LOOK
LISTEN
DO IT BETTER

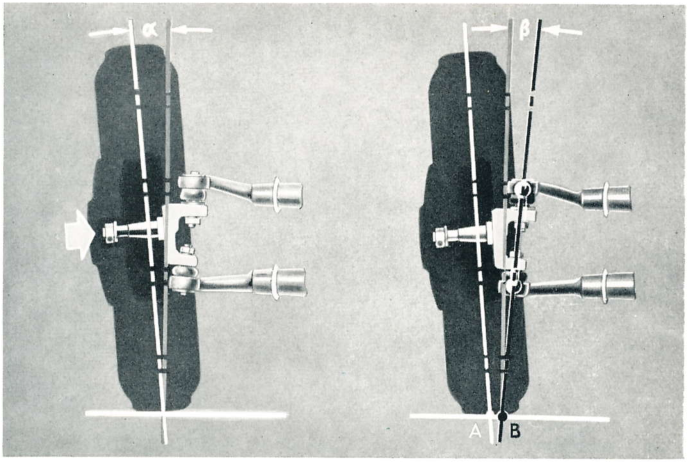
Optical Vehicle Measurement

Slide Series No. 28

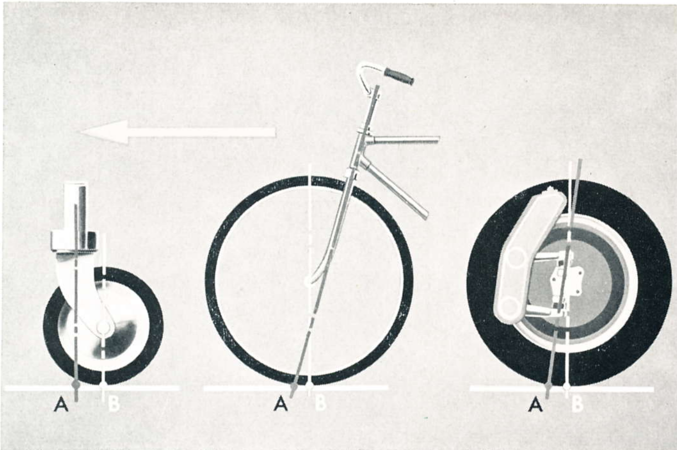
OPTICAL VEHICLE MEASUREMENT

Part 1: Pictures 1—31

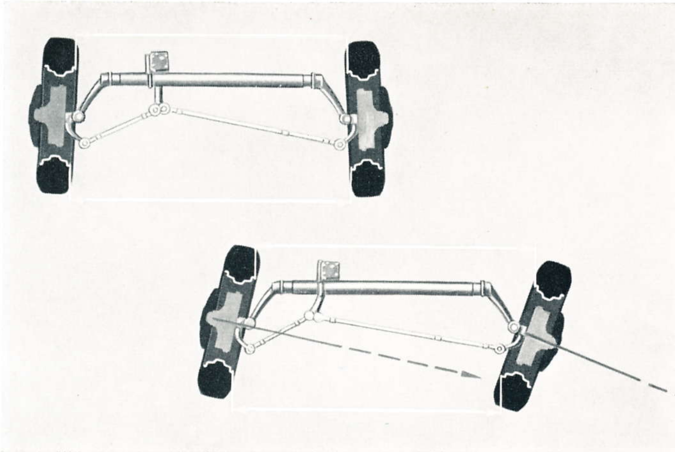
28/1 Years ago, a measuring bar and a steel tape were sufficient to measure the wheel alignment of a vehicle.
To bring roadholding and driving characteristics to a high standard, the axle and wheel settings have become more cunning and more complex. To measure and check these settings, modern optical wheel alignment appliances are required, for only these are accurate enough.
Let us now carry out such an optical wheel alignment check. Before we start, however, we shall explain a few of the expressions used in conjunction with it.



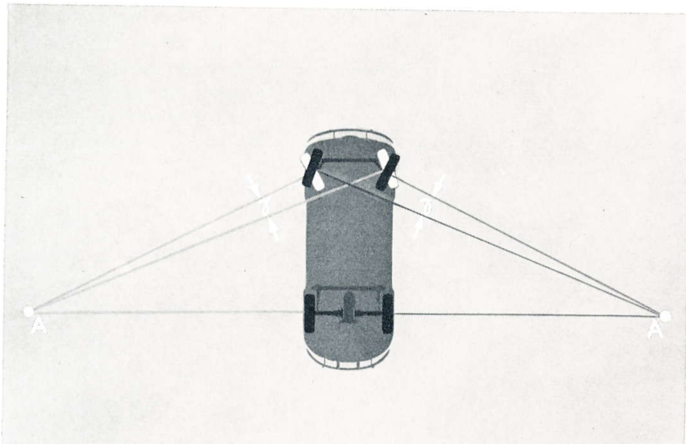
28/2 Here we have the "camber" of the wheel. You probably already know what that is. The wheel is not in a vertical plane to the road. The drawing on the left shows clearly that the top of the wheel leans outward at a certain angle α. The experts say that the wheel has positive camber. Now, why do the chassis designers suspend the wheel like this? From the drawing we can see that because of the angle of the steering knuckle, the wheel tends to be pushed in the direction of the arrow. By this means, the play in the wheel bearings is eliminated and the load is taken off the axle nut as well as the outer wheel bearing. But the technicians have done even more. Look at the right-hand drawing. The steering knuckle attachment leans towards the other side. This is called king pin inclination and it is denoted on the drawing by β. You can see that the white line through the wheel and the black line through the axle joints are close together at A and B on the road.
It is sufficient for us to know that this results in lighter steering, it weakens the jolts from the road and it also reduces wheel wobble.



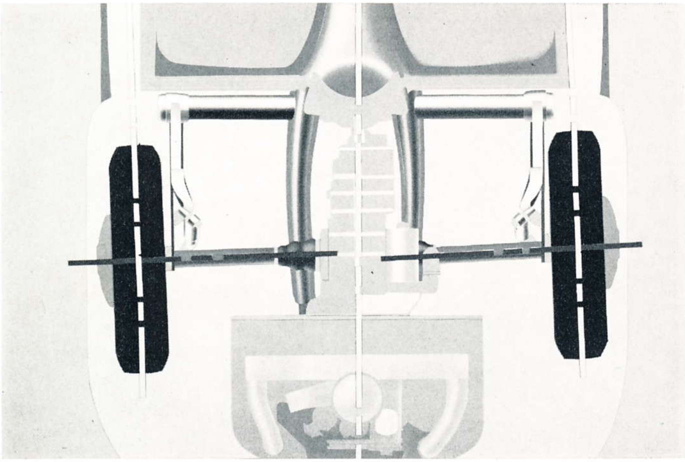
28/3 Caster is a further means of preventing the tendency of the front wheels to wobble. The main thing is that caster causes the "trailing" or "drawn" wheel to align itself to the straight-ahead driving direction and keep itself there. This self-alignment of wheels can be found on the castors on pianos, tea trollies, and other pieces of furniture. And who has not ridden his cycle "no-handed" when he was young? The caster of the front wheel makes it possible to do this "trick". Take a look at these drawings. You can clearly see why this is possible. The white vertical line through the center of the wheel intersects the road at point B where the tire touches the road. B is behind intersection A, the dark line of which runs through the center of the spindle. The wheel is drawn along although, especially in the case of the bicycle, at first glance this does not appear to be the case.
The same principle is applied to the front wheels of a motor vehicle, shown on the right in the illustration. Location B lies behind intersection A of the continuation line through the ball joints or the king pins on older vehicles. Caster of the wheels is attained by arranging the ball joints offset to each other. The dark line illustrates this clearly.



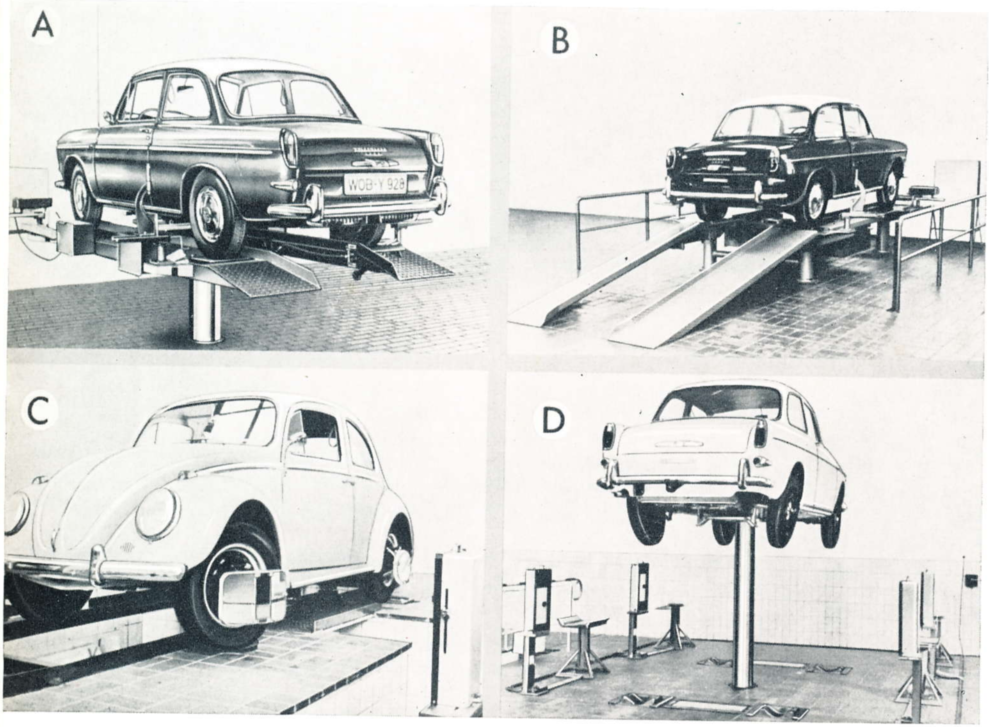
28/4 If we take a look at the wheel position from above, we find that the front wheels are not parallel to each other. At the top of the picture you can see the toe-in. Measured at the rim shoulder, at the center of the wheels, the wheels are closer together at the front and farther apart at the rear. You probably know the reason for this. Due to the rolling resistance when the vehicle is operated, the wheels are pressed apart at the front as far as the play of the torsion arms, ball joints or king pins, tie rods etc. permit. And you can imagine what would happen if the vehicle were unladen and stationary and the front wheels were parallel to each other. Each wheel tries to go its own way when the vehicle is operated and the wheels would wobble, the steering would be heavy and, because of the heavy tire wear, the driver would have to be the owner of a tire factory.
One exception to this is our Transporter. In the case of this vehicle, the adjustment range for the toe-in of the front wheels is so arranged that there can be a small amount of toe-out even when the vehicle is unladen. This is due to the fact that special demands are placed on commercial vehicles, the axles of which have to fulfil all demands with respect to steering and driving characteristics and tire wear over the full range, from an empty to a fully loaded condition.
Now let us take a look at the lower picture. The front wheels are turned to negotiate a bend and we can clearly see that toe-in has now become toe-out. This is achieved by an ingenious arrangement of the front axle and steering parts, known to the specialist as steering geometry; and you certainly know why this is so. When negotiating a bend, the outer wheel has to describe a larger circle than the inner wheel. Assume we have put a 20° lock on the wheels and imagine that the axes of the wheels are extended by lines, . . .



