When carrying out routine checks it is generally sufficient to take measurements with the car in curb condition.

The measurement and the evaluation of the measurement requires expert knowledge and experience. For this reason only specially trained mechanics should be permitted to carry out this job.

B. Terminology and Methods of Adjustment

a) Camber

Camber is the term used to designate the angle which the wheel plane forms with a line drawn at right angles to the road surface. If the wheels are inclined outward at the top the camber is said to be positive (+) and if the wheels are inclined inward at the top the camber is said to be negative (—) (Fig. 40—3/1).

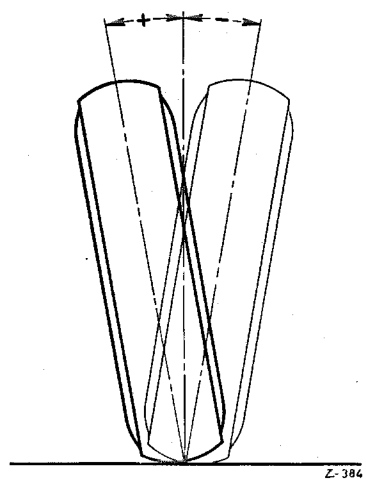

Fig. 40—3/1

Front Axle

The front wheels are adjusted to a positive camber. Positive camber together with king pin inclination ensures stable and smooth steering. With the low-pressure tires which are in general use today, the front wheel camber must not be too great, because this causes increased wear at the outside shoulder of the tire. The camber at the left and the right should be as nearly identical as possible. If there is a considerable discrepancy between the left and the right, the car tends to veer to the side at whichever wheel the camber is greatest. Camber is adjusted so that the least possible variation in camber results when the springs are fully depressed, with the car in normally loaded condition.

A camber of $\pm 0^\circ$ to $+ 1^\circ$ is permissible with the car in normally loaded condition, and a camber of $+ 0^\circ 20'$ to $0^\circ 40'$ should be aimed at. The difference between the camber at the right and the left should be as slight as possible; however, a maximum difference of $\pm 0^\circ 30'$ is permissible.

Adjustment of camber is carried out by turning the eccentric bolt (7) (Fig. 40—3/2). To do this, first back out the hexagon screw (13) and the lock washer (12) and remove it together with the locking plate (11). After unscrewing the hexagon nut (10), camber can be adjusted to the prescribed value with the aid of an SW 19 box wrench.

