

G. Measurement with an Optical Axle Gage

Measurements should be made wherever possible with an optical axle gage. We recommend for this purpose the Exacta-Gage manufactured by Müller (Heilbronn). When using this gage, the makers' instructions should be observed. However, the method – which is recommended by several of the firms marketing optical gages – of pressing the front wheels in toward each other at the rear, is not permissible for our cars. The correct method is to measure toe-in with the vehicle loaded and the wheels "rolled", not pressed in. The term "rolled" means that before measurements are taken, the car should be forcibly pushed to and fro and rocked by hand, so that the wheels can settle into a position of minimum stress.

H. Measurements with Mechanical Gages

For smaller workshops we have developed a number of mechanical gages, with which measurements can be made which are in general sufficiently accurate for practical purposes.

As is the case with an optical gage, measurement should be commenced at the rear axle, since all further measurements or adjustments are dependent on both the correct positioning of the rear axle relative to the longitudinal axis of the vehicle and the camber of the rear wheels.

a) Rear Axle Center Position and Axle Positioning Distance

The axle is in **center position** when the connecting pin, which is the fulcrum of the two axle halves, is parallel to the longitudinal axis of the car at a certain distance from it.

Use Master Gage 180 589 08 21 to check the axle for center position. The gage should be placed against the two torque arm mountings on the chassis base assembly (Fig. 40 — 3/21). If the center position is correct, the measuring pointer on the gage points to the center of the hexagon head of the connecting pin for the rear axle suspension (permissible lateral divergence 2 mm).

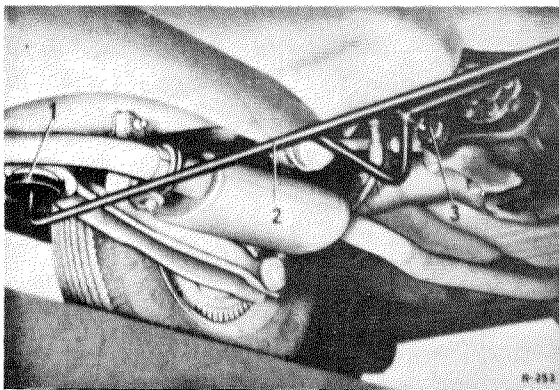


Fig. 40 — 3/21

- 1 Cup on torque arm mounting
- 2 Master Gage 180 589 08 21
- 3 Connecting pin hexagon screw

After checking the rear axle for center position, the axle positioning distance should be checked. The axle positioning distance should be measured with the aid of Master Gage 180 589 08 23. A measurement should be taken from the check bore on the chassis base to the torque arm fixing screw bores in the bearings of the two support tubes at the rear axle (Fig. 40 — 3/22).

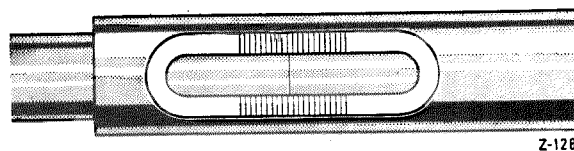
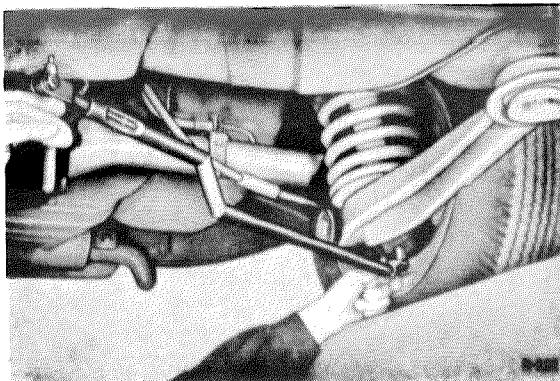


Fig. 40 — 3/22

For reasons of uniformity, measurement should always be taken first at the left side. The difference in distance (+ or —), as compared with the left side, should be entered on the measurement chart (permissible difference 3 mm). Lateral divergence from center position and rear misalignment can be corrected by adjustment of the cross strut.

b) Rear Wheel Toe-in (Toe-out)

Rear wheel toe-in or toe-out should be measured only if uneven tire wear occurs. If possible it should be nil, although divergences of up to ± 2 mm are permissible. The method of taking measurements is described in Section h) — Front Wheel Toe-in.

c) Rear Wheel Camber

Correct adjustment of rear wheel camber is particularly important for vehicles with independent rear suspension, in order to achieve optimum road holding qualities. Camber should therefore be measured both with the vehicle in curb condition and also in loaded condition. Measurement of camber is carried out with Camber and Caster Gage 180 589 02 21 (Fig. 40 — 3/23).

