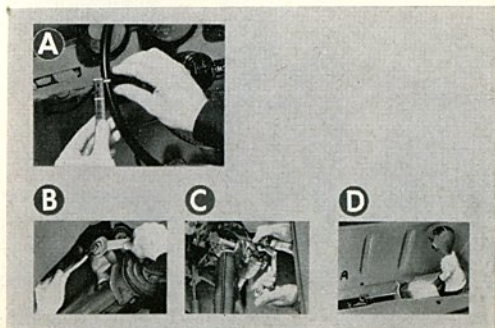


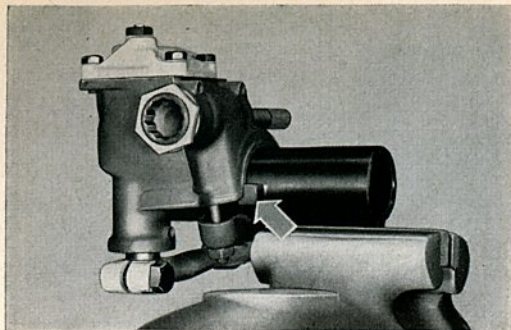
**19/13** It is important to know that the steering gear is filled with SAE 90 hypoid oil — the same oil which is used in the transmission. The oil level in the steering gear must be checked during lubrication services at 500 km (300 miles), 5000 km (3000 miles) and then every 5000 km (3000 miles). The oil should be approximately up to the lower edge of the filler hole. If the oil has to be topped up, only SAE 90 hypoid oil must be used and on no account grease or other oils.



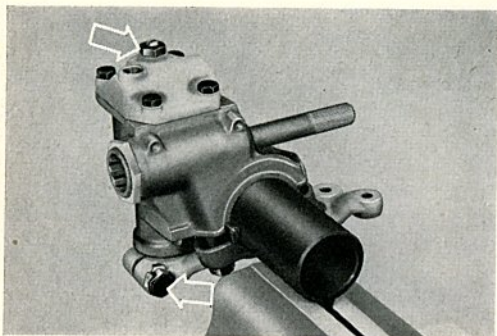
**19/14** Let us summarize the points: the following points on the steering should be observed during Inspection and lubrications services:

- a - check play at steering wheel
- b - if the range of play is excessive eliminate worm play as necessary
- c - adjust the roller correctly to the steering worm. After completing the operations b and c re-check the play at the steering wheel.
- d - check oil level and top up

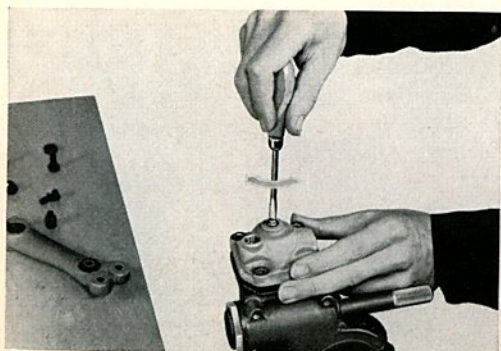




**19/15** If the roller play has to be checked or there is a suspicion that a particular part of the steering gear is damaged, the steering gear must be removed and disassembled. Remove the oil filler plug first and drain off the oil. The test jig VW 280 will facilitate matters for you. The steering gear must be attached to the assembly tube of the jig in such a way that it seats correctly in the stop. The stop is shown by the arrow on this picture.



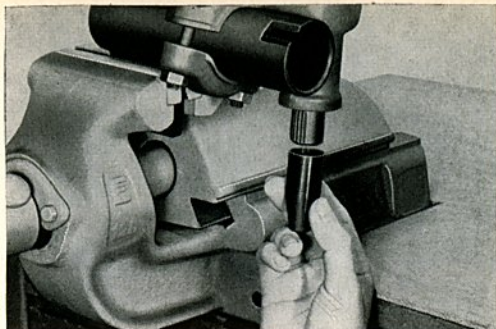
**19/16** The steering gear can be disassembled quickly. After bending up the lock plate for the drop arm pinch bolt and removing the pinch bolt (lower arrow), you can pull the drop arm off the roller shaft. Now remove the adjusting screw lock nut for the roller shaft shown by the upper arrow and remove the 4 steering gear case cover screws.



