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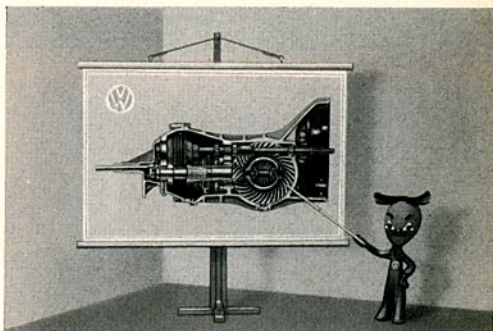


**Adjustment of the fully synchronized
transmission**

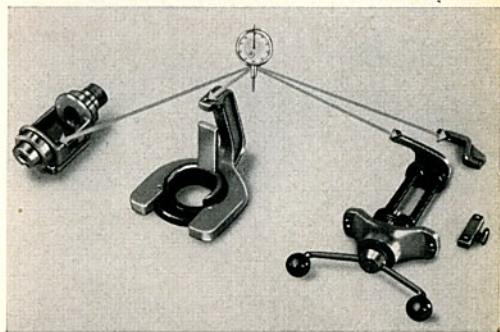
Slide Series № 12

ADJUSTMENT OF THE FULLY SYNCHRONIZED TRANSMISSION

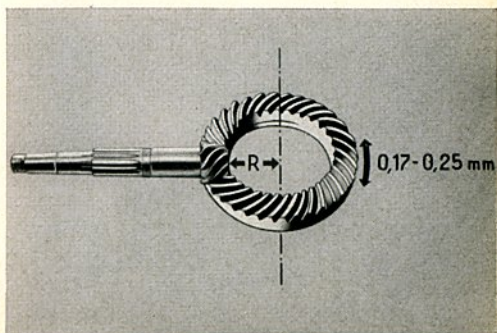
12/1 Have you ever considered what a correct rear axle adjustment actually means? Did you know that every gear set only runs smoothly in one particular setting and that a few hundredths of a millimeter play an important roll?

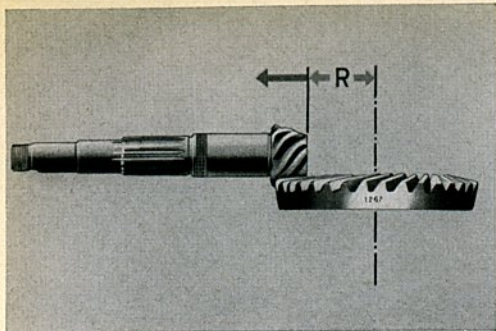


12/2 These measuring devices make it possible to achieve the exactness of the adjustment required. On the left you see the mandrel for the drive pinion adjustment, in the middle the differential housing gauge and on the right the ring gear adjusting device. We shall now see in detail how these tools are used. But first we must understand the essentials of ring gear and drive pinion adjustment.

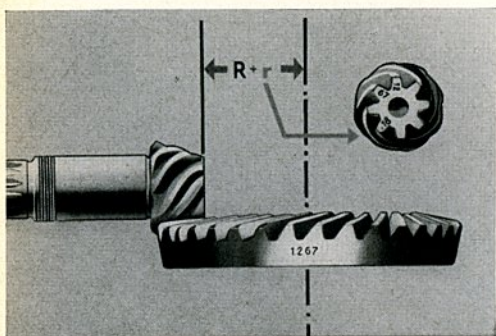


12/3 During the construction of the fully synchronized transmission, the position of the pinion in the transmission case has been determined by the distance from the pinion face to the ring gear center line — R — and a definite backlash is prescribed for the ring gear. The distance R is 58.70 mm (2.3110"), whereas the ring gear backlash should be between 0.17 and 0.25 mm (0.0067 and 0.0098").

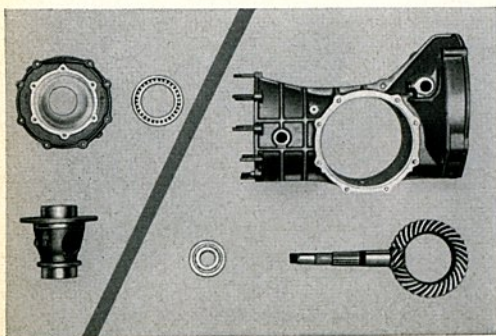




12/4 The actual fitting dimensions of a gear set i.e., the position with the most silent operation, can only be obtained when manufacturing ring gears and pinions. Starting from the standard fitting dimension R , the drive pinion is adjusted endwise on special appliances in the direction of the dark arrow with the ring gear lifted sufficiently out of the fully engaged position to ensure that the backlash is within the prescribed tolerance.



