Front Axle and Steering

Dismounting and Reinstalling Steering Assembly

The following special tools are used:

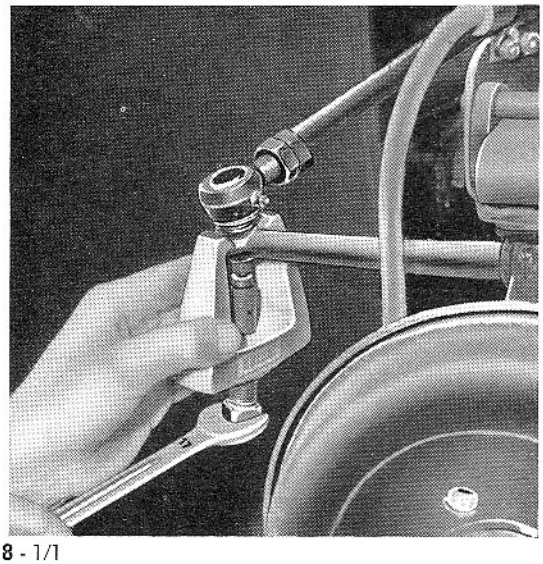
WO 9 – Extractor for steering arm and tie rod bolts.

Dismounting

1. Unscrew wheel bolts; jack up car at front and take off front wheels.

2. Remove cotter pin from castellated nuts SW 17 (fastening of tie rods on the wheel side at steering arm) and unscrew.

3. Pull off tie rods R. H. and L. H. with special tool WO 9 (Fig. 8 - 1/1).

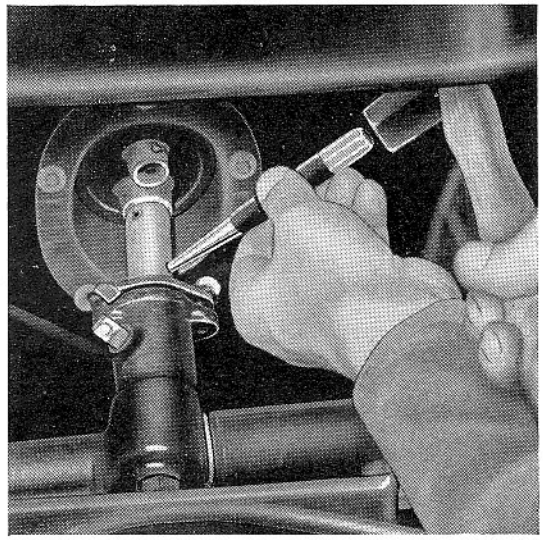


8 - 1/1

Do of twist tie rod ends in order to maintain the proper installation length when reinstalling the steering assembly later on, provided neither repairs no changes have taken place.

4. Disconnect return spring from control shaft rod. Loosen clamping clip screw SW 10 and pull control shaft rod into the car. In cars with three-speed synchromesh transmission it is necessary to loosen also the second clamping clip (hex nut SW 10) underneath instrument panel.
(See also dismantling steering tube jacket Fig. 9-3/4).

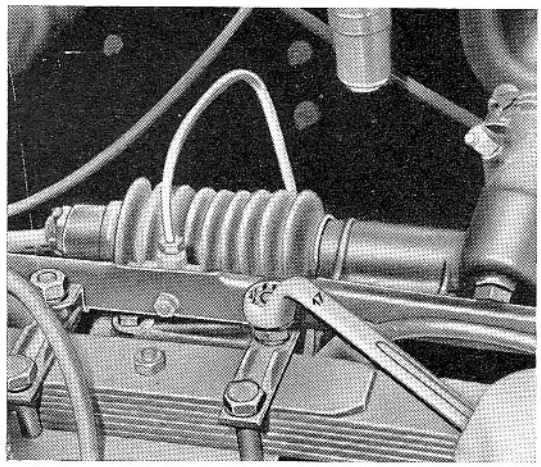
5. Drive tension pins 6 x 24 out of steering tube with a drift (Fig. 8 - 1/2).



8 - 1/2

6. Pull steering tube upward until the pinion on the steering box is free.

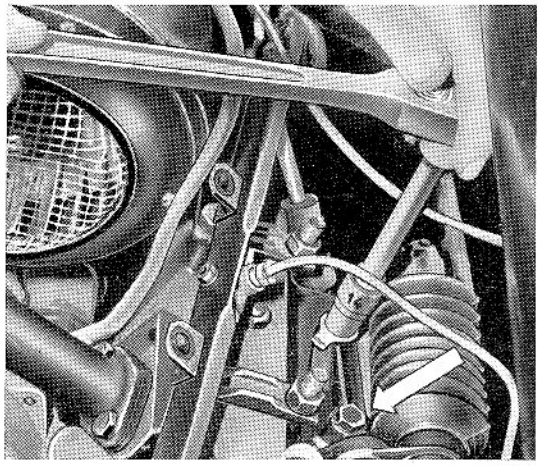
7. Unscrew both hex nuts SW 17 on the front brake hose holder (Fig. 8 - 1/3).



8 - 1/3

8. Lift brake tube holder with connected brake hoses and brake line and push it to the front end. Do not take off brake line, otherwise the entire brake system requires to be bled when reinstalling later on.

9. Unlock, loosen and take out both hex head bolts SW 14 at bracket for steering (Fig. 8 - 2/1).



8 - 2/1

10. Take out to the left steering assembly with assembled tie rods (in direction to the wheel case).

Reinstalling

1. Check tie rods for proper length if new tie rods have been installed or tie rod ends have been twisted. In this case it is recommendable to set the tie rods to the following basic measures: (See also Fig. 8 - 6/1). Basic measures: Centre to centre tie rod end:

LP/LC 600 to Chassis-No. 6/293 408
Short tie rod = 312 mm
Long tie rod = 412 mm

LP/LC 600 from Chassis-No. 6/293 409
Short tie rod = 320 mm
Long tie rod = 420 mm

LT/LTK 600
Short tie rod = 390 mm
Long tie rod = 490 mm

2. Fasten steering gear with assembled tie rods (short tie rod on the right, long tie rod on the left) and bracket for steering with 2 hex head bolts M 8 x 35. (Interpose new locking plates). Do not yet tighten bolts firmly.

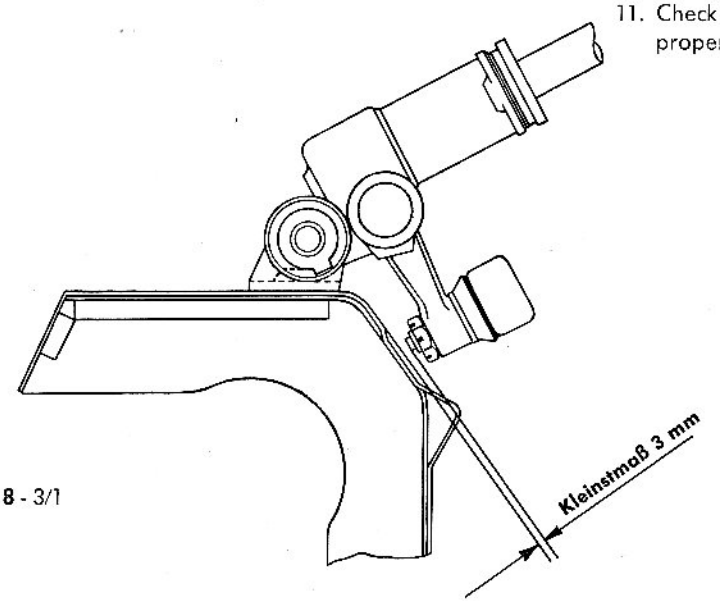
3. Push steering tube onto the pinion shaft and secure with 2 tension pins 6 x 24.

4. Reconnect control shaft rod; adjust steering linkage and gear shift lever.
For more details see under G. Sub-Group 7 "Steering Linkage".

5. Connect tie rods on the wheel side to steering arm; secure each tie rod with one castellated nut and lock with cotter pin.
Torque: Md = 4.5 m/kg.

6. Firmly tighten hex head bolts at steering bracket; bend lock plates at the edges.

7. Check for free working of tie rod ends at front axle carrier. Be sure the distance between front axle carrier and threaded piece of ball joint must not be smaller than 3 mm. If necessary, shorten a little ball joint thread (Fig. 8 - 3/1).



8 - 3/1

8. Install brake hose holder with assembled brake tube and assembled brake line in proper position and secure with 2 hex nuts M 10. Interpose spring rings.

9. Check all bolts andnuts of steering gear to see whether safety devices are installed. (Cotter pins!)

10. Mount front wheels and put car on ground again.

11. Check for proper track. If necessary readjust to proper measure.

Disassembly, Assembly and Adjustment of Steering Gear

(Steering gear removed from car)

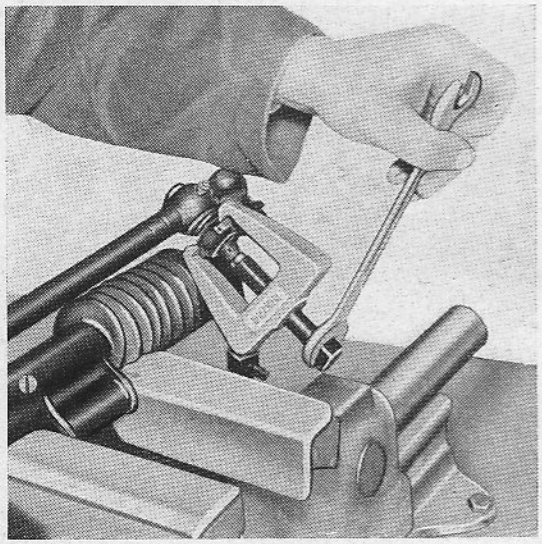
The following special tools are required:

WO 9 – Extractor for steering arm and tie rod bolts.

Disassembly

1. Take out cotter pin from castellated nut (tie rod fastening on steering arm) and unscrew with an open jaw wrench SW 17.

2. Pull off both tie rods with special tool WO 9. (Fig. 8 - 4/1).



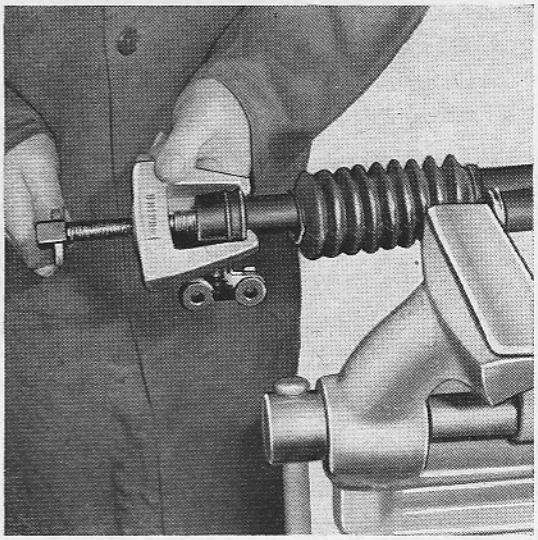
8 - 4/1

3. Bend at the edges upward lock plates on flange. Loosen and take out hex head bolt SW 10.

4. Take out eccentric bearing bush with pinion and spacer.

5. Loosen wire locks on rubber collar and rubber bushing. Unscrew nut SW 24 (fastening of steering arm).

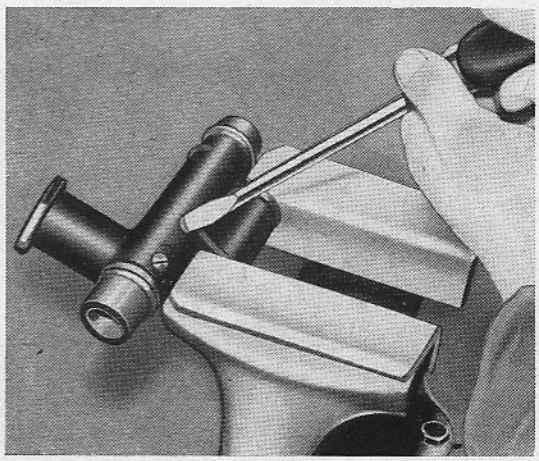
6. Pull off steering arm with special tool WO 9. (Fig. 8 - 4/2).



