

2CV KNIFE EDGES REPLACEMENT

By Graeme Dennes

Revision 3



Photo 1: Knife Edge (left, centre) and Knife Edge Retaining Clip

Background:

The 2CV has four steel knife edges of the type shown in Photo 1. Two are part of the front suspension system and two are part of the rear suspension system. The rear knife edges are a little larger than those at the front. The knife edges are located between two mounting brackets attached to the suspension arms and held in place by two retaining clips fitted in the grooves at the ends. The knife edges are not circular in cross-section but have an angled edge. The items in the photo are shown approximately full-size.

A suspension cylinder lies along each side of the chassis under the vehicle. A suspension tie-rod exits from each end of the suspension cylinders, and a suspension tie-rod eye (Photo 2) is screwed onto the threaded end of each tie-rod. Each tie-rod eye is held in position between the mounting brackets by a knife edge and retaining clips. A suspension tie-rod boot (Photo 2) is fitted over each tie-rod at its exit point from the suspension cylinder.



Photo 2: Suspension Tie-Rod Eye (left) and Suspension Tie-Rod Boot.

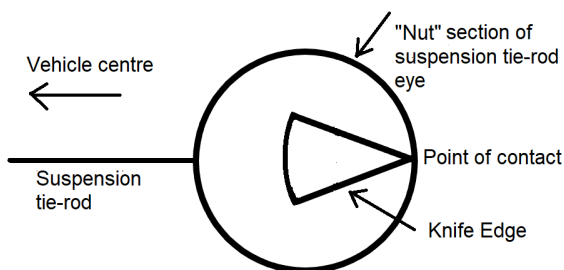


Fig. 1 (left) shows the physical relationship between the "nut" of the suspension tie-rod eye and the knife edge. The knife edge is positioned inside the "nut". The angled edge of the knife edge forms one contact face and the inner face of the "nut" forms the other. These two faces are held in constant contact with each other due to the tension on the tie-rod from the suspension cylinder spring.

Over time, both contact surfaces slowly wear and the knife edges and tie-rod eyes will need to be replaced at some point in the life of the vehicle.

The angled edge of each knife edge faces directly away from the suspension tie-rod and the vehicle centre when the vehicle is on level ground, as depicted in Fig. 1 above.



Photo 3 (left) shows a suspension tie-rod at lower right, fitted with its screwed-on tie-rod eye. The “nut” section at the end of the eye fits centrally between the two mounting brackets shown, locked in place by the knife edge which is ready to be inserted into position in the openings in the brackets. The brackets are fitted to the suspension arm assembly. The “nut” of the tie-rod eye is ready to be raised into position between the brackets, after which the knife edge is inserted into one bracket, passes through the “nut” of the tie-rod eye and out through the other bracket, then is locked in place in the brackets by retaining clips at each end. The large pin at lower left is a shock absorber mounting spindle.



Photo 4 (left) shows a knife edge retaining clip being fitted into the grooved end of the knife edge after the knife edge has been passed through the mounting brackets and the tie-rod eye.

The retaining clips appear to be small and flimsy for performing such a critical role but they do their job perfectly!

Theory of the Knife Edge:

The 2CV knife edge is one part of a mechanical linkage. The other part is the “nut” section of the suspension tie-rod eye. Although the parts are in constant contact with one other and movement between them continually takes place as the wheels of the vehicle move up and down, *in theory*, wear at the small contact area between them does not occur. Why is that?

To understand the operation of the knife edge, consider a hypothetical see-saw, where the central supporting stand is formed by an upward-facing, exceedingly sharp edge of a very large knife blade and the see-saw plank rests across the blade edge (don't try this at home!).

As the see-saw motion occurs, the actual point of contact between the plank and the blade edge is not changing, i.e., *the point of contact remains the same*, so in the absence of any *sliding* motion between them, there is no wear. The see-saw plank is simply rocking around the clock, sorry, rocking around the point of contact with the blade edge, so in theory, there is no wear of the two surfaces, even though they are in constant contact with one another and have constant relative motion between them.

In practice, wear does occur because the edge of the knife blade cannot be (and is not) infinitesimally thin. For the 2CV it means the life of the knife edges (and the tie-rod eyes) is finite.

In summary, the hypothetical see-saw's plank is akin to the “nut” of the suspension tie-rod eye and the see-saw's large knife blade edge is akin to the angled edge of the knife edge. Thus the see-saw helps explain the theory of operation of the 2CV's knife edge. It's a good analogy to the physics of the design and is perhaps why the knife edge earned its name!

The knife edges and tie-rod eyes tend to be very reliable devices, rarely causing problems. They are examples of fine engineering.

Citroën's Lubrication Recommendation:

Citroën recommends greasing the knife edges at regular intervals. However, as we know, the knife edges can easily fall into the “out of sight, out of mind” category, where they can become neglected and eventually forgotten about. Unfortunately, the absence of *fresh* grease only exacerbates the wear problem because the old grease continues to accumulate dust and dirt, which works its way in between the contact faces of the knife edges and the tie-rod eyes, adding to the wear on those components.