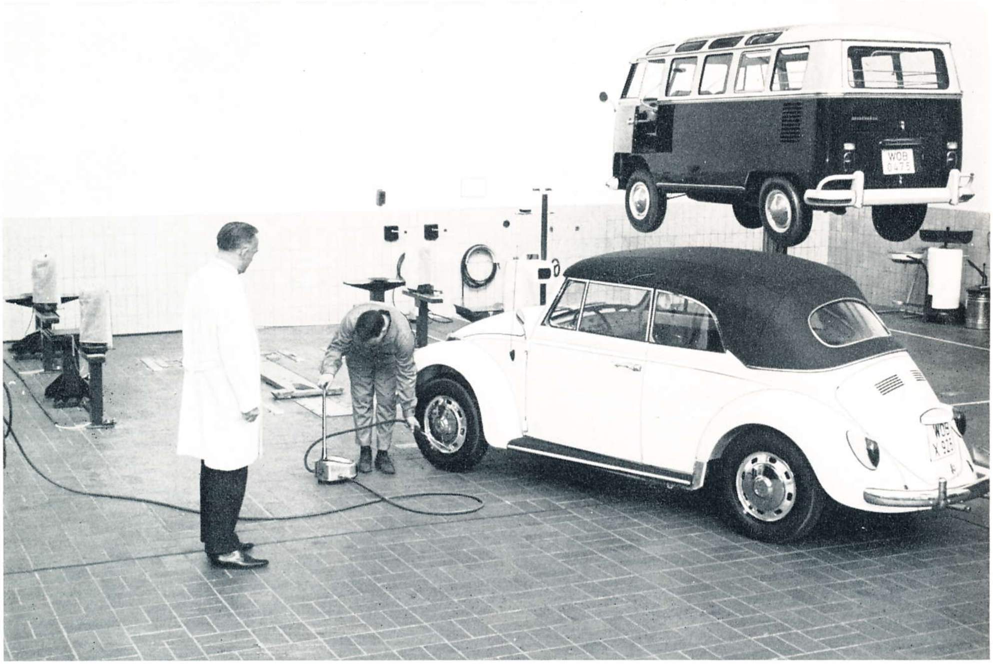
28/5 . . . they would then meet at A. The difference in lock of the outer wheel we call wheel angularity. You can see that in our illustration, the lines through the wheel axes showing the wheel lock angle do not meet just anywhere, they meet on a line forming a continuation of the rear axle. If we assume that the conditions are the same when the wheels have a 20° lock on the other side, we have then, so to speak, ideal conditions. In such a case, all four wheels would revolve round the common location A when negotiating a bend.
From this we conclude that the rear wheels have to be in the correct position in relation to the longitudinal axis of the vehicle, for the driving characteristics of a vehicle are not only influenced by the front wheels but also by the rear ones. When cornering, for example, the rear wheels as well as the front ones have the task of keeping the vehicle on the required track and providing stable control at higher speeds.



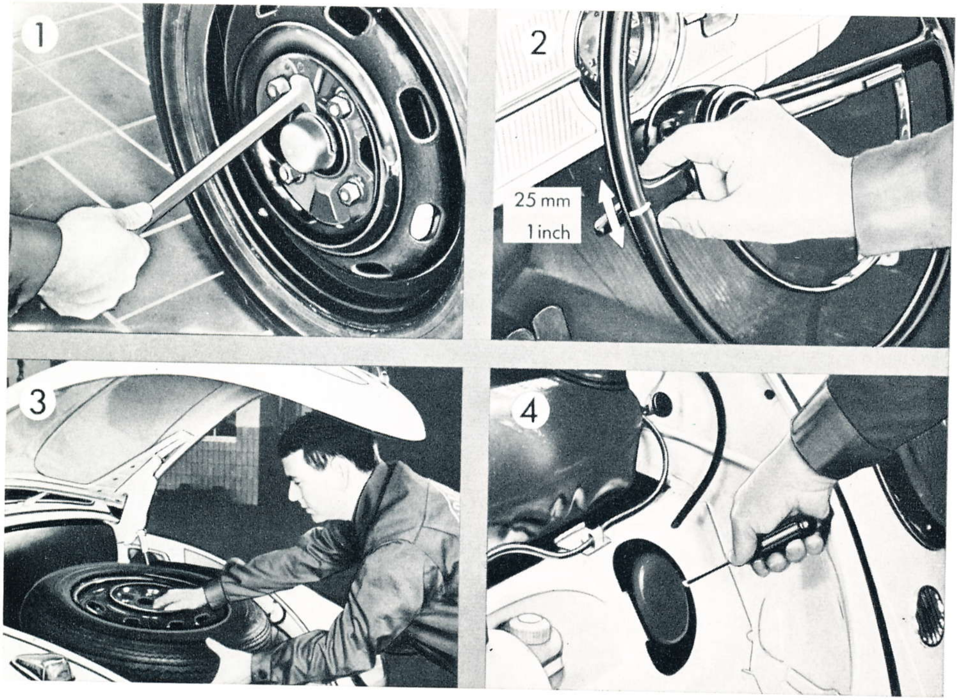
28/6 Incorrect alignment of the rear wheels also has a negative effect on roadholding, cornering and tire wear.
It could be that the rear wheel track is correct but the rear axle or perhaps one half shaft is at an angle to the longitudinal axis of the vehicle as shown exaggerated in our illustration.
Well, that is that. Let us just summarise what we have said so far: The camber, king pin inclination, caster and toe-in all work together to make the steering light, prevent wheel wobble, increase road safety and keep tire wear within normal limits. To do this properly however, all the angles must be correct and the only way to check them is to use an optical axle alignment gauge.



28/7 Before starting to measure the vehicle we should like to show you how the optical measuring equipment can be installed. Picture A at the top left, is a single ram vehicle lift, B is a drive-on type and C is a pit type layout.
Whereas these three layouts require an additional area in the workshop, the fourth arrangement in picture D, which consists of a vehicle lift with pivoting wheel supports, does not. The advantage with this layout is that the floor space can be used for other work, when the optical alignment equipment is not in use.
We shall now measure a vehicle on one of these modern systems which is already in widespread use. You will then get to know all about the optical equipment and its use.



28/8 Here you see the measuring stand in front of the vehicle which the service adviser has just driven in.
"Give this one a complete check Harry because the owner has hit a curbstone good and hard and he wants to know if the wheel alignment is still O.K."
The mechanic, Harry Jones, has already started on the preparatory work. He is a keen and conscientious young man who has been given the job of alignment checking in this workshop and considers this, quite justifiably, to be something special. But let him tell you what he is doing in his own words.
"First of all I check the tire pressures and rectify them if necessary. I enter the pressures on a card which I have made out for this vehicle. Later on, when we get to the alignment check, you will see this card.

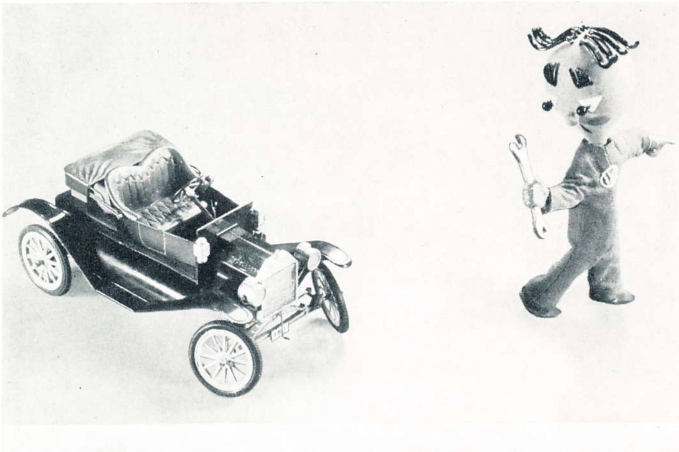


28/9 1 - Then I take the wheel caps off and remove the front wheel hub caps with the special lever as shown in picture 1. This is done because at the end of the alignment test, I have to check whether the offset between the stub axles is within the specified limits. This and other preparatory operations must be done now because if done when the vehicle has been set up on the stand it might upset the vehicle alignment.

2 - On the steering wheel rim I check the play in the steering gear which, as you probably know, must not be more than 1 inch. The road wheels must be in the straight-ahead position of course.

3 - The regulations state that the vehicle must be measured in the curb weight condition, that is, with spare wheel and a full tank of fuel, so I just glance into the luggage compartment to see that it is empty. At the same time I lift the spare wheel up into the luggage compartment so that the cover over the steering gear inspection hole is accessible.

4 - I then take the cover off because I have to check the central position of the steering gear later on.



28/10 The next thing to do is to check the front axle. It would be pointless to measure the front wheels when there is far too much play in the bearings or in the linkage and suspension as shown in our little cartoon. When this cannot be corrected by adjustment the damaged parts must be replaced.

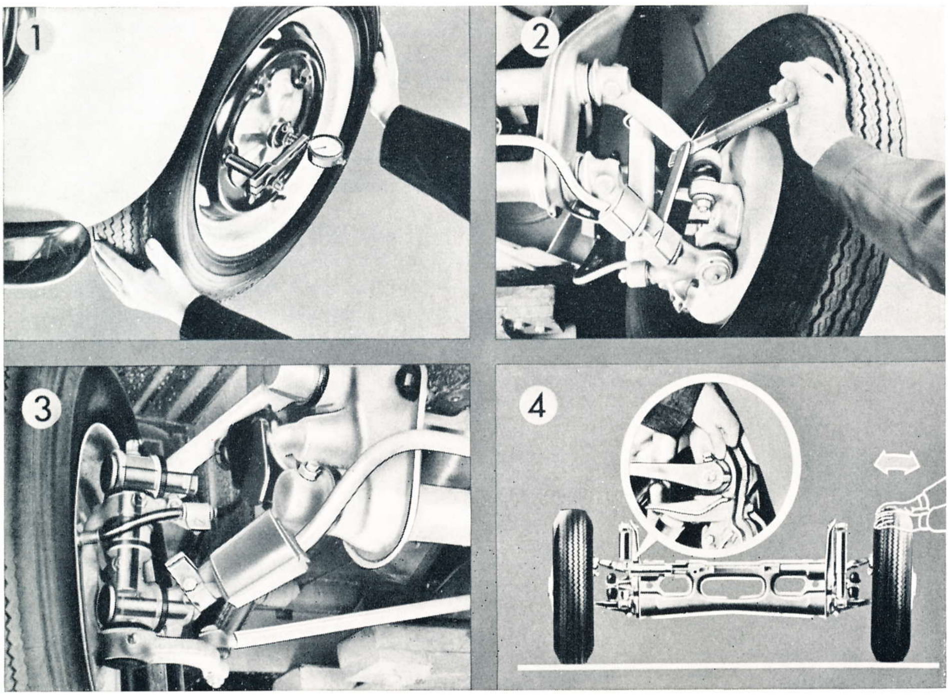
28/11 In this picture you can see what has to be checked:

