Checking caster angle on a Traction

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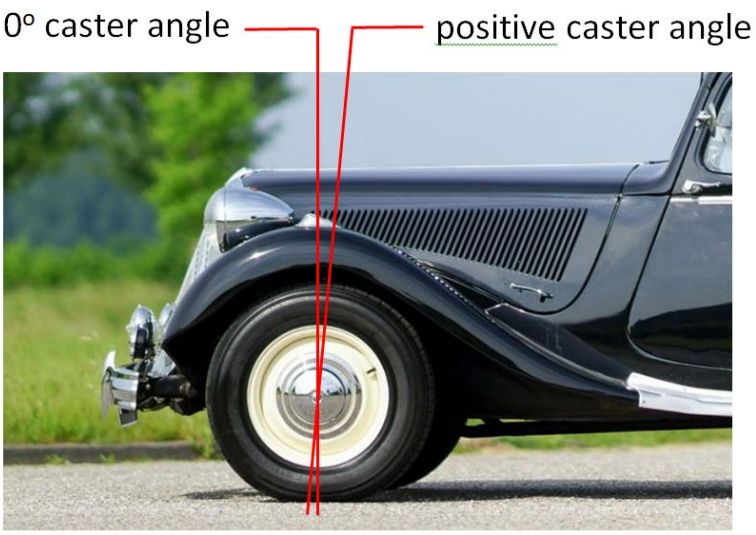
One of the key adjustments on the front end of a Traction is caster angle. One always has the option of taking the car to a front end specialist and getting them to make measurements, and adjust the caster angle if necessary. However, putting one's faith in the people in some of these facilities, where they have probably never seen a Traction before, is reason enough to stop and consider whether doing it yourself is not a reasonable course of action.

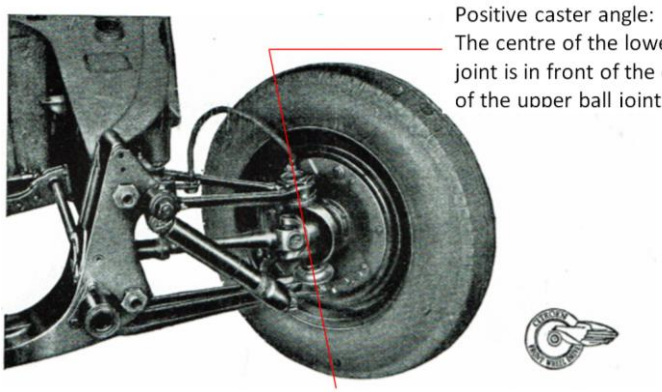
Before explaining how to measure caster angle, it is worth a brief explanation about what caster angle is, and why it is important.

What is caster angle?

Look at the front wheel of a car from side-on and imagine a line running through the centres of the steering pivots down to the road. On a Traction these pivot points are the ball joints. Caster angle is zero when the line is perfectly vertical, positive when the line leans toward the rear of the vehicle and negative when the line leans toward the front of the vehicle.

Most vehicle manufacturers specify a few degrees of positive caster angle.





How does caster angle affect the handling of the car?

Caster angle has little effect at low speed. However, at higher speeds the greater the caster angle, the greater the tendency of the steering to "self-centre." This is useful in reducing the effort required to keep the car driving in a straight line. However, with greater self-centring effect, more effort is required to turn the steering wheel when going around corners. Too little caster angle will result in the car wandering, requiring more concentration to keep steering in a straight line.

How accurately adjusted does caster angle need to be?

Caster angle needs to be as close to equal as possible on the left and right sides of the car. Generally, the motor industry says the difference in caster angle across the car should be less than 0.5 degree. That just happens to be the entire range of the caster angle specification for a four cylinder Traction.

With a difference greater than 0.5 degree, the car will noticeably pull towards the side with the smaller caster angle.

What is the correct caster angle?

Vehicle manufacturers specify what the caster angle should be for each model in their range. The geometry of front axle design is complex, and there is no single caster angle setting that suits all cars. In the past, after design and construction of prototypes, specifications were arrived at through repeated testing. Even with today's computer-aided design techniques, manufacturers still use testing on the road to validate the design and arrive at final specifications for various parameters.

Some of the extremes of caster angle can be found on older model Citroens:

- The nominal specification for the Big 6 is 0 degrees. (Nobody ever complained about the steering of a Big 6 not being heavy enough).
- The nominal specification for the 2CV is 15 degrees. (The camber that results from this, when the steering is on full lock, can lead to casual observers thinking that the car's wheels are falling off).