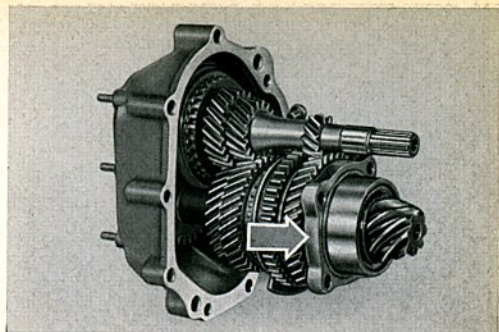
12/5 Once the silent operation required has been obtained, the distance from the pinion face to the ring gear center line is measured and the tolerance discrepancy r from the standard fitting dimension R is marked in hundredths of a millimeter on the pinion face. Moreover, ring gear and drive pinion are given a matching number. Naturally the fitting dimension R plus r is only valid for the pinion together with the ring gear with which it was tested.



12/6 Transmission adjustments are always necessary if you have replaced one of the parts shown here. The parts to the left of the dividing line affect the ring gear adjustment only. If a final drive cover, differential bearing or the differential housing have been replaced, you need only re-adjust the ring gear. However, the drive pinion and ring gear must be re-adjusted if the transmission case, the drive pinion ball bearing or the gear set itself have been replaced.

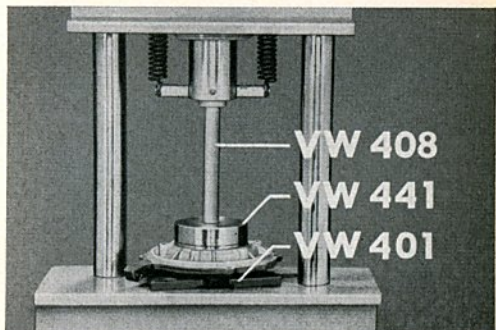
12/7 Three points during the transmission assembly are of particular importance for the drive pinion adjustment.

1 - The position of the drive pinion in the transmission case is determined by the seating of the ball bearing. Therefore always tighten the ball bearing retainer correctly — shown by the arrow — with its four screws when you insert the transmission in the transmission case for the pinion adjustment.

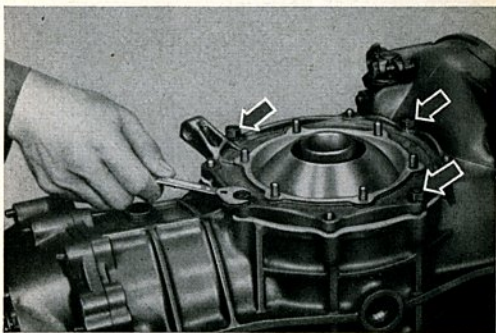


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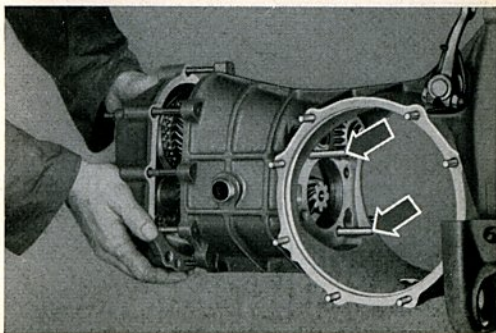
2 - The depth of the transmission case between the differential bearings is measured simultaneously during the pinion adjustment. Before installing the final drive covers use the Repair Press to ensure that the bearings are correctly seated. When disassembling the transmission they usually work loose a few tenths of a millimeter.

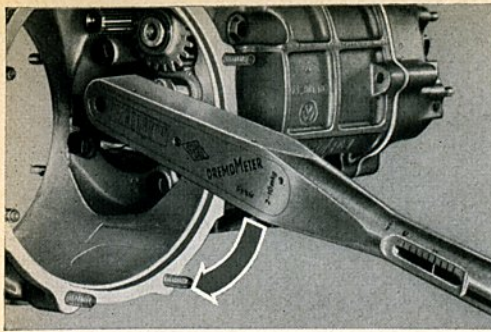


12/9 The third point concerns the installation of the final drive covers during the pinion adjustment. At first the covers should be tightened evenly with four nuts to ensure that the covers seat correctly in the transmission case. Then tighten all the eight nuts to between 2 and 2.2 mkg (14 and 16 ft.lbs.). If the covers are installed in an unskilled manner, for instance with a rubber hammer, the bearings may work loose again.

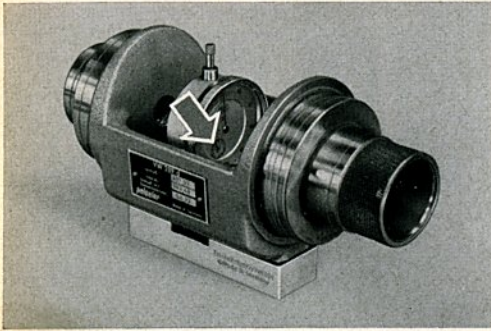


12/10 Install the transmission in the transmission case without pinion shims. Both arrows show the two guide studs approximately 100 mm long (4") which ensure that the holes in the ball bearing retainer are flush with the holes in the transmission case.