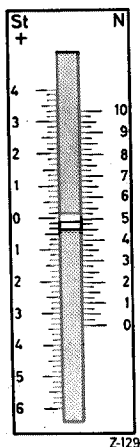
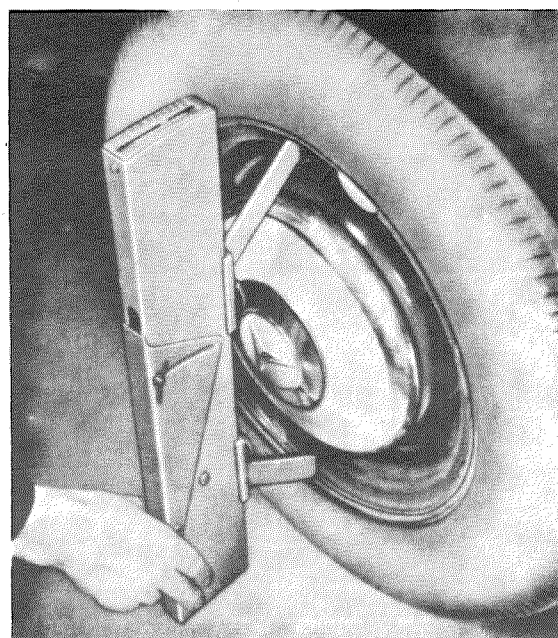


Fig. 40 — 3/23



Care must be taken to ensure that the measuring surfaces are brought into definite contact with the extreme edge of the rim and that the camber gage is held perpendicular, so that the measuring pendulum can swing freely and does not stick. The camber amount can be read off the left-hand scale on the gage (one graduation = 10').

To counteract possible rim run-out, an average measurement should be taken by measuring at two opposite points. To do this proceed as follows:

1. Place the gage in position and read off the amount of camber. (Example: + 1° 30'.)
2. Make a chalk mark where the upper tip of the gage touches the wheel.
3. Move the vehicle (in the direction of travel) until the chalk mark is at the bottom of the wheel.
4. Place the gage in position again and read off the amount of camber (Example: + 1° 50').
5. The actual amount of camber is the mean of the two values read off the gage.

$$\text{Example: } \frac{1^{\circ} 30' + 1^{\circ} 50'}{2} = \frac{2^{\circ} 80'}{2} = 1^{\circ} 40'$$

The correct camber amounts are given in Section C.

d) Axle Positioning Distance for the Front Axle Halves

Use Master Gage (1) 180 589 02 23 to measure the axle positioning distance of the front axle halves; measurement should be made from the check bore in the chassis base assembly to the centering bores in the two king pins (Fig. 40 — 3/24).

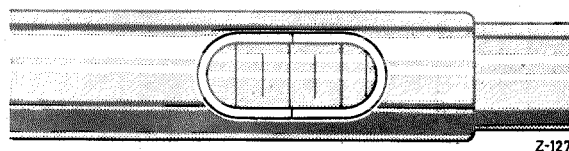
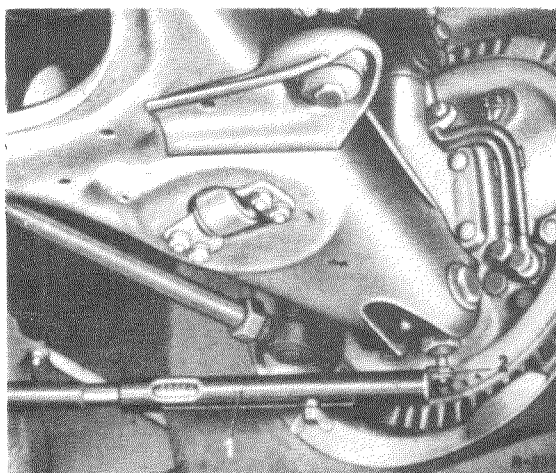