8 - 4/2

7. Remove rubber collar, rubber bushing (left-hand) and take washer from rack; take rack out of steering box.

8. Loosen both countersunk screws M 6 x 10 and remove with guide tongue (rack guide) (Fig. 8 - 4/3).



8 - 4/3

9. Clean and check all components of steering gear; renew defective parts. Remove sharp burr (especially from tooth flanks and guide tongue).

Assembly and Readjustment

1. Insert guide tongue; slightly oil countersunk screws M 6 x 10 on rack and push it in the box. In doing so, check for free travel. If necessary, install new guide tongue.

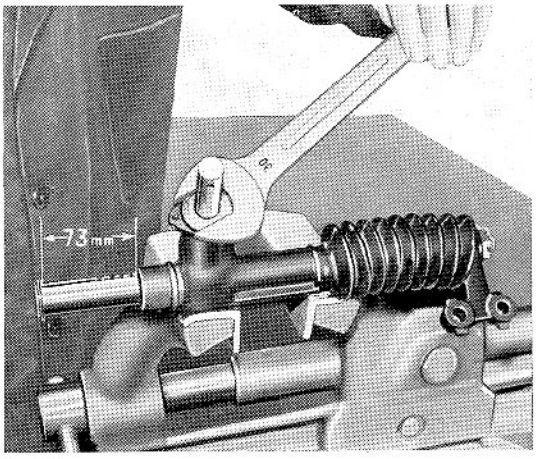
2. Install lock washer A 24 x 1.2 left side and folded bellow right side.

3. Insert Woodruff key 5 x 6.5. Install steering arm and tighten firmly on castellated nut SW 24. (Torque = 6-8 m/kg). Install cotter pin in castellated nuts.

4. Install eccentric bearing bush with inserted pinion and interposed spacer.

   Attention! Do not forget to install spacer (Spring washer), otherwise heavy wear of bearing bush and quick increase of axial play would result.

5. Place rack for adjusting radial clearance between pinion and rack in center position.
   Distance between lock washer and steering box = 73 mm (Fig. 8 - 5/1).



8 - 5/1

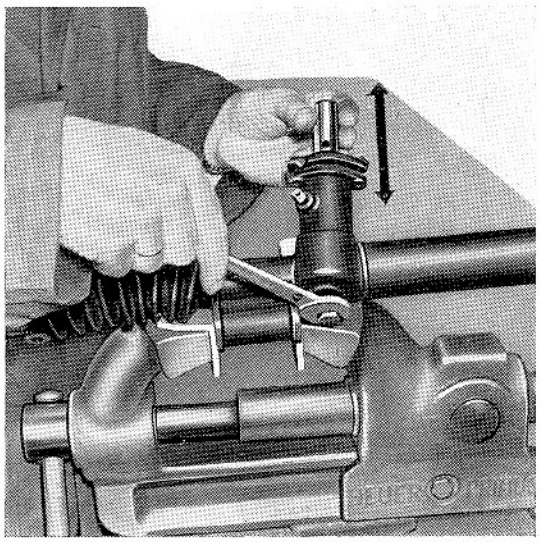
   The racks are to be finished in such a manner that tooth flank clearance in the center position is smaller than in the extreme position.

6. Adjust steering gear until any play is removed by turning the eccentric bearing bush (SW 30), simultaneously turning the pinion either to the right or to the left (Fig. 8 - 5/1).

   Attention! Readjust steering always in time. Avoid wear to tooth flanks, otherwise no play-free adjustment in center position (which is mostly used when driving) can be accomplished without risk of the rack being jammed in the extreme position!

7. Secure flange with 2 hex head bolts M 6 x 18. (Interpose new locking plates). Tighten up nuts firmly and secure in position.

8. Loosen counter nuts SW 17. Move steering pinion in the direction of arrow and turn set screw SW 17 to the right until any axial play is removed. Hold fast set screw and tighten counter nut securely (Fig. 8 - 5/2).



8 - 5/2

9. Install rubber collar and rubber sleeve and fasten with binding wire (aluminium 2 mm dia.). In doing so, be sure that the vent holes in the rubber collar and sleeve point upward with steering gear installed so as to avoid oil leakage. Principally, oil steering gear with transmission oil SAE 140. For lubricating use only a hand press and no high-pressure lubrication guns.

10. Connect short tie rod R. H., long tie rod L. H. to steering arm. Interpose resp. install thrust washer, spring retainer and conical spring.
Put castellated nut M 10 (SW 17) in place and tighten with torque wrench and secure with cotter pin.
Torque = 4.5 m/kg.

11. After installing new tie rods or renewing or readjusting tie rod ends it is advisable to adjust the distance between tie rod ends for the following basic measures to facilitate toe-in adjustment.

Basic Measures:

LP/LC 600 up to Chassis-No. 6/293 408

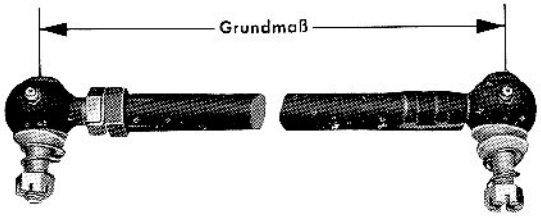
Short tie rod = 312 mm
Long tie rod = 412 mm

LP/LC 600 from Chassis-No. 6/293 409

Short tie rod = 320 mm
Long tie rod = 420 mm

LT/LTK 600

Short tie rod = 390 mm
Long tie rod = 490 mm
(Fig. 8 - 6/1)



8 - 6/1

12. Tighten counter nut on tie rod ends and bend lock plates at the edges.

Adjustment of steering gear in the car

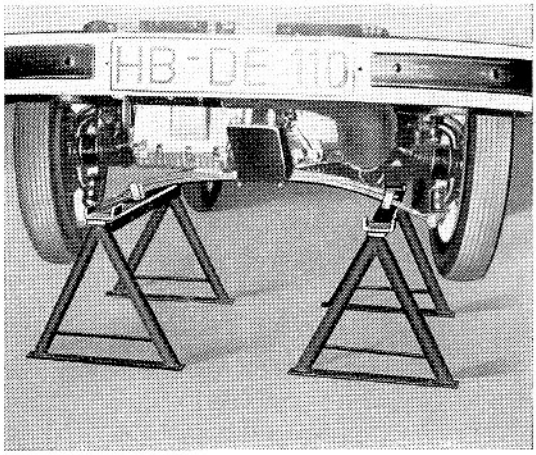
The following special and shop tools are to be used:

WO 9 – Extractor for steering arm and tie rod bolts.

A flat short sheet-metal wrench SW 30 for self-manufacturing as shown in Fig. 8 - 7/2.

Adjustment

1. Before checking steering gear, jack up car at front end (Fig. 8 - 7/1).



8 - 7/1

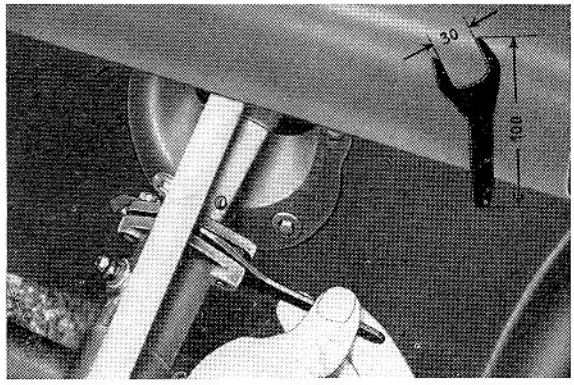
2. Unhook tie rod heads on the right and on the left on both steering arms.

3. Check whether heavy motion is due to the steering knuckle and turn front wheels to both sides. If these wheels have a correct play, proceed as follows:

4. Check for free motion and backlash of steering gear by turning steering wheel. If irregularities over normal conditions are stated, readjust steering gear as follows:

5. Loosen flange on steering box. Release set screw below steering wheel by loosening counter nut.

6. Rotate bearing bush for rack steering gear until steering wheel with the car jacked up can be turned to the right or to the left without any backlash (Fig. 8 - 7/2).



8 - 7/2

7. Tighten up flange and lock bolts (open jaw wrench SW 10).

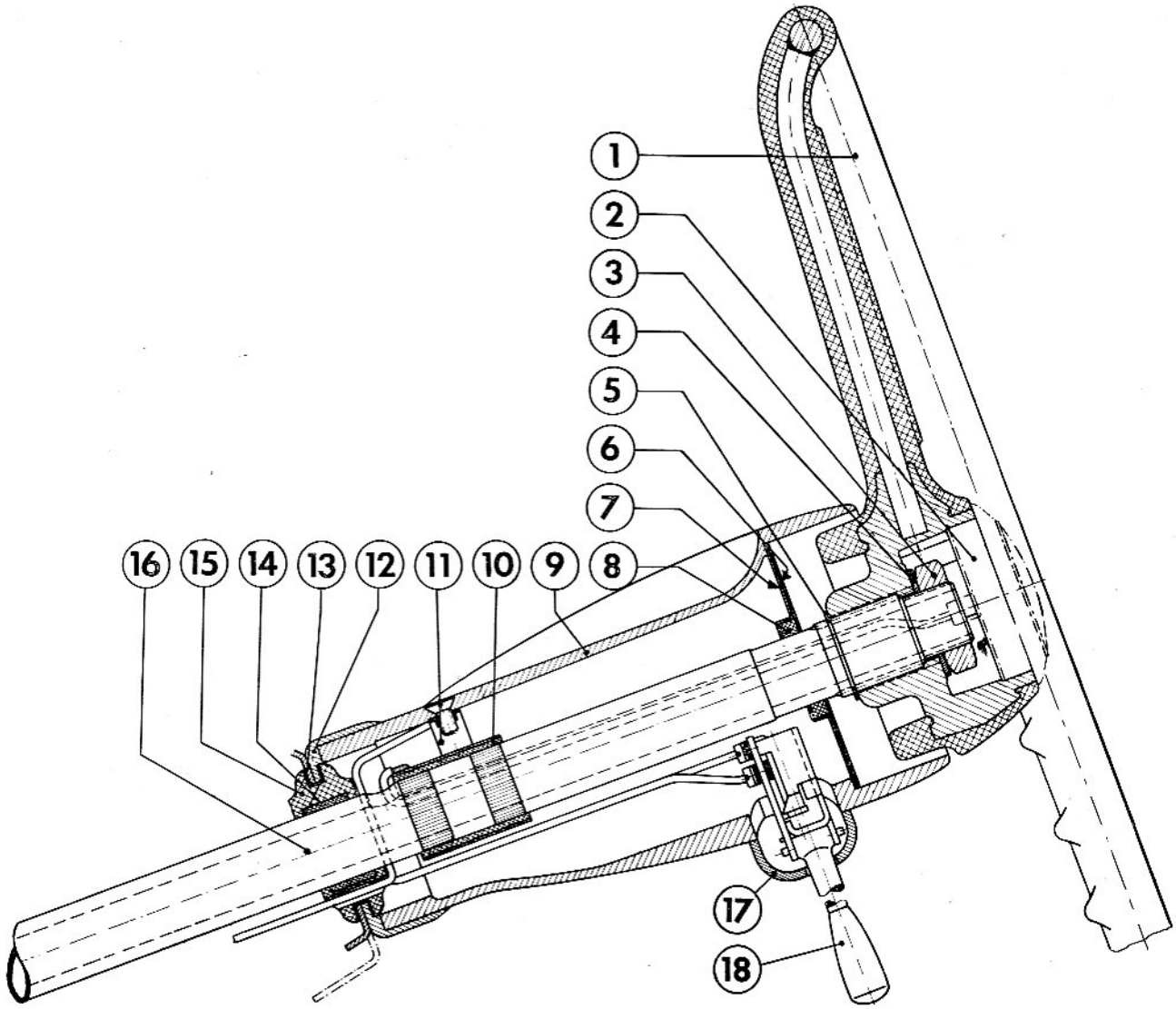
8. Check tooth play and steering system by turning steering wheel.