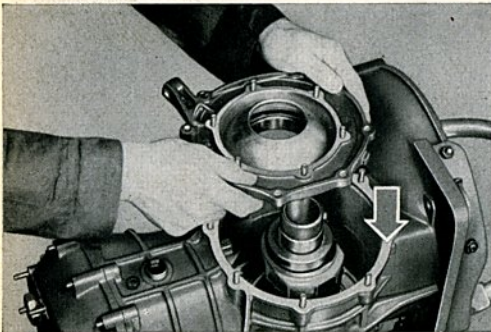




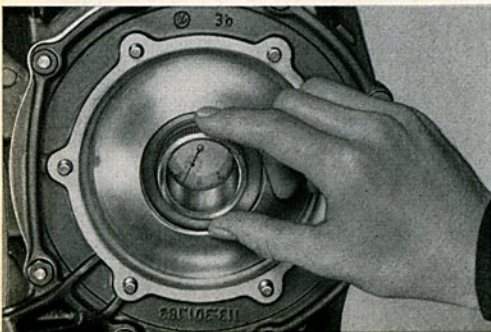
12/11 The ball bearing retainer screws are tightened to 5 mkg (36 ft.lbs.). Use thick washers with the screws as otherwise the transmission case will be damaged by the screw heads when tightening to the prescribed torque. The gear carrier does not require tightening when adjusting the pinion.



12/12 The fitting dimension of the pinion without shims is measured with this mandrel. With the mandrel there is an adjusting plate by means of which you set the dial indicator to zero with a pre-load of 1 mm (0.039"), as shown by the arrow. The distance from the measuring surface of the adjusting plate to the mandrel center line is marked as the third value on the plate on the mandrel you see here.

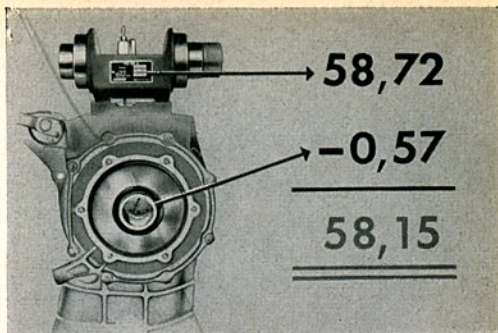


12/13 Instead of the differential the mandrel is installed in the transmission case. We have already mentioned that the final drive covers must be carefully installed and that the bearings must be correctly seated. It is also important, however, that the gasket shown here by the arrow must be installed on both sides between the transmission case and final drive cover. In this manner the various thicknesses of the gaskets are taken into consideration when measuring the transmission case depth.

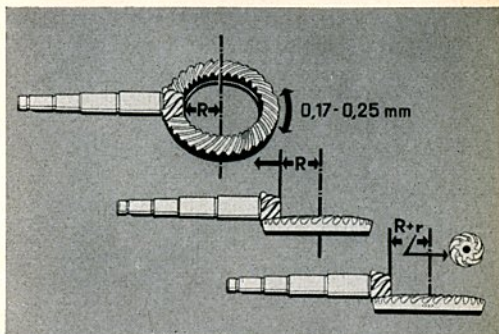


12/14 Now turn the mandrel slowly until the tracer pin contacts the pinion and is perpendicular to the pinion face. The indicator needle which you can see through the hole in the mandrel now gives its maximum reading.

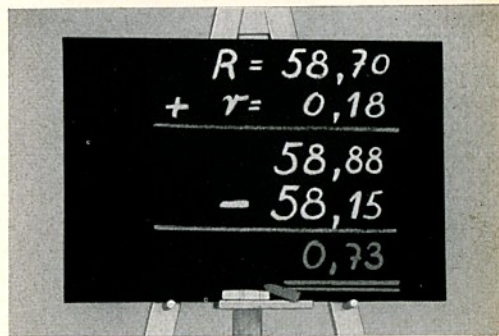
12/15 Taking the pre-load of the dial indicator into consideration, the dial reading is subtracted from the nominal dimension of the mandrel with adjusting plate. Thus you obtain the fitting dimension of the pinion without shims, which in our case, is 58.15 mm.



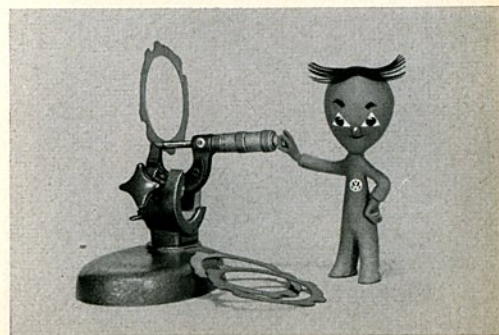
12/16 Here, once more, you see how the fitting dimension which is the position of maximum silent operation, is obtained. Above, the standard fitting dimension R ; in the center the endwise adjustment of the pinion until maximum silent operation is reached; below, the tolerance discrepancy from R is marked on the pinion face.