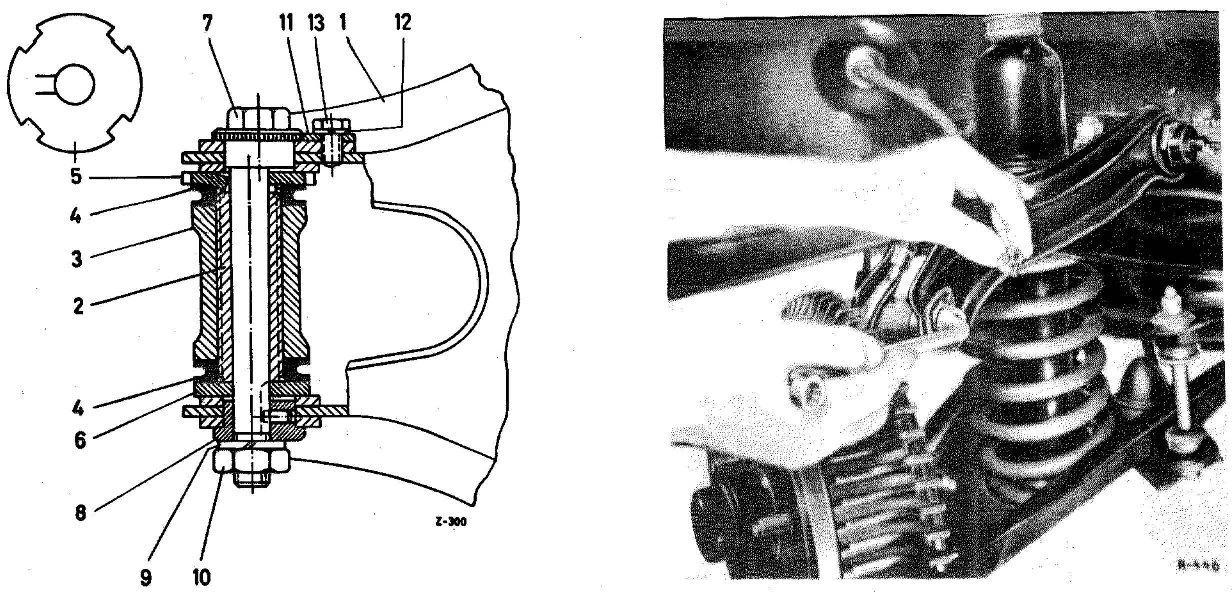

Fig. 40—3/2

1 Upper left control arm
2 Threaded bushing
3 King pin
4 Sealing ring
5 Adjusting washer for caster adjustment
6 Washer
7 Eccentric bolt for camber adjustment
8 Eccentric bushing
9 Lock washer
10 Hexagon nut
11 Locking plate
12 Lock washer
13 Hexagon screw

From the neutral position an adjustment of $\pm$ ½° is possible. **If in special cases the camber adjustment is not sufficient to achieve uniform camber at the left and the right, pivot pins can be installed on the upper control arms, whose fixing bores are offset $\pm$ 2 mm compared with the standard version.**

Offsetting the bores by —2 mm yields an alteration in the camber of approx. —½°; offsetting by + 2 mm yields an alteration of approx. + ½°. Pivot pins are obtainable as part No. 120 333 03 30 for the shorter version and as part No. 120 333 04 30 for the longer version.

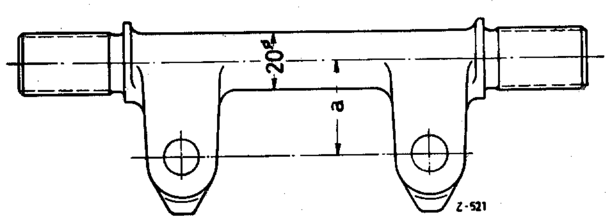

Fig. 40—3/2a

a = 35 mm standard version
a = 33 mm shorter version
a = 37 mm longer version

Rear Axle

The rear wheel camber varies according to the load, since the axle tubes swing about a common fulcrum. Variation in camber is, of course, less in the case of the single-jointed swing axle than in the case of the twin-jointed swing axle.

The rear wheels also assume a negative camber with increasing load.

It is advisable to adjust the rear wheel camber with the car in curb condition. In consequence of the difference in length of the axle tubes when the car is standing in a horizontal position, the camber is greater at the right than at the left. With the car in curb condition the difference amounts to approx. 0° 15′, and with the car in normally loaded condition to approx. 0° 30′.

To achieve optimum road-holding qualities the rear wheel camber should be adjusted to approx. + 1° 30′, with the car in curb condition.

With the car in normally loaded condition, the camber at the left is from —2° 30′ to —3° 30′, and at the right from approx. —3° to —4°. The relatively high tolerances with the car in loaded condition arise because of the tolerances in the rear axle suspension and because of the rubber buffers which extend the action of the springs.

Care must be taken to ensure that, when the car is in normally loaded condition, the camber never reaches a greater negative value than —4° since otherwise the upward spring deflection is too small and moreover there arises the danger of increased wear at the inside shoulder of the tire. Before the measurements are taken, the rubber buffers must be checked to ensure that they are in perfect condition. The camber of the rear wheels is adjusted by turning the spring plate (5) (Fig. 40—3/3). The spring plate can be turned to four notch positions; turning the spring plate one further notch causes an alteration of wheel camber of approx. 0° 10′. If it is not possible to adjust the camber sufficiently by turning the spring plate (5) an attempt may be made to adjust the camber to the specified value by adding or removing compensating rubber rings (9). (For further details see Job No. 32—5).