9. Readjust set screw below steering wheel until there is no longitudinal play – axial play available any more (2 x wrench SW 14). (See also Fig. 8 - 5/2).

10. Secure set screw by tightening up counter nut.

11. Connect tie rods. Fasten each rod with a castellated nut and lock with cotter pin.
Torque = 4.5 m/kg.

Attention! Racks are finished in such a manner that tooth flank play in center position is closer than in both extreme positions. Readjust in time steering so as to avoid tooth flanks being worn down! In case of neglecting these hints, it may occur that steering gear in the mostly used mid-position fails to be adjusted without any play because steering system tends to jamming in the extreme positions.
Do not rotate bearing bush for rack steering gear by means of drift and hammer, but work only with a short flat-type sheet-metal wrench.



SECTIONAL VIEW

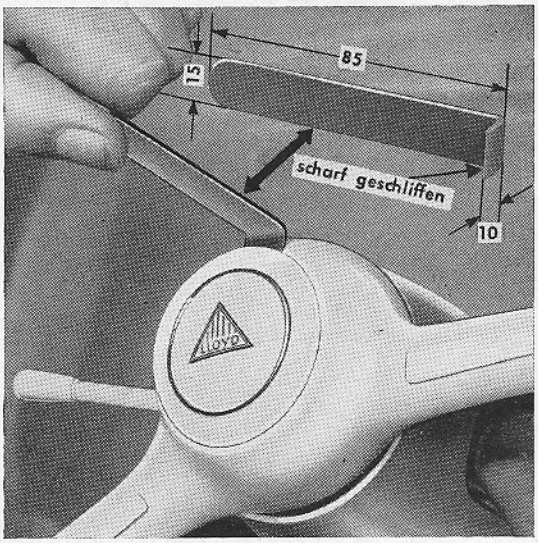
1 – Steering wheel
2 – Horn knob
3 – Hex nut SW 30
4 – Wave washer
5 – Seeger retaining ring
6 – Holding plate
7 – Supporting ring
8 – Felt ring
9 – Steering column jacket
10 – Sliding ring
11 – Contact spring
12 – Rubber, holding bush for steering column jacket
13 – Reinforcing eyeplate
14 – Felt strip for steering column
15 – Rubber ring for steering column
16 – Steering column
17 – Blinker switch head
18 – Blinker switch

Steering wheel, steering tube and steering tube jacket

Dismantling and installing steering wheel

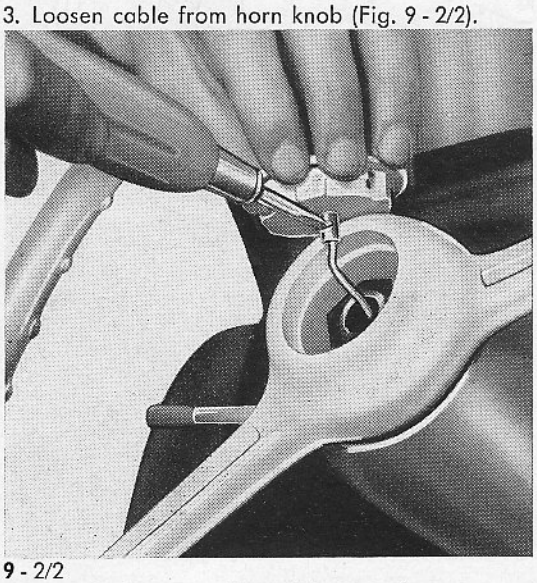
Dismantling

1. Loosen positive cable from storage battery.
2. Lift with care horn knob round about with a tool (see Fig.) and take out (Fig. 9 - 2/1).



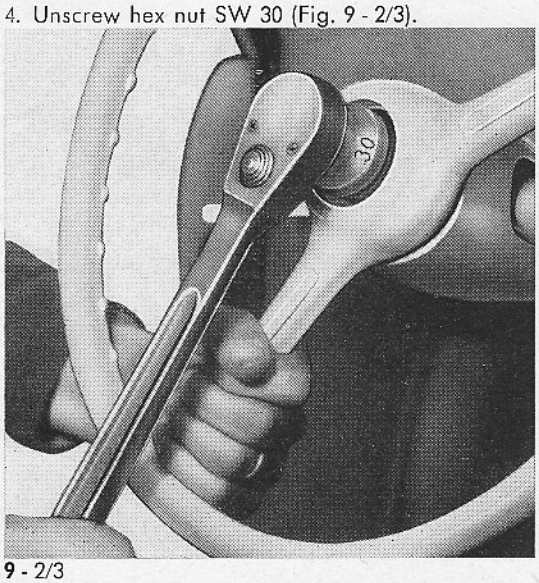
9 - 2/1

3. Loosen cable from horn knob (Fig. 9 - 2/2).



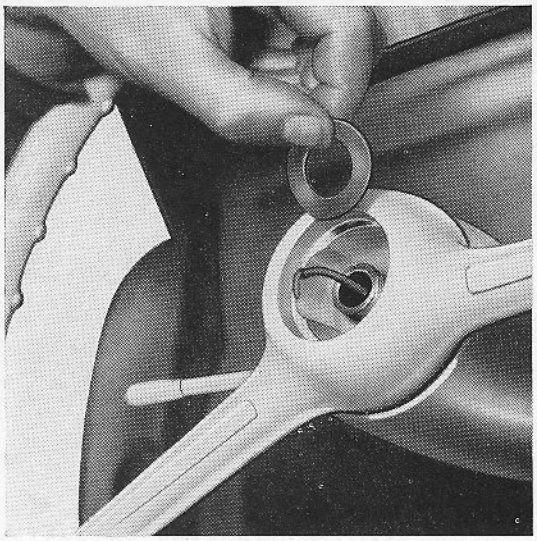
9 - 2/2

4. Unscrew hex nut SW 30 (Fig. 9 - 2/3).



9 - 2/3

5. Take out spring washer and remove steering wheel from splined steering tube (Fig. 9 - 2/4).

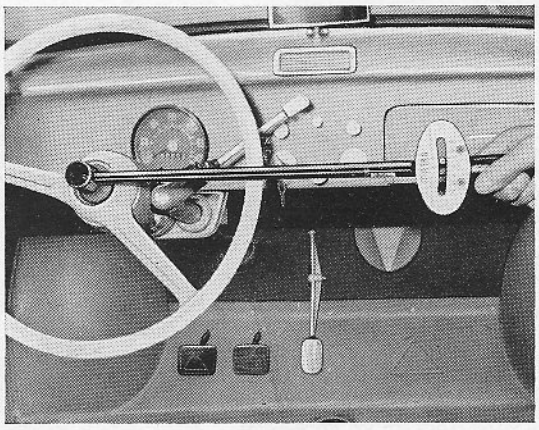


9 - 2/4

Installing

1. Put front wheels in straight ahead direction and push steering wheel over the splined steering column in such a manner that both spokes show downward at the same angle (referred to the horizontal).

2. Insert spring washer. Install hex nut SW 30 and tighten with a torque wrench. Torque = 4.5 m/kg (Fig. 9 - 2/5).



9 - 2/5

Attention! Do not exceed torque, otherwise risk of safety ring being forced out of the groove.

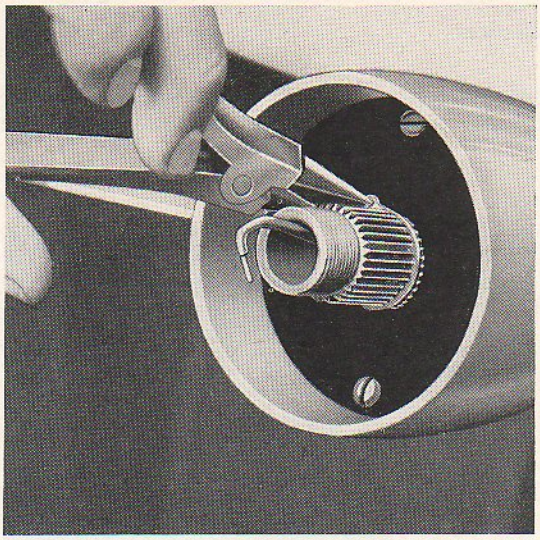
3. Connect cable and insert horn knob. Be sure Lloyd sign lies horizontally with steering wheel in straight ahead position.