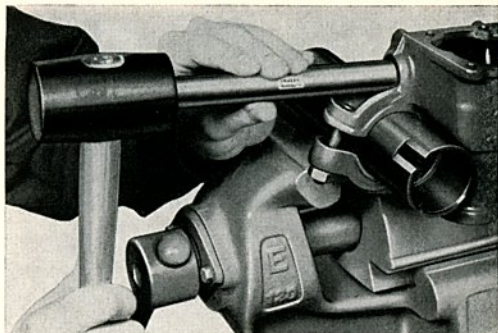
**19/17** You can take off the steering gear case cover together with the roller shaft. It is, however, better to unscrew the cover from the roller shaft. To this end the cover is held and the roller shaft adjusting screw is turned in an anti-clockwise direction. In this way you can separate the cover from the roller shaft.



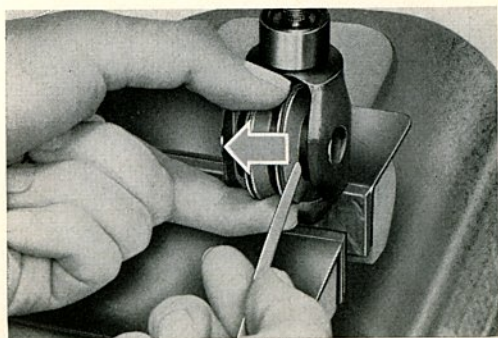
**19/18** Have you already manufactured the guide sleeve VW 649? The drawing is listed in the publication "Local Manufacture of Workshop Equipment". Please note that before the roller shaft is pressed out — to do so the steering must be in the center position — the guide sleeve must be pushed on over the splines as far as the stop. If you don't do this the oil seal can become damaged when pressing out the roller shaft. It is also important that prior to removal, any traces of paint or rust should be removed from the protruding part of the roller shaft so as to avoid damaging the bushes in the steering gear case.

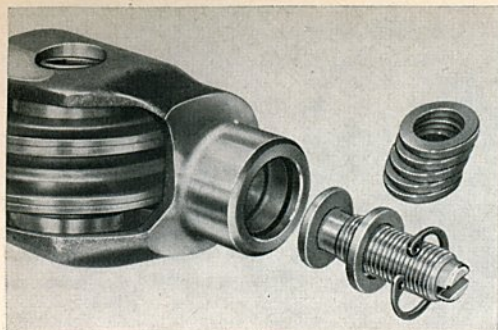


**19/19** The steering worm must now be removed. Unscrew the lock nut and adjusting screw and remove the worm together with the lower ball bearing. You can drive out the upper ball bearing, shim and oil seal with the tube VW 423.

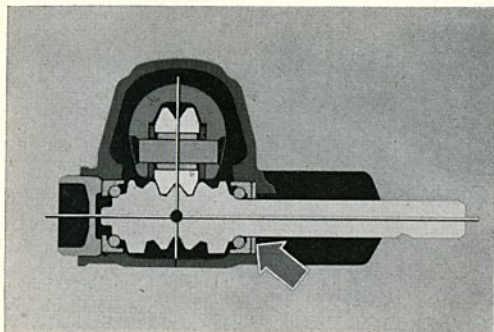


**19/20** Here the roller play is being checked. It must not exceed 0.04 mm (.0015"). If it is possible to insert a feeler gauge with a thickness of 0.05 mm (.0019") between roller and shim the wear limit has been exceeded and the roller shaft must be replaced. When measuring, the roller is pushed to one side. Make sure that the roller does not tilt or otherwise incorrect readings will result.

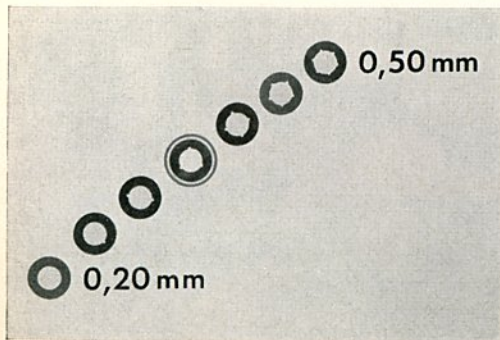




**19/21** Knocking noises can occur in the steering if the roller shaft adjusting screw is not a perfect fit. Select the shim so that it can be screwed in by hand without noticeable rock. Shims are supplied in thicknesses from 2.0 to 2.25. The adjusting screw should be inserted with oil but on no account with grease. Make sure that the circlip engages in the groove all the way round. This is very important because if the circlip jumps out the steering can become blocked.