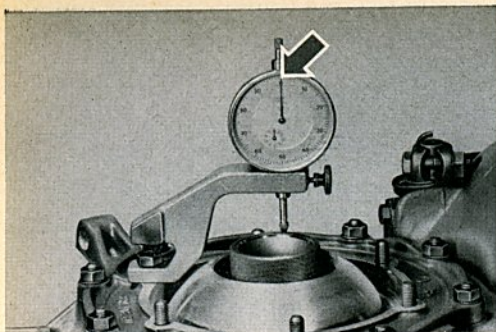


12/17 The correct fitting dimension is arrived at, therefore, by adding the tolerance discrepancy r which was obtained on the test appliances to the standard fitting dimension R . In our case it is 58.88 mm. 58.15 mm was the fitting dimension we had calculated without shims. To obtain maximum silent operation, 0.73 mm must be compensated for by shims.

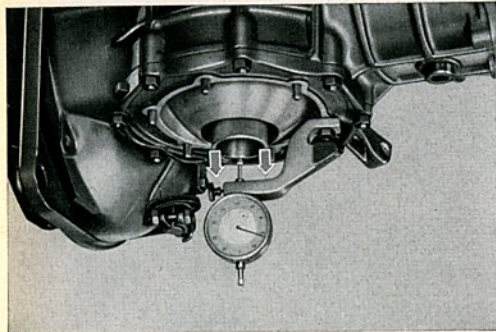


12/18 Measure the shims carefully at various points so as to avoid even the slightest adjustment errors which could be caused by the shim tolerances.

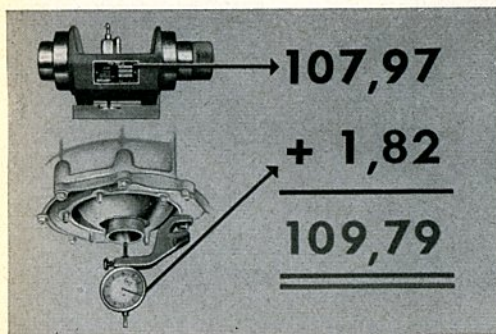




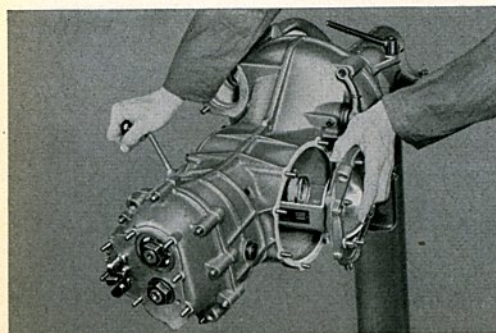
12/19 Before you insert the pinion shims, measure the depth of the transmission case between the differential bearings with the mandrel. The dial indicator tracer pin bears on the upper edge of the mandrel. The dial indicator bracket is part of the ring gear adjusting device and is attached to one of the studs for the axle tube retainer. After setting the dial indicator to zero —



12/20 turn the transmission case 180° so that the mandrel falls of its own accord into the bearing of the final drive cover to which the dial indicator is attached.

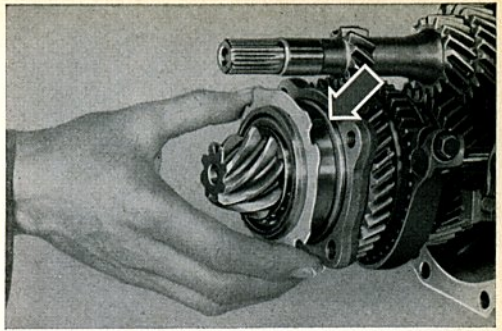


12/21 The depth of the transmission case is obtained from the length of the mandrel which similar to the nominal dimension for the pinion adjustment is marked on the mandrel, and the dial indicator reading.

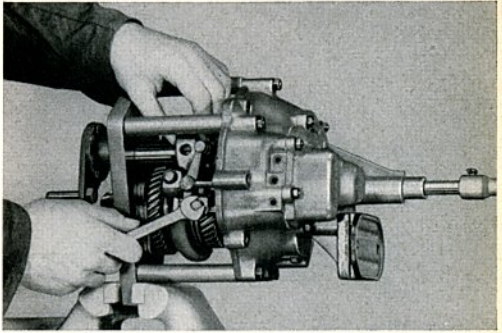


12/22 Use the spindle of the ring gear adjusting device when removing the mandrel. As you see here, with this method you can press off one of the final drive covers with the mandrel and thus avoid damage to the seating surfaces.