Relationship between caster and camber

Camber is a measure of how far the wheels "lean over" when the vehicle is turning. There is a relationship between caster angle and camber of the wheels.

A bicycle is useful for visualising this. The head tube of the frame slopes backwards, and that provides a lot of caster angle. The self-centring effect derived from this means that a bike can be ridden "no hands." When the frame of the bike is held vertically and the front wheel points straight ahead, the wheel is also vertical. Camber is very obvious if one continues to hold the frame vertically and turns the handlebars. The further the handlebars are turned, the more the wheel leans over.

We won't go into the mathematics of this. Nor will we concern ourselves with a small amount of camber which is built into the design of a Traction front end, even when the wheels are pointing straight ahead.

Does caster angle affect tyre wear?

Incorrect caster angle has little effect on tyre wear. Too much or too little caster angle (and therefore too much or too little camber) will cause more scuffing of the edges of tyres than normal when going around corners. Caster angle would have to be seriously wrong for this to be the sole reason for rapid tyre wear.

How do front end shops measure caster angle?

A front end shop has to be able to determine caster angle on every make and model of car coming through the door. On most cars it is not possible to measure caster angle directly. The usual approach is to measure camber of the wheels when they are turned left, and then right, a certain amount, typically 15 degrees or 20 degrees depending on the type of gauge being used. Caster angle is then calculated from the change in camber.

The accuracy of measuring the angle to which the wheels are turned is important. If that is not accurate, the camber measurement will be wrong, and the caster angle derived from that will also be wrong.

The accuracy of measuring camber is another question. Simple camber gauges are based on spirit levels. They measure camber accurate to 0.25 degrees, and calculate caster angle to the nearest 0.5 degree. Even modern digital camber gauges, which use inclinometers, are often only accurate to 0.1 degrees of camber.

In summary, some front end shops' methods might not be as precise as we would like to believe.

Measuring caster angle on a Traction

The design of the upper and bottom ball joint housings on a Traction provides the basis for checking caster angle directly on the front end, rather than indirectly using change in camber when the wheels are turned. This is unusual, and it was a bit of creative genius on the part of the designers.

There is no doubt that the measuring instruments used by today's front end alignment specialists are more accurate than they were in the 1950s. Having said that, if it was possible 70 years ago to perform front end adjustments on a Traction to an acceptable level of accuracy without the use of today's electronics, it should still be possible to use simple methods and get a good result.

Can we measure and adjust the Traction's caster angle in the home garage?

It goes without saying that caster angle cannot be accurately adjusted if there is excessive wear in pivot points and ball joints on the front end of the car. In particular, if the silentblocs have "let go" a small amount of movement at the pivot point of the lower link arm will result in a large amount of fore and aft movement of the lower ball joint housing. This movement will vary, especially when the car is accelerating or braking, leading to caster angle when driving being different from that set up in the garage.

A method for checking and adjusting caster angle on a four cylinder Traction is described in Operation 149 of the workshop manual. The specification is $1^{o}30' \pm 15'$ – or $1.5^{o} \pm 0.25^{o}$.

The first requirement is for the heights under the hull to be adjusted correctly, tyres to be at the correct pressure, and the vehicle to be on a horizontal surface or on an elevating service platform. That all sounds OK, but in practice it is not as simple as it sounds.

The workshop manual makes no mention of the effect of the weight of fuel in the petrol tank. A rough check shows that putting something weighing 12 kg (equivalent to 16 litres of petrol) into the boot of the Traction changes the height from the floor to the underside of the rear mudguard by 5 mm. With a wheelbase of 2.9 metres, this change of 5 mm at the back of the vehicle results in a change of 0.1 degrees of caster angle at the front. If we extrapolate to the difference between a full tank of fuel and an empty tank, we have pretty much used up half of the tolerance range!

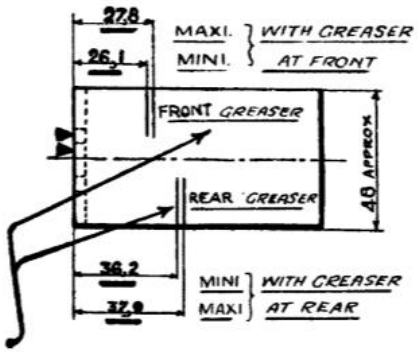
Then there is the question of how level is the floor. A concrete floor is unlikely to be perfectly flat. Even what the construction industry calls a “superflat” concrete floor is regarded as acceptable with a slope of 0.1 degrees. And if the floor slopes, which way does it slope? Does it run uphill or downhill, adding to the caster angle we measure, or subtracting from it?