Dismantling and reinstalling steering tube and steering tube jacket

(Steering wheel removed from car)

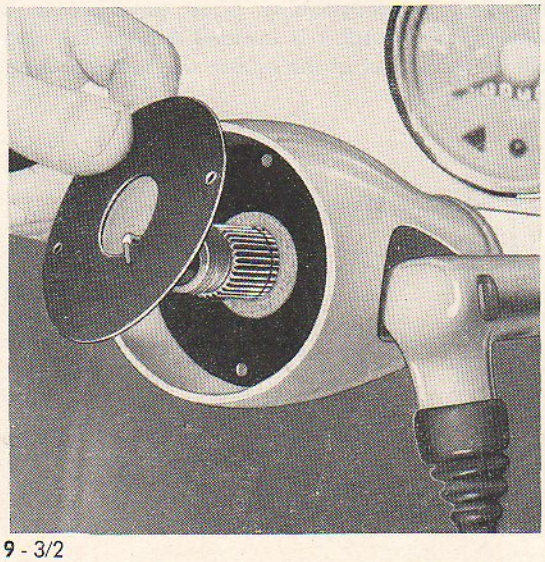
Dismantling

1. Remove lock washer from steering tube with pointed pliers (Fig. 9 - 3/1).



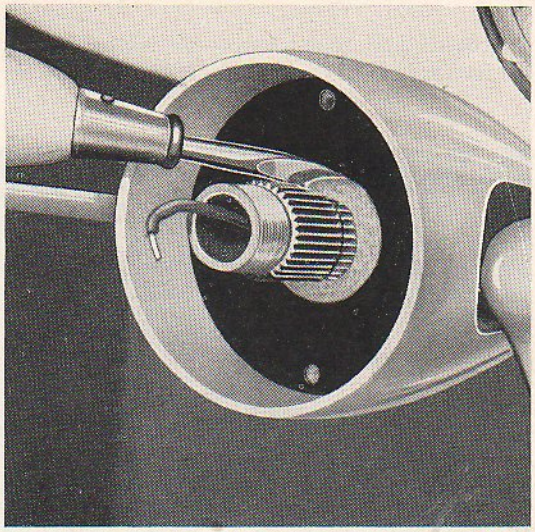
9 - 3/1

2. Loosen both half round screws and take out holding washer (Fig. 9 - 3/2).



9 - 3/2

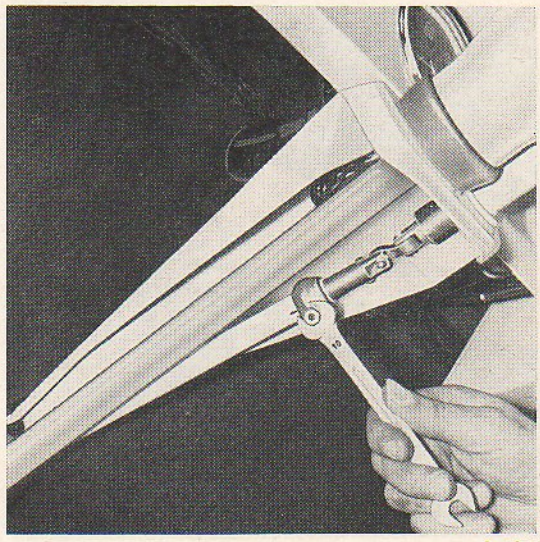
3. Take out with care slotted felt ring from supporting ring with a screw driver (Fig. 9 - 3/3).



9 - 3/3

4. Take out supporting ring.

5. Loosen clamping clip (SW 10) of control shaft rod on the transmission side. In cars with 3-speed synchro-mesh transmissions the second clip (SW 10) below instrument panel should likewise be loosened. (Fig. 9 - 3/4).



9 - 3/4

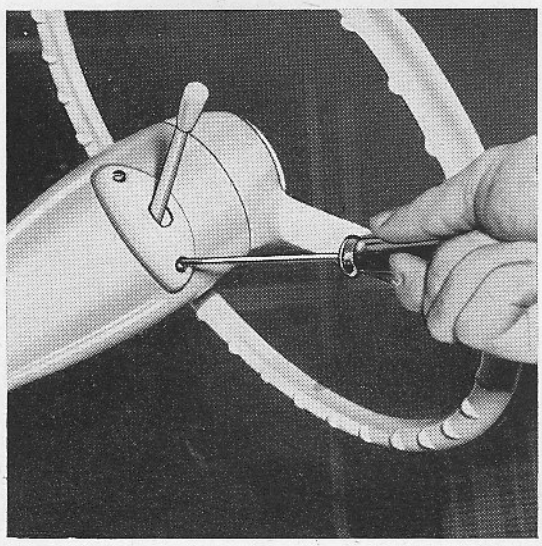
6. Pull control shaft rod out in the car until tension pins on steering tube can be reached at bottom.

Steering wheel, steering tube and steering tube jacket

7. Drive out tension pin 6 x 24 with a drift. (See Fig. 8 - 1/2).

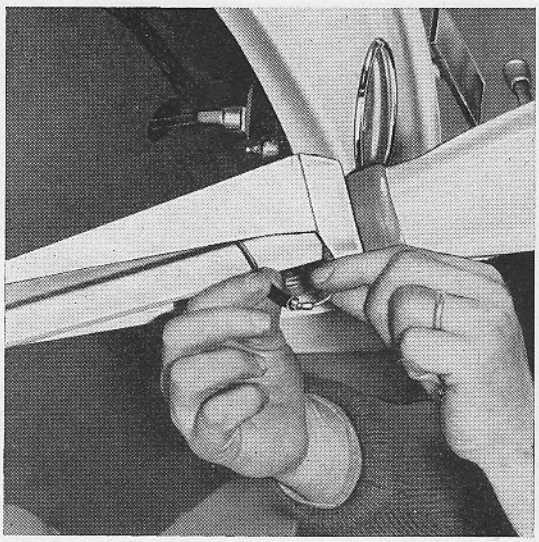
8. Pull steering tube out in the car.

9. Loosen half round screws on blinker switch. Pull forward switch and remove cable (Fig. 9 - 4/1).



9 - 4/1

10. Loosen connection of the cable leading to the slip ring of signal horn (Fig. 9 - 4/2).



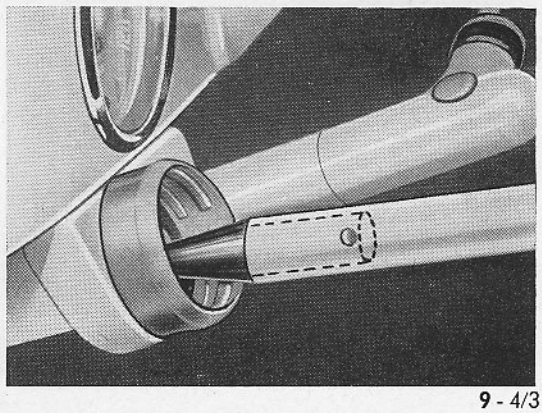
9 - 4/2

11. Remove steering tube jacket from end plate.

12. Check rubber ring in steering column with inserted felt strip. If necessary, reinstall a new one.

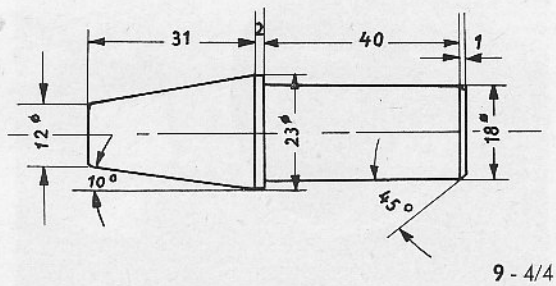
Installation

1. Push steering tube through rubber ring with inserted felt strip with the help of a shop tool (Fig. 9 - 4/3).



9 - 4/3

By using the lengthening piece (auxiliary tool) shown in the sketch it is avoided that the felt ring will be forced out of the rubber ring when pushing in steering tube.

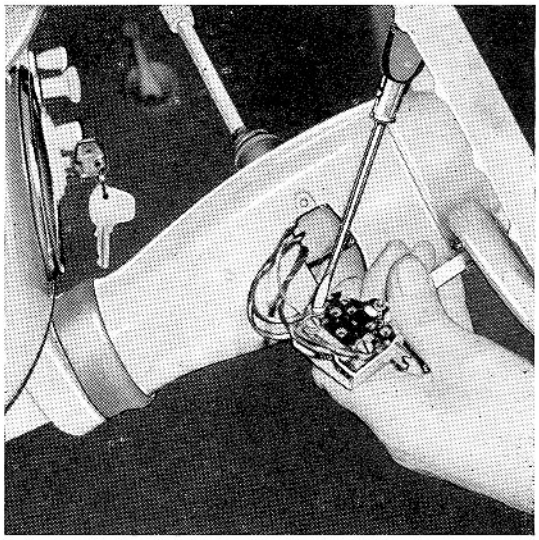


9 - 4/4

2. Push steering tube on to the shaft of pinion (steering box) and secure with 2 tension pins 6 x 24.

3. Push steering tube jacket into the rubber holding bush at the bearing bracket. In doing this, care is to be given that the cable leading from the contact spring (slip ring) to cable connection is being pushed through the rubber ring.
(See also sectional view 9 - 1 and Fig. 9 - 4/2).

4. Connect cable and secure blinker switch with half-round screws AM 4 x 10. (Do not forget to interpose spring washers) (Fig. 9 - 5/1).



9 - 5/1

5. Push into place control shaft rod. Readjust linkage and gear shift lever and fasten with clamping clip SW 10.

6. Install supporting and felt rings. Insert holding plate and fasten with 2 half-round screws AM 4 x 6 with interposed spring washers.

7. Insert lock washer. (See Fig. 9 - 3/1).

8. Conect signal horn cable to cable connection and push over rubber sleeve properly to avoid ground short-circuit.

General

Absolutely safe driving depends in the end also upon proper wheel alignment and wheel adjustment, that is: upon the position of the wheels to each other and upon their position to the roadway. Any wrong wheel adjustment gives rise to one-sided tyre wear, improper track keeping, shimmy these vibrations being transmitted through wheel track rod lever, track rods and steering levers to the rack and being felt as "steering wobble" at the steering wheel.

The driver is not always aware of the fact that sometimes a slight bump of the wheels into the curb or any other minor accident of similar kind may cause either change of the wheel adjustment or a damage to the track rod levers, respectively, to the track rods, and that afterwards this may result in excessive tyre wear. These faults in wheel alignment can be checked only in an accurate wheel aligning procedure. Although these checks can be performed by means of track, camber and caster testers of simple design, the measuring results will not be exact enough to meet to-day's requirements.

A real correct wheel alignment can be performed only with an optical measuring device.

The following requirements must be complied with if an exact wheel alignment shall be maintained.

1. **Tyres:** A good tread showing a wear as even as possible is necessary. If required, new tyres should be mounted for the aligning procedure.

2. **Tyre pressure:** The tyre pressure, in conformity with the load on the car as required for the aligning procedure, must be maintained.

LP/LS 600	Tyre pressure front Tyre pressure rear
LT/LTK 600	Tyre pressure front Tyre pressure rear

3. **Loading:**

LP/LS 600: On the front seats: 2 x 65 kg (143.3 lb); in the baggage compartment: 45 kg (99.2 lb).

LT 600: On the front seats: 2 x 65 kg (143.3 lb) + 150 kg (330.69 lb) at height of rear axle.

LTK 600: On the front seats: 2 x 65 kg (143.3 lb) + 200 kg (440.9 lb) at height of the rear axle. (Corresponding to the average load of the car: 2 passengers including baggage resp. pay-load).

In cars which for the most part are driven with the same load it is convenient to load the cars with the same weight for the aligning procedure.

4. **Wheel rims:** Damaged rim flanges can give rise to erroneous measuring results. Therefore, check all rims and, if necessary, replace them. However, if the rim should show any irregularity, this can be compensated for, when using the "Exacta" – Axle Measuring Equipment, by correspondingly adjusting the wheel mirror.