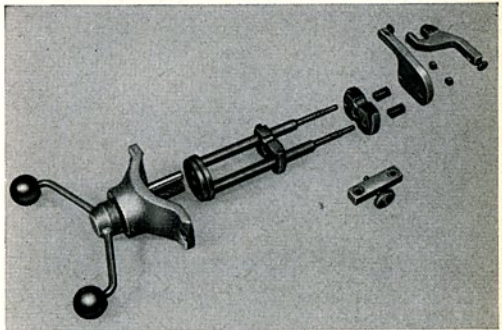
12/23 After this loosen the ball bearing retainer screws and push the transmission out of the transmission case with the removal tool. The pinion shims are positioned between the ball bearing shoulder — shown by the arrow — and the machined contact surface of the bearing shoulder in the transmission case.



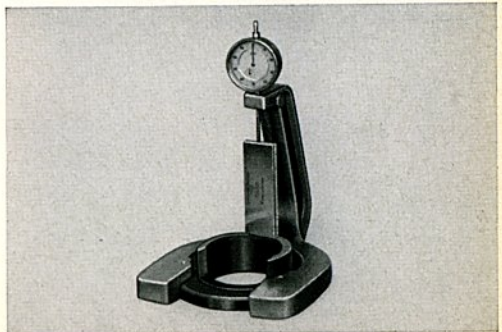
12/24 The selector fork adjustment is the last stage of the pinion adjustment as you can then finally install the transmission in the transmission case. Due to the exactness of the measuring devices it is not necessary to re-check the pinion adjustment.

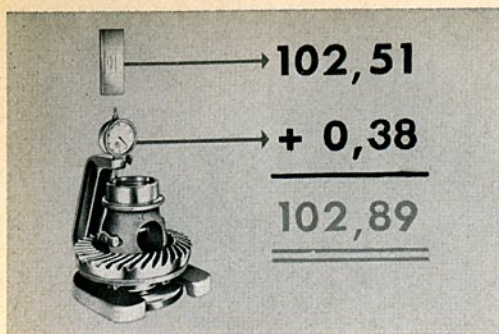


12/25 This adjusting device was designed for the ring gear adjustment. With it you can graduate the meshing depth of the ring gear by moving the differential axially. Once the prescribed backlash 0.17 to 0.25 mm (0.0067 — 0.0098") has been obtained you can read the thickness of shim S_1 on the ring gear side direct from a dial indicator. You then calculate shim S_2 by subtracting the length of the differential housing and S_1 from the depth of the transmission case between the two differential bearings which we have already measured.

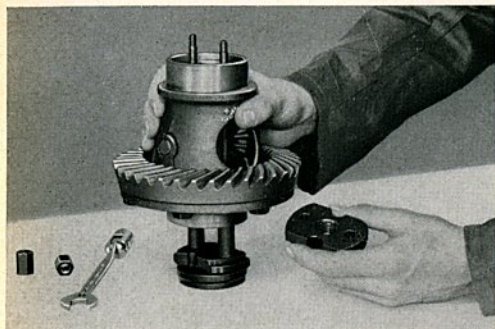


12/26 Even though the length of the differential housing is only required at the end for calculating S_2 , it is advisable to commence with this measurement. For this you use the differential housing gauge shown here and set the dial indicator with the adjusting plate to zero.

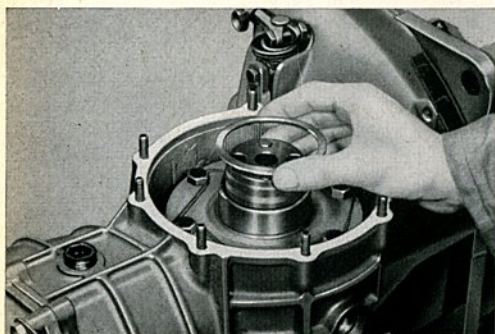




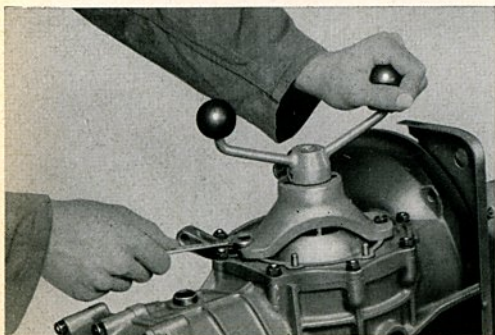
12/27 Now insert the differential into the gauge instead of the adjusting plate and add the dial indicator reading to the nominal dimension of the adjusting plate. Here the length of the differential housing is 102.89 mm.



12/28 The next pictures show the installation of the ring gear adjusting device. First of all place the differential between the two thrust plates of the device. It is important that the ring gear end of the differential is always facing down when being inserted over the retaining bolts. The retaining bolt nuts — shown on the left — must be fully tightened.