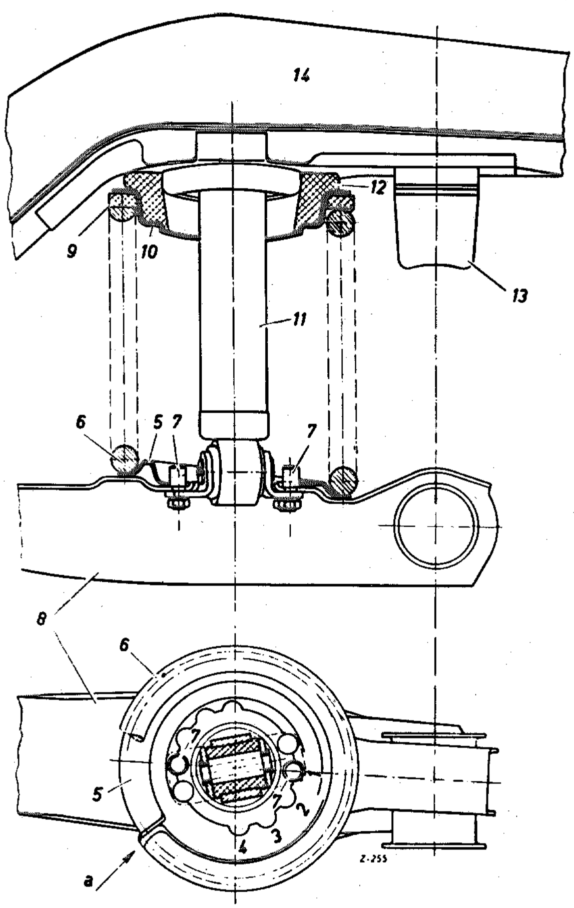

Fig. 40—3/3

1—4 Notch position
5 Lower spring plate
6 Spring
7 Cheese head screw
8 Torque arm
9 Compensating ring
10 Upper spring plate
11 Shock absorber
12 Rubber mounting
13 Rubber buffer stop
14 Chassis base panel
a = distance between the end of the spring and the heel of the spring plate

b) King Pin Inclination

The term king pin inclination designates the angle which the king pin forms with a line drawn at right angles to the surface of the road. This is measured by producing the center line of the king pin to meet a line drawn at right angles to the direction of travel and to the surface of the road.

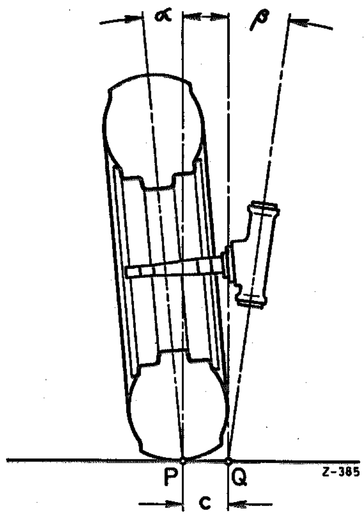

Fig. 40—3/4

a Camber in degrees
b King pin inclination in degrees
c Effective rolling diameter in mm
P Point of contact of the tire with the surface of the road
Q Point of intersection of the center line of the king pin and the surface of the road

The sum of the camber and the king pin inclination is constant, due to the design of the king pin. For this reason when the camber is adjusted, the king pin inclination is automatically adjusted as well.

c) Rolling Diameter

The term rolling diameter (rolling circle diameter) designates the distance (c) between the point of intersection (Q) of the center line of the king pin and the surface of the road and the point of contact (P) of the tire with the surface of the road (see Fig. 40—3/4). The rolling diameter is critical for ensuring easy steering action at low speed, e.g. when parking, since the tire describes a small arc when the steering is locked hard over. The contact surface in modern low pressure tires is so large that steering would be very heavy if the tire had to turn more or less on the spot when parking.

d) Caster

The term caster designates the angle which the axis of the king pin forms (when "produced" upward and rearward) with a line drawn at right angles to the surface of the road (Fig. 40—3/5). To measure this, the central axis of the king pin is produced to intersect with a plane parallel to the direction of travel and at right angles to the surface of the road.

The point of contact S of the tire with the surface of the road thus lies behind the point of intersection R of the axis of the king pin and the surface of the road.

Direction of travel

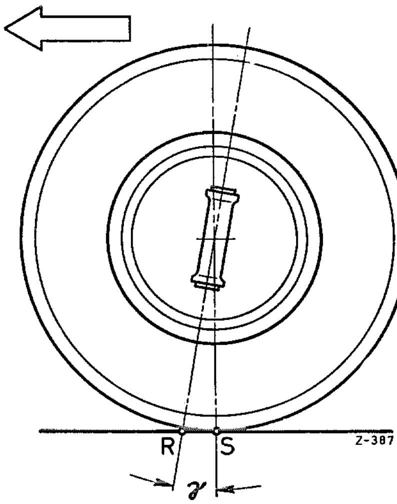

Fig. 40—3/5

γ Caster
S Point of contact of the tire with the surface of the road
R Point of intersection of the axis of the king pin and the surface of the road

Caster facilitates stable steering and automatic return of the road wheels to the straight-ahead position after cornering. The effect of the caster achieved by the angle of the king pin is the same as with the action of an ordinary dinner-waggon.