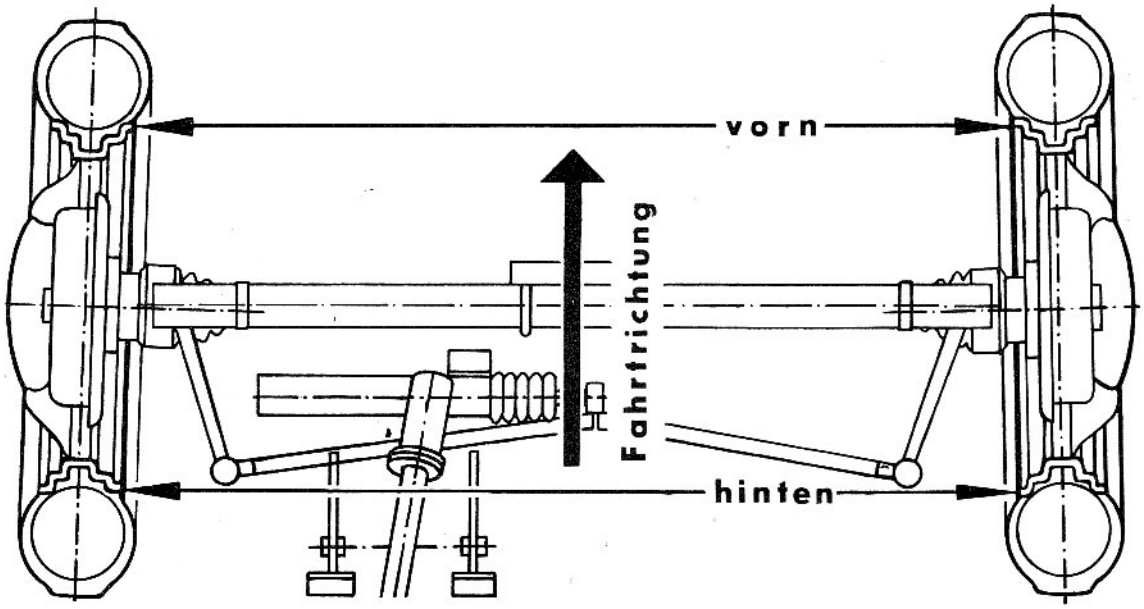
5. **Springs:** All springs should be in perfect order. Broken spring blades are suited to deliver different measuring results.

6. **Wheel bearings:** Wheels must be mounted in their bearings, if possible without any play. If prior to any aligning procedure components of the front and rear axle such as: spring bolts, wheel bearings, steering knuckles, and track rods, have been replaced or their original position has been altered in reassembling the parts, first it is necessary to make a trial run. During this trial run all replaced parts will change again their position due to road jerks and jolts.

Definitions and Adjustments

1. Toe-in

Toe-in denotes the difference in the distance between the rims of a pair of wheels when they are out of parallelism. If the distance between the wheels is smaller at the front than at the rear, toe-in is positive (+), otherwise it is negative (–). Toe-in must be measured at wheel center height with the wheels in straight-ahead position (Fig. 11-2/1).



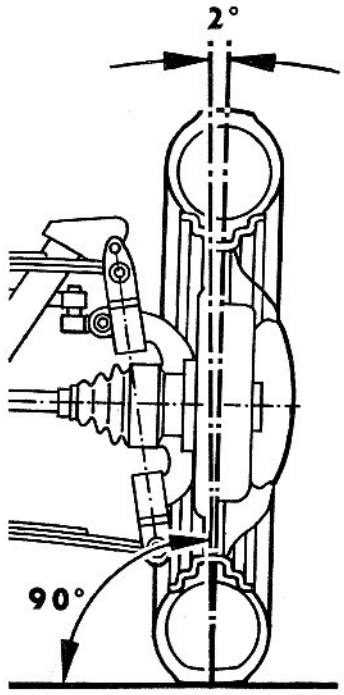
11 - 2/1

Remark

Vorn	=	front
Hinten	=	rear
Fahrtrichtung	=	driving direction

2. Camber

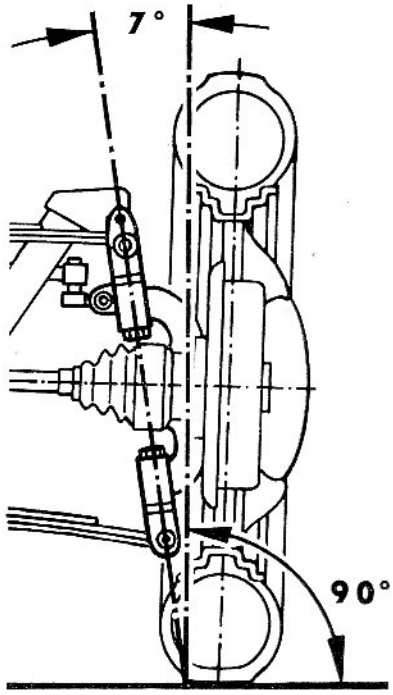
The tilt of the wheel from the vertical erected at right angle to the road plane is called camber. If the wheel is tilted outward, the camber is positive (+), and it is negative (–) if tilted inward. If the wheel stands perpendicularly on the road plane, the camber is zero. The designed camber angle in Lloyd vehicles determined in correlation with the front and rear suspensions is 2 degrees (+). (Fig. 11 - 2/2).



11 - 2/2

3. Kingpin inclination

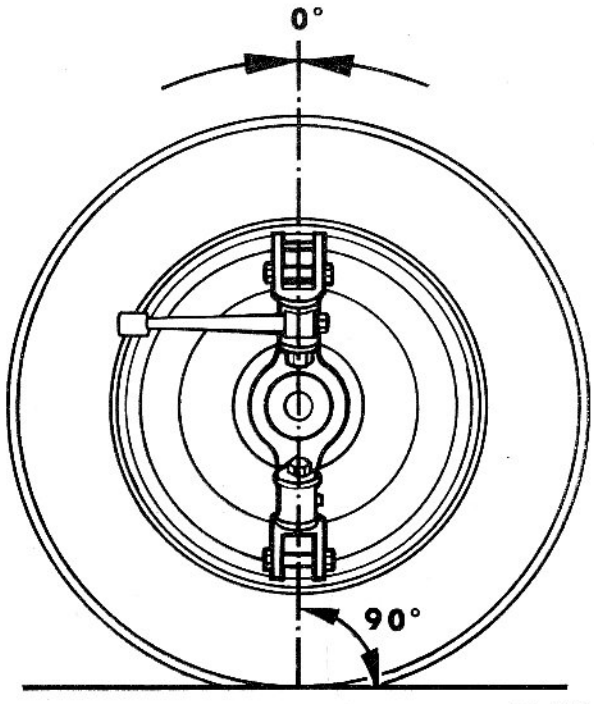
The tilt of the kingpin with respect to a vertical erected at right angle to the road plane is termed kingpin inclination. The kingpin inclination fixed by the front axle design is 7 degrees. (Fig. 11 - 3/1).



11 - 3/1

4. Caster

Caster is the distance between the point where the kingpin centre line intersects the road plane, and the vertical through the wheel centre. If the vertical through the wheel centre – viewed in the direction of motion – lies behind the point of intersection of the kingpin centre line, the caster is positive (+); inversely it is negative (–). The positive and negative castor angle formed by the inclination of the kingpin centre line with respect to the vertical erected at right angles to the road is measured in degrees. In LLOYD-cars the designed caster is = 0°, that means that the kingpin centre line is in a vertical position to the road plane. (Fig. 11 - 3/2).



11 - 3/2

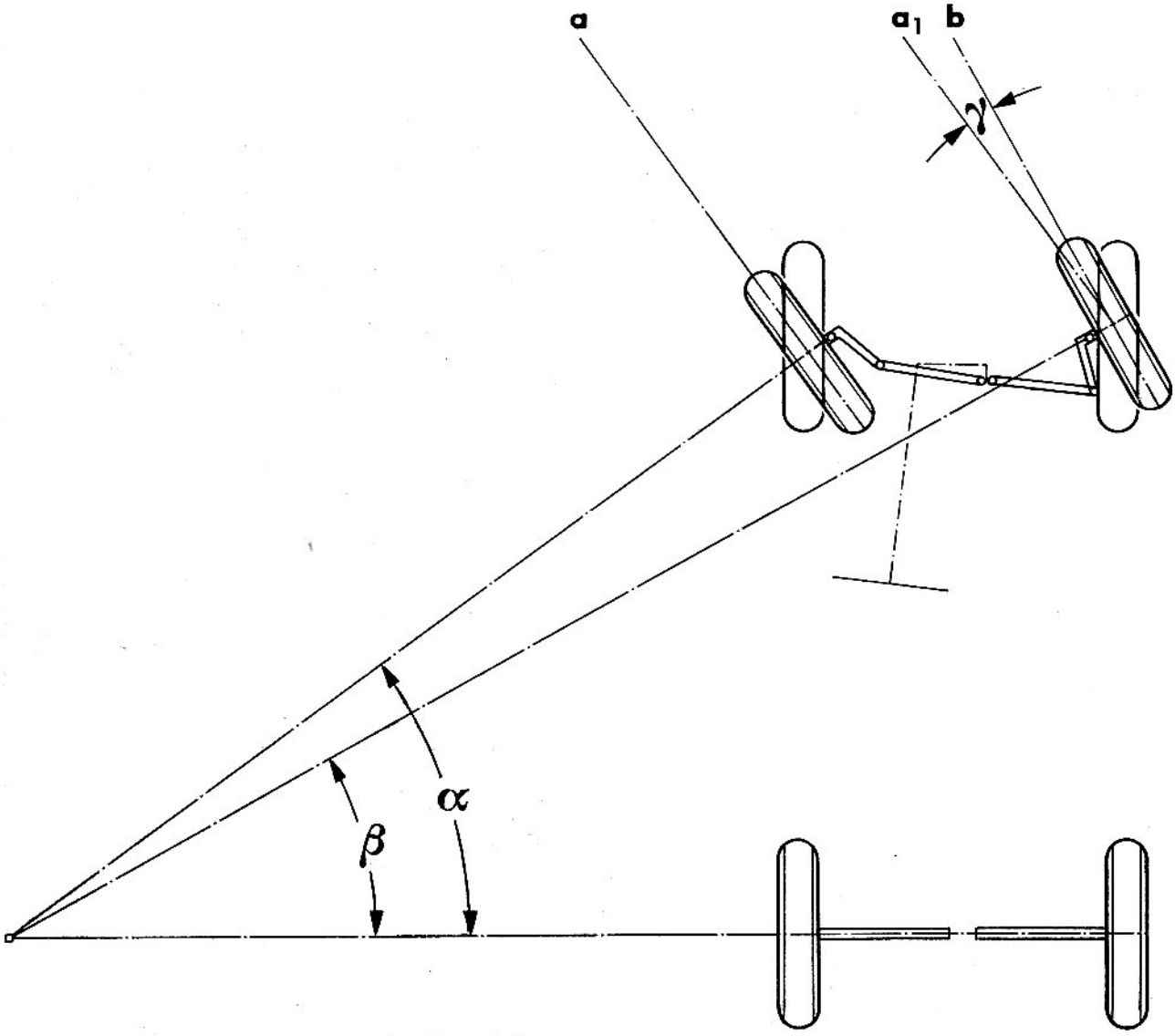
5. Toe-out Difference Angle

When the car is moving straight ahead the front wheels are travelling parallel or approximately parallel with respect to each other. Due to the radius during turns the outer wheel follows on a curve always a greater radius than the inner wheel. In order to obtain good steering performances of the car, both front wheels should be at right angles with respect to the focal point of the curve so that both wheels will describe an accurate turning circle around the focal point of the curve. It results therefrom that the wheels when making a turn are no longer in parallel with each other thanks to the design of the steering geometry.