The Alternative View:

Although Citroën recommends that the knife edges are regularly greased, such a view is not universally held. In fact, globally, some 2CV owners are quite open about their disagreement with Citroën's view on knife edge lubrication. As already noted, the knife edges and suspension tie-rod eyes do not have a *sliding* motion at their point of contact, but instead have a *rocking* motion, so *in theory*, there is no requirement to lubricate the knife edges because wear does not occur at the contact faces. Should grease be added, the dust, dirt and grit which accumulates on the grease can *eventually work its way in between the contact faces of the knife edges and tie-rod eyes, exacerbating the wear at the contact faces which the lubricating grease is supposed to prevent!* Touché.

In summary, the alternative view is *not* to grease the knife edges but simply keep them clean. From this engineer's perspective, this view does carry some merit, but whether greasing or not greasing produces *different* wear outcomes is not known. Perhaps, in the end, either approach is fine *practically*, because dust, dirt and grit will still come between the contact faces whether grease is present or not.

The reader will need to decide which approach to take. There are four options: (1) add grease at regular intervals (Citroën's view); (2) *regularly replace, yes, replace*, the grease in the knife edges to ensure the intended lubrication is provided between the contact faces *without* the presence of dust, dirt and grit (utopia!); (3) don't grease them at all and keep them clean which will keep out most of the dust, dirt and grit (the alternative view), and (4) grease them then forget all about them! In reality, the last option may well be the most popular, demonstrating the stamina of the knife edges and tie-rod suspension eyes...! You must decide.

Replacement of Knife Edges:

A reality for 2CV owners is that knife edges and tie-rod eyes eventually wear sufficiently to require their replacement. See Photo 5. Also, tie-rod eyes can and do break! See Photo 6. The following describes the parts required and the procedure to be followed to replace the knife edges, *and optionally*, the suspension tie-rod eyes. If one knife edge has worn, replace all four. If one tie-rod eye has worn or failed, replace all four.

Parts Required:

- 2 front knife edges
- 2 rear knife edges (larger)
- 8 knife edge retaining clips
- 4 suspension tie-rod eyes (optional)
- 4 suspension tie-rod boots

Burton 2CV Parts in the Netherlands sells a Knife Edge Set containing two front and two rear knife edges and eight retaining clips with part number A1.8370. Suspension tie-rod eyes have part number A1.8361 and suspension tie-rod rubber boots have part number A1.8349. These items may also be available from other 2CV parts suppliers.

Preparation:

Raise the car on a chassis-lift hoist to allow all four suspension arms to drop. Removing the wheels will assist the procedure. Alternatively, jack up each corner of the vehicle in turn and fit a jack stand under the chassis lifting point (between the pair of bolt heads) and remove the wheel. As often happens, it is more difficult to describe the procedure than it is to demonstrate it!

Procedure for Each Knife Edge:

1. Remove the shock absorber (where fitted), noting its orientation, to gain clear access to the tie-rod, the tie-rod eye, the knife edge mounting brackets, the knife edge and the knife edge retaining clips.
2. The outer end of the tie-rod is threaded and is fitted with a tie-rod eye. Measure and record the length of the *exposed* threaded section on the tie-rod. We later return the tie-rod to this same position in the tie-rod eye, so take an accurate measurement. Note that each suspension tie-rod exits from the suspension cylinder via a rubber boot.
3. Using a *special* 9 mm tool designed to turn the tie-rod in the tie-rod eye, unscrew the tie-rod from the tie-rod eye until the items separate. Don't damage the threads on the tie-rod. *Warning: Don't use a standard 9 mm spanner or an adjustable spanner. You may regret doing so!* (Refer to Fig. 1 on page 8 of the writer's article, "2CV Maintenance" for details of the special tool.)
4. Using a steel bristle brush, thoroughly clean the entire threaded section on the tie-rod.
5. Completely remove the old boot from the suspension cylinder and tie-rod, then carefully clean any accumulated dirt from around the end of the suspension cylinder.
6. Slide a new boot onto the tie-rod and fit it onto the end of the suspension cylinder, ensuring a secure fit.
7. The knife edge locks the tie-rod eye in position between the two mounting brackets, with the knife edge being held in the brackets by two retaining clips. Remove any accumulated dust, dirt and old grease from around the outer mounting bracket so as to expose the outer end of the knife edge and the retaining clip.
8. After noting the manner in which the retaining clip fits onto the end of the knife edge, remove the outer retaining clip from the outer end of the knife edge.
9. Tap the exposed outer end of the knife edge inwards until it fully passes through the two mounting brackets, at which point the tie-rod eye may be removed from between the mounting brackets. Support the tie-rod eye while removing the knife edge.
10. Thoroughly degrease and clean the tie-rod eye and inspect it. There may be a small "vee" groove worn into the inside face of the "nut" on the tie-rod eye at the point where the "nut" contacts the angled edge of the knife edge.
This is the only point of contact between the knife edge and the tie-rod eye. If the "vee" groove is very small, all is fine. Should excessive wear be observed, the tie-rod eye will need to be replaced. Don't attempt a repair.
Photo 5 shows a worn tie-rod eye and a worn knife edge. Note the depth of the "vee" worn into the "nut". This amount of wear will be adding to the stress experienced by the "nut" because of the reduction in its cross-sectional area, so this suspension tie-rod eye is clearly overdue for replacement. The angled edge of the knife edge has also clearly worn and the edge rounded, so the knife edge shown is also due for replacement.
11. Thoroughly degrease and clean the four faces of the mounting brackets.
Mon dieu, after all these years, I finally know what's been hiding behind that hard thick lump of grease and dirt!
12. Add a 10 mm bead of copper grease into the opening of the threaded end of the (optionally) new tie-rod eye and add a thin wipe of copper grease to the threaded end section of the tie-rod.
13. Very carefully, *by hand*, fit the tie-rod eye onto the threaded end of the tie-rod and engage the threads. Turn six turns *by hand* to ensure the thread engagement is correct. Thread damage here is not desirable!
14. Fit a new retaining clip to one end of the new knife edge, remembering the rear knife edges are a little heavier than those at the front.
15. With the tie-rod eye lifted into position between the two mounting brackets, insert the knife edge through the opening in the outer bracket, passing it through the tie-rod eye "nut", then rocking it until the inner end of the knife edge passes through the inner bracket opening. Then holding the knife edge in position, fit a new retaining clip to the inner end of the knife edge. Ensure the retaining clips are securely fitted in the knife edge grooves.
(Alternatively, the knife edge could be inserted through the inner bracket first, then pushed outwards through the outer bracket.)