The magnitude of the caster angle is dependent on the loading of the car. In Model 190 the caster, allowing for all tolerances, is 2° 30′ to 4°, according to the loading of the car. The caster should be as nearly identical as possible between the right and the left. A discrepancy of approx. ½° is, however, permissible.

Caster can be adjusted by turning the threaded bushing (2) (Fig. 40—3/6).

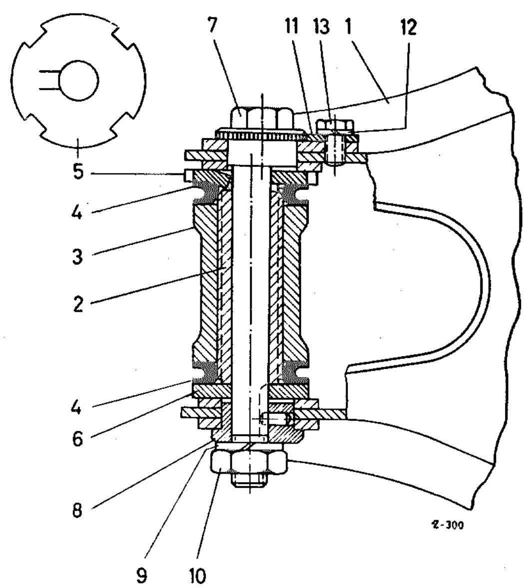

Fig. 40—3/6

1 Upper left control arm
2 Threaded bushing
3 King pin
4 Sealing ring
5 Adjusting washer for caster adjustment
6 Washer
7 Eccentric screw for camber adjustment
8 Eccentric bushing
9 Lock washer
10 Hexagon nut
11 Locking plate
12 Lock washer
13 Hexagon screw

After the hexagon nut (10) has been unscrewed, the threaded bushing (2) can be turned by turning the adjusting washer (5) with the aid of Special Wrench 180 589 00 05 (Fig. 40—3/6).

When the threaded bushing is in the neutral position, an adjustment of 1.5 mm in both directions is permissible. This allows a variation in caster of ± 0° 20′. A greater amount of adjustment is not permissible, since on the one side the rubber ring would be crushed and on the other it would no longer make a perfect seal.

A further limited adjustment of caster can be made by turning the upper control arm pivot pin one turn to the right or to the left from the neutral position. To do this it is necessary to take off the front wheel and remove the shock absorber. Then use Spring Tensioner 120 589 01 31 to compress the front spring so that the upper pivot pin is not under load and can be screwed off the front axle support.

e) Toe-in and Toe-out

The term toe-in (or toe-out) designates the difference in the distance between the wheel rims, at the front and at the rear of the wheels. Measurement for this is taken at a point level with the wheel centers, with the wheels set in the straight-ahead position (Fig. 40 — 3/7).

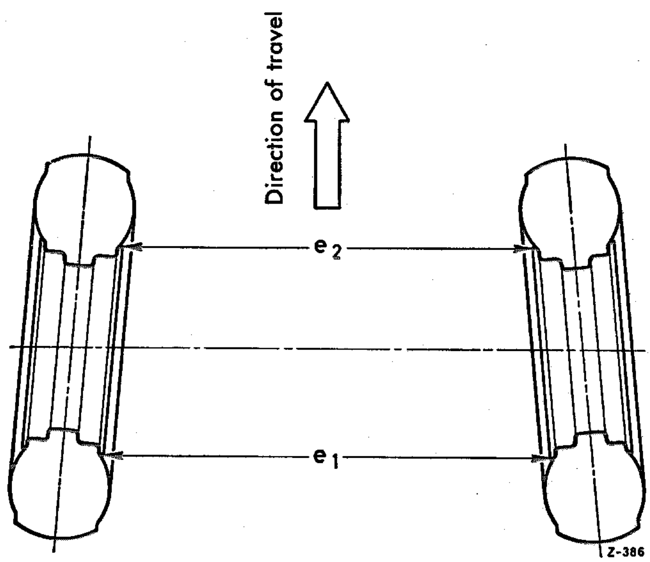

Fig. 40 — 3/7

$e_1 - e_2$ = toe-in (e_1 larger than e_2)
$e_2 - e_1$ = toe-out (e_2 larger than e_1)

Front Axle

Toe-in counteracts the tendency of the front wheels to spread — a tendency caused by the camber. Furthermore, owing to the slippage, lateral forces are brought into play which allow the vehicle to maintain a steady course.