The difference in the angles ($\alpha - \beta$) between the inner and outer wheel is termed "toe-out difference angle" (γ) At an angle of 20° of the inner wheel on turns the nominal value effect for Lloyd cars

Toe-out difference angle = –2°40'

This nominal value has been found by calculation and checked on several trial runs; it must be maintained with due regard to the permissible tolerances (± 30 minutes) and shall, if possible, be the same, particularly with the wheels turned to the right and to the left. (Fig. 11 - 4/1).



a_1 = Parallel to "a"

b = Position of the outer wheel on turns

11 - 4/1

Adjusting Front Axle

In the following only the most essential details of a front-wheel align-on the precision optical alignment procedure with the Exacta-Axle Check Device are given. More particulars will be found in the operating instructions supplied by the Manufacturers with each check device.

Fitting and adjusting the Exacta-Device

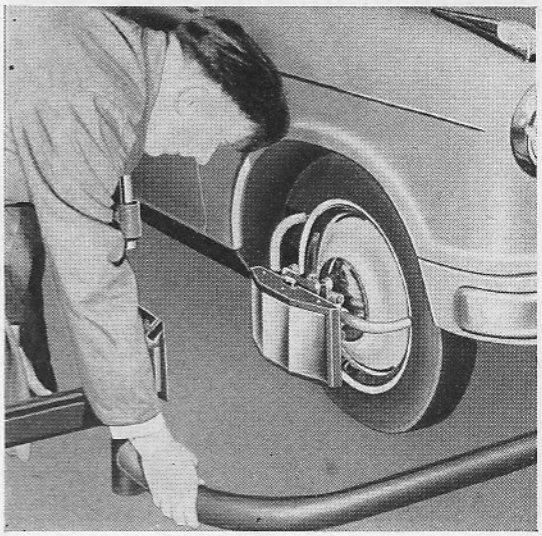
1. Place vehicle in straight ahead position on level floor. Install wheel mirror mounting attachment at the front wheels on the right and left. (Fig. 11 - 5/1).

11 - 5/1

2. Mount wheel mirrors to the front wheels on the right and left and secure with clamping screw. (Fig. 11-5/2).

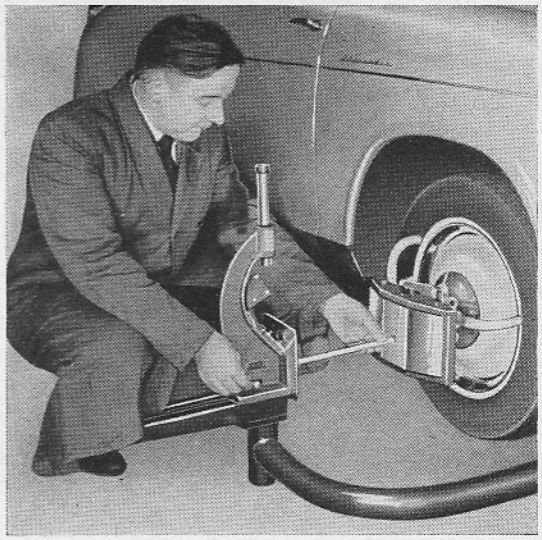
11 - 5/2

3. Place Exacta-Check Device at the front axle into position so that both vee guides are in line with the wheel mirror centres. (Fig. 11 - 5/3).



11 - 5/3

4. Check and adjust distance between optical equipment and wheel mirror by means of the adjusting rod. (Fig. 11 - 5/4).



11 - 5/4

For obtaining in LLOYD 600 cars a correct distance it is necessary to measure it on both sides. For this purpose turn one of the vee guides by 180°. The measuring equipment in the figure shows the opposite Vee guide turned by 180°.

5. Jack up car at the front end so that the wheels may freely turn. Hold fast wheel mirror; turn slowly wheel and while doing so watch scale and cross wires through the eyepiece. If, while turning, the scale circulates around the cross wires, then adjust the wheel mirror by means of the three knurled nuts so as to immobilize the scale. (Fig. 11 - 6/1).

11 - 6/1

The purpose of adjusting the wheel mirror is to avoid any error in measurement due to inaccurate felloes (e. g. damaged wheel rim edges). The accurate level adjustment of the wheel mirror is to be made shortly before the wheel aligning procedure.

6. Place turntables under the wheels; let down car and make the car several times whipping up and down until wheel steering elements and wheel bearings have settled into permanent working position.

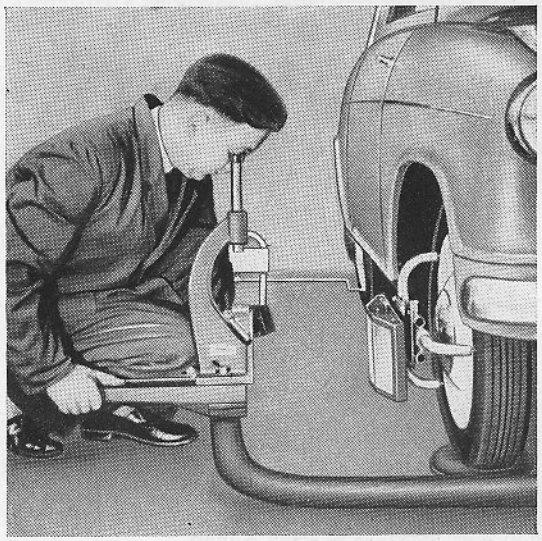
7. Load the car according to the instructions given on page 11-1, Item 3.

8. Recheck distance between optical equipment and wheel mirror with the distance control rod and adjust distance accurately. (See also Fig. 11 - 5/4).

9. Place both scale supports with the small mirror (on the plate of the scale support) bordering on the measuring scale of the optical equipment. Place feeler stick at the bottom against the centre of rim edge and secure with clamping screw. (Fig. 11 - 6/2).

11 - 6/2

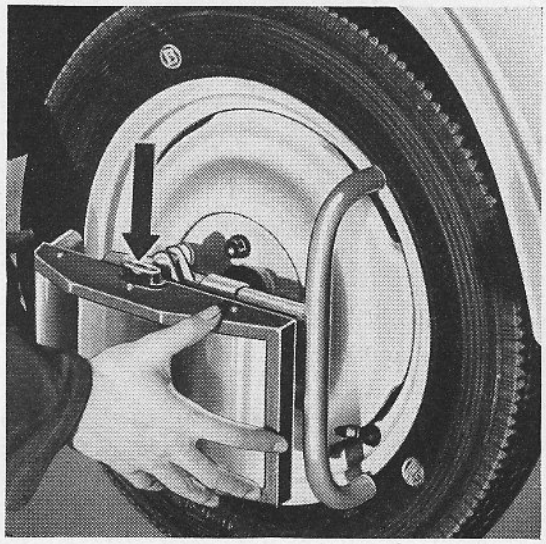
10. Place preset scale support at the rear wheel on the same side of the car so that the feeler stick as with the front wheel when placed at the bottom, is bordering on the rim edge (Fig. 11 - 7/1).



11 - 7/1

11. Swing optical system into position and take readings on both sides of the position of the scale supports by looking through the eyepiece. The readings taken must be the same on both sides. If the readings are not the same, lift Exacta-Device as shown in the Figure at one side and correct its position by alternately moving it back and forth until the same number can be read behind the cross wires on both sides in the same colour field. Thus the vehicle stands in the optical reference rectangle. (Fig. 11 - 7/1).

12. Place mirror in horizontal position. This adjustment and control can be done by means of the level fitted in the mirror. (Fig. 11 - 7/2)



11 - 7/2

Take Readings of the Amount of Toe-in and Camber in straight-ahead position

1. Place left front wheel in straight ahead position. Adjust left front wheel to the track measurement 0° with the aid of the optical equipment. The horizontal line of the cross-wires indicates the camber measurement simultaneously.
   After having read the camber measurement of the left front wheel it has to be registered on the control-chart with the mark gr (see page 11 - 10, fig. 11 - 7/3).

11 - 7/3

2. To evaluate measurement results correctly, free play of the track rod joints, wheel bearings and steering knuckles has to be considered and due to that wheels have to be pressed together in front and rear simultaneously, with a force of 22 lbs.
   The straining device necessary for this work is attached to the Exacta-Device.
   Measurement procedure is as follows:

   a) Press together wheels at the front and check straight forward position of left front wheel; then adjust if necessary and take reading of the track difference angle of right front wheel. Write down the result in the control-chart under marking **"v ged – straight forward track".**
   (See page 11 - 10, Pos. 2).

   b) Press together wheels at the rear, again check straight forward position of left front wheel and then take reading of track difference angle of right front wheel. Enter result into the chamber scale of the control-chart under marking **"h ged – straight forward track".** (See page 11-10, Pos. 3).

3. By looking through the eye-piece on to the horizontal wire-cross, take reading of right front wheel camber and enter the result into the camber-scale of the control-chart for right front wheel under marking **"h ged".** (See page 11 - 10, Pos. 4).

Determination of Track- and Camber-amount at a 20° left lock of front wheels

1. Turn wheels to the left and watch track-scale through the eye-piece (left front wheel).

   A 20° left lock is established as soon as the track-scale is moved to zero marking again, due to oblique positioned mirror on the wheel, which in fact is the inner wheel; in this case the left front wheel.

2. Using master-rod check distance between the optic and the mirror mounted on the wheel and also check horizontal level of mirror mounted on the left front wheel; correct if necessary.

   Should thus the zero marking on the track-scale have been altered, correct lock of wheels until zero marking is reached once more.

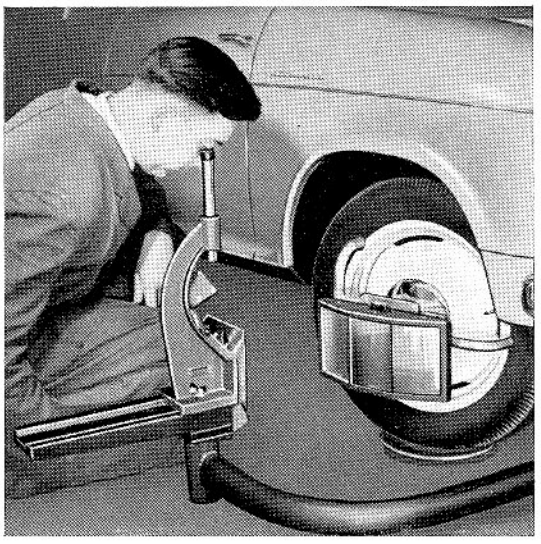
3. Take reading on the camber-scale for left front wheel and enter the amount into the camber-scale of the control-chart with the marking **"L".**
   (See page 11 - 10, Pos. 5).

4. Using master-rod check distance between mirror and the optic and also position mirror horizontally level by means of build-in spirit-level.

   Take reading through the eye-piece of the track-scale and enter result into control-chart under marking **"track at 20 degrees left lock".** As the right front wheel is the outer-one when turning to the left, the reading on the track-scale must always remain below 20 degrees.

5. To evaluate the correct camber result, turn right wheel so far to the left, until zero marking on the track-scale is reached. Thus the wheel is turned exactly 20 degrees to the left.

6. Check the distance between optic and the mirror mounted on the wheel; correct if necessary. Check for horizontal level of mirror and correct if necessary. Take camber-reading through the eye-piece and enter result into the camber-scale of the control-chart for right front wheel with the marking **"L".**
   (See control-chart on page 11 - 10, Pos. 7).