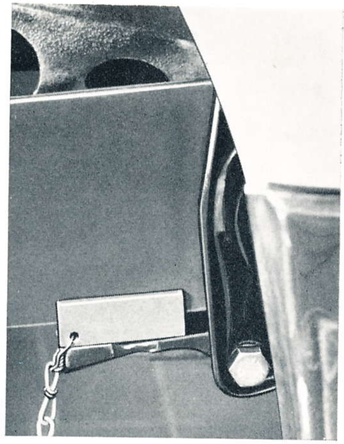
1 - Wheel bearing play
and, according to vehicle type
and year of manufacture

2 - Steering ball joints

3 - King pins and link pins
and,

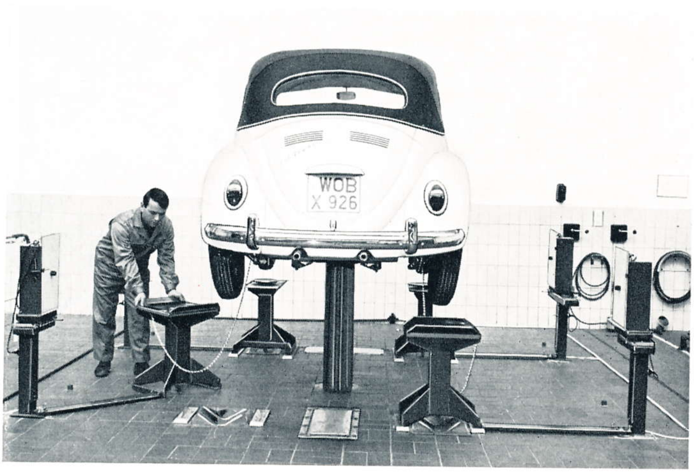
4 - Axial play in upper torsion arms.





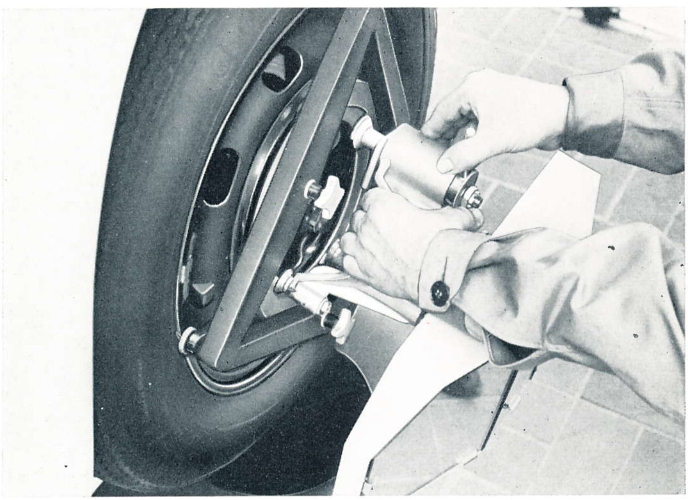
28/12 I have now driven the vehicle onto the test stand, but before I lift the car, there is one more important thing to do and that is to insert these small spacers between the spring plates and the lower stops. The object of fitting these spacers is, as shown on the right, to stop the wheels dropping when the vehicle is lifted and turning the spring plates in the rubber bushes more than they are turned in normal operation. The rear wheels would then be very bowlegged when the vehicle is lowered again and it would take a few miles of driving to move them back to the normal position. Without the spacers, the camber measurement would be too large.

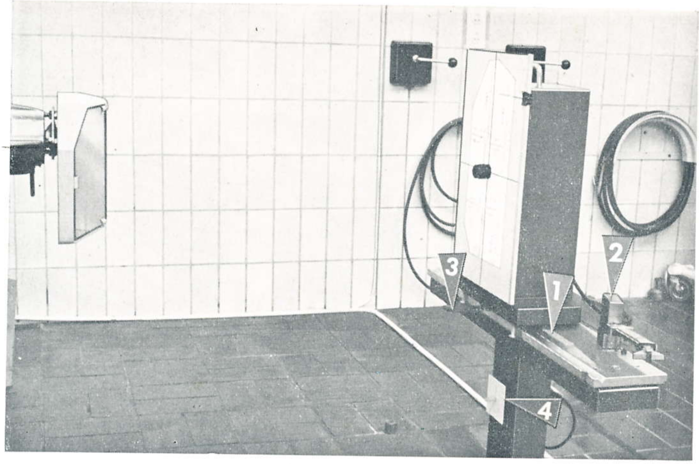
28/13 I have now lifted the vehicle so far that the supports can be swung into position. The chains leading upwards from the rear supports show that the spacers mentioned before have been inserted. When all four supports are in position, I lower the vehicle until the wheels can just be turned by hand. A red warning lamp on the wall to the right of the car shows that the supports have been swung in as far as they will go.



28/14 Now I fit the VW brackets on the wheels. The two fixed lugs at the top are pressed between tire and rim by tapping lightly with the flat hand and then the third adjustable lug is fitted in the same way. The lever is tightened while tapping all three lugs alternately with the hand.
The three knobs which are shown light colored here to make them stand out better, are used to adjust the mirror.

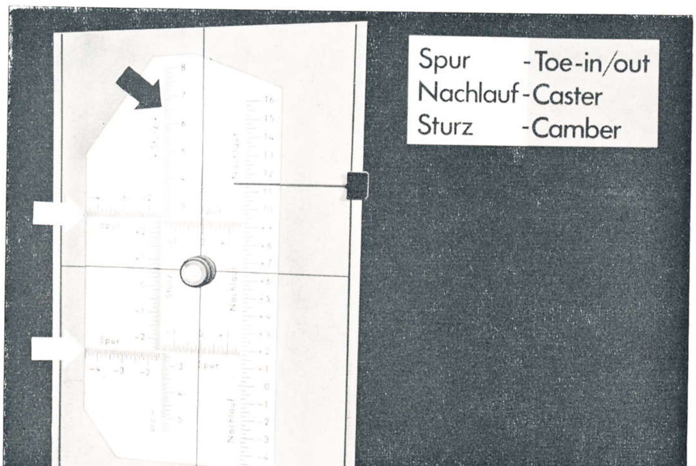
28/15 When all the brackets have been fitted, the mirrors are installed. This is quite simple, just insert the three legs of the mirror holder into the ring on the bracket and tension them with the lever.
The mirror is pivoted on the holder and swings into the horizontal position automatically. Each mirror has three surfaces, the center one for the straight-ahead wheel position and two angled at 20° for the measurements with the wheels on right and left lock.

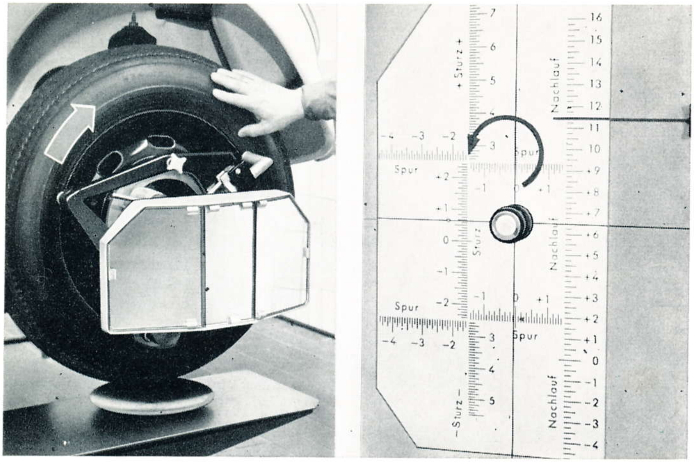




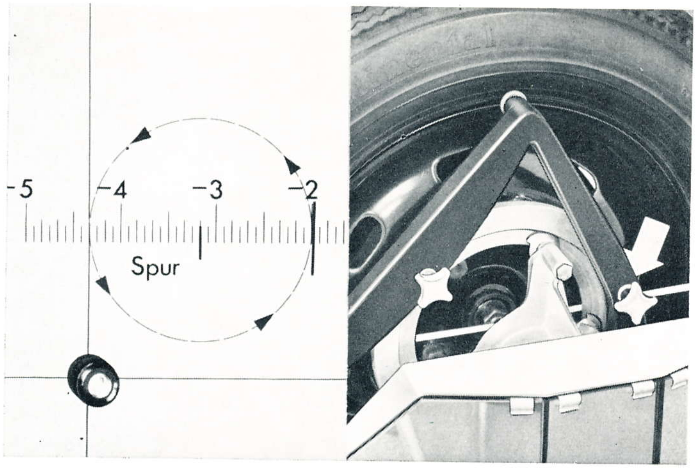
28/16 When the mirrors have been fitted, the projector is switched on. The lens in the center of the screen throws a graduated image onto the mirror which enlarges the image and reflects it back to the screen. This is shown clearly in the next picture.
The projector can be moved sideways so that the complete graduated image is visible. Arrow 1 points to a millimeter scale which is used later on to check the stub axle offset. Under arrow 2 is a feeler device which can be attached with a magnet to the bracket (arrow 3) on the projector and used to align the vehicle properly.
Underneath on the pillar supporting the projector (arrow 4) is a measuring plate which is attached to the stub axle during the stub axle offset check.

28/17 Here is the screen with the reflected image and the graduations which can be read off with a hairline cross. The image has two horizontal track scales — white arrows — and a vertical camber scale — black arrow. These scales are marked in 5 minute graduations.
On the right-hand side of the screen is a caster scale with 15 minute graduations. Over this scale is a pointer which slides up and down the edge of the screen.