Without toe-in, it is only with a greater angle of "yaw" that lateral forces come into play, so that the car would not maintain a steady course when travelling straight ahead. However, toe-in must not be excessive. If this is the case, considerable tire wear results. Toe-in for Model 190 is 0—2 mm.

When measuring toe-in, the front wheels must not be pressed toward each other at the rear. Toe-in must be measured with the car in normally loaded condition.

Toe-in can be altered by adjusting the lengths of the two tie-rods. To do this, the locking plate (3) must be tapped up, the hexagon nut (4) unscrewed, and the lock ring (2) must be tapped off the cone of the tie-rod tube (1) (Fig. 40 — 3/8).

Note: The tie-rod end on the left side of the tie-rods (seen in the direction of travel) has a left-hand thread. For purposes of identification the two tie-rod tubes have a milled edge on the left side.

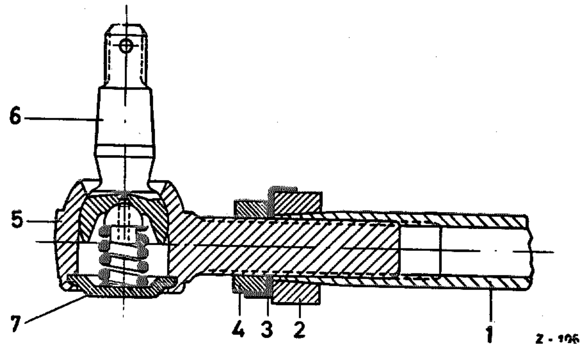

Fig. 40 — 3/8

1 Tie-rod tube
2 Lock ring
3 Locking plate
4 Hexagon nut
5 Ball head
6 Ball stud
7 Plug

The toe-in can now be adjusted by turning the tie-rod tube (1).

To adjust the toe-in, set the wheels in the straight-ahead position and lock them by means of Center Fixing Screw 186 589 00 23. Toe-in must be distributed evenly between the left and the right wheel. If an optical axle gage is not available, the front wheels must first be lined up parallel to the rear wheels, with the aid of Wheel Base Measuring Gage 136 589 07 21. In the absence of a gage, this alignment can be carried out with the aid of a straight-edge or simply visually.

The wheel base measurement at the left and the right must be equal.

After adjusting toe-in, press the lock rings (2) onto the tie rod tubes (1), tighten up the hexagon nuts (4) and tap over the locking plate (3). When tightening up the hexagon nuts (4), care must be taken to ensure that the ball-heads always rest against the ball pin in the direction of rotation of the hexagon nut. This ensures that the tie-rods are free to turn as required when the car is in motion. If they are incorrectly installed, the danger exists that the tie-rods will bend when the car is being driven. **For this reason it is necessary to carry out a check after adjusting toe-in, by turning the tie-rods to ascertain whether the tie-rod heads can turn to the full extent.**

Rear Axle

Toe-in at the rear axle should be nil. It is not normally necessary to measure toe-in at the rear axle; if, however, rear wheel tire wear is excessive, toe-in at the rear axle must be measured. If the toe-in or toe-out is found to exceed 2 mm, the fault may be bent axle tubes, bent torque arms or faulty seating of the step bearings supporting the torque arms. In the latter case, the rear axle mounting bolt will no longer be perpendicular to the road surface, as in the original design, but will be inclined forward or backward. In this case there will be considerable variation of toe-in, when the springs are fully depressed, and increased tire wear will result.

f) Track Angularity Differential

It is a known fact that when the front wheels turn about a definite angle, the lock of the outside wheel is less than that of the inside wheel, since the outside wheel has to describe an arc of greater diameter. The difference between the angle subtended by the tangent of the arc of the outside wheel and that of the inside wheel is designated the angle of track angularity differential (Fig. 40—3/9).