16. Run a couple of turns of lockwire around the ends of each retaining clip to act as a security measure to stop the clips being dislodged.
17. Inject some high-shock-loading grease such as Castrol Spheerol LMM into the tie-rod eye “nut” into the space above and below the knife edge using a needle-size attachment on the grease gun, angling it in via the small side openings. It does indeed work!
Don't be tempted to modify the tie-rod eyes to fit grease nipples to simplify greasing of the knife edges. Although some 2CV owners have gone this route, it can result in the destruction of the tie-rod eyes and a very, very long and winding road home! Refer to Photo 7 for an example of a tie-rod eye destroyed by such action!
18. Using the special tool, tighten the tie-rod in the tie-rod eye until the length of visible thread previously measured at step 2 is achieved. The tie-rod has now been returned to its original position in the tie-rod eye.
19. Wipe off any excess grease from around the tie-rod eye and the mounting brackets.
20. Repeat from step 1 until all four knife edges (and optionally, the four tie-rod eyes) have been replaced.

The Final Steps:

1. *Check/Set Vehicle Height with the vehicle resting on flat level ground.* Because the tie-rods have been disconnected and reconnected, the vehicle height settings need to be checked/set. To prepare to set the height, per Citroën's advice: *The vehicle should carry no load except the spare wheel (in its proper position), the tool kit and five litres of fuel in the tank. Ensure the tyre pressures are correct and the vehicle is on flat level ground.* Following each interim height adjustment, give several pushes on the vehicle body at each corner before taking the new measurements to ensure the suspension components have settled into their positions. The adjustment of one tie-rod affects the height at the other three measurement points. Repeat the adjustments to all four tie-rods until all height measurements are correct.
2. *Fit Shock Absorbers with the vehicle resting on flat level ground.* Refit the shock absorbers to their original positions and orientation. Do up the nuts but DO NOT tighten them yet. Per Citroën's advice: *The nuts on the shock absorber spindles must not be tightened until the heights are adjusted and the vehicle is resting on the ground.* Give several pushes on the vehicle body at each corner to allow all suspension components, including the shock absorbers, to settle into their positions, THEN tighten the shock absorber nuts.
3. *Test Drive:* Take the vehicle for a test drive and check if all is well with the undercarriage!
4. Whenever kingpins and driveshafts are greased, grease the knife edges as described above. This task is made so much easier if the dirt, dust and old grease is removed from around the tie-rod eyes and the mounting brackets before greasing.
5. All done!



Photo 5: Well-worn “nut” on the Tie-Rod Eye and well-worn Knife Edge. Both items are due for immediate replacement. Don't attempt to repair them!



Photo 6: Suspension Tie-Rod Eye broken on Raid Cape York 2022
(Photo courtesy of Peter Moloney)



Photo 7: Suspension Tie-Rod Eye destroyed
by a modification to fit a grease nipple

My grateful appreciation and acknowledgement is given to the web sites
from which images have been accessed.

This document may be updated in the future and assigned a new revision number.
Before using the information in this document, ensure the most recent revision is being used.

Should you have any questions about the document or if you find errors or have suggestions for
improvement, please contact the writer at: gdennes@gmail.com

Copyright © Graeme Dennes 2022