Fig. 40 — 3/24

- 1 Master Gage 180 589 02 23
- 2 Feeler inserted in the centering bore in the king pin

A difference of 5 mm between the left and the right halves is permissible. The axle positioning distance of the front axle halves cannot be adjusted. A slight correction is possible by removing the fixing screws on the front axle support and turning the support.

If greater divergences are found, a check should be made to see whether the control arms are bent, the front axle support is defective or the step-bearings for the front axle support are incorrectly positioned. Use the chassis base panel gage (see Job No. 61 — 1, Section B) to check the step bearings, and the specially designed checking fixture to check the front axle support (see Job No. 33 — 8).

e) Front Wheel Camber

As with the rear wheels, use the Camber and Caster Gage 180 589 02 21 to measure the front wheel camber. To counteract possible rim run-out, an average measurement should be taken as before (see Section c) Rear Wheel Camber).

f) King Pin Inclination

King pin inclination cannot be measured by mechanical means. It is determined by the design of the steering knuckles and can only be adjusted together with the camber.

g) Caster

The amount of caster is fixed by the design of the car. The adjusting mechanism serves merely to remove slight differences in left and right wheel camber.

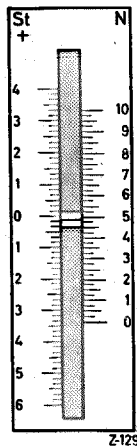


Fig. 40 — 3/25

Caster should be measured (as was the case when using the optical axle gage) by measuring the difference in camber amounts of the front wheels when set at a left and right lock of 20°.

There are two scales on Camber and Caster Gage 180 589 02 21. The left-hand scale gives the camber amount in degrees and minutes and the right-hand scale enables easier measurement of caster to be made. The figures on this right-hand scale, however, do not give the actual caster or camber amount. The caster must be calculated from the difference between the readings taken when the wheels are over at left and right lock (Fig. 40 — 3/25).

When taking measurements proceed as follows:

- aa) Set the left wheel in the straight-ahead position; place a rule or draw a chalk line parallel to the road wheel at a distance of 200 mm from it.
- bb) Pull out the 20° angle guide of Gage 180 589 02 21.
- cc) Place the gage horizontally against the wheel. Now turn the wheel to the left until the rule or chalk line is parallel with the angle guide on the gage (Fig. 40 — 3/26).
- dd) Now place the gage against the wheel rim, set it exactly to the vertical position, and read off the value shown on the right-hand scale (one graduation = 15'). Example: 7° 45' (Fig. 40 — 3/27).

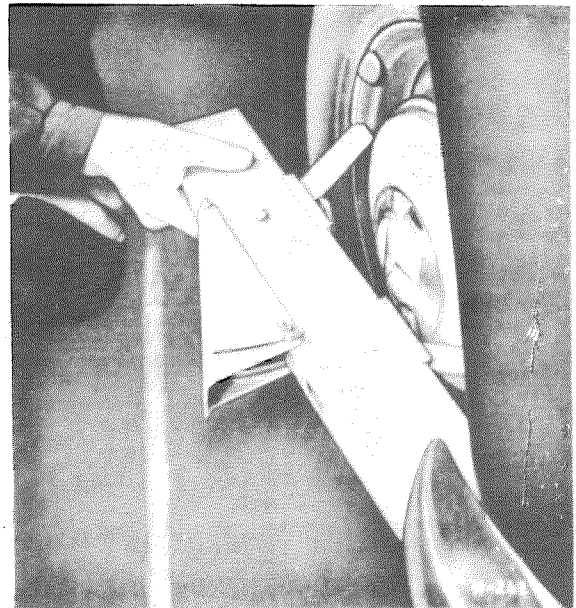


Fig. 40 — 3/26

Measurement at the right wheel

ee) Place the gage horizontally against the left wheel, this time with the gage turned to point in the other direction (i. e. turned through 180°). Now turn the road wheel to the right until once again the rule or the chalk mark is parallel to the angle guide on the gage when in the horizontal position.