11 - 8/1

Determination of Track- and Camber-amount at a 20° right lock of front wheels

1. Turn wheels to the right until track-scale on the right wheel is set to zero **again.** Thus the lock of the inner wheel is exactly 20 degrees.

2. Check distance and horizontal position of right mirror and correct if necessary. Should zero position on the track-scale have been altered, correct lock until the scale indicates zero again.

3. Take reading on the camber-scale for right front wheel and enter result into the camber-scale of the control-chart with he marking **"R".**
(See control-chart on page 11 - 10, Pos. 8).

4. Check the distance between optic and mirror and also for horizontal level of mirror; correct if necessary. Take reading on track scale and enter result into control-chart under marking: "Track at 20° right lock". (See page 11 - 10, Pos. 9).

   The left, resp. outer wheel must always show a reading below 20° at a right lock.

5. To evaluate correct camber-result turn left (outer) wheel to the right until zero position is indicated on the track-scale.

   Thus the left wheel is turned exactly 20 degrees to the right.

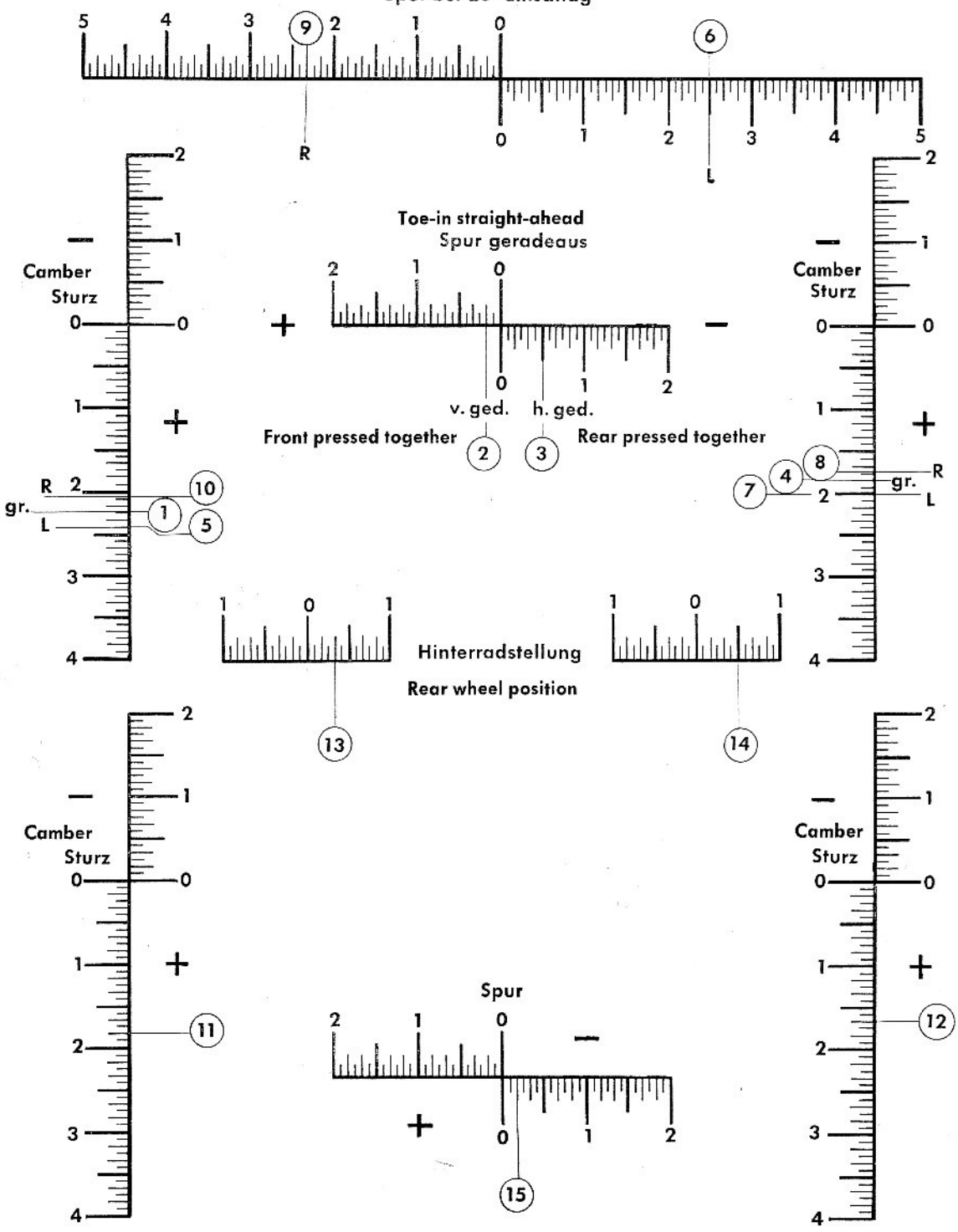
6. Check distance between optic and the mirror mounted on the wheel and for horizontal level of the mirror; correct if necessary. Take camber reading through the eye-piece and enter the result into the camber-scale of the control-chart for left front wheel with the remark **"R".**
(See control-chart on page 11 - 10, Pos. 10).

Measuring Chart

Toe-out on 20° turn

Meßkarte

Spur bei 20° Einschlag



The Abbreviations mean:

gr	= straight ahead	**R**	= turned 20° to the right
v ged	= at front pressed together	**L**	= turned 20° to the left
h ged	= at rear pressed together		

Example of Registrations to be made in the turn of the correct operation serie as mentioned on pages 11-7 to 11-9.

1. Amount of camber of the left front wheel in straight-ahead position:
   gr = + 2°15'
2. Amount of toe-in in straight ahead position with wheels pressed together at the front end
   v ged = + 10' = 1,2 mm
3. Amount of toe-in in straight-ahead position with wheels pressed together at the rear end
   h ged = – 30' = 4 mm
4. Amount of camber of the right front wheel in straight-ahead position:
   gr = + 1°50'
5. Amount of camber of the left front wheel turned 20° to the left:
   L = + 2°25'
6. Amount of toe-out read on the right wheel turned 20° to the left:
   L = 2°30'
7. Amount of camber of the right front wheel turned 20° to the left:
   L = + 2°0'
8. Amount of camber of the right front wheel turned 20° to the right:
   R = + 1°45'
9. Amount of toe-out read off on the left wheel turned 20° to the right:
   R = 2°20'
10. Amount of camber of the left front wheel turned 20° to the right:
    R = + 2°05'
11. Amount of camber of the left rear wheel: = + 1°50'
12. Amount of camber of the right rear wheel: = + 1°40'
13. Wheel position of the left rear wheel to the centre line of car:
    = 0°20'
14. Wheel position of the right rear wheel to the centre line of car:
    = 0°30'
15. Amount of toe-in of the rear axle: = – 0°10'

Evaluation of Measuring Results and Tolerances

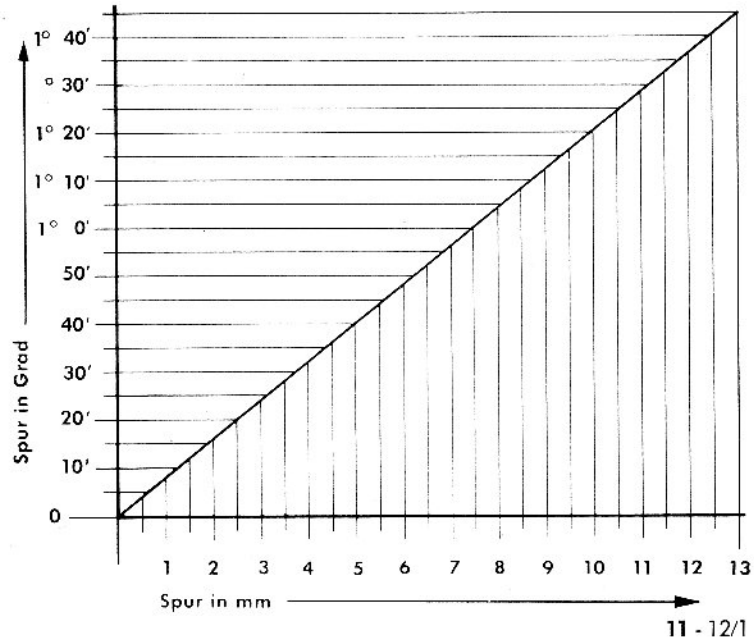
Toe-in straight ahead

From the scale "Toe-in straight ahead" read the amounts of toe-in with the denominations v ged (at front pressed together) and h ged (at rear pressed together).

The mean value of these measuring results shall be:

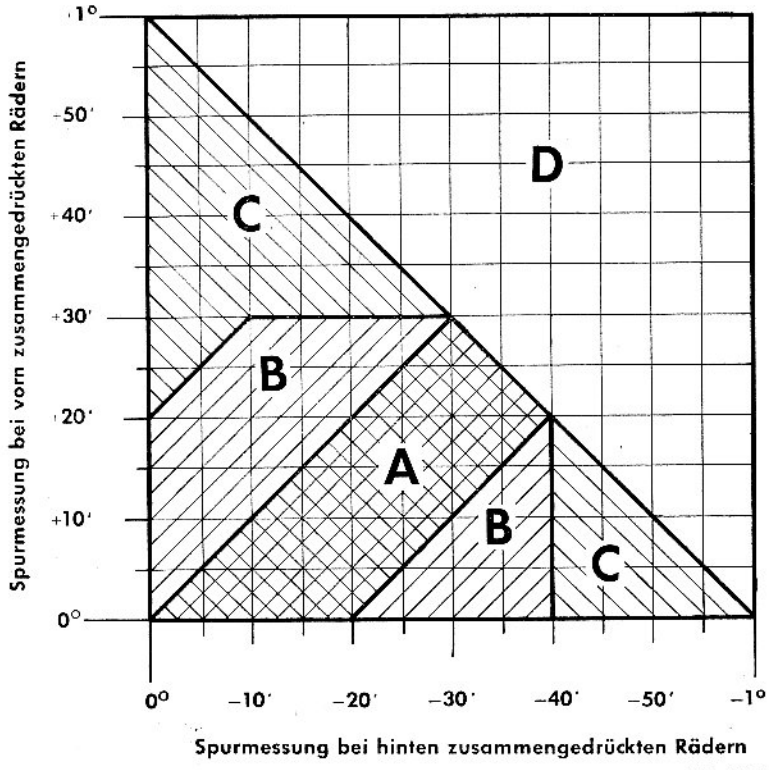
up to Chassis-No. 6/339 010 $0^{o} \pm 16' = 0 \pm 2$ mm
from Chassis-No. 6/339 011 $0^{o} \pm 8' = 0 \pm 1$ mm

In vehicles of the new type (from Chassis-No. 6/339 011) the track-rods are precisely adjustable through adaptors fitted with right-hand and left-hand threads so that an adjustment within the before mentioned range of tolerances can be easily made.
The amount of toe-in measured in degrees can be seen from the graph (11-12/1) in mm. (Fig. 11 - 12/1)



11 - 12/1

From the measuring results with wheels pressed together at the front end (v ged) and at the rear end (h ged) you will see the play existing in the joints. In order to enable you to judge of a replacement of the track rod ends, kingpin bushings or wheel bearings, refer to the graph. (Fig. 11 - 12/2)



11 - 12/2

Descriptive Notes to the Graph

1. Both amounts of toe-in with front and rear wheels pressed together should have, if possible, their point of intersection within the area A.