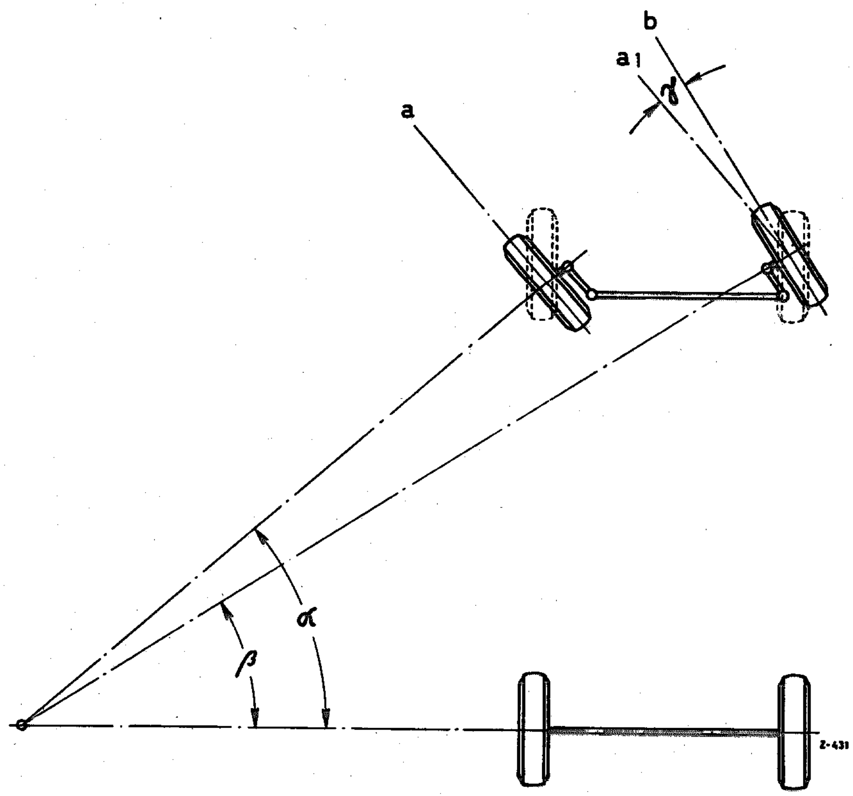

Fig. 40—3/9

a_1 = Parallel to a
γ = Track angularity differential
α = Angle of lock at the inside wheel
β = Angle of lock at the outside wheel

The track angularity differential for Model 190 at an inside wheel lock of 20° is —2° 30′.

In evaluating the track angularity differential, it must be borne in mind that the value indicated is determined geometrically. When the car is in motion considerable slip angles are generated independently of the radius of the curve and speed of travel, so that the track angularity differential most favorable for normal travel can only be ascertained by road tests. Deviations from the value specified are not critical for the behavior of the vehicle and especially not for tire wear. The track angularity differential should nevertheless be as nearly identical as possible on the left and the right locks.

g) Pivot Point Distance

Toe-in should remain constant when the front wheel springs are fully depressed. This is achieved in practice with sufficient accuracy by appropriate relative positioning of the ball pins on the steering gear arm or the steering relay arm, and on the steering knuckle arms (pivot point distance).