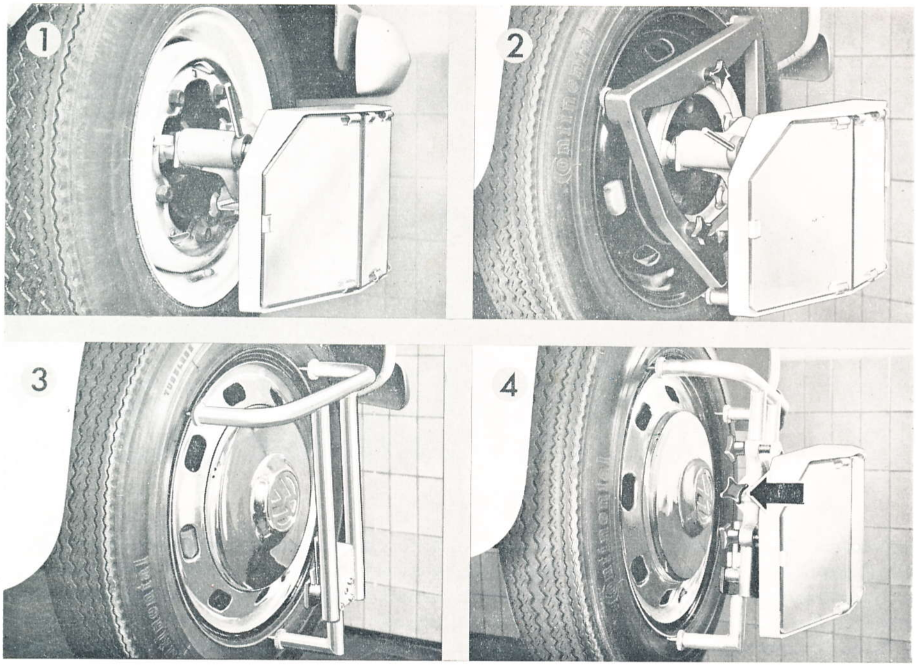




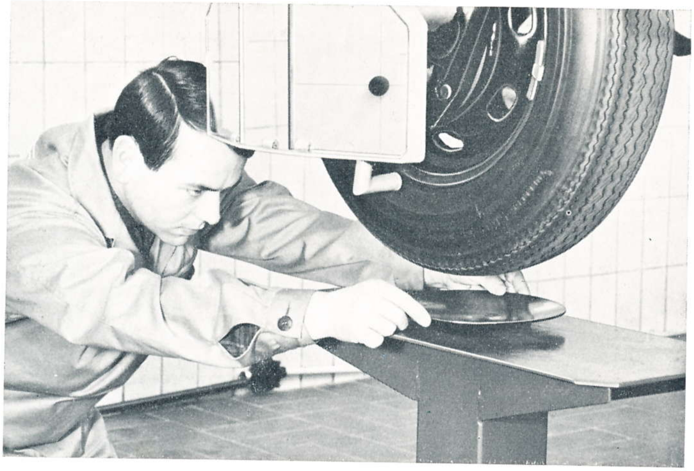
28/18 Now I have to align the mirror with the wheel axis. As I turn the wheel slowly, the image on the screen describes a large or small circle according to the degree of misalignment. The mirror must be aligned so that the image is completely stationary when the wheel is turned. How is this done?



28/19 It is not easy to explain how to align the mirror with a stationary picture, but I shall try with the aid of the drawing on the left of the picture. As we said before, the graduated image describes small circles when the wheel is turned. Look carefully at a track scale as this provides the easiest means of making the adjustment.
I may have to alter the wheel lock very slightly to move the location of the scale so that it circles through the vertical hairline.
I now note, on the circle which our track scale describes round the vertical hairline, the two horizontal end points at which the scale is intersected by the hairline.
On the drawing, this is the case at the left end point. On the right hand side it was just on the graduation —2 which is marked with a line. Now locate the center of these two points. This is easy with the aid of the scale. We have also marked the center point with a short vertical line.
I now hold the wheel at one of the end points and turn the knob nearest to an imaginary line drawn horizontally through the wheel center as shown in right-hand half of picture. In the picture this line is shown in white and the knob nearest to it is the one indicated by the arrow.
I have to turn this knob so that the center point of the circle moves over into the hairline.
Now turn the wheel again and see if the image is still circling. If it is, adjust again until the image is stationary when the wheel is turned. The remaining error must not exceed 5 minutes. This operation will probably seem difficult at first, but after you have done it a few times it will be quite straight forward.

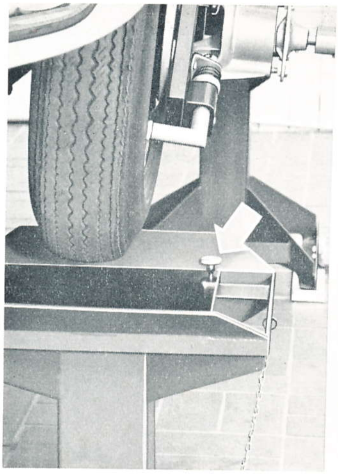


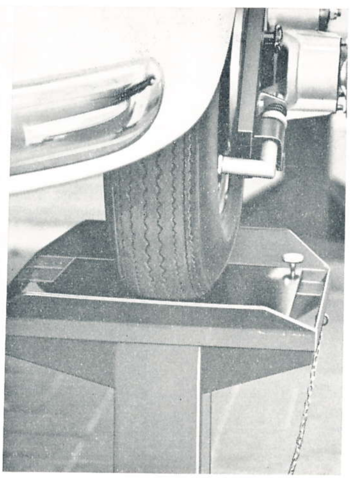
28/20 In this picture we show you various methods of mounting the mirrors on the wheels of different vehicles.
Picture 1 shows the VW special mirror holder which you have probably already seen. It can be attached directly to the wheels of all Transporters and passenger cars manufactured up to the end of July 1965. This holder is not adjustable. If the scale movement on the screen is more than 5 minutes, move mirror round on wheel and make sure there is nothing under the clamping legs and that the legs are not on a brake adjusting hole. If the scale movement is still more than 5 minutes it can be assumed that the brake drum is out of true and at the rear a halfshaft may be bent as well. It is obvious that such damaged parts must be replaced before attempting to measure the wheel alignment.
In Picture 2 is the bracket with mirror which is described in this slide series. Picture 3 shows the universal wheel mirror bracket which can be used for all wheels from 13 to 15 inches in diameter. It is clamped between tire and edge of rim in the usual manner. The mirror is then attached as shown in picture 4 and clamped level with the center of the wheel by tightening the knobs. The mirror is aligned with three adjusting screws as already explained. Now let our mechanic Harry Jones carry on with his story.

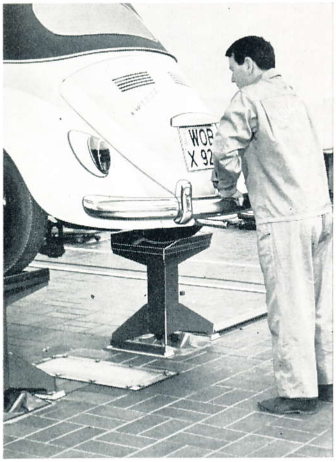


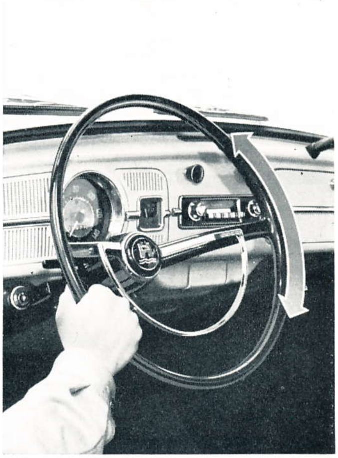
28/21 In the meantime I have fitted and aligned the four mirrors. Before I lower the car onto the supports I position the wheel plates under the front wheels. The wheels can be moved to any lock easily and free of stress on these plates.
One more point, before lowering the vehicle I must make sure that the wheels are positioned so that the bottom parts of the rims are free for the magnetically held feeler appliance. Balance weights or the clamp of the mirror bracket must not be in the way.

28/22 I must also ensure that the locking screws in the moving plates under the rear wheels are loose and that the plates are located roughly as shown in the picture on the left. They can then move out with the wheels as the vehicle is lowered as shown in the right-hand picture and still have enough movement to permit the rear suspension to be bounced and to allow the vehicle to be moved sideways to align it properly.



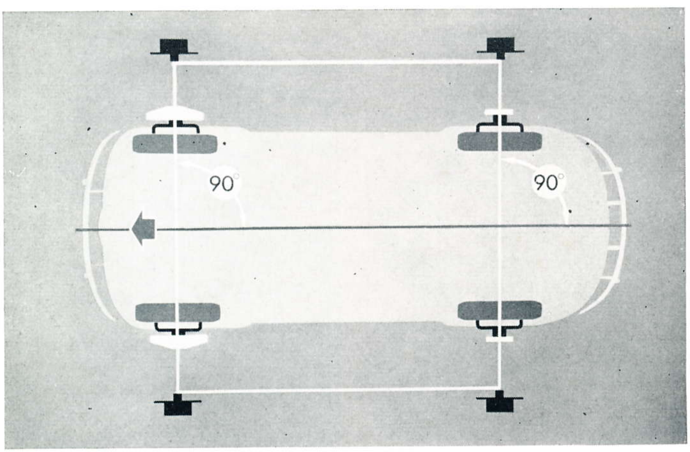


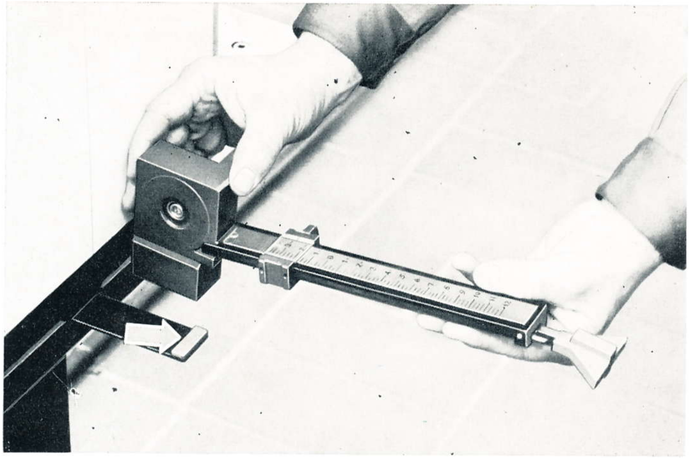




28/23 After lowering the vehicle, I take out the spacers because I have to bounce the vehicle at front and rear a few times. I then turn the steering wheel to left and right several times as well.

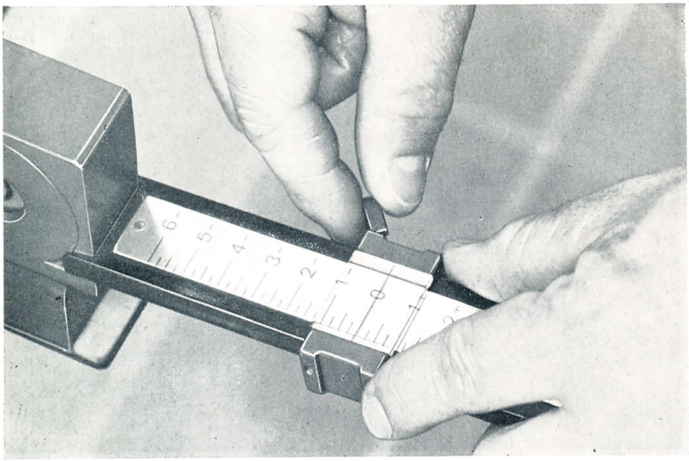
28/24 Now comes the last but most important job before the actual measurement starts. This is the alignment of the vehicle within the optical rectangle of the test stand and the whole success of the optical measuring procedure depends entirely on the accuracy of this operation. Looking at the picture you will see what I mean. The four projectors, connected by lines, form the optical rectangle. The vehicle is aligned so that the longitudinal axis as shown by the center line is parallel with the projectors. The longitudinal axis is thus at right angles to the two projector axes.