For practical purposes, we can only try to put the car on as flat a floor as we can find, aim for the mid-point of the range, and accept that we might finish up with caster angle slightly off the mid-point of the specification for reasons such as those outlined above. It is more important that we aim to have caster angle on both sides of the vehicle as close to equal as we can make it.

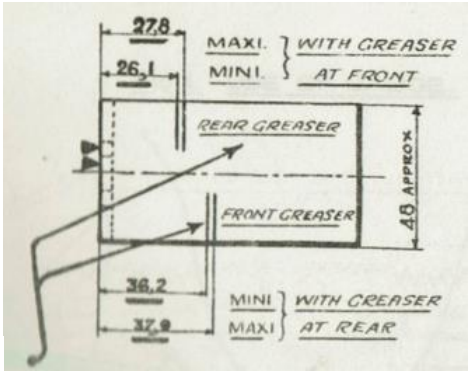
Method shown in the workshop manual

The workshop manual provides drawings of a gauge (MR 1767). This gauge consists of two brackets, which are bolted in place of the grease nipples on the upper and lower ball joints, and used with a plumb bob and string. People report achieving good results with it. The gauge doesn’t actually measure caster angle. It simply shows whether the string of the plumb bob is relative to the two lines marked on the lower bracket. If the string is between the lines the caster angle is within specification. Note: In some editions of the workshop manual the drawing is incorrect.

Correct



Incorrect



The distance between the two lines is only 1.7 mm, and the lines need to be marked accurate to 0.1 mm, so skill is required to make and mark the two parts of the gauge accurately. Needless to say, the string needs to be thin enough not to cover the marks on the gauge. The system is probably easy to use if the car is placed on a hoist or over a pit. However, if working on the garage floor, lack of room to slither under the front bumper to use the gauge makes it less than ideal.

A different method of checking caster angle

The gauge described here, with further details provided on page 8, was made largely from scrap materials. It has some advantages over the type of gauge shown in the workshop manual:

- No need to crawl under the car, making it more comfortable to use
- Low cost, and easy to make
- Easy to accurately measure the key lengths of the gauge using a Vernier, and make adjustments using threaded rod
- Is used with the wheel off the car, which provides easy access for adjusting caster angle, and checking the setting as adjustments are made

Materials used are:

- 40 mm steel square tubing
- ¼" BSF threaded rod
- Two pieces of 25 x 25 angle
- Stanley line level, no. 42-287
- Miscellaneous fasteners
- 2 rubber bands, to hold the level on the upper angle
- Loctite thread lock or a pair of nuts to lock adjusting nuts in final position

The Stanley line level is available at Bunnings and costs about $12.00. The barrel shaped glass and the hexagonal housing mean that the level is still able to be used, even it is rotated around its long axis. Although the level is intended to be supported from a string line, the bottom surface is accurate enough for it to be used as a conventional level.

Level accuracy

It is important that the level reads accurately. The upper angle piece of the gauge, on which the level is placed, is mounted perpendicular to the square tubing. A square can be used for initial positioning. If one of the bolt holes is drilled slightly oversize, one end of the angle can be moved up and down a small amount to provide fine adjustment before tightening the fasteners. As per normal practice with a spirit level, accuracy can be checked by holding the level against a nominally vertical surface, such as a door frame. First observe where the bubble sits in the glass. Rotate the device 180 degrees around its vertical axis and observe the bubble again. If it is in the same position the level is reading accurately. If not adjust the position of the upper angle until accuracy is achieved.

It is easier to check accuracy if the bottom angle piece and the threaded rod are removed from the square tubing. Reattach them after the accuracy has been adjusted.

Level sensitivity

Measurements on the bench, and confirmed with Stanley Tools in the USA, show that the bubble moves almost exactly 0.5 degree from touching one of the marks until it is touching the other mark.

Conveniently, this range matches the tolerance range for caster angle on the Traction. The distance between the lines on the bubble is 10 mm. At room temperature the bubble is about 8 mm long. In practice it is not difficult to adjust caster angle so that the bubble is central between the lines.

The sensitivity of the level is enough for the task of checking caster angle on a Traction, and not so sensitive that it is difficult to adjust the accuracy of the level.