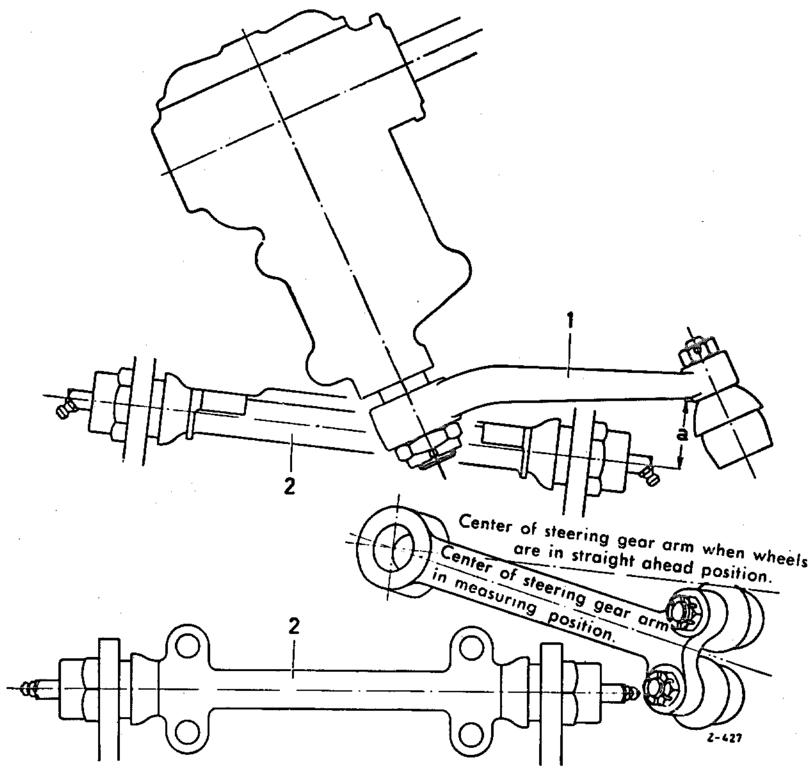

Fig. 40 — 3/10

1 Steering gear arm
2 Lower control arm pivot pin
a = 34 ± 2 mm

Larger variations in the pivot point distance manifest themselves in variation between toe-in of the wheels with the vehicle in curb condition and toe-in in normally loaded condition. This leads to considerable tire wear and tread defacement on the circumference of the tire.

If, when checking, a variation greater than 2 mm is discovered between the toe-in of the vehicle in curb condition and the toe-in in fully loaded condition, the pivot point distance must be checked.

It is normally sufficient to check the positioning of the ball pins on the steering gear arm and on the steering relay arm. Since in practice the central point of the ball pin cannot be measured, the distance a between the inner pivot pin on the lower control arm and the lower edge of the steering gear arm and steering relay arm must be checked (Fig. 40 — 3/10). When measurements are taken, the steering must be set in the measuring position. In the measuring position the extension of the pivot pin must be aligned with the measuring spot on the steering gear arm or steering relay arm (Fig. 40—3/10).

If the distance deviates from the prescribed distance, $a = 34 \pm 2$ mm, the steering gear arm must be replaced. If a replacement is not available, the steering gear arm may be straightened cold: **In this case it is essential to carry out a careful check for cracks before reinstalling.**
The steering relay arm can be adjusted for height (see Job No. 46—11, Note: Paragraph 9). The steering gear arm and the steering relay arm must be at the same level when the vehicle is traveling straight ahead, i.e. the tie-rod must be horizontal. A deviation of up to 2 mm is permissible.
If, when the vehicle is in curb condition, the toe-in varies by more than 2 mm from the toe-in when the vehicle is in normally loaded condition, despite correct positioning of the steering gear arm and the steering relay arm, the cause is probably a bent steering knuckle arm. If this is the case, replace the steering knuckle arm.

h) Wheelbase

The term wheelbase designates the distance between the central points of the front and rear wheels (Fig. 40—3/11). The wheelbase at the left should be as nearly identical as possible with the wheelbase at the right. Differences of up to 5 mm between the wheelbase at the left and the right are permissible.

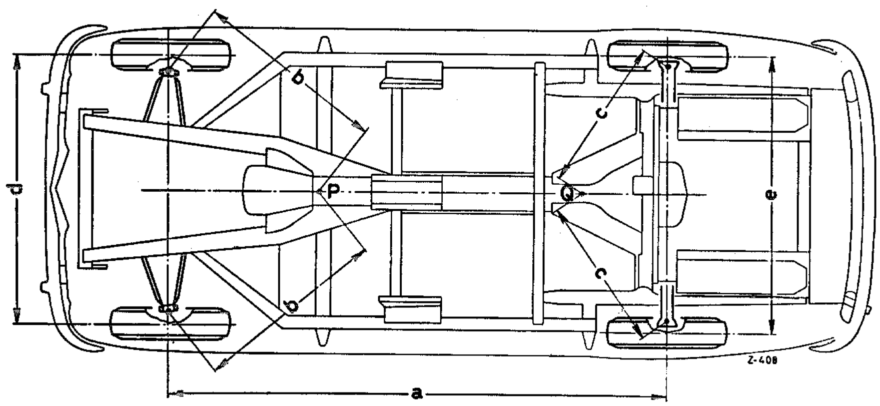

Fig. 40—3/11

P Check bore for front axle positioning distance
Q Check bore for rear axle positioning distance
a Wheelbase
b Front axle positioning distance
c Rear axle positioning distance
d Front axle track
e Rear axle track