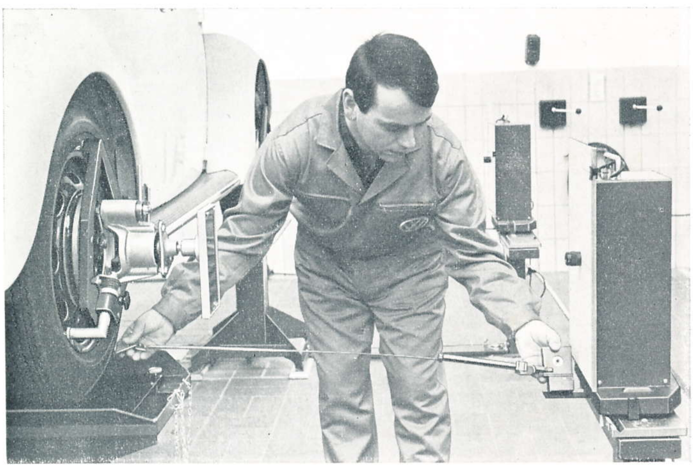
28/25 The alignment is done with the aid of two feeler appliances. Here I am just about to place one of these feelers on the bracket provided on the projector. The base of the feeler must be against the small shoulder on the bracket. The feeler has a graduated scale and a slide. Inside the feeler is a flexible steel rule to which the slide can be clamped. At the end of the steel rule is a magnet which can be seen at the right-hand end of the appliance.

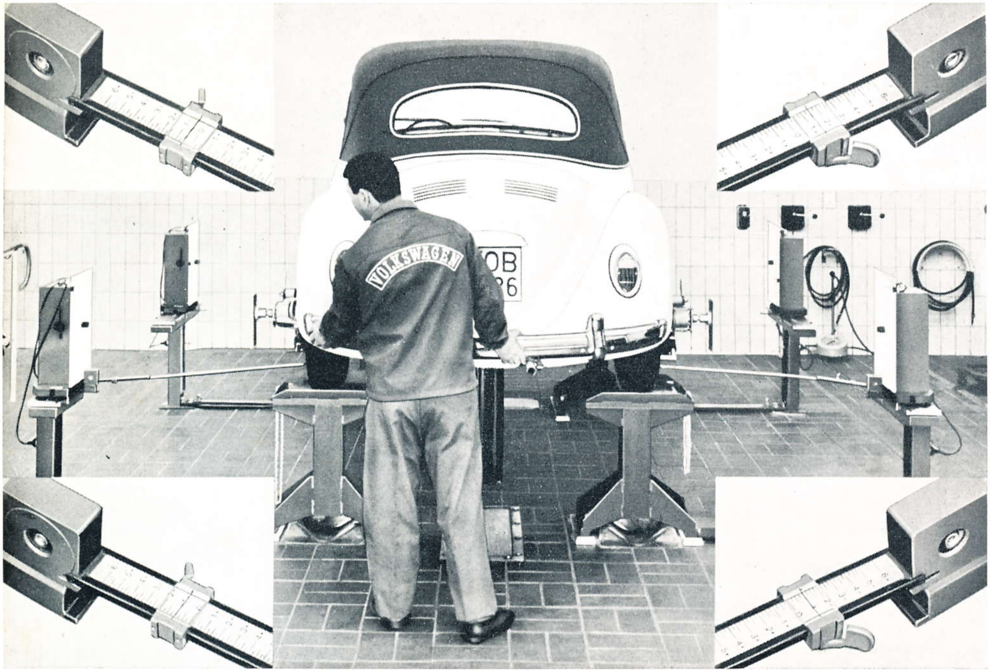
28/26 I now pull the steel rule out and stick the magnet on at lowest point of the wheel rim. The graduations on the rule are of no importance.



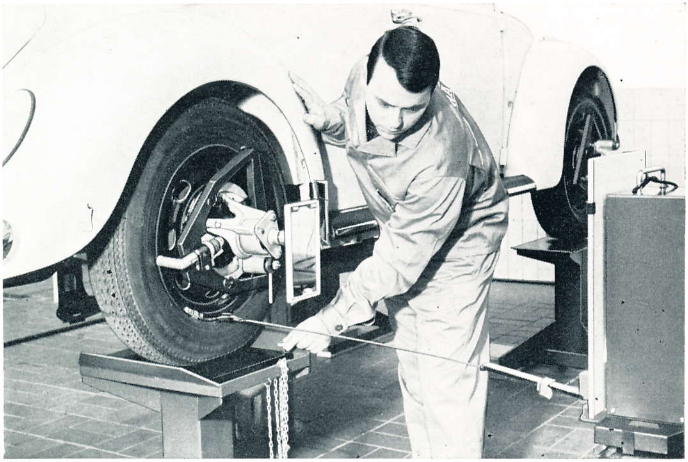
28/27 The red index line on the slide is placed at zero and the slide clamped in position. I now have a fixed dimension from the rim to the index line on the slide, but the slide can still be moved along the blue scale. You will soon see why this is so.

28/28 When I have repeated this procedure on the other front wheel, I move the two feelers to the rear wheels. The clamp on the slide must not be released when doing this.
As the rear wheels have a different track measurement the steel rule has to be moved and this also moves the slide which is clamped to the rule with the result that the index line is no longer at zero.



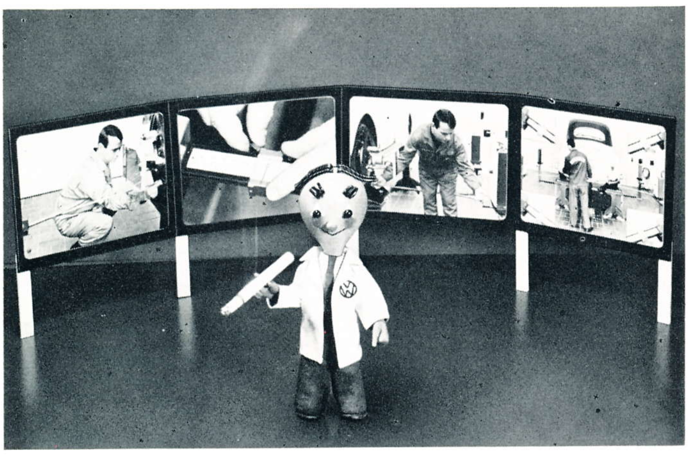


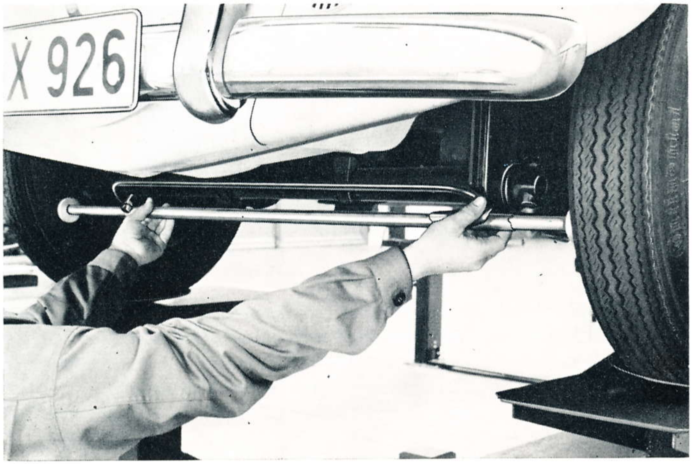
28/29 At the top of this picture are the readings obtained for the rear wheels and if you look closely you can see that the left side is —0.5 and the right side —1.5.
The vehicle must now be moved sideways until the figure and the sign is the same on both sides.
As the large minus figure is on the right-hand side I must move the vehicle to the left until the red index lines are on the figure —1 on each side as shown in the pictures at the bottom.
If the rear wheels were exactly as far apart as the front wheels the index lines would be at zero at the rear after centralizing just as at the front. Do you follow?



28/30 The vehicle is now exactly at right angles to the optical axes and must not be moved at all, so I tighten the two screws holding the roller plates in position taking care that the —1 setting does not alter.

28/31 That brings us to the end of the preparatory work and before we break off for a smoke let us just go over the procedure for aligning the vehicle again. The pictures in the background will help us:
With the aid of the feeler appliance Mr. Jones set the measurement to zero on the front wheels and then transferred it to the rear wheels. To equalise the index line difference on the scale, the vehicle was pushed to one side and the roller plates were then fixed in position.
Right, let us have a cigarette now and we will then go on with the second part.

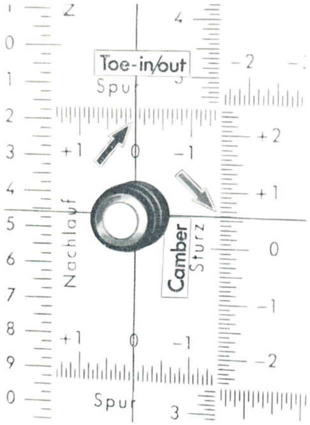


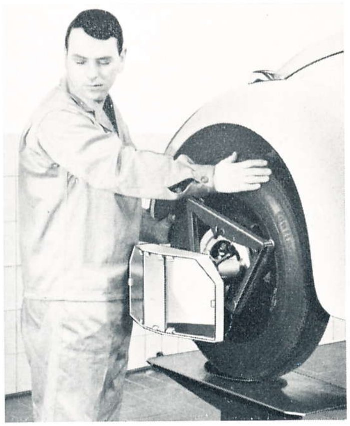


Part 2: Pictures 32—59

28/32 The first thing I do now is to place the wheel tensioner in position on the front wheels. I must check beforehand that the tension is set to 8—12 kg. which is the force specified for the passenger cars. On the Transporter models the setting is 12—18 kg.

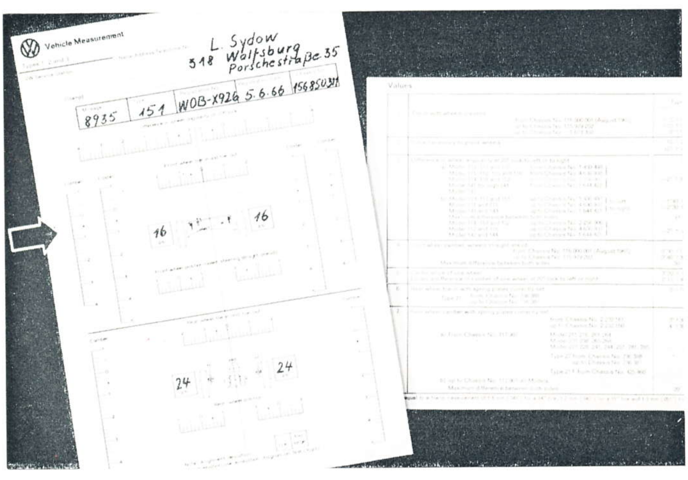
The tensioner is placed on the tires at the widest part of the walls and roughly level with the lower axle tube. The object of the tensioner is to take up all the play in the linkage and move the wheels to the position in which they are when the vehicle is running.