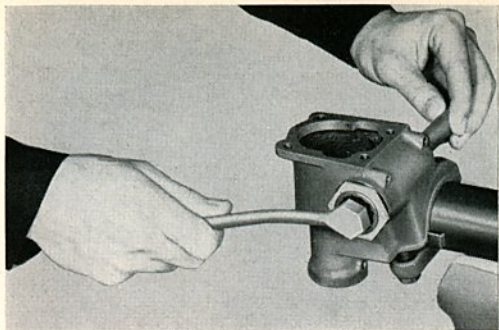


**19/22** You have already heard that the steering roller and steering worm only have firm contact in a range around the center position. By means of the shim shown by the arrow between the upper ball bearing and the case this range is altered so that with a steering lock in both directions it is situated evenly in the region of the center position. The center of the worm is shown by the dot. If the shim has been correctly selected and with the steering in the straight-ahead position the extended center line of the roller passes through this dot as shown here. Make sure when installing both ball bearings that the parts are in perfect condition. Damaged or worn bearings can lead to knocking noises or stiffness and must, therefore, be replaced.

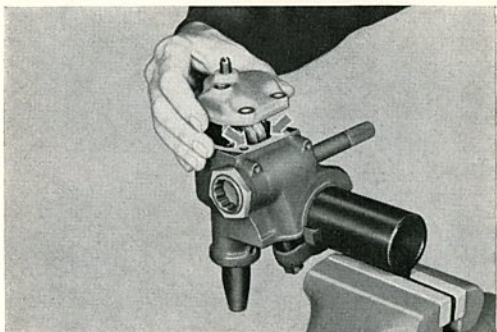


**19/23** The shims are available in thicknesses from 0.20 to 0.50 mm in 0.05 mm stages. The thickness can easily be seen from the grooves on the inner circumference since each groove represents an increase of 0.05 mm in the thickness. A shim 0.20 mm thick has no groove, a shim 0.25 mm has one groove etc. up to a thickness of 0.50 mm for a shim which has 6 grooves. You can save time by first of all inserting the steering worm with a shim of medium thickness — approximately 0.35 mm which corresponds to 3 grooves.

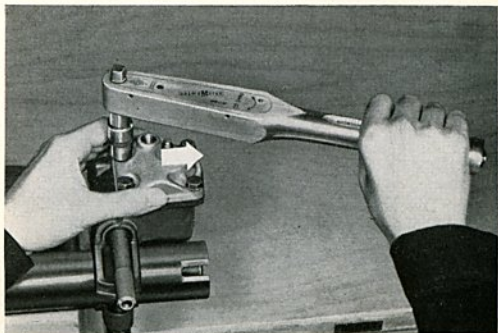
**19/24** During this operation the adjusting screw is tightened slightly, loosened and tightened again until the steering worm runs roughly when turned. Before the insertion of the adjusting screw it was coated with sealing compound to ensure efficient sealing in the steering gear case. When you have tightened the lock nut the steering worm must not have play when turned to and fro.

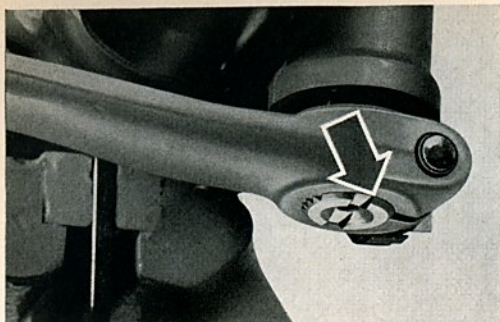


**19/25** The roller shaft with case cover can only be installed if the roller is directly opposite to the steering worm. If this is not the case the roller can strike against the edges of the case as shown by the arrows. You will of course not omit to check the gasket between case and cover. Only install gaskets which are in perfect condition. Use the guide sleeve when inserting the roller shaft as otherwise the oil seal can become damaged by the splines.