i) Axle Positioning Distance

To facilitate adjustment of the front and rear axles, two check bores (P) and (Q) have been made on the chassis base panel along the longitudinal axis of the vehicle (see Fig. 40—3/11). By measuring from these check bores, the position of the front and rear axle can be checked (axle positioning distance b and c). In the case of the front axle a difference of up to approx. 5 mm is permissible. The axle positioning distance cannot be adjusted on the front axle. But a small correction is possible by turning the front axle support, after unscrewing the fixing screws.
Where greater deviations are found, check whether the front axle support is properly fitted, and whether the step-bearings for the front axle support are correctly positioned. Use chassis base panel gage to check the step bearings (see Job No. 61—1, Section B) and use the checking fixture designed for this purpose to check the front axle support (see Job No. 33—8).
A difference of 2—3 mm between the left and the right is permissible on the rear axle. It is possible to carry out a correction by adjustment of the cross strut (see Job No. 35—1).

k) Rear Axle Misalignment

The axle tubes of the rear axle must be perpendicular to the longitudinal axis of the vehicle. If, however, the rear axle becomes turned about the mounting bolt, this results in misalignment and a maximum value of 0° 20′ is permissible (Fig. 40—3/12).

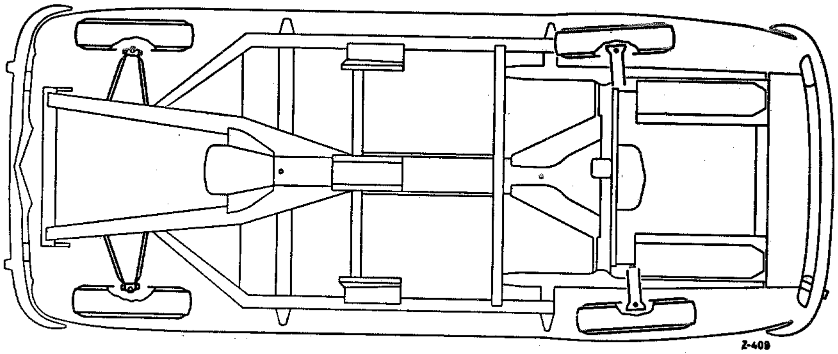

Fig. 40—3/12

If the misalignment is in excess of this value, considerable tire wear results. The rear axle can be straightened by adjusting the cross strut.

l) Lateral Axle Displacement

The term lateral axle displacement refers to the lateral offsetting of the rear axle, relative to the longitudinal axis of the vehicle.
An axle displacement of up to 20 mm is not normally a disadvantage when the vehicle is in motion. If considerable lateral axle displacement is present, the car will veer to the left (with engine pulling) and to the right (with car "driving" engine) or vice-versa, depending on whether the rear axle is offset to the right or to the left. It is usually unnecessary to correct this.

C. Wheel Adjustment Values

vehicle loading	Front axle							Rear axle							Wheelbase permissible difference in mm
	Camber	Toe-in in mm	Track angularity at 20° lock of inner wheel	Caster	King pin inclination	Pivot point distance in mm	Axle positioning distance permissible difference in mm	Camber		Toe-in or Toe-out in mm	Center position permissible deviation in mm	Axle positioning distance permissible difference in mm	Permissible misalignment up to		
								left	right						
curb condition	0° to 1°*	0–2	–	2°50'* to 4°	5°20' to 5°40'	34±2	5	approx. +1°30'	approx. +1°45'	0±2	2	3	0°20'		5
normally loaded	0° to 1°*	0–2	–2°30'*	3°10'* to 4°10'	5°20' to 5°40'	34±2	5	–2°30'** to –3°30'	–3°** to 4°	0±2	2	3	0°20'		5

* This value should be as nearly identical as possible at both sides the maximum permissible difference is 0°30'. The ideal value for front wheel camber = 0°20' to +0°40'.

** At the rear wheels a variation in camber of approx. 0°30' if the car is in loaded condition, and of 0°15', if the car is in curb condition, is normal. (The variation in camber at the left and the right arises from the design of the single-jointed swing axle, since the connecting pin of the axle halves lies outside the longitudinal axis of the car. For this reason right wheel camber is greater than left wheel camber).