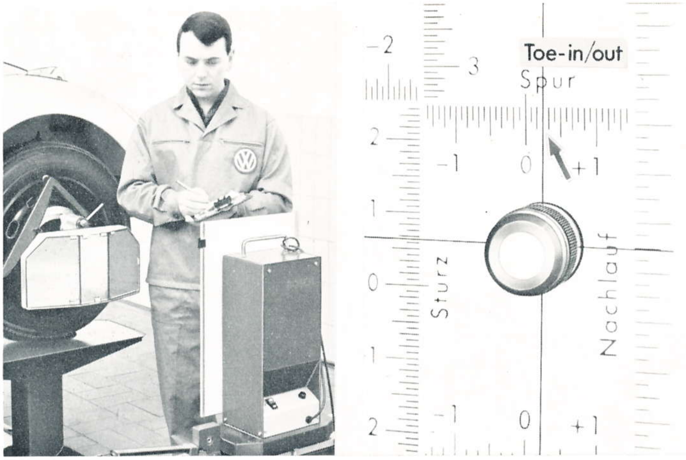




28/33 I set the left front wheel to zero on the track scale in the straight ahead position. In other words, the vertical hairline intersects the horizontal track scale at "0" as indicated by the dark arrow. I can now read off the camber angle on the vertical camber scale as shown by the light arrow. The angle is +35 minutes. Just to remind you: from mark to mark is 5′, the 10′ marks are slightly longer and the half and full degrees longer still. I then enter this camber angle of +35′ on the test card.

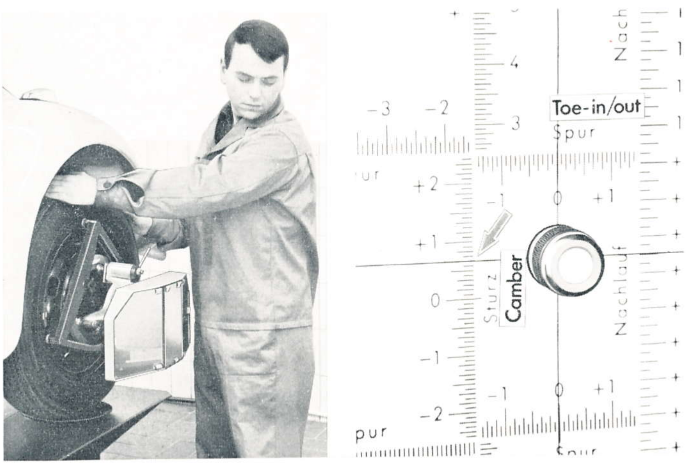
28/34 Here is a picture of a test card. A horizontal line divides it into two halves, the upper half for the front axle and the lower half for the rear axle. The card is also divided downwards by a green dotted line so that we have a quarter of the card for each wheel. Mr. Jones has entered the camber angle of +35 minutes for the left front wheel against the camber scale at the top left. On the back of the card are the correct settings for the various models.
We advise you to use the cards issued by the Volkswagen factory because they have suitable scales for all the necessary measurements as well as the specified settings for our vehicles.

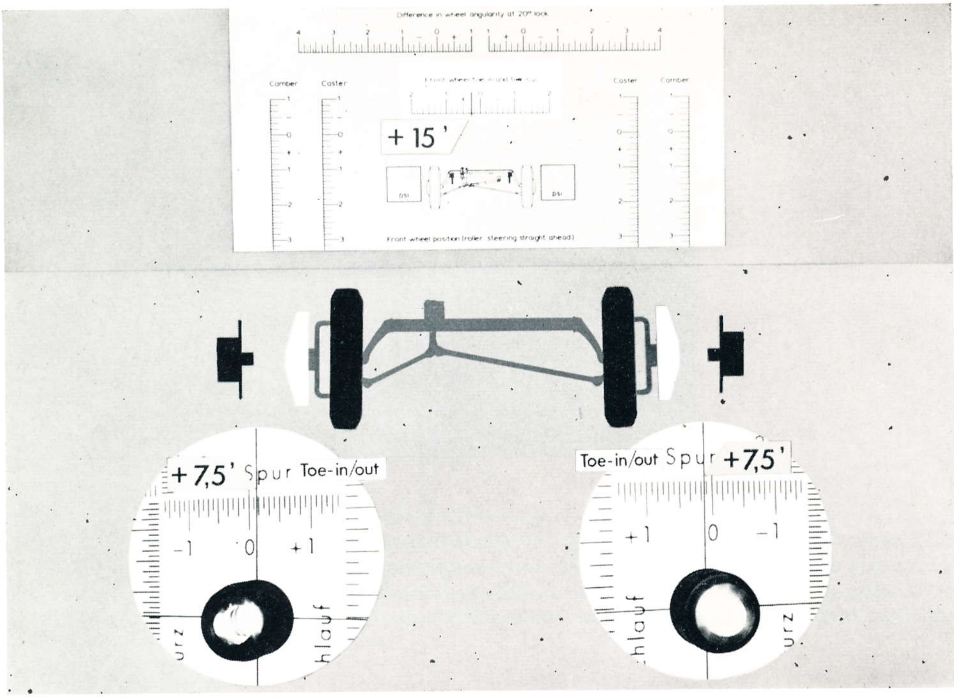




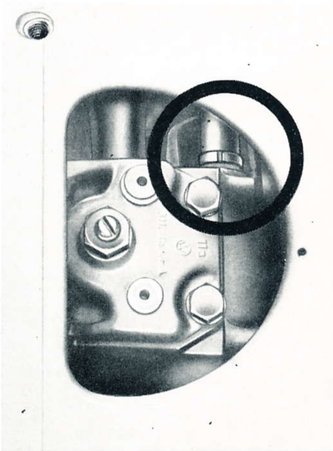
28/35 I had set the left front wheel to "0" track previously so I can now read off the total track angle or toe-in of the front wheels on the right-hand front wheel.
The reading of +15 minutes can be seen in the right-hand part of the picture and I also enter this in the test card. I shall explain how to use this figure in the next slide but one.

28/36 I now measure the camber of the right-hand front wheel by positioning the image at zero on the track scale and reading off the camber angle of +40 minutes. This is also entered on the card as with the other front wheel.



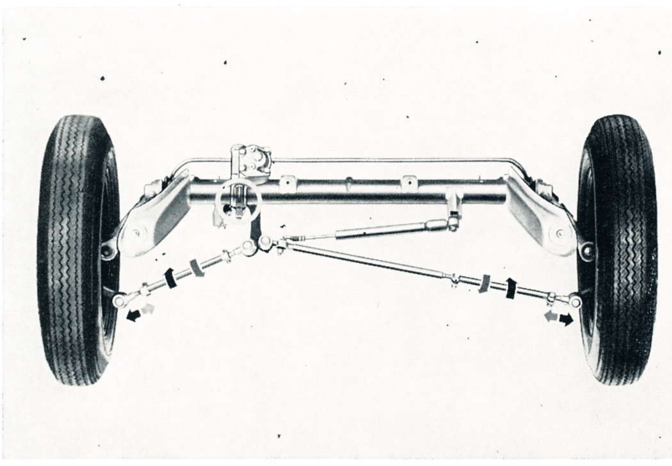


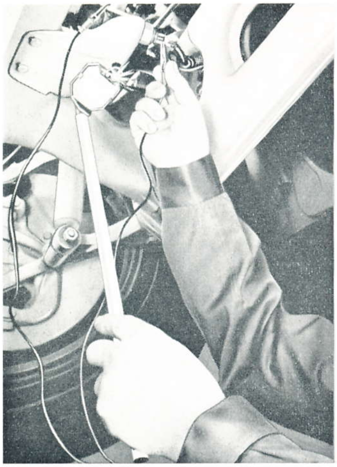
28/37 Back to the total track angle or toe-in as it is usually called. It was +15 minutes with the wheels pressed apart at the front and is shown as entered on the test card at the top of this picture. I now divide this figure into two parts by moving the wheels very slightly until the hairlines in both projectors indicate +7.5′ on the track scales as shown in the two circles at the bottom of the picture. The wheels are now in the straight ahead position and the steering gear should be the central position and this is what I am going to check next.

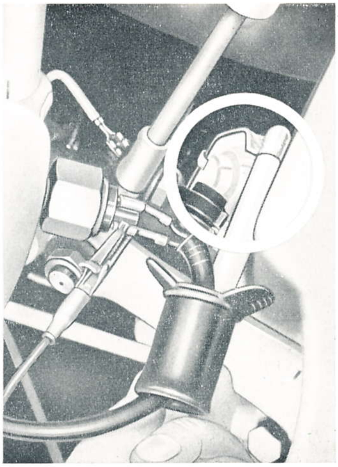


28/38 You will remember that when preparing the vehicle I put the spare wheel in the luggage compartment and removed the cover over the hole giving access to the steering gear. If I had to do this now I should probably upset the alignment of the vehicle and this would make further measurements useless. I proceed very carefully now when checking the central position of the steering with a torch. If it is correct, the groove in the marking ring or the etched mark on the worm spindle should be in line with the rib in the housing. The spokes in the steering wheel should also be horizontal.

28/39 If the steering gear is not centralised, the mark on the steering worm spindle must be brought into alignment. This is done by watching the image and turning the tie-rods in opposite directions to ensure that the toe-in on both wheels remains the same and the total toe-in is within the specified tolerance.
When the steering is only slightly out of line from the central position, it is usually sufficient to adjust one tie-rod only.
As you probably remember: Turning the tie-rod in direction of motion — dark arrows — increases the toe-in. Turning in the opposite direction — light arrows — reduces the toe-in.

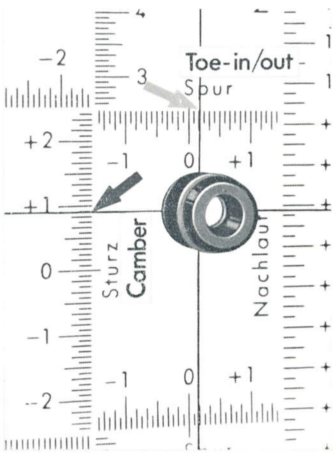


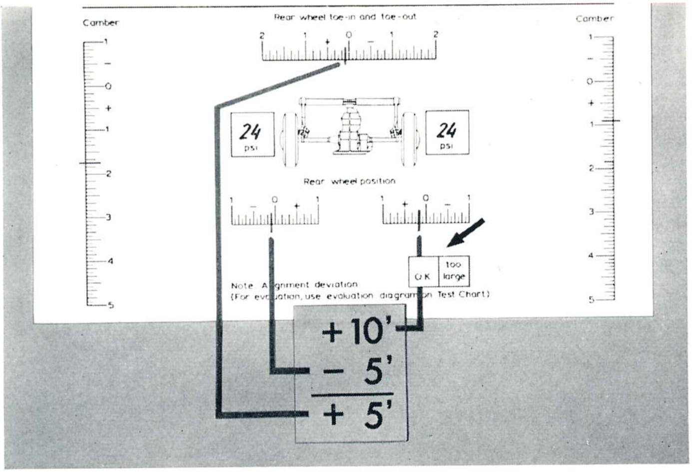




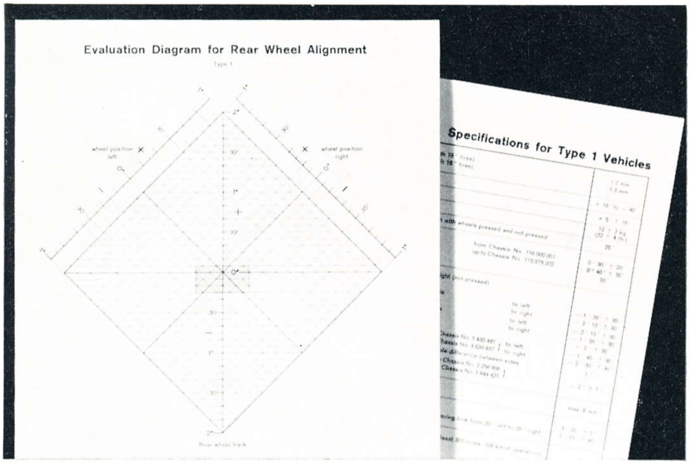
28/40 Here you can see how the central position of the steering is checked on Type 3 vehicles. On the left of the picture is the illuminated mirror Type W 144 which is made for us by Messrs. Matra. The cables for the lamp have crocodile clips so that they can be attached to ground and the live terminal of the brake light switch on the master cylinder. The ignition must be switched on. The mirror is then located above the steering box so that you can check the position of the steering. The steering is then altered as on Type 1 vehicles.