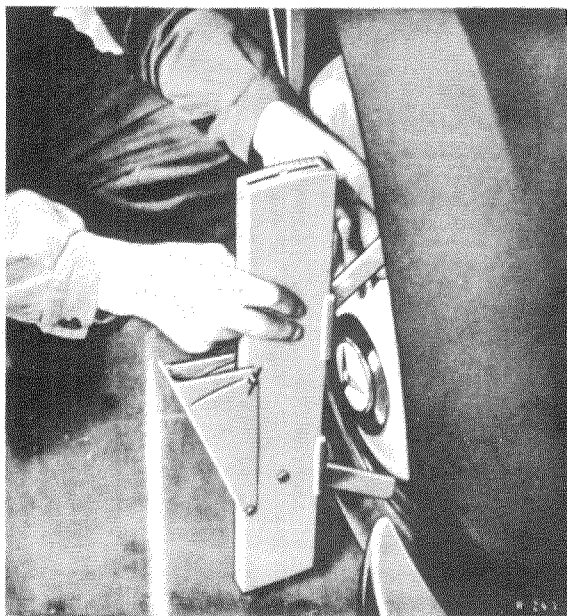


Fig. 40 — 3/27

ff) Place the gage in position as described under point dd) and again read off the value indicated.

Example: $4^\circ 15'$.

gg) **The difference between the two values is the caster.**

Example:

Left wheel

Reading at 20° left lock = $7^\circ 45'$

Reading at 20° right lock = $4^\circ 15'$

Difference
left wheel caster = $3^\circ 30'$

Note: It should be noted that left wheel caster must be greater when at left lock than at right lock, and right wheel caster must be greater at right lock than at left lock, since the car is designed to have positive caster.

If negative caster is found, there must be a major defect in the front axle (e.g. bent control arm etc.).

hh) Measurement at the right wheel should be carried out in the same way.

h) Toe-in of Front Wheels

The toe-in must be measured at the height of the horizontal diameter of the wheel and with the steering in a straight fore-and-aft position. For this purpose, Center Position Check Screw 186 589 00 23 must be screwed into the steering housing cover instead of the closing plug. When this is done, care must be taken to ensure that the point of the screw enters the centering bore in the steering shaft arm. The toe-in must be equally distributed at the left and right wheels. To ensure this, use should be made of Wheel-base Measuring Gage 136 589 07 21 in order first to line up the front and rear wheels so that they are parallel. If this equipment is not available, the alignment can be made with the aid of a straight-edge or it can be sighted out.

The toe-in must be measured with the vehicle normally loaded. When measuring the toe-in, the front wheels must not be pressed together at the rear.

Measurement is made by means of Track Measurement Gage 000 589 05 21. When measuring, the following procedure should be adopted:

aa) Set the distance between the rims at the front wheels at the rear on the gage. Fix in this position. (Fig. 40 — 3/28).

bb) Make a chalk-mark on the wheel at the point at which measurement is to be made.

cc) In order to obviate any difficulty which might be caused by rim run-out, measurement should be made at two places and the average taken. The vehicle should therefore be moved in the direction of travel a half-turn of the wheels so that the chalkmark is now at the front.