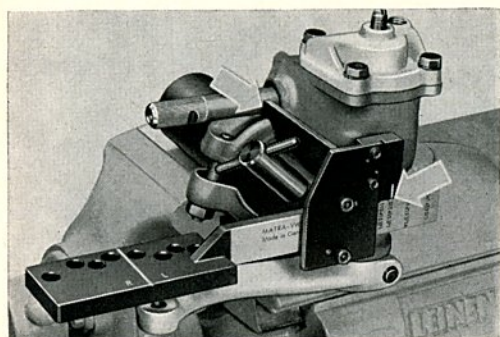


**19/26** And now a further important hint: make sure when tightening the 4 case cover screws that the cover is pushed away from the worm in the direction of the arrow until it bears firmly against the side of the case. This prevents the cover from moving and causing premature play in the center position. The 4 case cover screws should be coated with sealing compound before being inserted. They are then tightened to the prescribed torque of between 2.0 to 2.5 mkg (14 to 18 ft. lbs.).

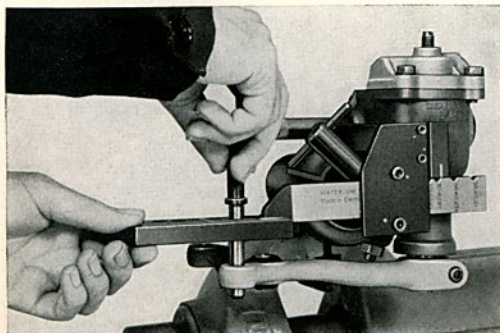




**19/27** Now we look at the steering gear from underneath. The drop arm must only be pushed on to the steering roller shaft until its lower edge is flush with the upper edge of the chamfer as shown here. If it is pushed on further it will jam at the end of the splines. Under driving conditions it will work loose due to the vibration and can lead to premature play and noises. The drop arm pinch bolt is tightened to 7 mkg (50 ft. lbs.). After you have checked the free movement of the steering by turning it to and fro a few times the assembly of the steering gear is completed and the adjustment can commence.

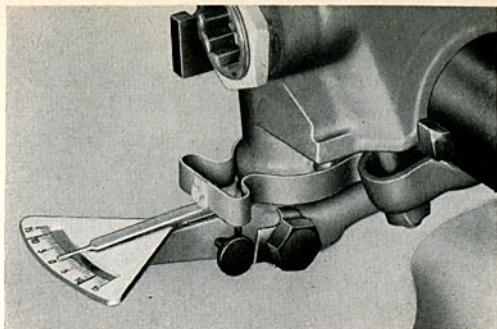


**19/28** To this end you need the measuring head of the test jig. It is pushed on to the assembly tube until it contacts the worm spindle as shown by the upper arrow. You know already that the roller steering gears of Type 1 and 3 vehicles are identical. Due to the various LHD and RHD versions as well as the different installation angles of the steering gears 8 drop arms are required. For this reason there are 8 different holes in the movable setting plate so that all the steering gears can be checked and adjusted irrespective of the kind of drop arm with which they are equipped. The various drop arm part numbers are shown on the setting plate. The right-hand arrow denotes a marking which should be in line with the corresponding part number.



**19/29** Align the right-hand hole in the drop arm under the appropriate hole in the setting plate. Move drop arm and plate to and fro slightly until the pilot drops into the hole in the drop arm under its own weight. By doing this you have established the steering center position exactly.

**19/30** The scale of the adjusting device is clamped in the slot of the drop arm, the pointer is placed on the boss of the steering gear case and set to zero. Remove the pilot and turn the steering  $11^\circ$  to the left or right. This value is only valid if steering worm, steering roller or both parts together have been replaced by new parts. If the parts have been run in the value is  $5^\circ$ .



**19/31** The adjusting screw shown by the arrow must then be screwed in until no further play is detected. You will notice this if you move the drop arm back and forth slightly and hold the steering worm with the other hand. The steering flange should be installed on the worm spindle to facilitate holding. When no play can be detected, tighten the adjusting screw lock nut and check the steering lock on the other side.