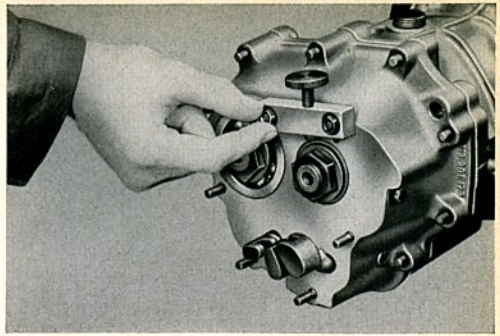


12/29 Insert the 2.8 mm gauge ring on the ring gear side when installing the differential. In this case the final drive covers need not be installed as carefully as during the pinion adjustment. They must, however, be again installed with gaskets and correctly tightened on all the studs.

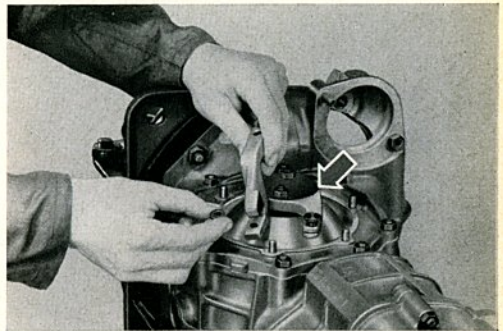


12/30 The spindle of the adjusting device is attached on the ring gear side —

12/31 — and the retaining bracket, which holds the pinion when the ring gear backlash is measured, to the gear carrier.

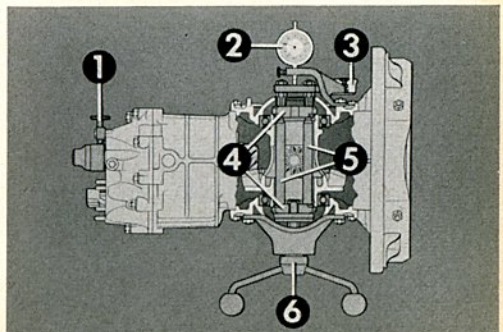


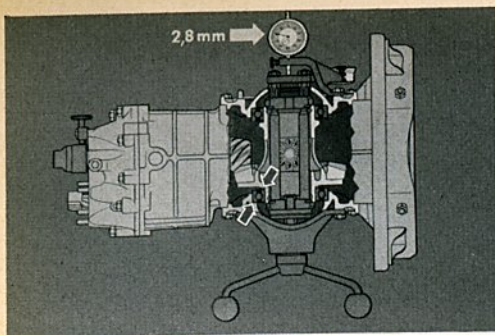
12/32 Turn the transmission case 180° and attach the two dial indicator brackets. Screw the bracket shown by the arrow tight with the retaining bolts of the two differential thrust plates. This bracket is for the dial indicator which measures the ring gear backlash. The contact surface for this dial indicator is provided on the bracket which you see being attached here and which is intended for the dial indicator which measures the differential axial adjustment.



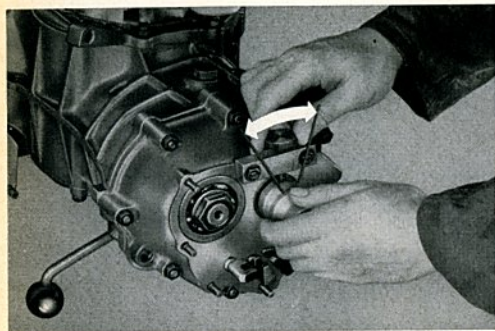
12/33 This is what the installed device looks like:

- 1 - The pinion retaining bracket.
- 2 - The dial indicator for measuring the differential axial adjustment.
- 3 - The dial indicator for the ring gear backlash.
- 4 - The two differential thrust plates.
- 5 - The retaining bolts for the thrust plates.
- 6 - The spindle for the differential axial adjustment.

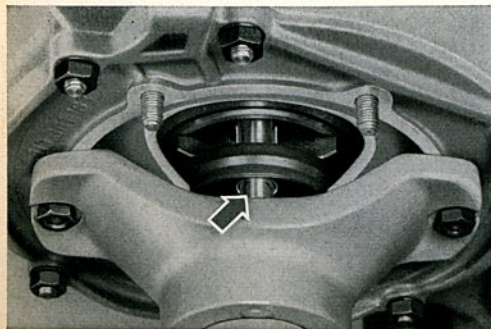




12/34 You always start the ring gear adjustment by pulling the differential fully into the bearing on the ring gear side with the spindle. It is important that not only should the differential bear correctly on the bearing, but also the bearing must be pulled fully into the final drive cover. The two lower arrows show this. Make sure that this is the case by tightening and backing of the spindle a few times and observing the dial indicator for the axial adjustment. Only after the dial indicator always gives the same reading with the spindle backed off, do you set it to 2.8 mm which is the thickness of the gauge ring on the ring gear side.



12/35 Now hold the pinion in place with the retaining bracket on the gear carrier. You can facilitate matters by placing a socket on the pinion nut. Now turn the pinion in both directions as far as possible and lock the pinion approximately half way between the two stop positions.