28/41 I now carry on with the measurement of the right-hand rear wheel. I read off the camber angle, + 55 minutes as indicated by the dark arrow and the toe-in, + 10 minutes as shown by the light arrow, and enter both figures on the test card. Then I do the same on the left rear wheel.



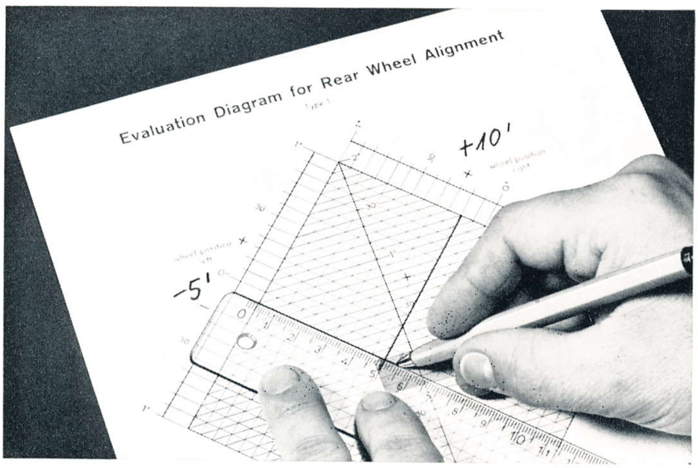


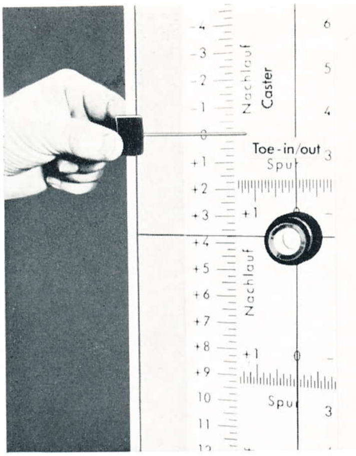
28/42 Here is the lower part of a card for a Type 1 showing the values for the rear axle. I have entered the camber angles in the two outer vertical scales and the track angle or toe in/toe out in the two horizontal scales. In this case, the wheel angle is +10 minutes for the right wheel and —5 minutes for the left wheel.
From these two figures I work out the total track angle. Figures with the same sign, that is plus or minus, are simply added together. When the signs are different, the small figure is subtracted from the large figure.
In our example, the —5 minutes are taken away from the +10 minutes and we then have a total track angle of +5 minutes, which I enter in the scale at the top. This figure tells me that the track angle is within the tolerance laid down but does not say anything about the position of the rear axle in relation to the longitudinal vehicle axis.
The next picture shows how this is done. According to results, a cross is made in one of the two squares to which the arrow is pointing.



28/43 The position of the rear axle is checked with the aid of the evaluation diagram on the back of the test cards for the various VW models.
Here you see a square standing on one corner. The square is divided into small squares with green lines and the two top sides have a scale which is marked from —1° to +1° in 5 minute divisions. The track angle for both rear wheels must be located on these scales and the green lines followed from these points towards the center of the square. Approximately in the center of the square is a small red oblong area. The point where the extended lines meet must be inside this small oblong. But don't let this diagram put you off, it is quite easy to use as I shall show you in the next picture.

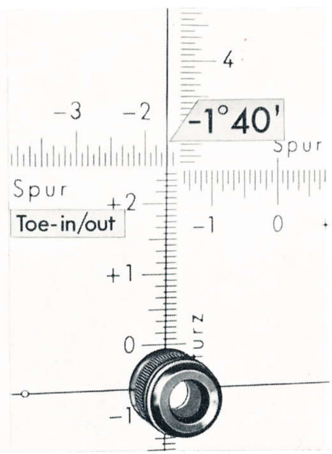
28/44 First of all I must find the track or wheel alignment angles on the two scales. The angles have been written on the card here to make it clearer. They are —5 minutes for the left wheel and +10 minutes for the right wheel. From these points I draw lines in towards the red oblong. As you see, the intersection point is just inside the red area. This means that the axle alignment and the total track angle of our rear axle are O.K.

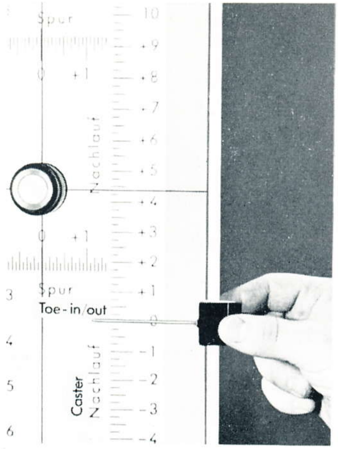


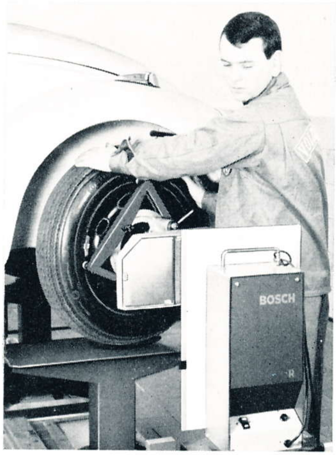


28/45 I now continue with the front axle check and find the difference in wheel lock angle and caster. Camber and track angle or toe-in were done earlier on. I start with the left front wheel and turn it to a 20° left lock so I can read off the difference in wheel lock angle on the right hand mirror, the 20° lock angle is obtained from the 20° angle of the side mirrors and when the track scale indicates zero after the wheel has been turned as shown in left picture. At the same time I set the caster indicator to zero so that later when the wheels are on the opposite lock I can read off the caster angle.

28/46 As I just said, I now read off the difference in wheel angle on the right hand front wheel and enter it against the appropriate scale on the card. This figure can be seen from the position of the vertical line on the track scale and is in this case —1° 40′. This is the difference in lock angle between the wheel on the outside of the curve and the wheel on the inside.
Just a word about reading the scale in this example. The track scale here is intersected on the minus side by the vertical camber scale and continues slightly offset. It is therefore easier to read backwards from the —2° mark. The four divisions to the right equal 20 minutes and this must be subtracted from —2° to give us —1° 40′.
When measuring the difference in wheel lock angle we must always remember that the wheel on the inside of the curve is locked over to 20° and the angular difference measured on the wheel on the outside of the curve.

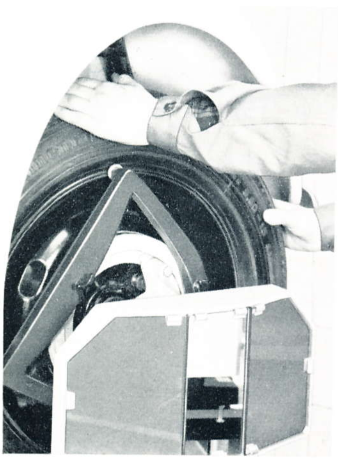
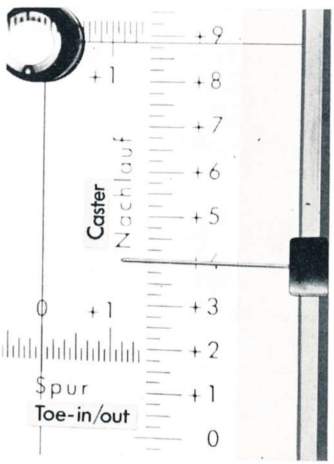


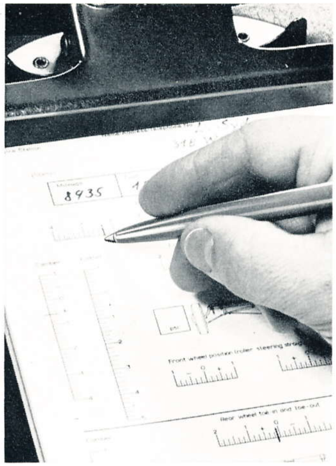




28/47 I now alter the lock of the right hand wheel to 20° and set the caster pointer to zero.

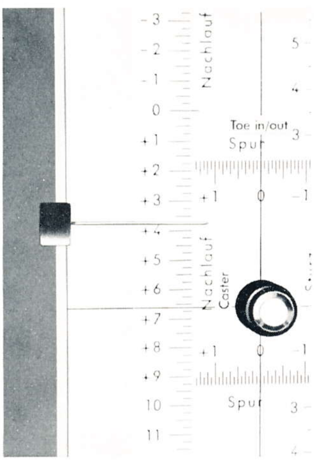
28/48 Having done this, I swing the wheel to a 20° right lock, read off the caster angle of +4° and enter this on the card. One advantage with this alignment measuring equipment is that I do not have to work out the caster angle; I can read it off directly after moving the wheels from one 20° lock to the other.