2. If the points of intersection come to lie within the areas C, correct the toe-in adjustment until the point of intersection lies within area A.
   In case the amount of adjustment does not suffice to bring the point of intersection back to area A, the condition of the wheel alignments is still sufficient when the areas B are attained.
   If there is no possibility of reaching the areas B, the joints (track-rod ends), if necessary, kingpin bushes and wheel bearing too, require to be replaced.

3. If the point of intersection of both amounts of toe-in is found within the area D, the play in the joints is too excessive; this will mean worn elements as mentioned in item 2. In this case, it is indispensable to carry out the necessary repair work for remedying these misalignments.

Note to Toe-in Adjustment

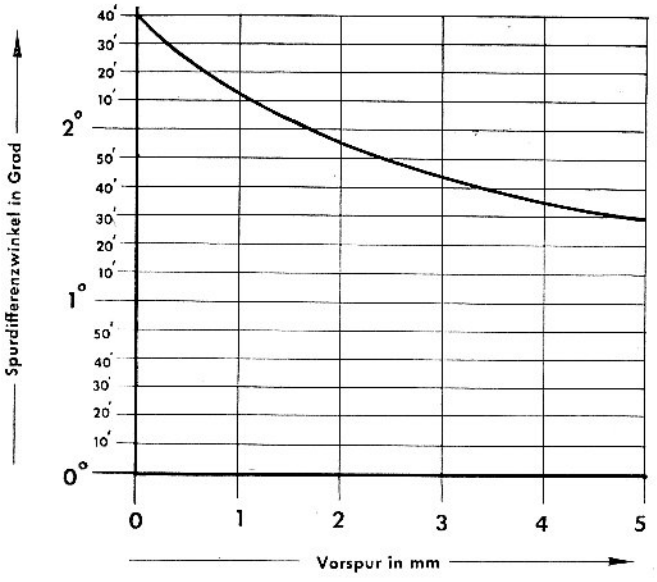
With front drive vehicle the toe-in undergoes in road operation a change to the positive side due to the pull exerted by the wheels, but to the negative side due to the thrust (e. g. when driving hill down) and while braking if a change be possible at all due to the play existing in the joints and links. These factors call for a measurement of the amount of "Toe-in straight ahead" with wheels pressed together at the front end, on the one hand, and with the wheels pressed together at the rear end, on the other hand, in order to determine the play in the linkage. Furthermore, it will be seen that the toe-out difference angle, too, depends upon the toe-in adjustment. As you will see on the following graph, the toe-out difference angle in relation to smaller amounts of toe-in will increase and will reach its optimum value of 2°40' if the measure "Toe-in straight ahead" will be 0°.

For this reason it is convenient to adjust the toe-in so that the mean value of the measuring results obtained with wheels pressed together at front and rear will be about 0°. (Fig. 11 - 13/1).

Remark

Spurdifferenzwinkel in Grad =
track difference angle in degrees

Vorspur = toe-in



11 - 13/1

From the above diagram it is possible to see the approximate curve of the values obtained during the measurement of new and used cars and plotted to a toe-in base in mm; it characterizes the dependability of the toe-in difference angle upon the toe-in adjustment. At this, the measured mean value of the R. H. and L. H. lock was taken as a basis. Scattered values are not taken into account.

Camber of Front Wheels

The values denoted on the Measuring Chart "gr" read on the right and left of the camber scale indicate the direct amount of camber. This camber depending upon the front axle and spring suspensions and determined on the usual design method

shall be 2° with a tolerance of ± 40'.

In this connection the following remarks must be made:

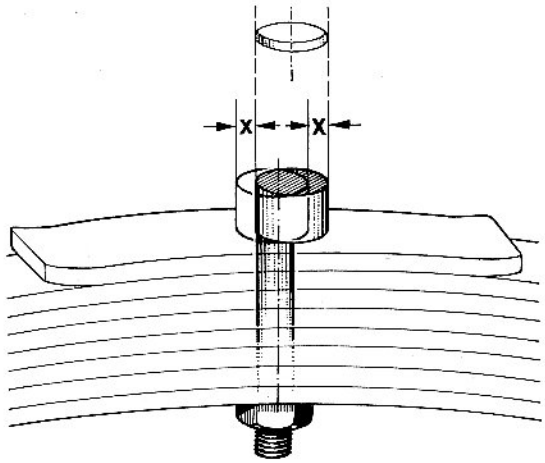
The camber of the right front wheel shall by no means be larger than that of the left front wheel, even not within the range of the permissible tolerances. A wheel more cambered than the other has the effect of pulling the car to the side, and this to that side where the wheel with the greater amount of camber does exist. The curvature and cross-fall of the road brings into effect, involved by using the right side on a roadway (in all countries with right-hand traffic) a so-called "pulling action to the right" which with equally cambered front wheels may be negligible. However, as soon as the camber of the right front wheel becomes larger than that of the left wheel, the forces set up by the road cross-fall and the larger amount of wheel camber will sum up so that a "pull to the right" is distinctly felt. These forces are offset when the car is in motion by a small angle of lock to the left and thus excessive tyre wear on the right front wheel will result. For these reasons it is recommendable, as soon as an increased amount of camber on the right front wheel has been stated, to effect the alignment so that the left front wheel will snow the larger amount of camber, naturally within the permissible tolerances. In the countries with left-hand traffic the conditions are reversed so that you must proceed in the inverse order.

Adjusting Camber

A change in the wheel camber adjustment can be made by shifting the front suspensions at top and at bottom, but to do this it must be taken into consideration that both suspensions are to be secured against lateral displacement by the locked center bolts. The center bolts are removed through the bores in the spring carriers.

Should the wheel camber require to be readjusted, it is recommendable to carry out this work at the lower front suspension because it can be far better reached and all work in connection therewith can be done in a shorter time.

Remove the front suspension at bottom. Take center bolt out of spring suspension and file off head at one side. Strengthen the opposite side by build-up weld and re-machine so as to secure a snug fit of the centre bolt in the holes of the spring carrier.



11 - 14/1

Hints for re-machining the center bolts:

If the bolt head be shifted by 1 mm, this results in a total adjustment of the wheel camber of about 24', that is, the camber of a wheel is reduced by 12' whereas that of the other wheel will be increased by 12'. The measure "x" may be taken from the measuring results "Wheel camber at front right" and "Wheel camber at front left" (in straight ahead position). (Fig. 11 - 14/1).

Caster

The caster of each wheel will be calculated from the amounts of camber of the wheel in question turned to the right and to the left. The amount of camber "gr" as shown in the Measuring Chart must not be taken into consideration but only the amount of camber denoted "L" and "R". The angular minutes obtained between a wheel turned to the right and to the left should be added. In doing this, 40 angular minutes give a caster of 1°, that is, 10 angular minutes establish a caster of 1/4° = 15 angular minutes.

Caster can be detected by the left wheel, if the amount of camber with the wheel set in to the left is below that of the wheel turned to the right. If the amount of camber with the wheels turned to the right lies below we have negative caster (reverse caster).

The term "below" refers to the entry made in the Measuring Chart. If the amount of left setting-in is below that of right setting-in, this means: "L" is on the respective chart below "R". The designed

amount of caster of the LLOYD vehicles is 0°,

determined by the front axle suspension; a tolerance of ± 30' being permissible. These permissible limits are derived from the constructional tolerances in the front suspension, spring bearings, king pins, spring forks, etc. and has no significance within the a/m limits.

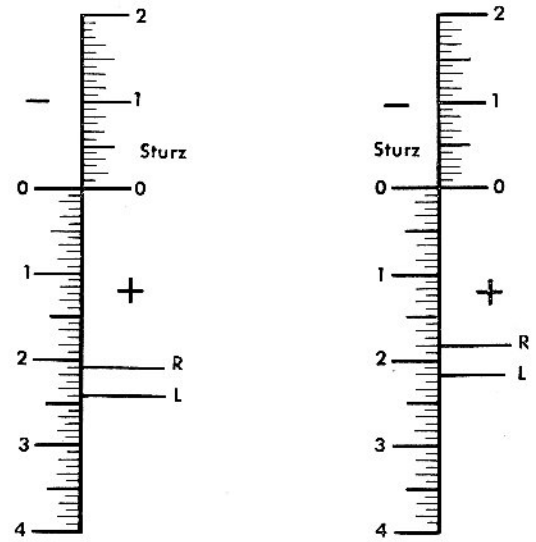
Example of caster calculation

In a vehicle, the following amounts of camber were measured:

1. **On the right front wheel**
   at right turn "R" = 1°50'
   at left turn "L" = 2°10'

2. **On the left front wheel**
   at right turn "R" = 2°05'
   at left turn "L" = 2°25'

(Fig. 11 - 15/1)



11 - 15/1

Caster of the Right Front Wheel

If on the camber scale "L" is below "R", we have negative caster (reverse caster).
The difference between the amounts of camber (1°50' and 2°10') will be 20' x 40' deliver a caster of 1°. In this case, we have therefore a negative caster of 30 angular minutes.

Caster of the Left Front Wheel

Even in this case "L" is below "R" but we have here positive caster.
The difference of the amounts of camber between 2°05' and 2°25' is 20' that is, the left front wheel has a positive caster of 30 angular minutes.

Toe-out on 20° Turn

On the upper scale the amounts "L" and "R" are to be read. Provided that the adjustment "Toe-out on 20° turn" has been made with wheels not pressed together, add the difference of "toe-in straight ahead" from 0 to the non-pressed position for the purpose of determining the real toe-out difference angle. The correct amount "Toe-in straight ahead" in the non-compressed position follows from the mean values: "Toe-in straight ahead" v/ged (front wheels compressed at the rear).

In computing the real toe-out difference angle you must proceed as follows:

1. **At positive toe-in**

   Toe-out on 20° turn ("L" or "R")
   + Toe-in straight ahead (mean value between v/ged and h/ged)

2. **At negative toe-in**

   Toe-out on 20° turn ("L" or "R")
   – Toe-in straight ahead (mean value between v/ged and h/ged)

Example of application

Let us assume the following measuring results in a vehicle:

Toe-out on 20° turn R	=	2°20'
Toe-in straight ahead v/ged	=	+ 0°10'
Toe-in straight ahead h/ged	=	– 0°30'

From the results v/ged and h/ged a mean value of – 0°10' will be obtained;
thus the real amount of toe-out will be = 2°20' – 0°10' = **2°10.**

The nominal value of the toe-out difference angle will be 2°40',a tolerance of ± 30' being permitted.

In evaluating the measuring results care should be taken to ensure that the amounts of toe-out on left and right turns should – as far as possible – be the same.

If adjusting the track rods does not result in equal or approximately equal toe-out difference angles within the range of tolerances, we can probably assume a faultive steering linkage. For the diagnosis of steering linkage troubles refer to the drawings and illustrations in the EXACTA-OPTICAL ALIGNMENT SPECIFICATION supplied by the Manufacturers of that equipment. To determine the "Double Actual Value" required for this evaluation procedure, you must add the track difference angle with wheels in full right or left locking position.