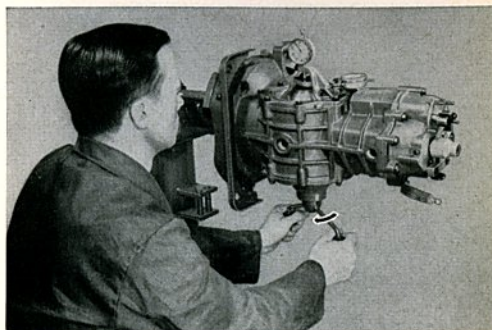


12/36 The stop positions are caused by the pin in the spindle — shown by the arrow — which prevents the differential from revolving when the spindle is operated. When securing the pinion, the pin must center in the holes in the thrust plates. Otherwise you will either not be able to measure the ring gear backlash at all, or you will measure the play between the tooth contact and the stop of the thrust plates on the pin which of course is quite audible.

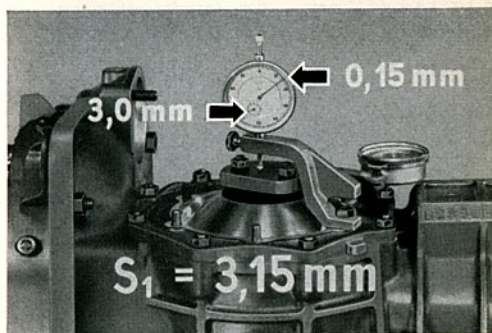
12/37 The backlash is measured at first with the differential contacting the lower bearing. You see that the dial indicator for the differential axial adjustment still reads 2.8 mm. The spindle is always backed off when measuring the backlash.



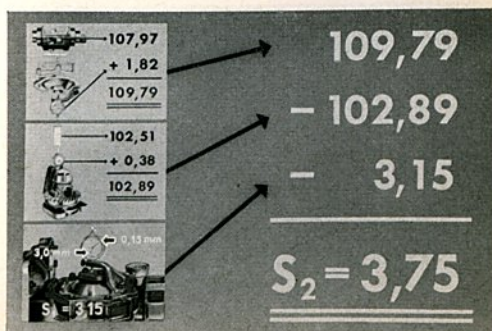
12/38 You will soon get to know how much the differential must be raised until the backlash is approximately in the middle of the prescribed range i.e. between 0.20 and 0.22 mm. Make sure that the transmission remains suspended with the ring gear side downwards during the whole course of the measurements. You will thus avoid errors which can result from the axial play of the differential bearings.

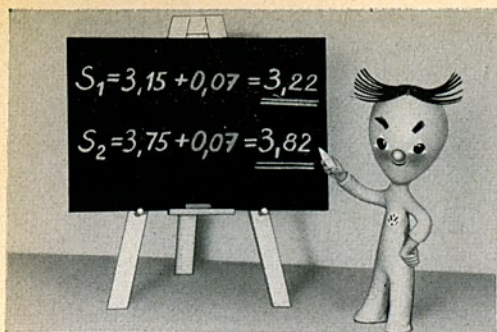


12/39 Once the required backlash has been obtained you can read the thickness of shim S_1 on the ring gear side direct from the dial indicator for the differential axial adjustment. In our case S_1 is 3.15 mm thick. Since we have already set the dial indicator to 2.8 mm which is the thickness of the gauge ring on the ring gear side, the differential had to be raised by 0.35 mm.



12/40 Shim S_2 is calculated as shown here from the depth of the transmission case between the differential bearings, the length of the differential housing and S_1 .

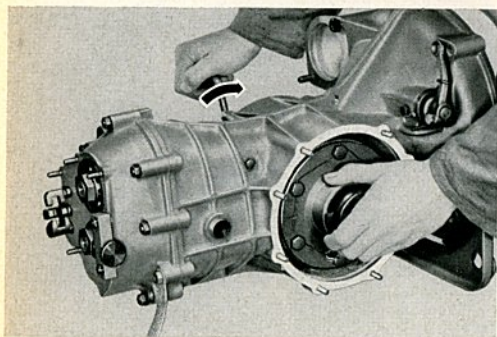




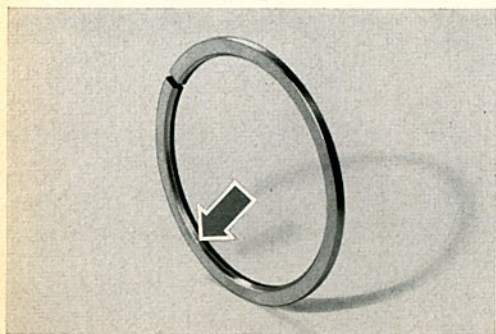
12/41 After that the pre-load is considered with which both final drive covers have to be installed. It amounts to 0.07 mm on each side so that the final shim thickness is 3.22 mm for S_1 and 3.82 mm for S_2 .