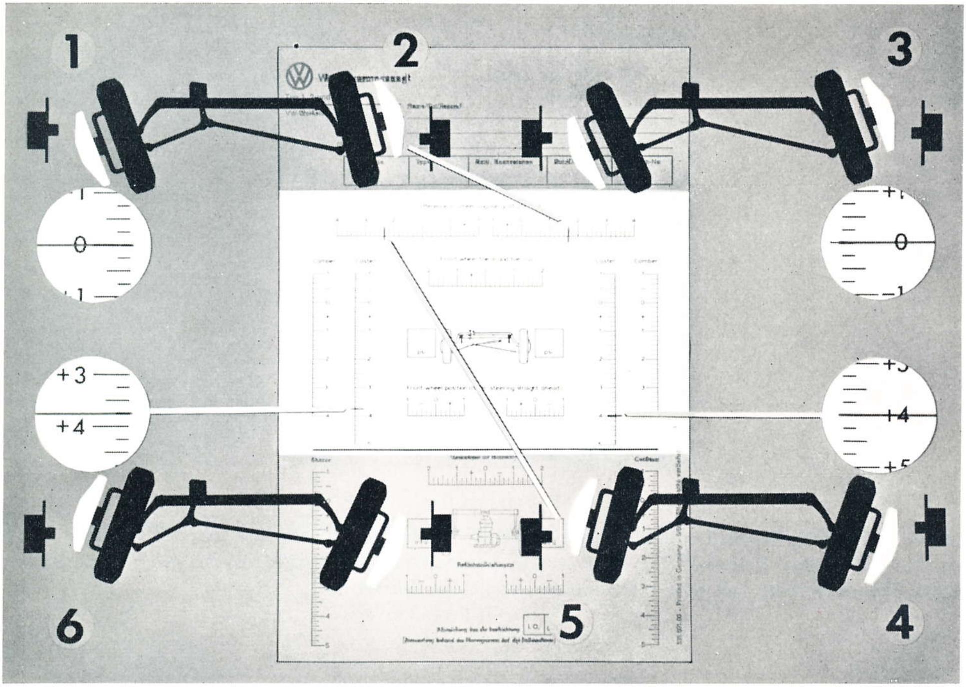





28/49 As the right-hand wheel is on a 20° lock I can read off the difference in wheel angle on the left wheel. It is —2° 20′ here and is entered into the scale for the left wheel on the card. The only thing left now is the caster angle for this wheel.

28/50 To measure the caster angle, I alter the lock on this wheel to 20° and read off the caster angle of +3° 45 minutes. This is obtained after setting the caster pointer to zero with the wheel on a 20° left lock. You will remember that this was the first setting I made after measuring the rear axle alignment.
That brings us to end of the vehicle alignment check.

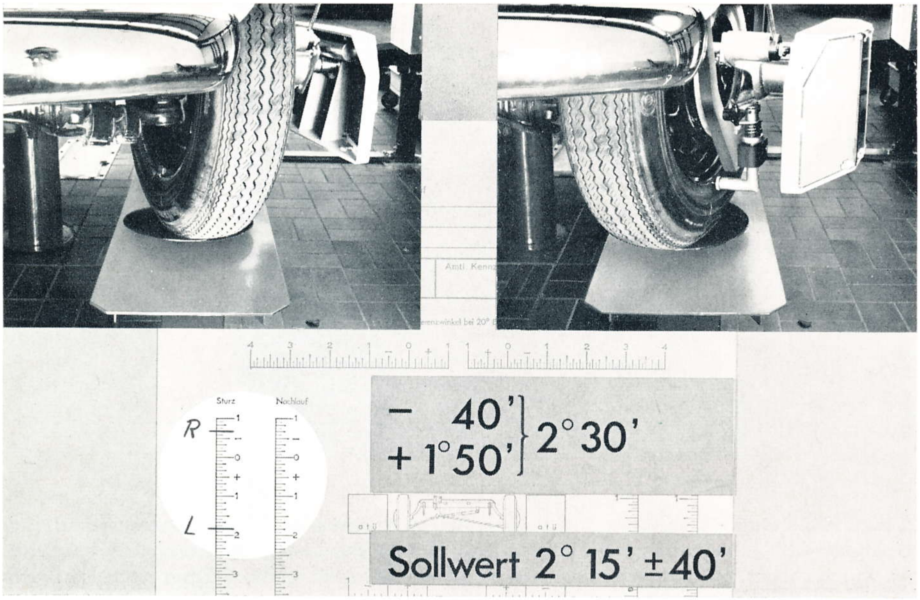




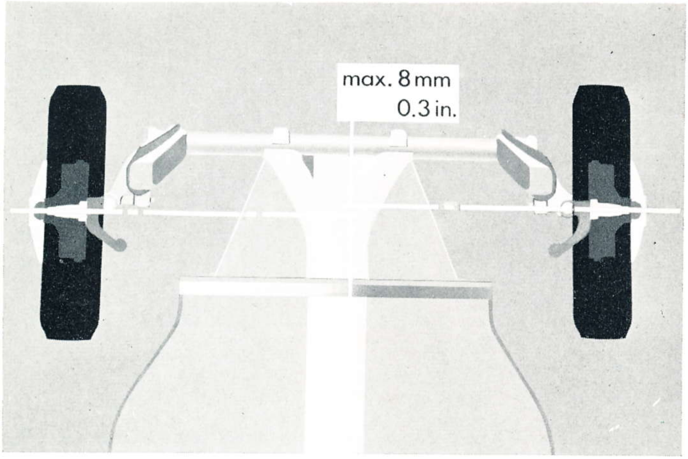
28/51 We shall now go over the last part of what Harry Jones showed us again just to refresh your memories.

He started on left front wheel shown at the top left of this picture.

1. Set wheel to 20° left lock and caster pointer to zero.
2. Then read off the difference in wheel lock angle on right-hand wheel and enter it on the card.
3. Alter lock of right wheel to 20° and set caster pointer to zero.
4. Move right wheel to 20° right lock, read off caster angle and enter it on card.
5. Back to left wheel. Read off difference in lock angle and enter it on card.
6. Alter lock of left wheel to 20°, read caster angle and enter it on card.



28/52 To go back to the subject of measuring caster. How do you check the caster when you cannot read it off directly as we could with this test stand?
It can be worked out from the camber angles at a 20° lock to left and right on each front wheel. In our example it was —40′ for the left wheel on a right lock and +1° 50′ on a left lock. The angle between these values is 2° 30′ and all you have to do now is to compare this figure with the specified figure.

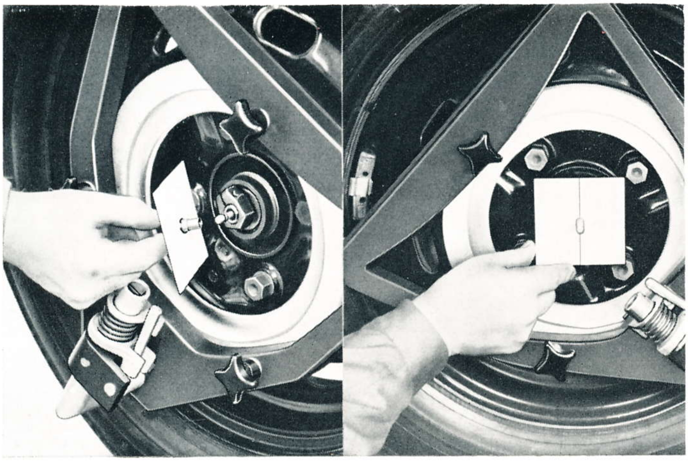


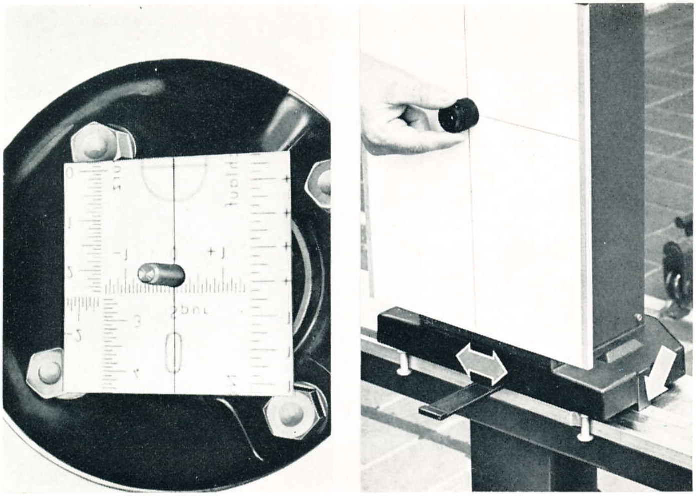
28/53 Finally we should like to show you how the stub axle offset is measured in addition to the normal vehicle alignment check. The picture shows the object of this measurement. Mr. Jones checks whether the stub axle offset is within the limit of 8 mm which is the figure laid down for all VW vehicles. This check only brings usable results if, as in our case, a complete alignment check has been carried out beforehand and the front axle toe-in and camber angles are in order.
A further important condition is that the alignment of the vehicle in the stand must be checked again to ensure that it is still exact. The repeated changes of front wheel lock could have moved the vehicle slightly at the front and this would upset the measurement of the stub axle offset.

28/54 I have therefore checked the alignment of the vehicle and divided the toe-in of the front wheels so that it is the same on each wheel.

28/55 I then take the mirrors off very carefully to avoid altering the position of the wheels. Before removing the mirrors I have a quick glance at the track scale to see that the toe-in is still O.K.
Please note that the brackets are not taken off.

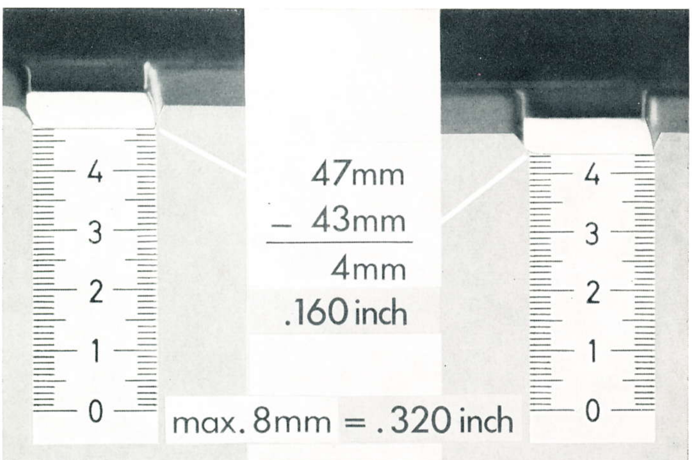
28/56 The two small plates which we mentioned when describing the projectors are now mounted on the stub axles. The plate for the left wheel, as shown in the left picture, has a hollow spindle which fits into the stub axle over the end of the speedo cable. The plate for the right-hand wheel has a magnet which holds it on the stub axle.
I then turn the plates so that the red lines are vertical.





28/57 I now aim the projector at the plate so that the projected zero line is aligned with the vertical red line as shown in left picture. The scale image is backwards because the reversing effect of the mirror is missing. For this same reason I must also turn the front ring on the projector lens to make the projected picture reasonably clear.
The arrow on the right-hand side of the picture on the right points to a millimeter scale on which I now read off a figure. I then repeat the process on the other side.

28/58 Here are the two scales with the indicated figures. On the left we have 47 mm and on the right 43 mm. The difference between these values gives us a stub axle offset of 4 mm. This is well within the limit of 8 mm, so I make a cross in the O.K. square on the card.



28/59 The alignment check is now finished and Harry Jones, our mechanic, takes the mirrors off the rear wheels and removes all the brackets. He then replaces the hub caps, not forgetting to secure the speedo cable with a new cotter pin, fits the wheel caps and hands vehicle and test card back to the service adviser.
The service adviser looks at the card and tells the customer, when he comes to collect his car, that the steering and wheel alignment are in order.

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