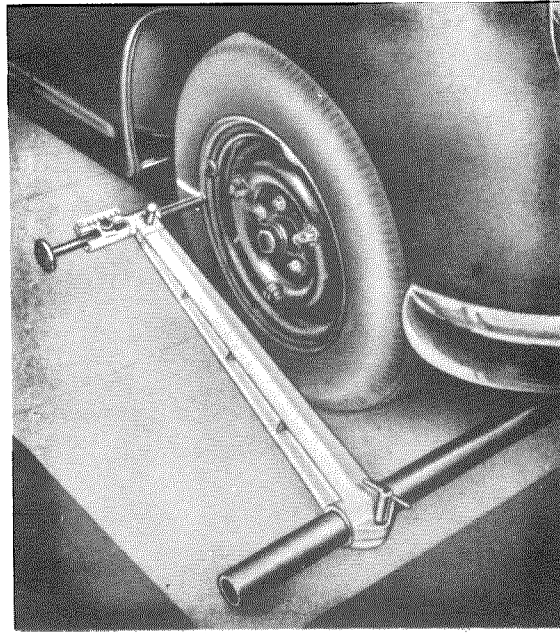


Fig. 40 — 3/28

dd) Now set the distance between the rims at the front on the gage and read off the difference between the distances at the front and at the rear. This measurement is the toe-in of the vehicle in mm.

Note: After adjusting the toe-in, a check must be made to see whether the steering knuckle arm of the left steering knuckle at left lock and the steering knuckle arm of the right steering knuckle at right lock strike against the lower steering knuckle support. The left and right steering locks must be limited by the steering knuckle supports and not by the steering housing (Fig. 40-3/29). (For further details see Job No. 33 — 2).

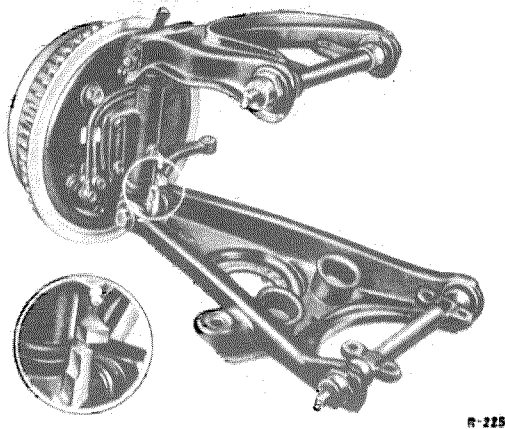


Fig. 40 — 3/29

i) Wheel-base

Measurement of the wheel base is made principally in order to assist in the adjustment of the toe-in of the front wheels. The wheel-base must only be measured when the center position check screw is actually screwed into the steering. Measurement is taken from the center of the rear axle shaft to the center of the front axle stub. Wheel-base Measuring Gage 136 589 07 21 is used (Fig. 40 — 3/30).



- 1 Centering bore of front axle stub
- 2 Wheel-base Measuring Gage 136 589 07 21
- 3 Centering bore of rear axle shaft

Fig. 40 — 3/30

Vehicle Measurement

Model: Mileage:

Chassis No:

First Licensed:

Owner:

Branch/Agent
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Measured by: Date:

Customer's complaint:

Make of tires, front: rear:

Condition of tires: front, left rear, left

front, right rear, right

Tire pressure checking and correction			Measurements			
			Before correction vehicle		After correction vehicle	
Front:	atm.	rear: atm.	curb condition	normally loaded	curb condition	normally loaded
Front axle	Wheel bearing play in° (with optical axle gage)	left				
		right				
	Axle positioning distance difference from left to right in mm					
	Pivot point distance in mm	steering gear arm				
		relay arm				
	Toe-in or toe-out*	in °				
		in mm				
	Camber in °	left				
		right				
	Caster Measurement	Reading or camber left at 20° left lock				
		at 20° right lock				
		Caster left in °				
		Reading or camber right at 20° right lock				
		at 20° left lock				
		Caster right in °				
	Track angularity diff. in ° (with optical axle gage)	left				
		right				
Rear axle	Center positioning or lateral divergence in mm					
	Axle positioning distance difference from left to right or rear axle misalignment	in mm				
		in °				
	Toe-in or toe-out*	in °				
		in mm				
	Caster in °	left				
		right				
Wheel-base difference from left to right in mm						

* Toe-in = +, toe-out = -. The toe-in must be measured with the wheels settled in their neutral position. They must not be pressed together. The toe-in must be measured with the wheels in the straight fore-and-aft position. At the same time the steering must be in the center position. Toe-in and camber must be measured on an average of two diametrically-opposed points in order to obviate difficulties caused by any rim run-out.
(For further details on vehicle measurements, see Workshop Manual, Model 190, Job. No. 40-3).