**19/32** The following points may be noticed:

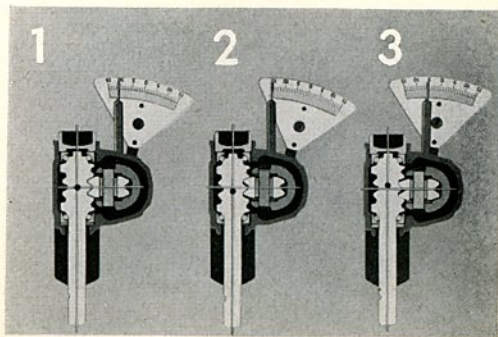
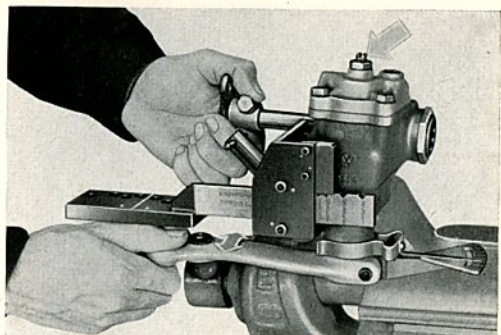
1 - At  $11^\circ \pm 2^\circ$  no play is detectable.

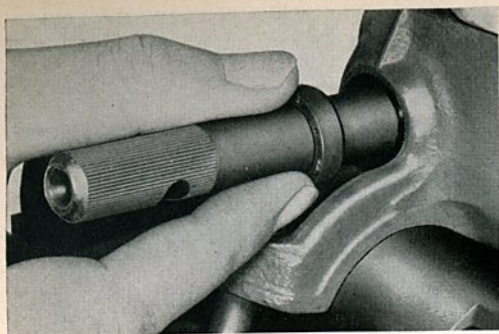
The steering gear is correctly adjusted.

We have marked the center of the steering worm with a dot. If the adjustment is correct the extended center line of the roller passes through this dot. To illustrate this the steering gear is shown in the straight-ahead position on all three pictures and the scale with the steering in the locked position.

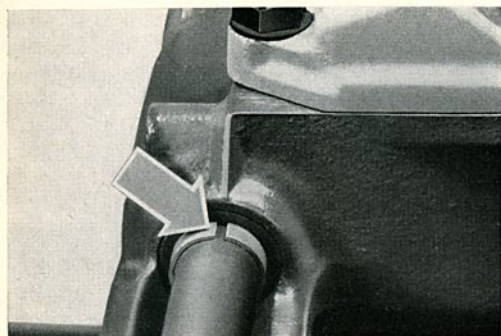
2 - The free of play steering lock is **greater** than  $11^\circ + 2^\circ$  to the left-hand side of the scale: a **thicker** shim will have to be installed. The extended center line of the steering roller no longer passes through the dot.

3 - The free of play steering lock is **smaller** than  $11^\circ - 2^\circ$  to the left-hand side of the scale: a **thinner** shim will have to be installed. As you can see the extended center line of the steering roller still does not pass through the dot.

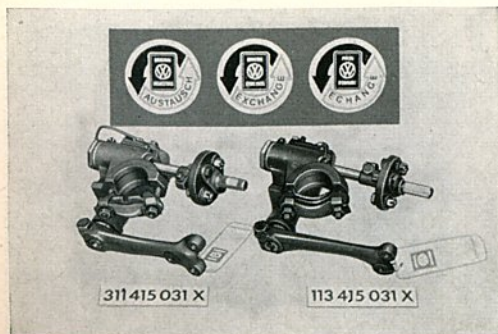




**19/33** After the adjustment operations the oil seal is pressed on to the steering worm as shown here with the tube VW 423 already mentioned. Make sure that the oil seal is not damaged when being pressed in or otherwise leaks can occur. Do not forget to bend up the lock plate on the drop arm pinch bolt.