12/42 You can also use the spindle of the adjusting device for removing the differential. Here you see the final drive cover on the ring gear side being removed —

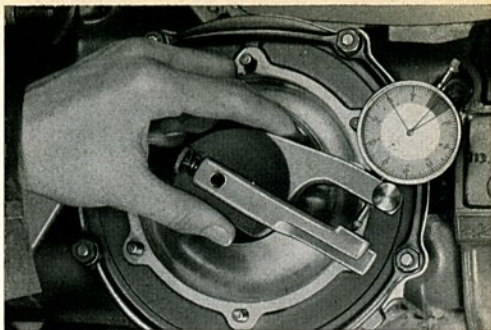


12/43 then you take off the two dial indicator brackets, attach the spindle on the other side, and press the differential out of the transmission case.



12/44 The shims are positioned with their chamfered edges facing the differential. If washers have to be installed, they are positioned between the shim and the bearing. Moreover, try to choose those shims which get as near as possible to the shim thickness calculated.

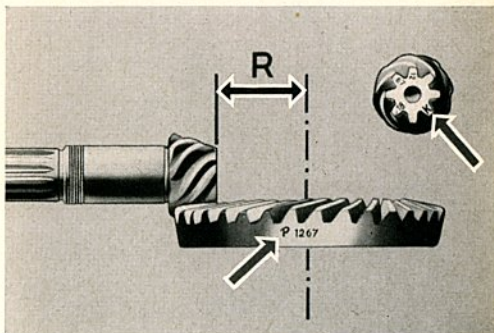
12/45 Finally check the ring gear backlash again in various positions by repositioning the dial indicator stop a few times. As already mentioned, the tolerance is between 0.17 and 0.25 mm. The measurements taken, however, must not differ by more than 0.05 mm (0.002") from each other. In this case you see that the backlash is really well adjusted. The dial indicator needle is approximately in the middle of the tolerance range which is shown in the darker shade.



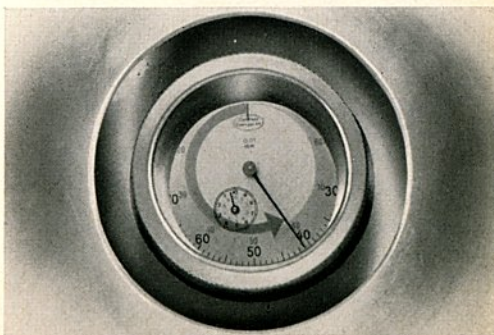
12/46 It is not necessary to open the transmission when removing the adjusting device. The thrust plates for the differential are so designed that they can be easily removed through the openings for the rear axle shafts after the retaining bolts have been loosened.

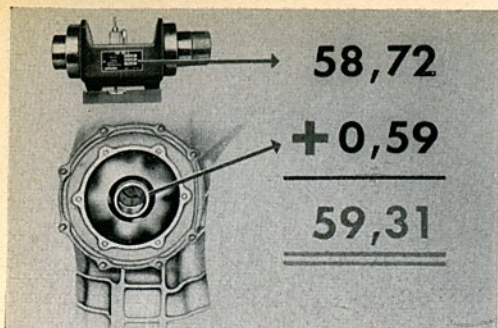


12/47 Now a final remark on the Klingelnberg gear sets which were installed in the first VW Transporters with fully synchronized transmissions. You are aware that the fitting dimension R which is 58.7 mm, and on which our previous calculations were based, is valid for the re-inforced Klingelnberg gear sets only. For identification, these gear sets are marked with either "K" on the pinion face or "P" on the edge of the ring gear. The fitting dimension R of all Klingelnberg gear sets which do not have these markings is 59.7 mm.

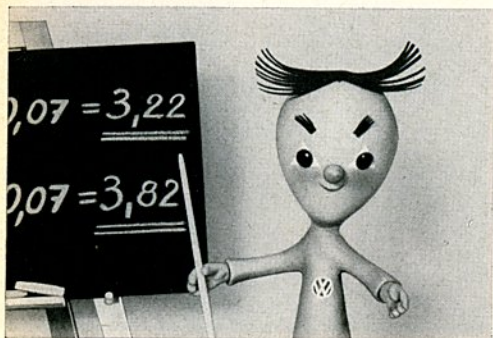


12/48 When adjusting this type of gear set it must be noted when adjusting the pinion that the fitting dimension of the pinion without shims is larger than the nominal dimension of the mandrel. The dial indicator which you had installed with a pre-load of 1 mm in the mandrel now gives a smaller reading. In this case you must read off the dial indicator in an anti-clockwise direction —





12/49 — and you obtain the fitting dimension of the pinion without shims if you add this value to the nominal dimension of the mandrel with adjusting plate. On most dial indicators the small red numbers are valid for this reading.



12/50 This concludes the theme "adjustment of the fully synchronized transmission". We wish you success. Care and cleanliness during all assembly and measuring operations are the first essentials.