Assembled gauge

The method for using the gauge is:

1. Place a tape measure on the floor under the hull, near the front on the side of the car on which caster angle is to be checked. Extend the tape until it touches the hull, and lock it in position.

2. Jack under the lower link arm, and remove the wheel.

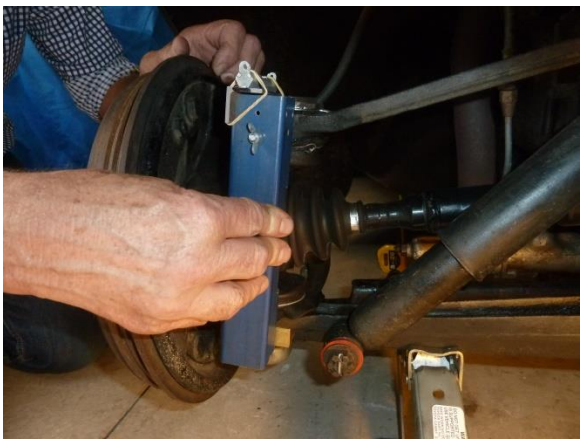
3. Lower the jack until the hull touches the tape. (This puts the hull back into the same position, with the ball joint housings in the same vertical plane, as when the wheel was on).

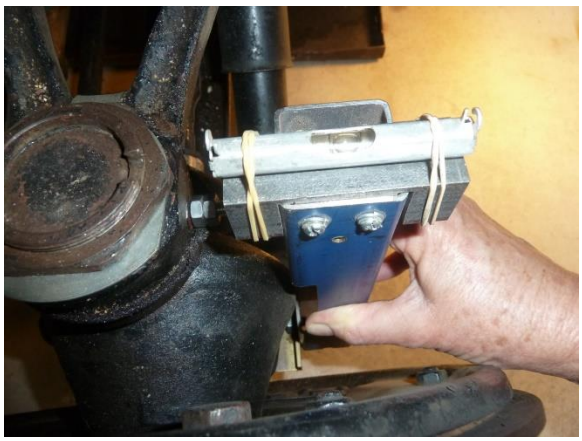
4. Remove the top and bottom grease nipples from the ball joint housings.

5. Put the threaded rod in the hole for the upper grease nipple, making sure the nut on the rod sits against the ball joint housing.

6. Press the lower angle of the gauge against the lower ball joint, so that it sits flat on the housing.

7. Observe the position of the bubble in the glass. With a caster angle of 1.5 degrees, the bubble will be central between the lines on the level. If the caster angle is out of specification, an end of the bubble will be past one of the lines on the glass.





So you need to adjust caster angle?

Useful information missing from the manual is which direction and how far to turn the shaft of the upper link arm, if one needs to adjust caster angle.

The shafts have right hand threads, so rotating a shaft anti-clockwise, when seen from the front of the car, moves the upper link arm forwards, and decreases caster angle. Similarly, rotating the shaft clockwise moves the upper link arm backwards and increases caster angle.

Slightly more than one complete revolution of the shaft is sufficient to alter the caster angle from one end of the tolerance range to the other.

Importance of correct assembly of the lower link arm in the front axle cradle
Caster angle always needs to be checked and adjusted after new silentblocs and spined shafts have been fitted to the front axle cradle, and the car completely reassembled after that.
Operation 120 in the workshop manual text Pg 62-71 https://citroenclassic.org.au/wordpress/wp-content/uploads/2016/11/Repair-manual-Text-L15.pdf, and drawing 38, https://citroenclassic.org.au/wordpress/wp-content/uploads/2016/11/4.-L-15-Front-Axle-Pages-37-61.pdf in the illustrations, describe the correct positioning of the lower link arm in the cradle. If the lower link arm is not positioned as per these instructions, it could turn out to be impossible to adjust caster angle so that it is within the designated tolerance range. If that happens, the only solution is to dismantle everything and start again. Not a pleasant prospect, given the amount of work that entails!

Details of gauge

Item no.	Description	No. off
1	40 mm steel square tubing, 220 mm long	1
2	¼" BSF threaded rod, 90 mm long, plus nuts to suit. (Thread pitch is not critical, but fine thread is preferable).	1
3	Stanley line level, no. 42-287	1
4	Two pieces of 25 x 25 angle, 75 mm long (Materials are not critical, but surfaces must be smooth.)	2
Other	Miscellaneous fasteners 2 rubber bands, to hold the level on the upper angle Loctite thread lock or a pair of nuts to lock adjusting nuts in final position