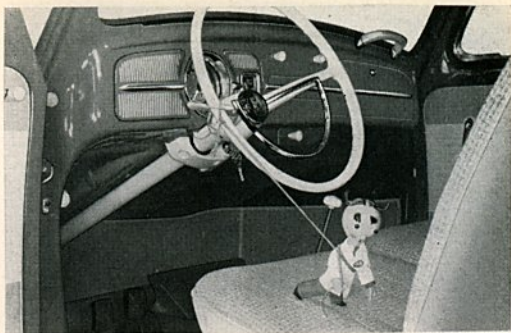


**19/34** Finally the center position has still to be marked and the steering gear filled with oil. Set the center position with the measuring head exactly and slide the marking ring on to the worm spindle. The ring is self-retaining. The slot in the ring must be in line with the nose of the case. After filling the steering gear with 0.16 liters (0.34 US pints, 0.28 Imp. pints) of SAE 90 hypoid oil the assembly and adjustment is completed.

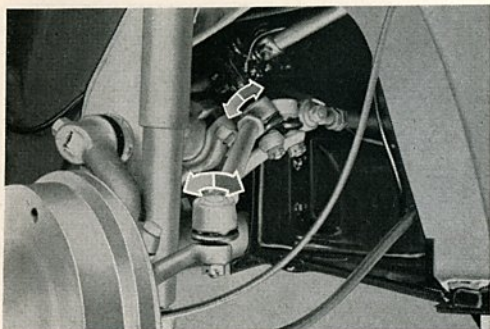


**19/35** Did you know that the roller steering is also supplied as an exchange part? In any event check whether it is more suitable to repair the steering gear or to install an exchange steering gear.

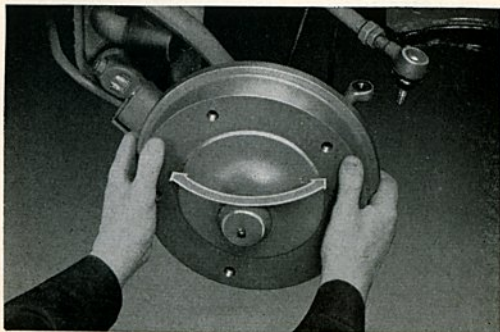
**19/36** A customer has complained of stiff steering. Since the correctly adjusted roller steering should not be stiff you will, in every case, have to check the steering gear adjustment thoroughly. You have already seen how this is to be done. We now wish to show you what points can lead to steering stiffness.

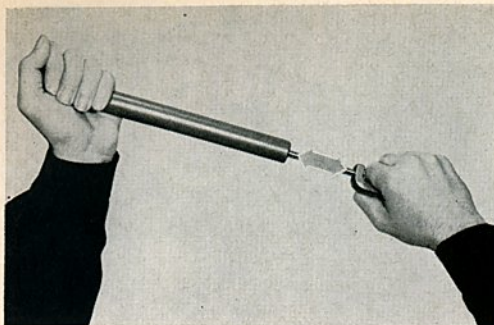


**19/37** First off all the tie rods are checked, it should be possible to turn them back and forth a small amount in the direction of the arrows. If this is not possible, the tie rod ends are damaged and must be replaced by new parts. It is important that you align the tie rod ends to each other when installing a tie rod. To do this, the ends are loosened, turned fully in the same direction back or forth and the nuts tightened fully. In this way stress will be avoided.

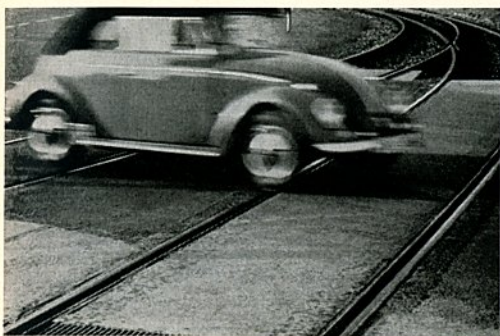


**19/38** The king pins in Type 1 and the upper and lower ball joints in Type 3 can be the cause of steering stiffness. Here you see how this is established: with the tie rod disconnected it must be possible to pivot the wheel easily. If this is not the case, the front wheel suspension is removed, checked and assembled in accordance with the instructions in the Workshop Manuals.

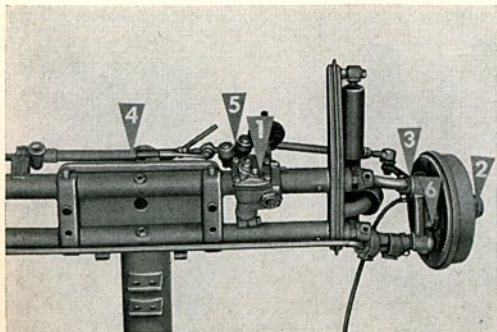




**19/39** Here we have located the cause of the steering stiffness: it is the steering damper. It is only possible to expand and compress it by exerting a lot of force. This method will only give an indication of whether it is working or not. If it is suspected that steering trouble is caused by the steering damper, the matter can be clarified by removing the damper and road-testing the vehicle without this part.



**19/40** Steering trouble can also be caused by front wheel flutter which can be transmitted as far as the steering wheel. The steering wheel begins to vibrate. The vibration increases very quickly and can only be steadied by reducing speed. Flutter can take place when driving over uneven surfaces, level crossings, manhole covers etc. This complaint can be dealt with in the workshop.

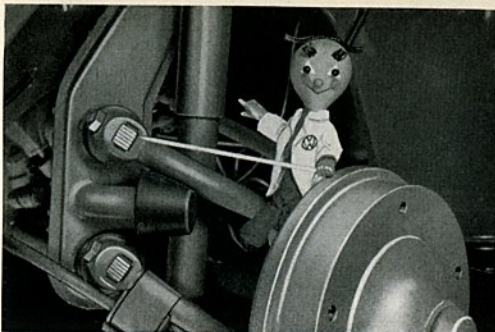


**19/41** Here we wish to illustrate the most important points which can cause wheel flutter:

- 1 - the steering adjustment is incorrect
- 2 - front wheel bearing play
- 3 - play between torsion arms and torsion arm link pins
- 4 - the steering damper is not functioning correctly
- 5 - excessive play in the tie rod ends
- 6 - excessive play in king pin bushes



**19/42** Damaged or inefficient shock absorbers can also be the cause of wheel flutter. A simple check can be carried out by bouncing each corner of the vehicle in turn or by driving it over uneven roads. An accurate check can be made with the test appliances in the VW test station by means of which the efficiency of the shock absorbers — in situ — can be established with accuracy. Remember also that a broken leaf in a torsion spring can also cause steering trouble, and consequently the torsion springs must also be checked for damage.



**19/43** Excessive front wheel unbalance can affect the steering properties, and for this reason the wheels must be balanced statically and dynamically in the event of steering unsteadiness or wheel fluttering.

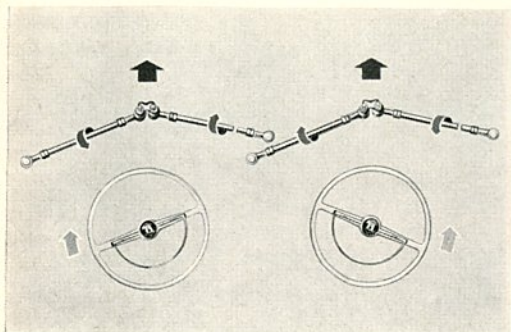


**19/44** Correct wheel position is a further important factor which is essential for ensuring correct steering properties. With the help of an optical axle alignment gauge which is used independently of the vehicle you can check the values for toe-in, camber, difference in wheel angularity and caster. The value for rear wheel position must also be measured and, if necessary, corrected as incorrectly positioned wheels can affect the steering properties.





**19/45** Finally we draw your attention to the following point: the steering gear must be installed so that the steering center position is attained according to the marking on the steering gear case and worm spindle. The steering wheel spoke must then be horizontal. If not the steering wheel must be repositioned. If it is established on a road-test after the toe-in has been set that the spoke is at an angle when driving straight-ahead, the steering wheel must **on no account** be repositioned again. Depending on the side to which the spoke slopes, one tie rod must be shortened and the other tie rod lengthened by turning it the same amount in the opposite direction. This does not alter the toe-in setting.



**19/46** Now you know everything about the roller steering which is of importance to you. Please remember that it depends on your skill and knowledge whether the customer is just as pleased with his Volkswagen after years of driving as he was on the day he bought it.



